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Analyzing the United States Department of Transportation’s implementation strategy for high speed rail: Three case studies

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Analyzing the United States Department of Transportation's Implementation Strategy for High Speed Rail: Three Case Studies

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Introduction

High-speed rail (HSR) has become a major contributor to the transportation sector in multiple countries throughout Europe and Eastern Asia. As Selcraig (2010) points out, a gap exists between the U.S. and the other industrialized countries:

> Over the last 20 years, this rail ridership gap between America and the rest of the industrialized world has only widened, as China, South Korea, Japan, France, Italy, Germany and Spain committed hundreds of billions of dollars not just to seamless networks of conventional trains (that is, those that travel at speeds below 125 mph) but to the construction of sleek, electrified, high-speed trains that can exceed 186 mph. From Shanghai to Madrid, from right-wing to socialist, governments taxed their citizens and granted subsidies or entered into private partnerships to fund their fast trains.

Currently, there is a push by President Obama and the U.S. Department of Transportation (DOT) to implement high-speed rail in the United States at the regional level, the 100 and 600-mile range. High-speed rail transportation is an alternative that can displace some car and airport travel and also increase energy security and environmental sustainability; however, the United States, as a society based around individual regional travel, is much different than the countries that have implemented HSR thus far (DOT, 2009).

In April 2009, the American Recovery and Reinvestment Act established new transportation goals: interconnected communities and continual economic competitiveness while ensuring safe and efficient transportation. Through this act, the DOT developed an implementation framework for HSR in various regions throughout the U.S. DOT (2009) explains that HSR will be funded and implemented in the transportation sector of 100-600 miles, a regional strategy. DOT is concentrating HSR on this range rather than the shorter and long distance ranges due to the fact that HSR is the most energy and economic efficient option at the intermediate level (Dutzik, Schneider, Baxandall, and Steva, 2010). Table 1(DOT, 2009) illustrates the way in which DOT plans to incorporate all three sectors of transportation.

Potential Modal Comparative Advantage by Market[4]

Intercity Distance Mile			
Population Density	**0-100**	**100-600**	**600-3,000**
Light	1) Auto	1) Auto 2) Conventional Rail	1) Auto 2) Air
Moderate	1) Auto 2) Commuter Rail	1) High Speed Rail 2) Auto	1) Auto 2) Air
High	1) Commuter Rail 2) Auto	1) High Speed Rail 2) Air	1) Air

Table 1: DOT (2009) strategizes implementing HSR in the 100-600 mile range in urban centers with moderate and high population densities

This table makes clear that the DOT is not completely abandoning the other two popular modes of transportation that Americans have grown accustomed; DOT is simply looking to implement HSR into higher populated areas to displace the Auto and Air sectors at the regional level. With the air and auto transportations sectors well developed in the United States, DOT holds the view that it would not be wise to abandon those successes for high-speed rail; however, DOT believes that intermediate travel can be much more energy and cost efficient with the implementation of HSR, working towards a total interconnected transportation system (DOT, 2009).

The purpose of this thesis is to examine the United States high-speed rail implementation strategy by comparing it to the implementation strategies of France, Japan, and Germany in a multiple case study. Each case will provide insight into the degree of success each country has achieved with HSR. The four main contributors to success include: economic profitability, reliability, safety, and ridership.

Transportation throughout the United States is a policy issue that will affect the overall social and economic well being of the nation. An issue of this magnitude needs to be addressed in the policy realm, taking into account many aspects that cannot be addressed in the private sector. First, DOT is required to spearhead the transportation issue because of the regional implementation. Differing from the more centralized European and East Asian countries, a U.S. HSR system would run through multiple communities and states, requiring the cooperation between multiple levels of government and private enterprises. Second, HSR is a costly expenditure that cannot be handled through only the private or public sectors. Rather, policy implementation is necessary, providing funding guidance between the different levels of government and the private sector.

Literature Review

History of High Speed Rail

High-speed trains are trains that travel at a much faster rate than the traditional rail services. The standards for HSR in the European Union constitute a train to be high-speed when it averages 125 mph or more; in contrast, the United States high-speed trains need to travel only 78 mph or more (Briney, 2009). The first true high-speed train began operation in 1964 in Japan and is known as the Shinkansen; the train averaged around 135 mph (Briney, 2009). Today, there are HSR systems through out the European Union and Eastern Asia; all averaging well over 100 mph. In contrast, the United States only has one current HSR system traveling from Boston to Washington D.C. through New York

City; however, this so called HSR averages well below 100 mph and is no where near as fast as HSR's in competing countries.

Beneficial Impacts

Energy Security

Energy security can be defined as the ability to produce as much of its own energy as possible without relying on purchasing from foreign nations (USHSR, 2011). A possible incentive for high-speed investment is the need to break away from the dependence on foreign oil consumption that has current market dominance on the United States transportation sector. With high-speed rail being operated primarily on electricity throughout the rest of the world, there is merit for researching an investment. Having a large transportation portion being run on electricity could result in a much lower dependence on foreign oil purchasing and could in turn further increase our energy security at the national level. Also, with the burning of petroleum products being a large contributor to global climate change, electric run transportation could reduce the carbon footprint since high speed trains produce less GHG's per person than cars and planes (Pollak, 2011). Table 2 supports the evidence that high speed trains are much more energy efficient than the other forms for transportation.

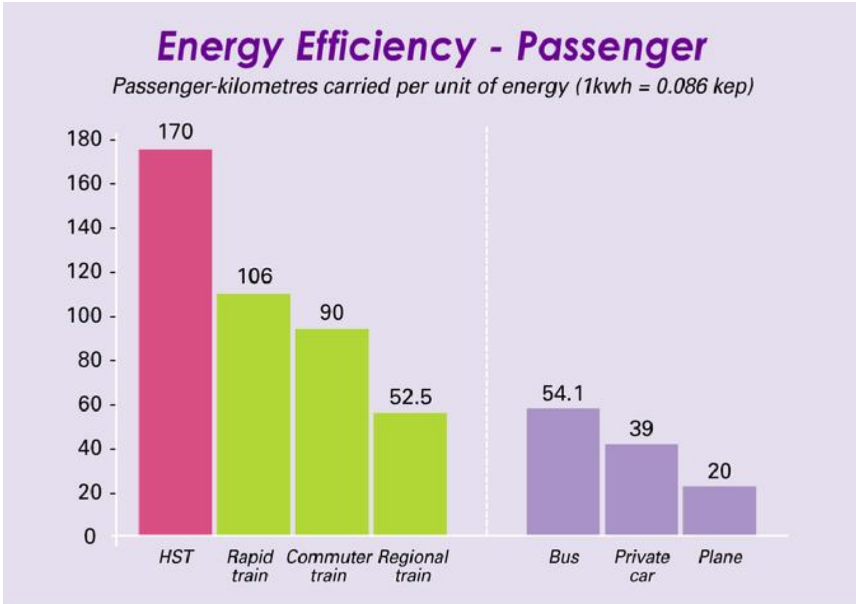

Table 2: USHSR (2011) illustrates that high speed trains are the most efficient form of transportation in terms of energy efficiency per passenger

It is understood that to create electricity, fossil fuels are often burned; however, there are many more alternatives for electricity generation including renewable energy and nuclear compared to the limited number of fuel sources in the current transportation sector.

Transit Oriented Development

Transit Oriented Development (TOD) incorporates HSR and addresses the climate change problem on a deeper level. TOD communities are built around a HSR system, connecting local transit systems to the HSR system and also incorporating green technology throughout the community to make the community as a whole more green. USHSR (2011) describes TOD's in more detail:

> Transit oriented development (TOD) is the exciting new fast growing trend in creating vibrant, compact, livable, walkable communities centered around high quality train systems. TODs can be stand-alone communities, or a series of towns strung along a rail line like pearls on a string. TODs are the integration of community design with rail system planning.

TOD could enhance a HSR system by connecting the maximum local and international travelers to the system through ease accessibility for citizens (USHSR, 2011).

Jobs

There could be an opportunity to promote strong economic development through job creation with HSR investment. Infrastructure investments alone have the potential to create large amounts of jobs in terms of rail and station creation, transit design, and train construction. There is also the potential for additional jobs to be created through research and development while designing and creating the most optimal, cost effective HSR system for each region of the United States. The Midwest High Speed Rail Association projected a major economic surplus through HSR investment in the Midwest alone, which could possibly be translated into other regions of the country (Table 3).

These economic impacts represent additional economic activity occurring locally as a result of high speed rail service.

Measure	Unit	150-mph Service	220-mph Service
2030 Employment	Jobs	58,049	103,610
2030 Output (business sales)	$billion/year	$7.6	$13.8
2030 Value-Added (Gross Regional Product)	$billion/year	$4.3	$7.8
2030 Wages	$billion/year	$3.0	$5.5

Table 3: Midwest HSRA job projections for a HSR implementation project in the Midwest United States (USHSR, 2011)

This study clearly projects a major economic surplus through job creation in only one region of the United States; if the projections are accurate, HSR has the potential to bring large profits to a region.

Convenience

High-speed rail has the potential to be a major boost in convenience for passengers throughout the country. The U.S. High Speed Rail Association (USHSR, 2011) illustrates the potential convenience by pointing out the easy access to downtown city-centers, little or no delays, no security delays, lessened security lines, fast boarding, few restrictions, increased cabin space, and travel time comparable to planes. The other major convenience of HSR is that passengers are allowed to do their personal work throughout transit. In cars, the work has to be delayed due to the driving process, and in planes, cell phone use is prohibited. Grunwald (2010) sums up the potential convenience of HSR by stating:

> You wouldn't have to get to the airport ridiculously early, take off your shoes, turn off your phone or pay extra for luggage; you wouldn't have to worry about the weather or some Icelandic volcano canceling your trip. You wouldn't have to watch the road, wait in traffic, find parking or pull over to stretch your legs; you wouldn't risk arrest or an accident by drinking or texting. (USHSR, 2011)

With the increasing dependence on technology and especially mobile telephones, HSR could hold an advantage over both the automobile and airplanes.

Mobility

In terms of mobility, HSR may have the ability offers intercity hubs, increased passengers per car than planes, and lessened congestion from traffic. HSR could have the ability to take passengers directly into downtown areas at a high speed depending on station design; airports are generally on the outskirts of towns and cars that travel into the inner city usually need to travel at a very slow speed. Also, a high-speed train car could have the ability to carry more passengers than both cars and airplanes, resulting in more people being taken into urban centers with fewer trips; a green incentive. Lastly, a HSR system has the potential to drastically reduce the amount of congestion from cars on U.S. roads and highways, greatly reducing carbon output. USHSR (2011) provides some key statistics in favor for HSR. First, a single high-speed train line can carry the equivalent passengers of a 10-lane freeway. Second, the average American motorist will spend 6 months of their life waiting for red lights to change, and over 5 years of life stuck in traffic (Grunwald, 2010). Third, road and airport congestion cost America over $156 billion per year in wasted time and fuel (USHSR, 2011). The time and money being saved from less time, congestion and accidents as a result from HSR could be used in much more productive areas, such as renewable energy investments.

Overall the potential benefits for a HSR system in the U.S. are vast; however, it is important to understand that these benefits are not guaranteed. An implementation strategy with the proper precautions and steps could enhance the potential for vast benefits; yet assurance that all the positive aspects will be fully utilized from the beginning of implementation is ignorant.

<u>Negative Impacts</u>

Three possible negative impacts of high-speed rail will be considered: initial costs, severity of accidents, and ridership. The major driving for critics of HSR are the high up front cost that a high-speed rail system requires. Arduin and Ni (2005) state that the approximate average for high-speed lines construction costs per kilometer around the world is $53 million U.S. dollars. This price could easily be higher depending on the type of infrastructure and terrain the line is be implemented in. The costs include planning costs, infrastructure costs, and superstructure costs. Infrastructure costs include that of land manipulation and track to be laid. Superstructure costs include rail-specific elements such as guide ways (tracks) plus the sidings along the line, signaling systems, catenary and electrification mechanisms, communications and safety installations, etc. (Campos, 22). However, some of the infrastructure and superstructure are already in place due to the low-speed rail system that has been implanted in America for a significant time.

Another negative impact for high-speed rail is the severity of accidents in terms of fatalities. Naturally, as train speeds increase, the probability of an accident causing a significantly larger number of deaths increases in direct proportion. Table 4 from USDOT (2000) shows this direct relationship in a graphical function.

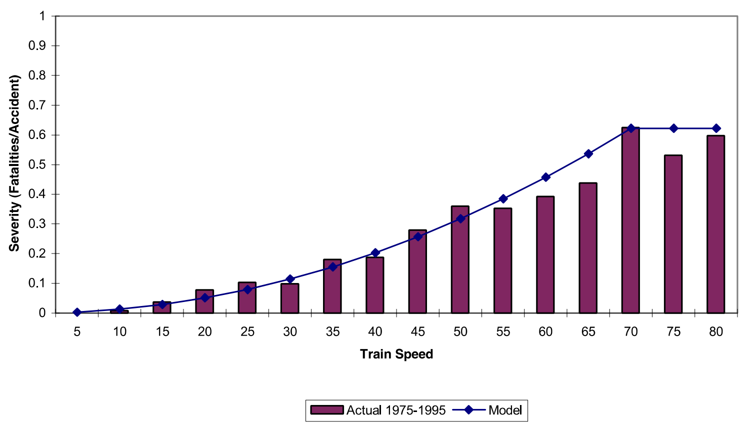

Table 4: USDOT (2000) illustrates the exponential relationship between the speed of the train and the severity of a possible accident in terms of fatalities per accident

This relationship of train speed to severity can be directly related to additional costs since more precautionary measures will need to be taken both in research and development and daily practices to ensure the safest practices are being implemented.

The third drawback of implementing high-speed rail in the US is the potential for low ridership, resulting in low revenues from passenger tickets. As Americans, we have grown comfortable with the prospect of individualized travel. Societal norms have moved away from public transportation and more towards individual car travel when it comes to short and intermediate distances. However, if there is an economical and sociological advantage for citizens to take HSR over cars and planes such as increased convenience over other transportation options and competitive ticket prices and travel time, the ridership percentage will be high, resulting in an economic and environmental advantage.

