

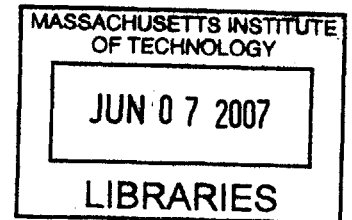
**A Lean Enterprise Approach for Developing High Speed Rail  
in Japan and Portugal**

by  
**Nobuhiro Iwamura**

**M.E., Engineering Synthesis, the University of Tokyo, 2001**  
**B.E., Engineering Synthesis, the University of