United States High-Speed Rail Plan

The 2009 High-Speed Rail Strategic Plan through the American Recovery and Reinvestment Act has established new transportation goals for the United States: ensure safe and efficient transportation choices; build a foundation for economic competitiveness; promote energy efficiency and environmental quality; and support interconnected livable communities. Through these goals, the President proposes a long-term strategy intended to build an efficient, high-speed passenger rail network of 100-600 mile intercity corridors, as one element of a modernized transportation system (p. 2). One of the major initiatives for HSR implementation is to reduce the carbon footprint of the country as a whole from the transportation sector. Table 5 shows the lessoned energy consumption per passenger mile for HSR (intercity trains) compared to the other major transportation sectors.

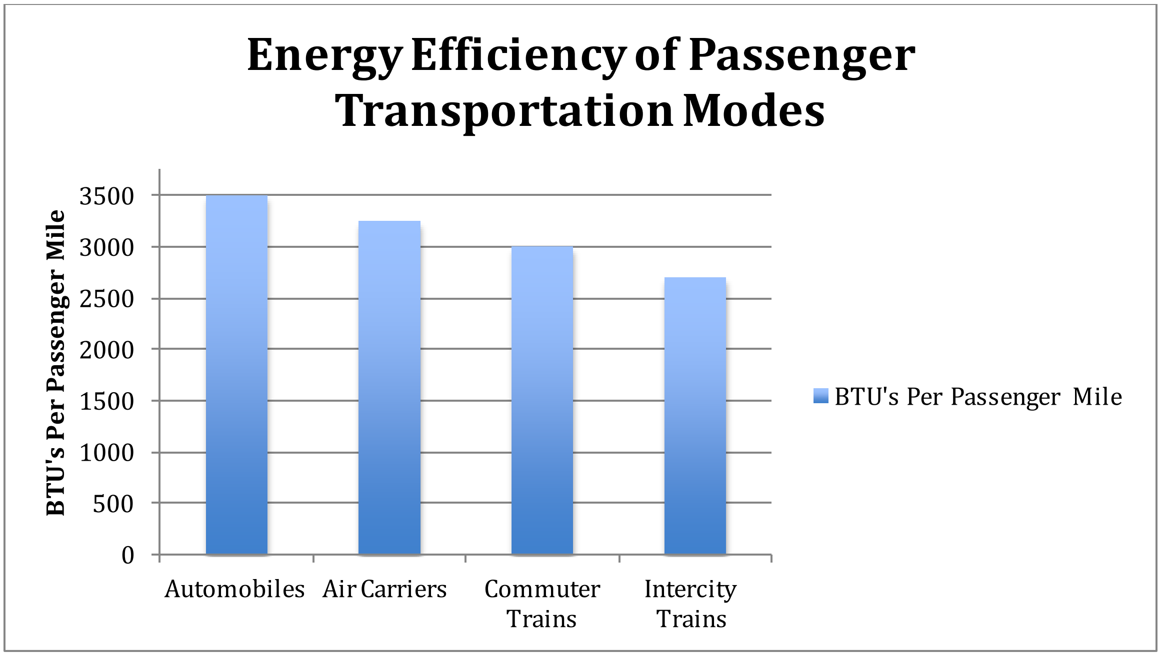

Table 5: Intercity Trains (HSR) uses the smallest number of BTU's per passenger mile. Data from DOT (2009)

Historically, the federal government has done little to fund the development of HSR in the US. However, DOT (2009) argues that there is a direct relationship between federal funding and societal transportation preferences. Table 6 represents the major federal investments in the highway and air sectors, while Table 7 represents the increased amounts of passenger miles. These two graphs show a clear correlation between allocated funds and passenger use. DOT (2009) has made a clear stance that HSR funding will spur a societal preference resulting in an increased percentage of rail ridership.

Federal Investment in Intercity Transportation, 1949-2008
(2009 Constant Dollars. Time Axis Not to Scale.)

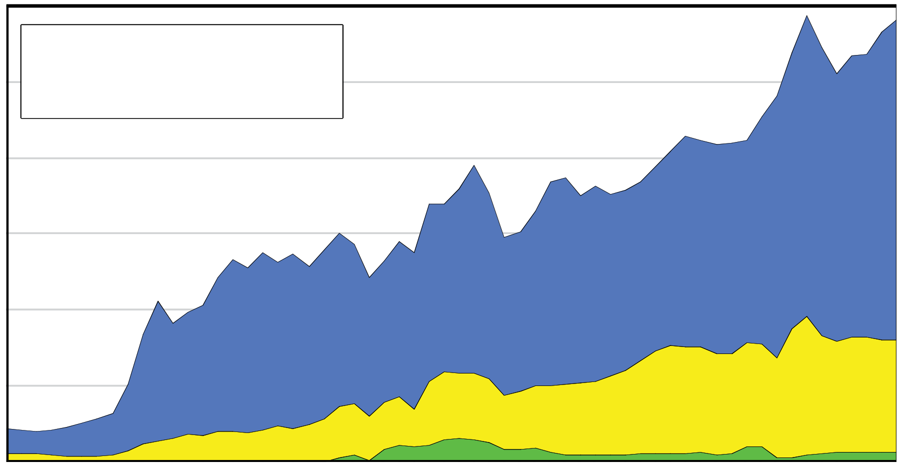

Table 6: From 1949-2008, the federal investment has had little focus on intercity passenger rail (DOT, 2009)

U.S. Intercity Travel Trends by Modal Share, 1929-2004

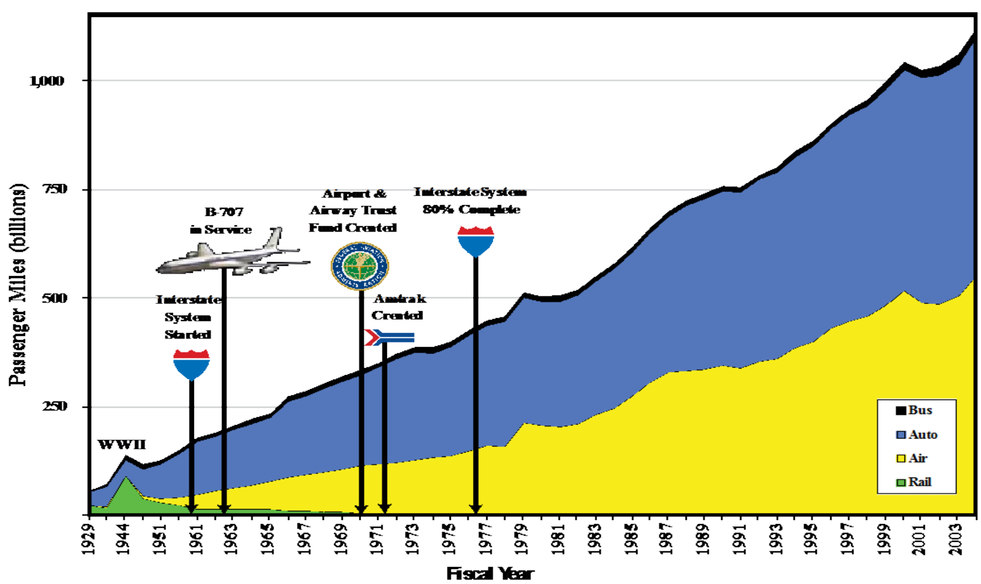

Table 7: DOT (2009) makes an argument for a correlation between federal funding and passenger use

DOT (2009) has developed regional projections of HSR development in the United States. As Table 8 represents, the HSR systems would be implemented on a regional basis; however, the rail lines would show a conclusive connection to other passenger rail systems throughout the country, preventing the isolation of any one regional system.

Designated High-Speed Rail Corridors and the North East Corridor

Table 8: Source DOT (2009)

In April 2009, through the American Recovery and Reinvestment Act, DOT developed an implementation framework for HSR in various regions throughout the US. DOT (2009) explains that HSR will be funded and implemented in the transportation sector of 100-600 miles.

Funding

DOT (2009) has proposed two governmental funding strategies: grants, and cooperative agreements. The grants will be awarded to qualified regional public and/or private applicants for the improvement of existing services. The eligible projects include infrastructure, facilities, and equipment. These projects must be “ready to go” and demonstrate “independent utility” (p.12). Cooperative agreements will contribute funding to corridor programs in which entire segments or phases of corridors will be developed.

Cooperative agreements are also to be used for additional planning past the corridor plans. This segment is meant to establish a foundation for the successful implementation of a national HSR system (p. 13).

<u>Implementation of High-Speed Rail Infrastructure</u>

Campos and Rus (2009) explain that there are many economic aspects of development that need to be considered when implementing a high-speed system. One of the major economic factors of implementation in a country such as the US is finding the most cost-effective relationship between HSR infrastructure and existing conventional services. Campos and Rus (2009) are quoted establishing four separate models that can be chosen from when establishing the relationship:

> 1. The exclusive exploitation model is characterized by a complete separation between high-speed and conventional services, each one with its own infrastructure. One of the major advantages of this model is that the market organization of both HSR and conventional services is fully independent.
>
> 2. In the mixed high-speed model, high-speed trains run either on specifically built new lines, or on upgraded segments of conventional lines. This reduces building costs, which is one of the main advantages of this model.
>
> 3. The mixed conventional model, where some conventional trains run on high-speed lines, has been adopted by Spain's Alta Velocidad Española (AVE). The main advantage of this model is the saving of rolling stock acquisition and maintenance costs and the flexibility for providing 'intermediate high-speed services' on certain routes.
>
> 4. Finally, the fully mixed model allows for the maximum flexibility, since this is the case where both high-speed and conventional services can run (at their corresponding speeds) on each type of infrastructure. High-speed trains occasionally use upgraded conven- tional lines, and freight services use the spare capacity of high- speed lines during the night. The price for this wider use of the infrastructure is a significant increase in maintenance costs.
>
> (Campos and Rus, 2009)

The multiple case study will be conducted in order to establish an understanding of the most cost-effective implementation model that would be established in a given US region. Some factors that will need to be considered include: quality of existing infrastructure, cost of completely separate infrastructure, and cost savings of a mixed model.

Station Area Planning

The Federal Railroad Administration (FRA, 2011) has developed a planning guideline for station implementation and placement to be used for HSR development. FRA (2011) states that although each station will require a degree of unique traits based on regional characteristics, there are three overarching themes that need to be addressed when implementing a HSR station: location, transportation, and development. The ultimate goal of FRA (2011) is to ensure ridership growth and capture livability, sustainability, and economic benefits (p. 2).

Specific considerations for optimal station location need to be a joint effort by multiple levels of government and stakeholders. When considering the general location of the station, the state department will need to take a broader perspective in order to optimize the regional impacts of the location. This will allow for an intermediate branch of government to consider both local and regional variables. The local jurisdiction will then take on a larger role in the specific location selection in order to address the local impacts on a micro-level in order to maximize social and economic benefits. With the goal of ever-increasing ridership, implementation of a HSR station in an existing regional center may prove optimal. Two advantageous characteristics for ridership increases include walkability and connections to local transportation.

The principles of TOD prove vital in HSR station planning. TOD communities are built around a HSR system, connecting local transit systems to the HSR system and also incorporating green technology throughout the community to make the community as a whole more green. TOD is a way to not only advance the U.S. in the HSR investment and fight global climate change as stated above, but also a cost-effective solution to secure further energy security. FRA (2011) is calling for TOD by developing the local community around the station; making the station the center of a walkable, connected community. Connectivity also needs to extend further than just to the local transportation sector; the station needs to be a regional hub for multiple rail-lines, connecting the station to neighboring stations. Overall, the location selection of a HSR station is a multi-faceted approach that needs to take into account regional centers, population and employment statistics, and societal and economics impacts at the local and regional levels

Safety Plan

The Department of Transportation's HSR safety plan (Safety, 2009), in response to the American Recovery and Reinvestment Act of 2009, is one of ensured rail safety equal other countries and other forms of transportation. The DOT states:

> the expansion of HSR in America will yield safety benefits for those who choose to use the service instead of driving the same distance via roads and highways. Data published by the National Safety Council shows that, based on miles traveled, personal motor vehicle travel is 12 to 20 times more likely to result in a fatality than passenger rail travel. (p. 1)

The main goal proposed by the Federal Railroad Administration (FRA) is to ensure the same amount of safety for all passengers across all rail lines, regardless of speed. Currently, FRA has established standards on safety equipment that allow for rail travel up to 150 mph. These standards include requirements for track, equipment, operating rules and practices, signals and train control, communications, emergency preparedness, certification of locomotive engineers and control of alcohol and drug use, among others (Safety, 2009; p. 5). Overall, the current safety system is insufficient to support a HSR system of speeds up to 220 mph; the DOT safety plan (2009) implies further research and an established plan based on foreign research and enhanced research. The case studies of France, Japan, and Germany will provide an insight into a developed safety plan with evidence of effectiveness.

<u>Corridor Planning</u>

Corridor planning takes HSR implementation beyond station and safety plans, connecting each and every aspect of a regional HSR project into one functional system. Interconnectedness of a HSR system is essential to reliability, communication, safety, speed, and efficiency; Table 9 illustrates the interconnectedness of the French TGV corridor system.

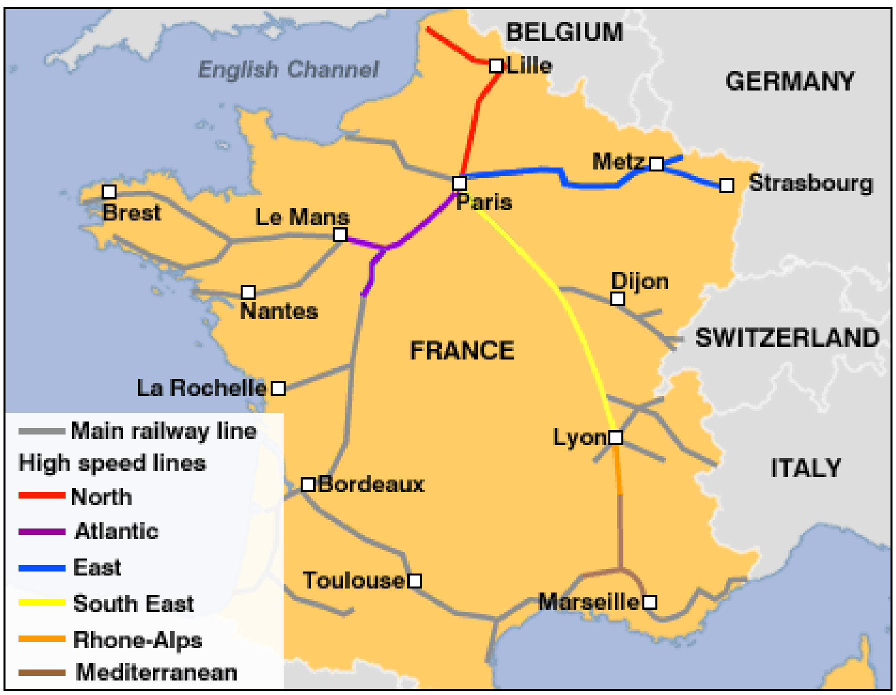

Table 9: Source BBC (2007)

FRA (2005) explains that when planning and submitting a HSR corridor plan, two published volumes need to be produced in order to fully cover every aspect of the proposal. Volume one summarizes the findings and projected costs of the various implementation processes; Volume Two contains the detailed analysis and justification of all the implementation processes contained in Volume One (p. 19).

Volume one will first need to contain a detailed look into the corridor today and how the HSR project is going to improve the given corridor and at what cost. Aspects of the "corridor today" sector include: location; background and ownership; track conditions; bridges, culverts and other structures; highway/railroad grade crossings; electrification needed; signals and communications; support facilities; and stations and parking (p.19-20). The "corridor today" sector will also need to have a detailed look into the services currently in use and how they will be changed/improved with the HSR implementation including: intercity passenger, commuter, and freight. After the "corridor today" section, the project goals section will specifically outline the project timeline including the estimated finishing date and total cost. Further analysis in volume one includes: time travel and capacity analysis; environmental impact analysis; corridor-wide investment projections; and site-specific investment projections.

Volume two for corridor planning proposals requires a much more detailed insight into how the HSR station would operate on a day-to-day basis. FRA (2005) advises preparing a final proposed operating schedule in volume two including the operating of all trains (intercity, commuter, freight, and long distance service), and the ultimate destination and origination of each train (p. 21). Volume two also requires a detailed look into track configuration; signaling systems; speed vs. distance plot; and a further look into necessary individual projects (i.e. replacing a bridge). FRA (2005) explains that corridor planning is a lengthy process that requires a detailed look into each and every aspect of HSR implementation, and more importantly, how each aspect connects, resulting in a successfully operation HSR system.

Conclusion

HSR may have an economic and environmental advantage over the air and auto transportation sectors at the regional level; however, if there is low ridership due to the individualized mindset of American transportation, the economic and environmental considerations can be discarded. Therefore, HSR implementation at the regional level calls for societal and economic impact projections along with investment strategies and environmental benefits in order to truly find the suitable US regions.

Methodology

Using a multiple case study analysis of France, Japan, and Germany, along with the already developed US HSR plan, this project will examine the strengths and weaknesses of the current US implementation framework. Yin (2009) explains that case studies are a combination of a mixture of both qualitative and quantitative research evidence that looks into a contemporary issue with multiple sources of evidence and converging data to result in a resulting conclusion. An often-cited limitation of case studies is the lack of external validity they may hold; for example, the United States HSR plan may not be applicable and/or comparable to the nations under study. However, with each case study being reviewed under the same criteria, the external validity of the case study remains strong. It is important to note that the context of this study is to find the over-arching criteria of success in a high-speed rail system; by studying the criteria in each case, valuable lessons can be taken and applied to the United States HSR vision.

The definition of success for a HSR system in this thesis has many variables; each variable is in intricate part of the overall success of the overall system. The variables of success include: a mixed funding approach with little legal and/or political obstacles, a regional (100-600 miles) implementation strategy, an incremental implementation strategy, having a strong safety record in terms of accidents and human deaths, support of the other transportation sectors, incorporation of transit-oriented development, and incorporation of designated high-speed lines. These three cases provide for the most in-depth analysis due to the implementation and longevity of the systems. Japan, France, and Germany HSR systems have been running since 1964, 1981, and 1991 respectively;

this provides an ample timetable for analysis. China was also considered for this study; however, the youth of the system results in an unreliable sample for analysis.

According to the United States Department of Transportation (USDOT), the following criteria are essential for the successful implementation of High-speed Rail in the United States:

Mixed Funding	**Loosely Coupled System**	**Transit Oriented Development**
- Strict Applications	- Regional Implementation	- Connectivity to local transportation
- Grants	- 100-600 mile range	- Energy efficiency
- Cooperative Agreements	Moderate and high populated cities only	
- Funding for future system expansion	- Continual support of air and auto sectors	

Table 10: (USDOT, 2009) variables of HSR vision

The multiple-case study of France, Japan, and Germany will examine each case by answering the following set of questions:

1. Was each implementation deemed a success?
2. Did the case support the U.S. HSR mixed funding strategy?
3. Did the case have a regional implementation scheme?
4. Did the case support other transportation sectors?
5. Did the case develop transit-oriented development?
6. Did the case develop a mixed rail infrastructure?

Upon completion of the individual case studies, a triangulation, or cross-case analysis, will provide insight into how each case is alike or different from the United States plan. This section will combine the most important lessons by examining the same questions being examined in the separate case studies, allowing for a clear view on the most significant variables for a successful high-speed rail system. DOT has an implementation plan in which they feel will be successful both short-term and long-term; this multiple-case study will test the strength of the established plan on a comparative basis.

Finally, based on the outcome of the separate case studies and the cross-case analysis, a discussion on the lessons learned from each case study will be made to potentially strengthen the HSR plan and ensure the most cost-effective strategy. The questions and criteria examined in each case can be generalized to any other country that has implemented a high-speed system. Due to the length of time each HSR system has been operating, France, Japan, and Germany provide the strongest sample for analyses, allowing for the strongest multiple-case study to examine the strength of the US implementation plan. The evidence provided by various scholarly sources converging on similar conclusions about each country provide over-arching data with strong internal and external validity to help determine the degree of success for each case.

Findings

In this section the individual findings for each of the three cases will be presented. The findings will be structure using the six questions from the U.S. plan.

France: TGV

Background

The French high-speed rail system, deemed *Train à Grande Vitesse* (TGV), was opened in 1981 with the TGV Sud-Est. Arduin and Ni (2005) explain that the Sud-Est, linking Paris to Lyon, was the first high-speed rail system implemented in Europe. From 1981 to 2001, the TGV has expanded its system from one line to seven; adding the TGV Atlatique (1989), TGV Rhone-Alpes (1992), TGV Nord Europe (1993), TGV Paris interconnections (1996), TGV Mediteranee (2001), and TGV East (2007). Today, with all lines interconnected, the French TGV network totals approximately 962 miles (Albalate and Bel, 2010).

Three components of the TGV stand out when determining the degree of success the system has had: a highly flexible infrastructure system, incremental regional implementation in highly populated cities, and a mixed funding approach. Due to the versatility in design, the TGV is compatible with the existing conventional rail network; this has led to low construction costs and the connectivity to the UK, Belgium, Netherlands, Germany, Switzerland, and Italy (Arduin and Ni, 2005). Also, the TGV dedicated lines were implemented at an incremental rate in city centers with high population density, assuring high ridership and low economic vulnerability.

The TGV is owned and operated by French National Railways (SNCF), the French state-owned railway company. The SNCF owns the TGV trains and stations; the

French Rail Network (RFF) owns the remaining infrastructure, including the railways. It is important to note that SNCF and RFF operate under non-federal budgets, displacing economic burden from the federal government. Eironline (1997) explains that the RFF was formed in response to passed legislation: splitting off operating activities from network development and maintenance. In addition to the undertaking of the formally SNCF railways, the RFF undertook the SNCF debt owed to the French government of about $27 billion USD (134.2 FRF). The SNCF pays the RFF for the use of the railway infrastructure, while the RFF uses the earned revenues to pay the owed debt to the French government. Overall, the French high-speed rail system is a government owned business; however separate railroad budgets from the governmental budget alleviates economic pressure, avoiding an economic over-burden on the French national budget. This system is affective in connecting France with the rest of the European Union at an extremely low construction cost of US$10 million per km (Arduin and Ni, 2005).

Question One: Was the implementation deemed a success?

Arduin and Ni (2005) state that since the first commissioning of the TGV in 1981, the traffic volume for the rail line has steadily increased as more TGV branches have been added over time. As of 2005, about 250,000 passengers take one of the 600 TGV trains running daily. The yearly traffic totals 90 million passengers. The sources of increased rail traffic are a result of passengers switching preferences from the air and road sectors to the TGV due to the shorter trip times, frequent services, high comfort, and competitive prices the TGV provides (p. 25). Table 11 shows both the continual increasing size the TGV traffic and passenger totals.

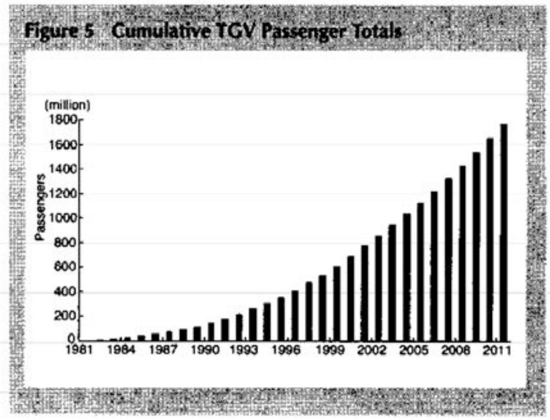

Table 11: (Arduin and Ni, 2005)

A second aspect contributing to the success of the French TGV is the implementation structure the SNCF chose. By choosing a mixed infrastructure system, large costs were avoiding, making the French TGV the cheapest implementation process of the other European Nations at US$10 million per kilometer. This concept will be addressed in further detail below.

A third important aspect that the TGV has been proven successful with is economic self-sufficiency. Dutzik, Schneider, Baxandall, and Steva (2010) state that on an annual basis, 80 percent of TGV services break even or make profit. In 2008, a record breaking year, SNCF did so well that it paid a dividend of $190 million to French taxpayers. Transit-oriented development is a fourth factor that has played into the success of the TGV. Although this aspect will be further discussed below, it is important to point out that connectivity the TGV has provided to other transportation sectors (light-rail, air, etc.) and is a large contributing factor to the overall successfulness of the system.

The final and most important aspect to the successfulness of any transportation sector is safety. Even though it has an annual ridership of 48 million passengers, there has never been a single passenger death due to an HSR accident in the 29 years of existence of the TGV. Dutzik, Schneider, Baxandall, and Steva (2010) explain the reason for this safety success:

> In France, TGV railcars are designed such that adjacent TGV cars rest atop a shared two-axle connector, which decreases weight and increases speed, but also prevents the cars from dangerously jack-knifing during a collision as would a conventional train.

A combination of inexpensive implementation, high initial ridership that continued to increase over time, economic self-sufficiency, transit-oriented development, and a continual immaculate track record for safety are the main contributing factors as to why the French TGV has been deemed a success.

<u>Question Two: Did this case support the USHSR funding approach?</u>

Since 1981, SNCF has been the main source of finance for the TGV; however, government contributions have come into play due to the initial economic and social success that the first line, the TGV Sud-Est provided. Vickerman (1997) explains:

> TGV Paris-Lyon was financed entirely by SNCF on the basis of an expected minimum 12% financial rate of return, which has in practice been surpassed. The success of TGV Sud-Est in terms of both traffic and revenue generation confirmed the French view that high-speed rail was an appropriate solution and this led to an early decision in favor of TGV-Atlantique, with an explicit recognition of the regional development potential which led to a 30% government contribution to construction costs.

The initial success of the first TGV line, financed entirely by SNCF, led to further governmental support and funding for continual TGV development.

In addition to the SNCF, the French Rail Network (RFF) has taken on a large part of the financial investment by taking ownership in the infrastructure after a 1997 legislation was passed stating the need of a separation between operating activities from network development and maintenance (Eironline, 1997). The RFF has also taken on the infrastructure debt SNCF has accumulated before the split in agencies occurred; this has helped ease the relationship between the French government and the SNCF since the RFF makes debt payments to the government while collecting payments for infrastructure uses from the SNCF. In sum the original projects were primarily financed by SNCF; however, as time went on the RFF (both state owned companies) and smaller portions by the French government became contributing factors.

The most recent project (TGV East), finished in 2007, was the first infrastructure project of its kind to be declared a public utility by the Ministry of the Environment; therefore, it is the first project to be primarily financed by the French regional governments and the European Union (EU). Arduin and Ni (2009) state that the total cost of the project was about US1.20 billion and was appropriated as follows: 61% public funds (French government, local authorities, EU, and Luxembourg); 17% RFF, and 22% SNCF. As HSR has expanded vastly beyond the borders of France, the EU has become more supportive of further developing the clean technology for the goal of enhanced HSR connectivity throughout the union.

When comparing the French funding approach to the United States, there are definite similarities in terms of mixed funding. SNCF and RFF are comparable to the US enterprises/regions that would be applying for grants and cooperative agreements. A connection exists between the processes of federal appropriation of funds after an initial financial investment is made from the smaller entities. The major difference in funding between the US and France lies in the fact that the United States does not have a further governing entity such as the European Union that could allocate further funding; therefore, it is crucial that the applying US regions be fully reviewed and deemed qualified before federal funding is allocated. The sheer size of the United States compared to France makes the funding process a more tightly strung process with an increased margin for error, requiring a more comprehensive precautionary process when selecting regions.

<u>Question Three: Did this case have a regional implementation scheme?</u>

France developed their TGV high-speed network with a clear regional implementation strategy. In fact, the different TGV lines are named after the regions they were implemented: TGV Sud-Est (1981), TGV Atlatique (1989), TGV Rhone-Alpes (1992), TGV Nord Europe (1993), TGV Paris interconnections (1996), TGV Mediteranee (2001), and TGV East (2007) (Arduin and Ni, 2005). Table 12 gives an illustration of where and when each regional line was implemented throughout the country.

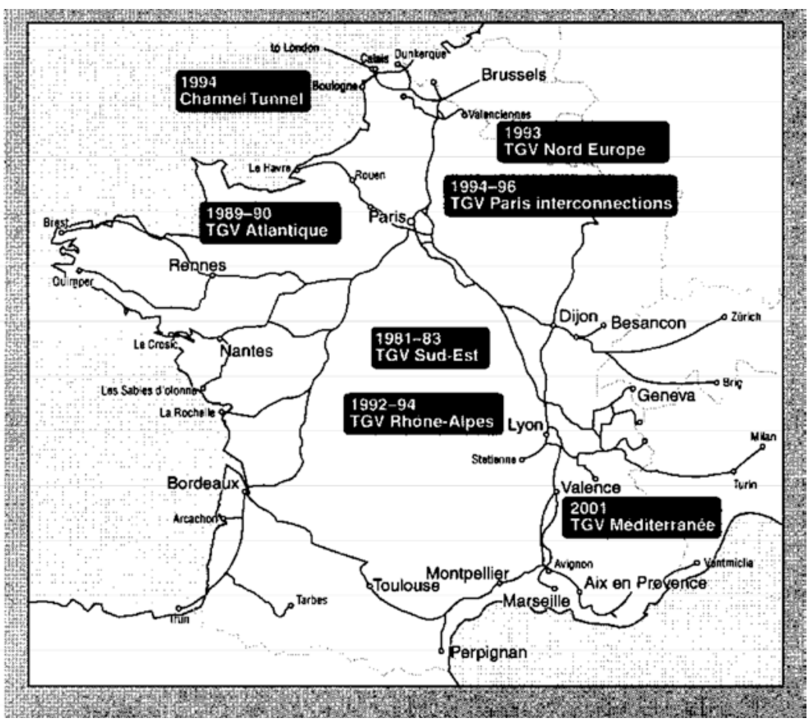

Table 12: (Arduin and Ni, 2005)

France not only developed their high-speed system on an incremental, regional basis; they also developed it in only highly populated cities, all based around Paris.

Albalate and Bel (2010) explain the motives behind the implementation strategy by stating:

> Routes have to be established between the most highly populated centers so as to ensure satisfactory occupancy rates and to guarantee that the service can break even, particularly in light of high construction and operation costs. This is the case in France, where HST lines are centered on Paris to reflect the country's strong political, economic and demographic centralization.

By developing the TGV incrementally, based around each regions population centered on Paris, the SNCF was able to keep production costs low with a high degree of economic return. If the TGV were developed all at once, the initial production cost would have been too high to be fully developed. By starting on a regional level, the SNCF was able to prove to the French government, other local regions, and the European Union that high-speed rail is a viable and economically advantageous investment that could be developed in around other regional centers.

A distinct similarity exists between the French implementation strategy and the US proposed strategy. The United States is proposing to implement HSR at an initial regional level based around highly populated centers and only at the 100-600 mile level. This is similar to the French strategy in that there is no initial attempt to connect they entire country at once. As stated above, the geographic size of the United States compared to France provides the greatest difference between the two. It is even more vital for the US to develop HSR on a regional basis for multiple reasons, which will be discussed more in the cross-case analysis. In sum there are many similarities between the French regional implementation strategy and the proposed US strategy; due to the successfulness of the TGV, strong merit subsists for these similarities.

Question Four: Did this case support other transportation sectors?

From 1981 on, the implementation of the TGV in France has led to a direct decrease in both plane and car travel. High-speed rail travel has resulted in a displacement of both plane and car travel at the intermediate level. Dutzik, Schneider, Baxandall, and Steva (2010) illustrate this trend by stating:

> The success of high-speed rail in diverting passengers from planes was demonstrated early on with the completion of the high- speed TGV rail line from Paris to Lyon in 1981. Before completion of the TGV, 31 percent of travelers from Paris to Lyon traveled by airplane. Following completion of the TGV, the air passenger share dwindled to 7 percent. The number of people traveling by air or rail between Paris and the region increased by 25 percent between 1996 and 2003, but the number of air passengers actually declined. All of the travel growth was accommodated via rail travel, which increased its share of the air-rail market from 39 percent before the TGV to 58 percent afterward.

Furthermore, between 1981 and 1984, the amount of car travel between Paris and Lyon (TGV Sud-Est) decreased from 28% to 21% (Dutzik, Schneider, Baxandall, and Steva, 2010).

One of the main advantages of the resulting trend after the introduction of HSR comes in terms of energy efficiency and carbon emissions. Tables 13 and 14 show the amount of energy and carbon emissions that are saved when comparing train travel to air and auto (Dutzik, Schneider, Baxandall, and Steva, 2010).

Figure 5: Energy Consumption of Trains, Cars, and Aircraft Traveling Between European Cities, Monday Morning Trip[61]

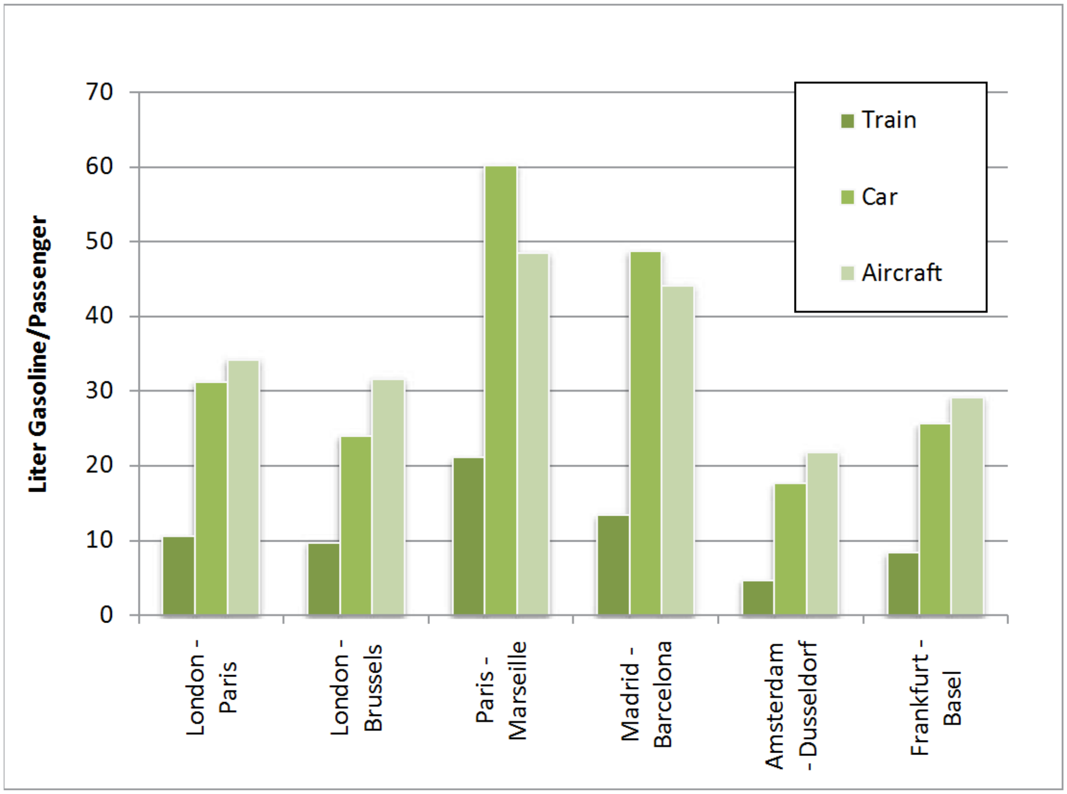

Table 13: Dutzik, Schneider, Baxandall, and Steva, 2010

Figure 6: Carbon Dioxide Emissions of Trains, Cars, and Aircraft Traveling Between European Cities[64]

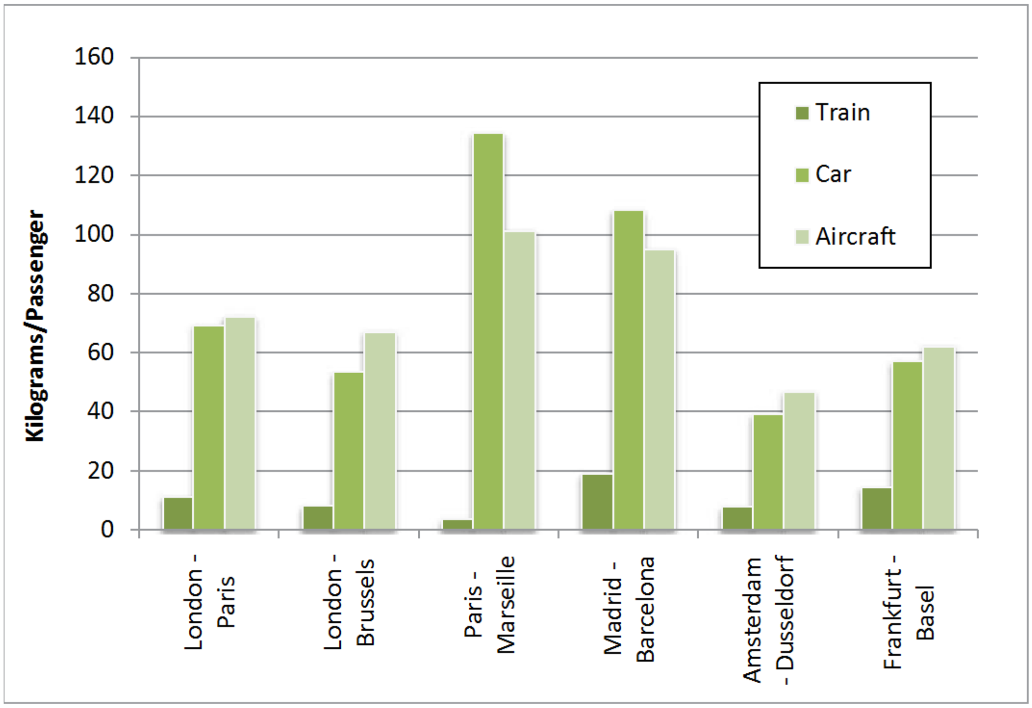

Table 14: Dutzik, Schneider, Baxandall, and Steva, 2010

When considering the fact that the TGV runs completely on electricity, and approximately 75% of the country's electricity is produced from nuclear power; it not only reduces France's carbon emissions, it also increases their energy independence and allows them to export large portions of their electric generation.

Despite the decline in air and auto travel throughout the country at the intermediate level, there is still a synergy between the TGV and airlines. Two airports- Roissy Charles de Gualle Airport (CDG) near Paris and Lyon Saint Exupery (LYS) have TGV stations in the actual airport. There are also combined services, deemed TGV Air, that allow for international flight travel and TGV travel all on just one ticket. In 2004 alone, Air France, Air Austral, American Airlines, Continental Airlines, Delta Air Lines, KLM, Lufthansa, and United Airlines were are in partnership with SNCF (Arduin and Ni, 2005). Overall, there has been a decrease in car and air travel between the major cities of both France and other European countries due to the development of the TGV; however, synergy between air and high-speed travel still persists at the long distance level.

When comparing these trends to the United States plan, it is quite simple to see the direct similarities. USDOT proposes a plan to only implement HSR into the intermediate level (100-600 miles). Clear emphasis is placed on the continual support of the other transportation sectors. Compared to France, the United States will need to put a larger emphasis on supporting the automobile sector due to the social norms of individualized travel that are much more developed in the US. However, there is still a direct correlation between the United States intermediate distance strategy and the TGV strategy. Each nation shares the ultimate goal to displace the energy inefficient and costly intermediate air and auto travel.

<u>Question Five: Did this case develop transit-oriented development?</u>

As Dutzik, Schneider, Baxandall, and Steva (2010) point out, the keys for high-speed rail to both compete against and compliment the air and auto transportation sector depends upon the accessibility of stations to a wide variety of travelers, both those arriving from mass transit or individualized auto. This type of communal advancement is known as transit-oriented development: building around a HSR system, connecting local transit systems to the HSR system and also incorporating green technology throughout the community to make the community as a whole more accessible to a wider variety of travelers.

France has incorporated transit-oriented development by further developing and expanding the local rail system throughout the nation. As of 1985, France has implemented 20 light rail city tram systems in and outside of Paris, with most of them directly connected to a TGV line (Dutzik, Schneider, Baxandall, and Steva, 2010). Placing TGV stations in airports also enhances transit-oriented development since the travelers do not need to travel to a new destination in order to use a different form of transportation. With the connections to both international and local travel from the airports and light rail systems, France has implemented transit-oriented development at a high degree. The United States HSR proposal has to opportunity to use France as a template in terms or transit-oriented development and connecting a wide range of travelers on an efficient and cost-effective basis.

<u>Question Six: Did this case develop a mixed rail infrastructure?</u>

One of the largest contributing factors to the success of the TGV is the infrastructure that SNCF decided to use from the beginning. From the start, the TGV system was designed to be compatible with the existing conventional rail network; therefore TGV trains can run on a much wider network than the dedicated high-speed lines (Arduin and Ni, 2005). When looking back on Figure 10, that map shows only the dedicated high-speed lines; however, TGV trains are able to travel on conventional lines as well, which created a loosely coupled, successful system of flexible infrastructure.

With the new and separate high-speed lines only being used for highly congested centers, it kept the cost per mile at a near minimum. Albalate and Bel (2010) further explain this cost-effective practice with the following statement:

> Indeed, France decided only to create a new, separate network along congested links, and to use conventional services along less crowded connections and for accessing big cities when construction and expropriation costs were likely to be exorbitant

Expanding on the point of cost-effectiveness, one of the largest economic advantages of the mixed rail infrastructure SNCF implemented was the ability for the TGV to directly serve other countries such as: the UK, Belgium, the Netherland, Germany, Switzerland, and Italy (Arduin and Ni, 2005), expanding the economic surplus beyond the French borders. Once again, the United States has the advantage of learning from other countries; the use of the already conventional rail lines should be adopted in the HSR system.

Summary

The French TGV, implemented in 1981, has been a success for a number of reasons. First, the mixed infrastructure, allowing for the TGV trains to run on conventional rails at conventional speeds, paved the way for a cost-effective implementation. The high-speed lines were implemented where they were deemed necessary: higher population centers centered around Paris. Second, the regional implementation allowed for a loosely coupled system that didn't risk massive up front investments. It also allowed for the federal government and the European Union to recognize the success and assist the SNCF in future investments. Third, the loosely coupled, invulnerable system has been progressively strengthened as a result of the support of the other transportation sectors through transit-oriented development. Lastly, the ever expanding TGV has not only been economically viable in ridership percentages, it also increased the nation's energy security, allowing for a further economic surplus from the exportation of electricity generated from the nation's nuclear plants. The TGV is a proven transportation option that has paved the way for the spread of high-speed rail throughout Europe.

Japan: Shinkansen

Background

The owner to the first high-speed train in the world, Japan introduced Shinkansen in 1964, running from Tokyo to Osaka. Albalate and Bel (2010) state that the regional structure of Japan: large metropolitan centers located a few hundred miles apart with a high demand for travel, favored high-speed rail. Okada (1994) states that approximately 30 million, 16 million, and 8.5 million people live within 50 km of Tokyo, Osaka, and Nagoya respectively. Table 14 provides a detailed map of the Shinkansen high-speed line throughout the country; connecting the major urban centers.

Table 15: Kagyama (2000)

These demographic statistics provide a strong support system for regional high-speed rail implementation.

Despite the high cost that has come along with some funding setbacks, Shinkansen has been both economically and socially successful over time. The state-owned Japan National Railways (JNR) produced the original design and financing of Shinkansen; however, following privatization in 1987, the high-speed rail system is currently managed by JNR and six regional private enterprises: JR East, JR Central, JR West, JR Hokkaido, JR Shikoku, JR Kyushu, and JR Freight (Kagyama, 2000).

Since opening 48 years ago, the Shinkansen has serviced several billion passengers including 350,000 per day between Tokyo and Osaka alone (JR Central). Albalate and Bel (2010) explain that the JR group as whole provides approximately 1,346 miles of high-speed lines. Japan as a whole has about 16,800 miles of rail lines (including traditional and HSR), with JR companies operating about 12,600 of those miles. Table 16 provides further detailed insight into the particulars of each branch, compiling into the Shinkansen system as whole.

Table 4-1. Comparison of JR Companies (1998) [15]

JR Company	Commuter and Shinkansen Line (miles)	No of Passengers per Year (millions)	Annual Operating Revenues (Billions of Dollars)[16]
JR Central	1,233	519	10.0
JR East	4,684	5,978	16.9
JR West	3,156	1,867	8.2
JR Hokkaido	1,553	125	.9
JR Shikoku	532	62	.4
JR Kyushu	1,306	315	1.5

Table 16: Kagyama (2000)

Overall, the Japanese Shinkansen system has been an ever expanding, time-saving, and energy efficient regional travel option between major urban centers; a more detailed analysis will reveal further insight into the level of overall success Shinkansen has had.

Question One: Was the implementation deemed a success?

One of the most important aspects of the degree of success an HSR achieves is profitability, and despite the large initial procured debt, Shinkansen has been economically successful. Dutzik, Schneider, Baxandall, and Steva (2010) state that the original Shinkansen line, linking Tokyo and Osaka, has been highly profitable, paying back its construction costs within approximately a decade. As stated above, the geographic and demographic layout of Japan created an environment suitable for a high-speed rail system. Consequently, cities with HSR, who have the population density to support the system, have benefitted immensely from the moment of implementation.

Although the cities with HSR stations have only averaged a 1.6% annual increase in population, the employment rate in these cities has been 16-34% higher than cities without, with also a 67% increase in land value (Albalate and Bel, 2010). A specific example of this local development is the city of Kakegawa in which the opening of a new station along an existing high-speed rail line contributed to the opening of five new hotels and boosted the local economy (Dutzik, Schneider, Baxandall, and Steva, 2010).

Another important aspect of success is safety and reliability. Since Shinkansen opened in 1964, no passenger has even been killed during an accident, despite carrying an average of 340 million passengers per year. Dutzik, Schneider, Baxandall, and Steva (2010) describe the system that has been so successful:

> The Shinkansen employs automatic train control, which will automatically decelerate or halt the train based on the conditions of the route ahead and distance to preceding trains. The Shinkansen system is also equipped with an earthquake alarm system that automatically brings trains to a rapid halt when seismic activity is detected.

The successful implementation of this advanced technology has undeniably set the safety standard for the rest of the world. In terms of reliability, citizens of Japan enjoy the spoils of one of the most reliable transportation systems in the world. The average delay time for all Shinkansen lines is just two minutes (Albalate and Bel, 2010). On more specific terms, the Tokaido Shinkansen traveling from Tokyo to Osaka- the busiest high-speed line in the nation- experiences an average delay (including delays from rain, typhoons, or snowfall) of a mere 36 seconds (Dutzik, Schneider, Baxandall, and Steva, 2010).

The last major aspect of success for a HSR system is continual improvement; the Japan Shinkansen has proven successfulness in this category on multiple fronts. First, Shinkansen has dropped its travel time between stops steadily since 1964 despite an ever-growing ridership. This clearly speaks of the correct implementation of technology and overall efficiency practices. Table 17 illustrates the fact that the overall travel time has dropped, along with continual improvements in trains per hour, trains per day, and passengers per day (Kagyama, 2000).

Tokaido Line	1964	1999
Travel time	4 hours	2 hr 30 min
Trains per hour from Tokyo	2	11
Trains per day	60	285
Passengers per day	61,000	357,000

Table 17: Kagyama (2000)

Second, Shinkansen has also provided continual improvements in terms of overall energy efficiency. Dutzik, Schneider, Baxandall, and Steva (2010) best illustrate the continual energy savings of the HSR system by stating:

> Shinkansen system is estimated to consume one-quarter the energy of air transportation and one-sixth the energy of automobiles on a per-passenger basis. Japan has continually improved the energy efficiency of the Shinkansen, with the latest, most energy-efficient trains consuming 32 percent less energy than the original Shinkansen trains, even though they are capable of traveling 43 miles per hour faster.

The continual improvements of both travel time and energy efficiency have been major contributors to the overall successfulness of Shinkansen.

Despite the high cost and initial financial setbacks that will be further dissected further along the study of Shinkansen, the implementation of the HSR system has been deemed an overall success. The demographic layout of the country has provided a strong setting for HSR; resulting in high ridership and a short timetable for economic payoff. Due to the fact that no passenger has ever been killed on the Shinkansen as a result of an accident; safety is another large indicator of success, which has been primarily due to the implementation of effective safety technology. Finally, the overall continual improvements of Shinkansen have assured a bright future in a country with an ever-growing economy.

<u>Question Two: Did this case support the USHSR funding approach?</u>

The initial funding approach for the Shinkansen in Japan derived from Japan National Railways (JNR), a state-owned company under the federal budget. The difference between JNR and SNFC of France was the budget. The SNFC, like JNR, was state-owned; however the major difference was that SNFC had a separate budget from the French federal budget. With the JNR falling under the Japanese federal budget, it left the JNR more vulnerable to debt problems. As Gourvish (2012) explains below, the development of HSR lines continued following the 1964 opening:

> Further Shinkansen building was undertaken, with government financial support, in accordance with a policy of geographically-balanced development, pursued via the National Development Plan of 1969 and the National Shinkansen Network Development Law of 1970. The policy, which envisaged some 7,200 kilometres of Shinkansen

This statement provides support to the fact that the initial cost of the Shinkansen was primarily laid upon the JNR.

There are two major factors that led to the eventual 1987 privatization of the Shinkansen rail lines. First, as stated above, the cost between 1964 and 1987 was placed upon the JNR, resulting in a large amount of debt. Kagyama (2000) explains the results of state-run sole funding:

> The over-commitments by politicians that led to over extending the initial Tokaido high-speed line terminus end points, and the overestimating of the ridership projections were the primary reasons for the financial difficulties of the JNR and taxpayers

These over-commitments led to political pressure, which in turn led to premature implementation of high-speed lines in low demand areas. Second, due to the high land price along with the fact that Japanese topography requires many kinds of expensive infrastructure such as tunnels and bridges for straight railway, the implementation of the high-speed system has been expensive (Taniguchi, 1992). Table 18 illustrates the ever-growing cost of HSR implementation in Japan (Albalate and Bel, 2010).

Line	**Year**	**Total Cost (nominal $US billion)**	**Miles**	**Cost per mile (nominal $US million)**
Tokaido	1964	0.92	347	2.6
Sanyo	1975	2.95	389	7.6
Tohoku	1985	11.02	335	32.9
Joetsu	1985	6.69	209	32.0

Table 18: Albalate and Bel (2010): Shinkansen implementation cost per mile

The price of high-speed implementation higher in Japan, along with all the debt falling on the state-owned JNR led to a large financial burden and privatization.

Leading up to 1987, the JNR compiled approximately $200 billion US Dollars, resulting in the necessity for privatization (Albalate and Bel, 2010). Since the privatization, the high-speed rail system has been managed by JNR and six regional private enterprises: JR East, JR Central, JR West, JR Hokkaido, JR Shikoku, JR Kyushu, and JR Freight (Kagyama, 2000). This transition has allowed for JNR to lesson the burden of the high implementation cost of HSR in the high land priced country. Since the privatization, a mixed funding approach has been adapted, leading to a much more economically successful HSR system. For example, the Kyushu Shinkansen, which was opened in 2004, was constructed by government and public funds; 50% of the construction cost was supplied by Shinkansen deliverance transfer revenues; and 50% was funded by central and local government (Lee, 2007). With HSR implementation presenting such a large up-front cost, the most cost-effective solution is to offset some costs by developing a mixture of private and public funding.

When comparing the Japanese funding approach to HSR implementation to the United States' funding plan, it is clear to see why the US supports a mixed funding approach. The upfront cost for HSR implementation was too much for the Japanese government to take on alone; mixed funding proved to be much more successful. The sheer geographic size of the United States compared to Japan provides merit to why total governmental public funding would not be feasible. Overall, Japan was forced to learn the hard way that HSR implementation requires a mixed funding approach; the United States has the opportunity to learn from Japans mistakes and adopt mixed funding from the start.

Question Three: Did this case have a regional implementation scheme?

The Shinkansen HSR system differed from the French TGV implementation scheme in that the regional implementation strategy was not as strictly followed. JNR was much looser about their political commitments to regional implementation. As stated above, one of the initial economic downfalls that led to privatization was the planned implementation in lower populated areas that resulted in lower ridership percentages; this planning in turn led to further debt falling upon the JNR. Following the 1964 (Tokaido Shinkansen) implementation, new Shinkansen lines were opened in 1975 (Sanyo Shinkansen), two in 1982 (Tohoku Shinkansen (Omiya-Morioka branch and Joetsu Shikansen), 1985 (Tohoku Shinkansen- Ueno-Omiya Branch), 1991 (Tohoku Shinkansen- Tokyo-Ueno Branch), 1997 (Hokuriku Shinkansen), 2002 (Tohoku Shinkansen-Morioka-Hachinohe), and the Kyushu Shinkansen branch in 2004 (Shinkansen, 2007). Table 19 gives a more detailed image of all the Shinkansen lines.

Table 19: Shinkansen (2007)

Despite the debt problems leading to privatization, the incremental implementation has ultimately led to an economic and social successful high-speed system.

When comparing this implementation strategy with the United States plan, there are two lessons that can be taken from Japan. First, the initial success of the 1964 Shinkansen line led to an over-excitement from political forces, resulting in financial commitments to development in geographic areas that were not ready for HSR. It is important for the United States to remember that HSR is only needed in highly populated areas at the regional level (100-600 miles). Second, and on a more positive note as a result of privatization, the regional impacts of HSR in highly populated areas have been positive on multiple fronts. Ultimately, the implementation strategy in Japan was one that was not properly planned, neglecting important regional demographic characteristics.

Mixed funding after 1987 led to a more comprehensive and precise implementation strategy; if this funding approach was used from the beginning, each regional enterprise could have decided on more specific guidelines for their given region.

Question Four: Did this case support other transportation sectors?

Despite the original skeptics of Japanese citizens about the HSR travel compared to other forms of transportation (Kagiyama, 2000), the implementation of the Shinkansen between Tokyo and Osaka immediately impacted the other transportation sectors. The first advantage that Shinkansen had over air travel was the fact that the commercial air sector was far from fully developed in Japan. Dutzik, Schneider, Baxandall, and Steva (2010) explain that because of this advantage, Shinkansen has dominated the market share of regional travel despite a rise in air travel over time (Table 20).

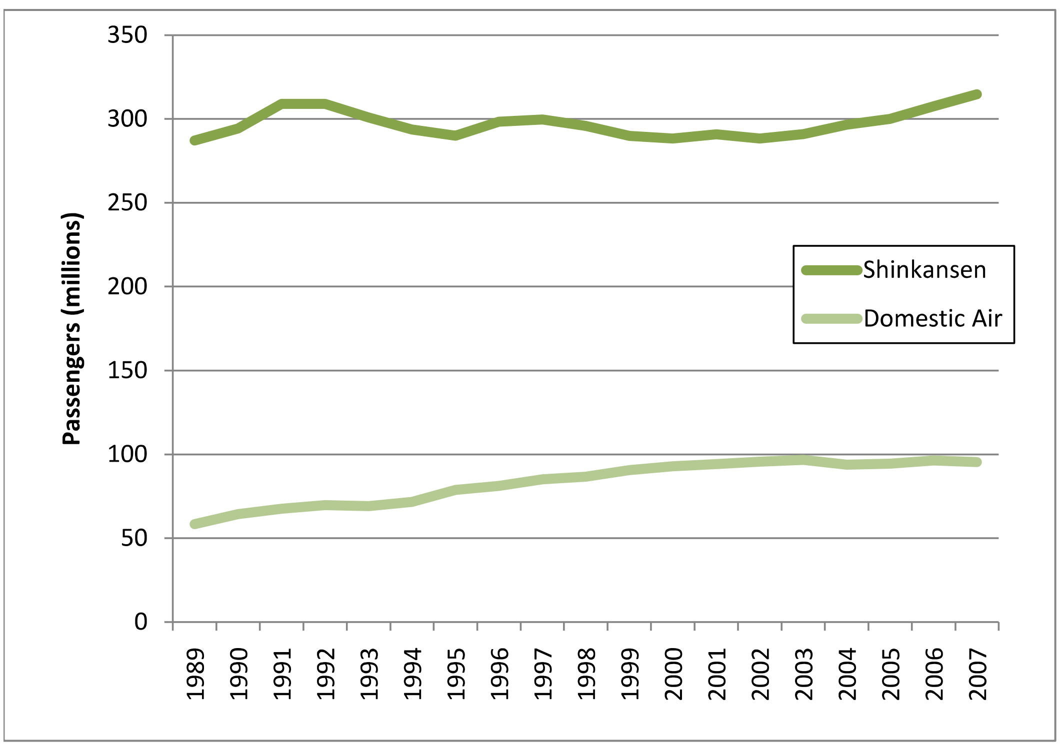

Table 20: Dutzik, Schneider, Baxandall, and Steva (2010)

Dutzik, Schneider, Baxandall, and Steva (2010) also explain that Japan's Shinkansen high-speed rail line draws more than three times as many passengers per year as air travel. For trips under 500 miles, Shinkansen holds a dominant share of the market (Table 21).

	Distance Miles	Rail %	Air %
Tokyo-Nagoya	227	100%	0%
Tokyo-Osaka	343	86%	14%
Tokyo-Okayama	455	82%	18%
Tokyo-Hiroshima	555	56%	44%
Tokyo-Fukuoka	733	12%	88%

Table 21: Dutzik, Schneider, Baxandall, and Steva (2010)

On more recent terms for Yamagata Shinkansen (1992), the total traffic volume increased by 15%; however, aircraft passenger, dropped sharply to 10% in the case of modal share, whereas HSR increased to 89% (Lee, 2007) (Table 22).

	HSR	Aircraft	Bus
1990(before)	874(67%)	396(31%)	30(2%)
1995(after)	3,147(89%)	340(10%)	41(1%)

Source: Ministry of Land, Infrastructure and Transport (Japan)

Table 22: Lee (2007)

Overall, Shinkansen has dominated the transportation sector in Japan at the regional level (less than 500 miles).

Despite the market share dominance at the regional level, Japan has worked hard in continual support and development for the auto sector in order to improve the overall surface transportation system. Japan has been spending massive amounts of money to further develop the auto sector. In 1987, the Seto Ohashi Bridge was completed for road travel, costing about 7.7 billion US dollars. In 1998, the Akashi Kaikyo Bridge opened to the public after ten years of construction and 500 billion yen or 4.6 billion U.S. dollars. Also in 1998, the Ministry of Transport approved construction for three new Shinkansen lines with a budget of one trillion yen or 9.2 billion U.S. dollars (Kagiyama, 2000). Kagiyama (2000) illustrates that Japan is not only developing HSR; they are also spending large amounts of money for auto sector development.

Comparing Japan to the United States, there are some clear lessons that should be learned. First, it is important to understand the differences in demographics between the United States and Japan. Okada (1994) explains that the population density (per square km of habitable land) is 1500 in Japan compared to a mere 50 in the US. Also, the populations of Japan are much more concentrated in urban centers, while US populations have been experiencing more urban sprawl over time. A further decentralized population calls for further investment in the auto sector. However, the market share that Shinkansen has at the regional travel level should not only be admired, but also strived for. The economic and environmental advantages that HSR has over air travel at the regional level (100-600 miles) are undeniable (Table 23: Dutzik, Schneider, Baxandall, and Steva (2010)); clearly, Japan can be a model for the United States in this aspect.

Figure 1. Airplane Energy Consumption per Seat Mile at Various Flight Distances[9]

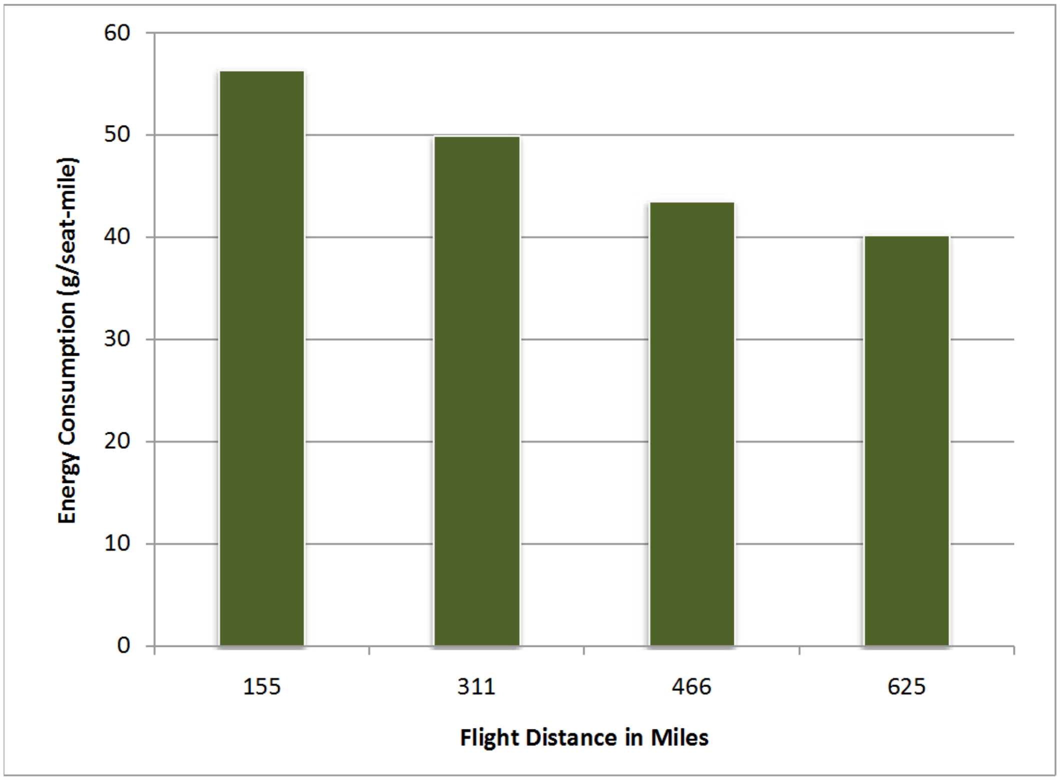

Table 23: Dutzik, Schneider, Baxandall, and Steva (2010)

In sum, Japan HSR has dominated the market share over air travel since its opening in 1964; however, the auto sector has recently (1990's) experienced a boost in economic support, working toward a further developed surface transportation system.

Question Five: Did this case develop transit-oriented development?

As stated in the French case, a high-speed system is only truly successful when it is fully developed and connected to local transportation sectors, allowing for a full range of travelers to access the train. Okada (1994) explains that in general, because the Japanese railways were developed before or during the large expansion of the industrial centers, and also because rail transport was the only means of reliable transportation during development, urban cities were built around stations that have been transformed into Shinkansen stations. This has allowed for an easy transition into a successful transit-oriented development program, connecting local transit such has suburban railway, subway, bus, and taxi services.

Japanese urban centers have been connected with the ever-advancing Shinkansen system, creating a fully extensive and connected transportation system. Kagiyama (2000) supports this claim by stating:

> In Osaka and Tokyo, subways, express trains, monorail, and Automatic Guideway Transit (AGT) are some of the transportation alternatives available throughout each city. In Tokyo, there is an extensive underground network of subways totaling 148 miles, which carry 7.3 million passengers per day with a headway of two minutes during the peak periods. The success of transporting people between major metropolitan areas could not occur without the metropolitan regional government's plan for an expansive and reliable transportation network to disperse incoming and outgoing traffic.

These are specific examples of how regional transportation, supported by government and private enterprises, are able to interconnect, developing into a successful transit-oriented system.

It would be difficult for the US to duplicate the transit-oriented development that Japan has accomplished simply because the US city centers are fully developed without centralized train stations. However, the lesson that Japan provides is one of connectivity upon multiple fronts. The more avenues that US systems can create for different travelers to access the train, the better off the transportation system (air, auto, and rail) will be as a whole. Japan has proven that connectivity to HSR is the key to smooth, reliable, energy efficient, and safe travel.

Question Six: Did this case develop a mixed rail infrastructure?

From the beginning of implementation, Japan has not used a mixed rail infrastructure for the Shinkansen. Similar to France, high speed specific, new-implemented lines were a necessity between the major city centers. However, there wasn't a need for the Shinkansen to have the capability to run on conventional lines like the TGV. First, the population density of Japan is extremely high and centered around the major cities. Second, the transit-oriented development was so well developed in the inner cities that there wasn't any need for Shinkansen to run on conventional lines. Again, this is due to the fact that the rail stations were placed in the city centers. Albalate and Bel (2010) also explain that the separation of high-speed lines from conventional rail service allowed Shinkansen to avoid problems from the conventional services and its ageing infrastructure, increasing its overall reliability.

Okada (1994) explains other aspects that relate to the need for the implementation of new infrastructure rather than mixed. First, in order to create the most direct path between city centers, many tunnels were required, creating the need for new track to be laid. Second, frequent earthquakes, heavy rains, and unstable ground on the plains are safety risks. Using conventional, aging lines at higher speeds is a safety hazard that cannot be taken for granted. Third, with Japan's high environmental regulations in terms of emission and noise pollution standards, new upgraded infrastructure became the most cost-effective route. All these reasons stated above relate to the high initial cost of the Shinkansen lines; however, it has proven to be a cost-effective, long-term solution to the unique demographic national layout.

Comparing the Japanese rail infrastructure to the United States should be taken lightly. The demographic layout does not require for Japan to develop HSR that can run on conventional lines; however, there is merit for the US to consider that development due to urban sprawl, a much smaller population density, and less-developed transit-oriented local connectivity. The United States should however, look into the infrastructure safety technology that Japan has implemented due to the immaculate record of success in that realm. Overall, Japan has developed a cost-effective infrastructure system that is molded specifically for the national demographic layout. The United States can learn lessons in terms of safety technology and the need for demographic-specific infrastructure design.

Summary

First implemented in 1964, the Japanese Shinkansen high-speed line is considered successful despite some financial setbacks for a number of reasons. First, the Shinkansen has successfully dominated market-share for the targeted regional travel throughout the county. Second, the Shinkansen has been the most reliable source of transportation and has continually cut travel time for millions of passengers between major city centers. Third, the Shinkansen has been economically profitable over time despite the large debt JNR acquired before the privatization. Fourth, there has not been one human death due to an accident since the first train left the station in 1964. Fifth, the ever-increasing energy efficiency of the Shinkansen continually increases Japan's energy independence. And last, the transit-oriented development built around the Shinkansen city-centered stations has opened up access to travelers of all sorts. The Shinkansen is a high-speed system that can provide numerous lessons for the US on efficiency, safety, reliability, local connectivity, and demographic specific design.

Germany: ICE

Background

The German Intercity Express (ICE) arrived in 1991, a decade after the French TGV. The largest considerable difference between the ICE with the French TGV and Japan's Shinkansen is that freight was placed as a much higher priority in Germany. Gleave (2004) explains that the Germany's national railroads are owned and operated by Deutsch Bahn AG (DB), a private joint stock company, which is responsible for both passenger and freight trains and is also responsible for maintaining the infrastructure. It is divided into a number of different divisions, of which DB Reise & Touristik is responsible for all long distance passenger services, including high-speed services, and DB Netz in responsible for all infrastructure.

In 1991, the Hanover-Wurzburg and Mannheim-Stuttgart lines were opened, totaling 427 km in length. Other lines that have been implemented include: Hannover-Berlin in 1998; Köln-Frankfurt in 2002/04, Germany's first 300kph line; and Hamburg-Berlin in 2004 (Gourvish, 2012). There are also connections with the Netherlands, Belgium, France, Switzerland, and Austria; adding to the interconnectedness of rail throughout the European Union. Table 24 provides a detailed layout of the German ICE lines and their connectivity with other nations (Eurail, 2012).

Table 24: Eurail (2012)

The economic and social impacts of the ICE will be discussed in further detail below; however, there is a sense of lack of success in Germany compared to France and Japan due to the following reasons: expensiveness of implementation, policitcal and legal obstacles within the government, and low population density in German cities.

<u>Question One: Was the implementation deemed a success?</u>

When examining the success of the German ICE, there is merit to consider a different viewpoint. Albalate and Bel (2010) state that overall goals of the German HSR implementation were different than France and Japan:

> The main consideration when designing the new lines was not faster passenger traffic, but rather the highly profitable overnight traffic between the North Sea ports and the industrial areas and consumer markets in Southern Germany. Goods transport was deemed more important, because it contributes considerably more to the turnover than is the case of passenger traffic. A further difference with the TGV in France is that the HSTs in Germany are heavier, wider and more expensive to run, but offer greater flexibility

With more emphasis placed on freight transfer, it is therefore necessary to judge the German implementation based upon their goals. However, even when taking upon a freight-based viewpoint, there are still some characteristics of the implementation of the ICE that have been deemed unsuccessful on the whole.

The first aspect that has led to the high cost of implementation was the choice of infrastructure combined with the nation's geographic terrain. A highly mountainous terrain and the requirement to build sections to provide easier gradients so that freight could also use the new infrastructure, made construction costs comparatively high (Gourvish, 2012). Gourvish goes on to state in further detail of the high costs compared to the TGV and the Shinkansen:

> Construction costs were inevitably higher than with the French TGV – as much as three times higher per kilometer. At the same time the more limited impact of the ICE, in comparison with that of the TGV and Shinkansen, means that the pay-off in terms of traffic generation has not been as great as in Japan and France

The mixed infrastructure implementation combined with the mountainous terrain led to high implementation costs. The second aspect leading to high construction costs were the various legal and political obstacles, delaying the ICE implementation for a decade. Before new lines can be formed, German law requires public disclosure and public hearings. The ICE generated 360 lawsuits and 10,700 objections (Najafi and Nassar, 1996). This led to inevitable delays in implementation and eventual higher costs.

The other aspect that has led to ICE unsuccessfulness compared to the TGV and Shinkansen is ridership percentages, directly attributed to the low population density of the German cities. Greave (2004) illustrates how the population distribution affects the productivity of the ICE:

> Germany's population is widely dispersed: only three cities have a population of more than 1 million (Berlin, Hamburg and Munich) and only one of these (Berlin) has a population of more than 2 million. As a result, long distance trains need to make multiple

> stops to serve the potential market and this tends to increase journey times; for example, the high-speed train between Munich and Hamburg makes a minimum of seven intermediate stops.

The population density of Germany is much lower compared to France and Japan, which has led to lower ridership percentages and low economic profitability as a result of HSR development. Dutzik, Schneider, Baxandall, and Steva (2010) explain this slow growth by stating:

> The economic growth associated with high-speed rail came before the line entered into service, as businesses and individuals changed their economic behavior in anticipation of the arrival of high-speed rail. Based on their results, the researchers project that every 1 percent increase in market access delivered by high-speed rail will result in a 0.27 percent increase in economic activity in a region.

The low percentages of annual economic growth, along with low population densities throughout the German cities has led to lower ridership percentages compared to France and Japan. Overall, the successfulness of the ICE HSR system is largely dependent on strict characteristics; the high cost infrastructure, a high amount of legal obstacles, and the low population density, leading to the ICE being deemed relatively unsuccessful compared to France and Japan.

Question Two: Did this case support the USHSR funding approach?

The ICE has been funded over the years, by a mixture of the private DB and the German government. This funding approach is similar to the TGV; however, it is again the political obstacles that have provided for a difficult funding approach. This section will examine the in-depth policy implementation process that is required for HSR implementation in Germany.

Gleave (2004) explains that the HSR and infrastructure programs are addressed in the *Bundesverkehrswegeplan* (BVWP), a transportation plan developed by the regional governments, local governments, and the DB. This plan alone can take up to ten years to complete. Once the BVWP is completed, it is presented to the national government and must be passed by both houses of parliament in order for federal funding and implementation to begin. In each plan, a risk assessment, environmental assessment, and a cost-benefit analysis must take place. Once the plan is passed by parliament, it is passed on to the EBA (*Eisenbahnbundesamt*, the federal railway office, which also functions as the rail regulator), which fields all objections and lawsuits and decides whether the financial agreement with the government and DB is feasible. If the BVWP passes the review of the EBA and all lawsuits are settled, the implementation of the lines can take place.

When comparing this funding approach to the U.S. process, there are some similarities in the selection processes. Like Germany, U.S. regions need to produce their own plan, including risk assessments, implementation plans, environmental assessments, and a cost-benefit analysis, before any construction can begin. The difference between the two countries lies in what branch of government the plans are being presented to. The U.S. plans state that regional implementation strategies will be presented to the Department of Transportation, which will decide if the strategy is feasible. This process will generally run more smoothly than the German process since the BVWP needs to be approved by both houses of parliament and the EBA. Also, the DOT has developed guidelines for each region to follow when compiling an implementation strategy. Some of these criteria include the need for a high population and the implementation at the 100-600 mile range; low population areas and plans outside this mile range will not be considered. Therefore, although there are some characteristics similar to the German process, the U.S. plan, in theory, will develop faster and more efficiently.

Question Three: Did this case have a regional implementation scheme?

The main goal for the German ICE implementation strategy was to improve on existing lines to make suitable for high-speed travel, while still allowing for freight travel; this was a clear strategy in avoidance of bottlenecking. As stated in the background section, the ICE was implemented on an incremental level, piecing together different parts to make the system as a whole accessible to both rail services. Dutzik, Schneider, Baxandall, and Steva (2010) elaborate on this concept in further detail by stating:

> Incremental improvements were an important part of the build-out of high-speed rail in densely populated Germany, where freight trains have always shared track with high-speed and conventional passenger rail out of economic necessity. Germany moved toward high-speed rail through a combination of track improvements that enabled travel at up to 125 miles per hour and the construction of new segments of line to bypass bottlenecks. Germany also built its system piecemeal over time, pursuing a long-term series of improvements that have resulted in continual improvements in service.

Besides the high implementation costs, this type of implementation can be successful in terms of vulnerability. With two separate rail sectors traveling on the same lines, the lines themselves are much less vulnerable to economic collapse. If the ICE system collapses, the lines can still be used to freight travel, and vise-versa. This type differs from France in that the TGV lines were not constructed in low populated areas or terrain that would be difficult to construct high-speed lines; instead, the TGV developed a train that has the ability to travel on high-speed tracks and conventional tracks. For Japan, they seem to be more vulnerable to collapse because of their high-speed specific lines; however, with the extremely high population density and ever growing overall population, a collapse is very unlikely.

When comparing the German implementation plan to the United States, there are some clear differences. In the U.S., it is up to each region, based on the specific demographics, to decide what type of infrastructure to implement. However, there is a set standard for both distance (100-600 miles) and population density requirements. At first, each region of the United States should be treated as its own separate system. The focus should be to connect only the highly populated cities with as few stops as possible, continually reducing travel time and increasing reliability. The German system was not implemented in this way; much more emphasis was placed on avoiding bottlenecking, making the system accessible for both passenger and freight travel. This has resulted in a less-vulnerable system in terms of the rail lines always being used, yet has also resulted in lower economic success compared to France and Japan because of lines being placed in low populated areas.

Question Four: Did this case support other transportation sectors?

Germany's ICE has had a mixture of success when competing with the air and auto sectors. In cities with high-speed stations, ICE has generally been successful in displacing air travel. For example, between Cologne and Frankfurt, since the arrival of high-speed rail, rail has come to account for 97 percent of the air-rail market share Dutzik, Schneider, Baxandall, and Steva (2010). However, Gleave, (2004)) explains that the decreasing of flight pricing in Germany has been affecting ICE market share:

> In part as a result of long journey times, rail is facing growing competition from low cost airlines in Germany and the rail regulator (EBA) has suggested that it will be difficult for rail to compete over long distances with the airlines. Rail fares have usually been charged

> on a per kilometer basis in Germany, which means that rail has become particularly uncompetitive for long distance journeys. Rail also faces strong competition from the road network: motorways have neither tolls nor speed limits.

The long journey times for the ICE are not necessarily from a lack of speed capability, but rather a necessity for more stops and higher rail traffic. The ICE needs to stop more than the TGV and Shinkansen because of the low population density; and there is more traffic on the ICE due to the freight sector also using the lines.

Although the ICE may become less attractive for German citizens on long distance travel, it is still in support of the air sector in Germany. Similar to France, high-speed stations can be found at various German airports, connecting travel at the intermediate distance to long-distance travel. For example, the ICE rail station at the airport in Cologne, Germany (above), provides direct access to the high-speed rail network connecting Germany and other nations in northern Europe (Table 25) (Dutzik, Schneider, Baxandall, and Steva, 2010).

Table 25: Dutzik, Schneider, Baxandall, and Steva (2010)

In terms of auto travel, strong competition exists between the two sectors; however, there is not much support from the ICE for the auto sector. The main source that drives the competition between HSR and auto in Germany is the fact that there are no tolls or speed limits on the German high way system (Gleave, 2004). This allows passengers to travel as fast as they want without paying tolls in the comfort of their individual vehicles. When it comes to buses however, DB has a monopoly control over the long distance buses and designs them to not compete with the ICE (Gleave, 2004).

Comparing this to the United States, if HSR is to be successful in the US, a greater effort needs to be made compared to Germany in supporting connectivity of both the air and auto sector. Also, HSR prices in the US need to be competitive with regional travel in order to develop and maintain high ridership. The US plan is to displace air and auto travel at the 100 to 600 mile range, Germany is a clear lesson on how connectivity can be improved to provide economic incentives for HSR.

<u>Question Five: Did this case develop transit-oriented development?</u>

Due to lower population densities in German cities, the transit-oriented development in terms of connecting major metropolitan centers to the ICE is lacking overall. However, in Berlin, the Savignyplatz Railway Station is fully connected not only to local transit, but also the local economy, making multiple facets of the city accessible to all ICE passengers (CHSRA, 2010). One of the main aspects of the Berlin station is the various commercial activities that are located under the track, leading to a greener, more connected community. Although transit-oriented development is lacking around many ICE stations, Berlin could be used as a sample city to base other development around.

In the United States plan, transit-oriented development is a major aspect that needs to be developed to the fullest in order to maximize the HSR benefits. If the HSR stations are not connected in some way or another to each urban center, the trains will be less attractive on the whole. Transit-oriented development increases convenience for the passengers to be able to connect to other forms of transportation; this increases the overall ridership of the line and also increases the economic profitability for the community and region. The lack of ridership and economic prosperity of the ICE compared to Japan and France provides a clear lesson to the U.S. on the importance of HSR based transit-oriented development.

Question Six: Did this case develop a mixed rail infrastructure?

As stated above, Germany has developed a mixed rail infrastructure, using the same lines for both the ICE and freight transport. As a result, the implementation of this specific infrastructure has proven more costly compared to other countries. Vickerman (1996) examines the reasons behind the high cost:

> The German new lines have been much more expensive than the French lines. Due to more difficult terrain (they are replacing difficult old lines through mountainous terrain), they have required a high proportion of line in tunnel. Secondly they have been designed for multi-purpose use, by the very high speed ICE trains at 250 km/h, by traditional IC trains running at 200 km/h and by freight trains running at lower speeds, but requiring more expensive engineering.

Another result of this mixed rail infrastructure is longer trip times due to more frequent stops and higher rail traffic (Gourvish, 2012). The frequent stops are attributed to a lower population density throughout the country, requiring the need for more stations in intermediate centers in between the larger urban centers. The higher rail traffic is attributed to the infrastructure design itself; with freight transport sharing the lines, there are more trains in commute. This also raises costs due to the need for enhanced communication and safety standards.

Although the costs of the implementation were high, the rail implementation has been able to achieve one of the goals of the original plan: avoidance of bottlenecking and flexibility. With the mixed infrastructure, bottlenecking is avoided due to the use of both freight and ICE. The design of the train itself has increased the flexibility due to the weight and width. The mountainous terrain and the freight service require wider, heavier trains that are more costly to run; however, they are more flexible because they are able to travel through the mountains on the most direct route, and can also break-off onto conventional lines.

For the United States, there are two clear lessons that should be taken from examining the German ICE infrastructure. First, HSR is only necessary and economically profitable with lines running between high densely populated urban centers. Frequent stops in lower populated centers reduce speed and increases travel time. Second, and in correlation with the first lesson, HSR should be implemented using their own designated lines in between the major urban centers. This will ensure low rail traffic resulting greater speed, reliability, and safety. The German ICE was successful in avoiding bottlenecking and inflexibility, yet was not successful in implementing the infrastructure at a relatively reasonable cost.

Summary

The German ICE was opened in 1991, a decade after the TGV, despite having planning commence around the same time. There are multiple aspects of this system that are deemed less efficient and less successful compared to France and Japan. Mixed rail infrastructure has led to higher costs and more rail congestion. The low population density of the German cities has resulted in frequent stops and increasing trip times. The political and legal structure of the German system allowed for numerous delays in the planning phase of the ICE. Finally, the lack of transit-oriented development in many of the cities with stations has cost economic opportunities to go unnoticed. The United States has the opportunity to take many lessons from the German ICE in infrastructure, political development of rail lines, and transit-oriented development.

Discussion

The case studies of France, Japan, and Germany have each individually provided lessons on the implementation of high-speed rail, policy implementation, demographics, and more; however, focusing on the case studies at the individual level does not provide the optimum setting for analysis. This section will consist of a cross-case analysis, a triangulation of the three cases to better understand the important lessons that are applicable to the United States. The structure of this section will remain consistent with the structure of the case studies; examining the similarities and differences from each of the six questions. The three HSR systems studied provide empirical insight into the strength's and weaknesses of the US Department of Transportation HSR plan.

Question One: Was each implementation deemed a success?

Both the France and Japan HSR systems have been deemed an overall success; Germany, comparatively, has not been deemed successful for a number of reasons. The French TGV has able to implement the high-speed lines in a relatively inexpensive form; both Japan and Germany have spent much more on the initial implementation of their infrastructure. However, because of the high ridership from large population densities, Japan was able to overcome the large initial investment much easier than Germany.

Ridership is one of the most important factors to the successfulness of a HSR system in any given country. France and Japan were both able to develop high initial ridership that has continually grown over the years due to a combination of high population density in urban centers, reliability, and few stops. Germany, has struggled with ridership numbers for the very same reasons: the population density in the major urban centers is lower, leading to the need for more stops along the high-speed lines, resulting in longer travel times and decreased reliability.

Safety is another imperative characteristic that must be near flawless in order to be considered successful. From the beginning of their existence, neither the TGV nor the Shinkansen have ever had a single passenger death due to a HSR accident; Germany cannot lay claim on such a statistic. The 1998 ICE crash of the Eschede train resulted in 101 deaths and 80 injuries of a total 287 passengers. Safety is an extremely vulnerable attribute that directly affects the overall economic output of the high-speed line. One accident, such as the 1998 ICE crash, will immediately result in lower ridership percentages and a loss in economic output.

Overall, cost of implementation, ridership numbers, and safety are the three main attributes that have separated France and Japan from Germany. There are many more attributes that will be discussed below; however, these larger concepts will be underlying each and every following concept, providing a continually clearer picture as to why each system was successful or not.

Success Variables	France	Japan	Germany
Mixed Funding?	Yes	No, Until Privatization	Yes, Long Legal Obstacles
Regional Implementation Strategy?	Yes	No	No
Incramental Strategy?	Yes	No	No
Strong Safety Record?	Yes	Yes	No
Air and Auto Support?	Yes	Yes	No
Strong Transit Oriented Development?	Yes	Yes	No
Designated High-Speed Lines?	Yes	Yes	No

Table 26: Variables of Success per Country

Question Two: Did each case support the USHSR funding approach?

When examining the three case studies side by side, France has clearly been most successful in terms of funding efficiency. The TGV was originally funded by the SNFC, a state-owned company with a separate budget. After the original success of the first TGV line, the RFF was formed to take the infrastructure debt away from the SNFC; also, the government and European Union began to support funding projects for additional lines.

Japan's funding approach provides a lesson easily avoidable by the United States. As stated in the case study, the initial funding approach for the Shinkansen in Japan derived from Japan National Railways (JNR), a state-owned company under the federal budget. From 1964 until the 1987 privatization, all Shinkansen expenditures fell upon the federal budget, leading to massive debt. The massive debt was only exasperated by the high implementation cost from the need for a high number of tunnels for the most direct route between city centers. Following the 1987 privatization, splitting the Shinkansen cost between the JNR and six regional private enterprises, a much more economically successful system was developed. The high initial cost of HSR projects provides merit for a public-private funding approach.

The German funding approach was similar to the French approach in that the cost was split between private enterprises and the government; however, the legal and political processes to approve funding led to slowed progress and ultimately much higher cost. Each German HSR project must be approved by both houses in parliament, and then reviewed by a separate governmental branch (EBA-*Eisenbahnbundesamt*, the federal railway office, which also functions as the rail regulator), for funding approval. This is a lengthy process that not only slowed the overall progress of the implementation and raised the cost, but also hamstrung the government to produce HSR results more quickly as time went on, regardless of quality.

Overall, valuable lessons can be taken from each case study when applying to the US plan. France has had the most successful funding approach with a mixture of funding, and just as important, an incremental implementation scheme as to not compile debt in a short amount of time. Japan has had success due to high ridership despite the poor initial funding approach, placing all debt on the governmental budget. Lastly, the German political system hampered and even raised the cost of the funding approach due to the political and legal obstacles.

Question Three: Did each case have a regional implementation scheme?

The implementation of HSR is best implemented with an incremental scheme, keeping the vulnerability of the system at a minimum. Once again, the French implementation proved to be the most successful compared to the other two cases. Not only did the implementation of the different lines occur incrementally over time, there were also strict demographic regulations in place for urban qualifications. The TGV was only developed in cities with high population densities, assuring a high ridership before the line even opened. As stated in the funding section, this strategy also led to political and economic support from the French government and the EU, once the economic benefits and potential were realized.

Originally, Japan was extremely aggressive with plans for Shinkansen implementation once the original 1964 line was deemed a success. However, JNR's over committed attitude to producing HSR lines as quickly as possible led to the large accruement of debt. The Shinkansen lines were eventually implemented incrementally at a regional basis and deemed successful due to the high ridership, but only because of line selection. Like France, the Shinkansen lines were placed only along corridors between cities with large populations, allowing for almost certain strong economic returns despite the high construction costs.

The goal of the German ICE developers was not to implement the lines at the regional level; rather, the goal was to develop national lines developed for both HSR and freight travel as quickly as possible. The result of this strategy was the development of ICE lines in cities with low population densities, leading to lower ridership percentages and the need for more stops between major cities. Although the lines were developed incrementally due to high construction costs, there were no demographic requirements, leading to a less successful HSR system compared to France and Japan.

<u>Question Four: Did each case support other transportation sectors?</u>

By implementing high-speed lines at the regional level (600 miles or less), France and Japan have been successful in both displacing and supporting the air and auto transportation sectors. From 1981 on, the TGV has been successful in diminishing air and auto travel at the regional level, while dominating the market share. Despite the competition and the intermediate range, France has been successful in supporting the air sector for long distance travel. There are numerous TGV stations located in airports, allowing for passengers to purchase one ticket for long distance flights, intermediate TGV travel, and local transit. However, there has not been a strong push by the TGV network to help support the auto sector.

In Japan, the 1964 implementation of the Shinkansen allowed for regional market share dominance from the very beginning due to the lack of an established air sector in the country. The size of the country has allowed the Shinkansen to dominate the overall regional transportation sector. Also, the mountainous geographic layout along with the high population density in cities allows for high-speed rail to have advantageous traveling abilities that the other two sectors do not have. However, by sticking at the regional level, the Shinkansen has supported the other two sectors by allowing for long distance flights and short distance car travel. There is also an even stronger push in Japan for increased auto transportation compared to other countries; the major bridges of the Seto Ohashi (1987) and Akashi Kaikyo (1998) have been constructed to promote road travel.

Instead of having the choice between supporting or dominating the other two transportation sectors, the German ICE has been preoccupied with simply staying in competition with air and auto. For air competition, there is an ever-growing preference towards air travel due dropping air ticket prices, high rail traffic (ICE and freight), and the many stops the ICE trains must make due to low population density. The lack of a speed limit and highway tolls are also contributing to lower ridership percentages for the ICE compared to the TGV and Shinkansen; making the auto travel option at the regional level more convenient than in other countries.

Overall, supporting the other two transportation sectors throughout a given country is vital to the overall success of its economy. France and Japan have both remained within the regional level for high-speed rail travel, leaving air for the long distance and cars and other forms of local transit for short distance travel. Germany has struggled to compete with the other two sectors due to the high amount of traffic on the rails from the freight service and the high number of stops between major urban centers.

<u>Question Five: Did each case develop transit-oriented development?</u>

When it comes to transit-oriented development, connecting the high-speed systems to local transit systems and local economy in a close proximity, France and Japan are far above Germany. France has focused on connecting the TGV to the local transit systems throughout the country; as stated above, since 1985, France has implemented 20 light rail city tram systems in and outside of Paris, with most of them directly connected to a TGV line. Also stated above, the TGV stations located in airports connect international travelers to the train. France has established transit-oriented development thoroughly through connecting the TGV to both local and long distance travelers. Japan's city-centered rail stations have made transit-oriented development come naturally. Shinkansen has always been thoroughly connected to local transit such has suburban railway, subway, bus, and taxi services.

As for Germany, the lack of transit-oriented development has once again come down to the lack of ridership and low population densities in urban centers. The low populations require more stations due to the dispersed people; therefore resulting in lower ridership percentages. This combination has led to a lack of transit-oriented development in the lower populated centers. However, in the largest city, Berlin, the transit-oriented development is well established with local transit and local businesses surrounding the ICE station. These case studies provide further merit as to why HSR should only be developed in higher populated cities in order to fully enhance transit-oriented development around the station.

Question Six: Did each case develop a mixed rail infrastructure?

In the examination of infrastructure, each case study provided different results, revealing important lessons to be applied to the United States. France has developed a system of mixed rail in a different form; instead of allowing conventional trains to run on designated the high-speed track, they simply made the high-speed trains compatible for conventional lines. France proved to have a successful system since the newer lines were designated strictly for the TGV trains; however, the TGV trains could travel onto conventional lines at slower speeds if needed, resulting in a minimum number of stops and increasing reliability. Not only has the TGV system been cost effective in terms of cost per mile, it has also proven cost effective due to its ability to connect to other European lines, enhancing economic gains.

Japan has developed a monorail infrastructure system with high-speed designated lines and Shinkansen trains. Allowing for mixed infrastructure would be cost effective in most countries; however, due to the extremely high population density of Japanese cities, there was no need for mixed infrastructure. As stated above in the Japan case study, three additional characteristics led to a cost effective monorail system. First, in order to create the most direct path between city centers, many tunnels were required, creating the need for new track to be laid. Second, frequent earthquakes, heavy rains, and weak ground on the plains are safety risks. Using conventional, aging lines at higher speeds is a safety hazard that cannot be risked. Third, with Japan's high environmental regulations in terms of emission and noise pollution standards, new upgraded infrastructure became the most cost-effective route. These factors, along with the high population density of the cities, led to a monorail system.

Germany has developed the most traditional mixed rail infrastructure for the ICE: lines that are compatible for both high-speed and freight trains. As stated throughout the paper, this infrastructure has led a much less successful system compared to France and Japan. First, the need for freight lines across the country led to development of high-speed lines in areas with low populations where they were not necessary. This has led to frequent stops and slow trip times. Second, the mixed infrastructure has led to higher implementation costs. And third, the mixed infrastructure has led to more rail traffic on the ICE lines, also resulting in slower trip times. The United States can learn from the successes of France and Japan, while also learning from the mistakes from Germany.

Summary

This section has compared each case study to the list of questions related to the United States high-speed plan. There are numerous points of each study that provide insight into the strength of the current US plan. The following section will provide a summary of the lessons learned that can be used in regards to the United States HSR plan. Some lessons learned are in direct correlation with the current plan, while others vary and provide further insight into important HSR issues.

Lessons Learned

Lesson One: Develop a mixed funding approach

Based on the funding lessons provided by the three case studies, there is strong merit for the United States to keep the mixed funding approach they have in place. The current structure calls for regions to submit applications for governmental funding grants; the plan also provides DOT cooperative agreements. This approach allows for a mixture of private spending, matched by government agreements and further bolstered by grants. This approach avoids placing too much financial pressure on either sector. France has been and continues to be successful in their mixed funding approach; also, Japan has been able to relieve much of their financial pressure once the privatization and mixed approach took hold.

Germany provides a valuable funding lesson in the political sense; the United States cannot have an over-extensive funding approval system. The German approval system has proven both timely and costly due to the need for both houses of parliament to approve implementation plans. The United States plan calls for the Department of Transportation to review each regional application, entrusting the department to make the right decision. There is no need for Congress to pass each and every application of high-speed lines; the DOT will provide the proper insight and review in a timely fashion. Overall, USDOT has developed a thorough mixed funding approach with a sound and timely review procedure.

Lesson Two: Develop incrementally at the regional level, with demographic requirements

The most important lesson that the three case studies provide is the need for implementation only in cities with high population densities. Germany has shown that the development in cities with low population densities leads to low ridership, frequent stops, and high costs; therefore, there is merit for HSR lines to only be developed in cities with populations of a minimum of 500,000 people. This provides the largest potential for a high ridership contribution.

Another lesson provided by the case studies is that US HSR lines should only be developed at the regional level, with distances no longer than 600 miles. The DOT plan calls for implementation between the 100 and 600 mile range; based on the cases, this is an appropriate range, allowing for the support of the other transportation sectors while displacing the unnecessary short flights and long car trips. Each region of the United States should be treated likes its own country in the European Union in terms of implementation strategy; however, these basic implementation strategy requirements for all would lead to a better HSR system on the whole.

Finally, it is important for the HSR systems to be developed incrementally. The geographic size of the United States will require large economic investments from the federal government for each region. If there is a large total investment in a short amount of time, the amount of financial pressure that will fall upon the DOT will be similar to that of the Japanese debt set backs. Therefore, it is important to implement the projects incrementally, developing the regions with the most promising plans and demographics before the others. This strategy will present a clear window for the DOT to evaluate the successfulness of the initial implementation projects, reducing the vulnerability of collapse.

Lesson Three: Support Air and Auto by staying at the regional level

When it comes having a comprehensive transportation system in a nation as large as the United States, there is no "silver bullet" technology that can dominate cost effectively over all distances of travel. In other words, HSR cannot look to dominate short, intermediate, and long distance travel; therefore, HSR implementation should support the air and auto sectors by remaining at the regional level among cities with high populations.

Air and auto are both large contributors to the overall US economy; neglect of these sectors from DOT would be an ineffective way to answer the transportation energy problems. Long distance HSR may not be able to compete with air due to slower speeds and ticket pricing. Also, Americans have developed a cultural norm of individualized car travel; to neglect that sector could result in a poor HSR system. Therefore, each region developing HSR travel in between highly populated urban centers would provide the highest potential to develop the most cost effective transportation system.

Lesson Four: Include transit-oriented development into HSR proposal

France and Japan have provided valuable insight into how an interconnected high-speed rail system to local transit, long distance transit, and local economies can enhance ridership and economic gains. In contrast, Germany has proven that lower population densities will result in a lack of transit-oriented development and a lack of economic potential. Therefore, there is merit for each region to be required by the Department of Transportation to include transit-oriented development plans that will enhance connectivity to local transit systems and local economies. The requirement of these plans could provide the largest opportunity to produce the most cost effective solution to the question of the enhancements a high-speed train can provide a community and region.

Lesson Five: Do not implement infrastructure using both high-speed and freight

The successes of France and Japan, along with the failures of Germany, have provided valuable lessons on HSR infrastructure. One of the main pillars for success of a high-speed train system is reliability; based on the case studies, a mixed rail infrastructure using HSR and freight on the same tracks reduces the HSR reliability due to increased traffic. This infrastructure has also proven to be more costly. Therefore, using the same lines for freight and high-speed should not be permitted in the US.

Each region of the U.S. is different in terms of demographics and geography; therefore, each region should decide which infrastructure is best. The TGV infrastructure may provide merit in regions with a high amount of conventional lines in place; this would allow for the high-speed trains to run on their designated lines and conventional lines if need be. In areas with higher population densities, there may be merit for a monorail system similar to the Shinkansen lines. Overall, the lessons from the case's make it clear that a system of designated lines may be the best option for the US high-speed train systems.

Conclusions

Limitations of the Study

There are three limiting factors of this study that need to be taken into account. First, this study is a mere prediction of what the US HSR implementation will be like based on the implementation plan and the case studies. Although France, Japan, and Germany reveal valuable lessons, providing examples and great successes and failures, there exist societal differences between the case studies and the US that should not be ignored.

Second, the time and resources that have been allocated towards this study have limitations. Due to the nature of the requirements, the time allotted for study has been limited compared to what other research opportunities might provide. Also, the lack of resources in terms of funds and collection methods is a limiting factor.

Third, and in direct correlations with the lack of time and resources, the collection of information came from secondary sources, resulting in the reliance of accuracy of information in what other authors provided.

Overall, the limitations of the study are kept to a minimum because of the strength of internal and external validity from conducting a multiple case study. The multiple case study improves internal validity by adding multiple countries of study to examine the success of each implementation strategy; examining multiple countries strengthens the questions that are posed. This in turn strengthens the external validity by making the study more generalizable to other countries if the study were continued; allowing for the same questions to be examined regardless of the nations high-speed system.

Future Research

There are many opportunities for continuation of research directly branching off this project. With further time and resources, some future studies that would prove valuable include: a pricing analysis to examine the price competitiveness of HSR compared to flights and car travel; an ecological footprint analysis including the environmental impacts of a high-speed train; a study on the different fuel sources that can be used to power a high-speed train, including renewable sources; and last, a continuation of the multiple case study by examining additional countries that have implemented HSR. These additional aspects of research would provide further comparative questions to be applied to the analysis if the US implementation plans, resulting in the strengthening of the high-speed system as a whole.

Final Comments

It is important to understand that this project was not established to create a comprehensive implementation plan for high-speed rail in the United States; rather, this project intended on observing the depth and quality of the current implementation strategy and making additional recommendations by comparing it with France, Japan, and Germany. Overall, after the comparisons, there are some clear successes of the US plan, along with some failures. The successes include the regional implementation strategy in cities with moderate to high population density; however, the plan lacks a specific required population number. DOT was also successful in developing a mixed funding approach with the cooperation of private and public expenditures. Lastly, the plan was successful in the continuation of support for the air and auto sector, with an attempt to enhance transit-oriented development.

Upon completion of the case studies, the analysis provided insight into two major holes of the US HSR plan. First, with partial funding being placed upon the government, it is vital for HSR to be developed incrementally; developing all regional projects in a short amount of time will result in a drastic financial burden for the US government. Second, the plan states that an eventual national HSR system will be completed; however, there isn't a need for a HSR system from coast to coast. The travel time and ticket prices will not be competitive with air, resulting in a large waste of resources on track in low populated regions. With the recommendations stated above implanted into the DOT plan, HSR has the opportunity to be an economic, social, and environmental success in the United States.

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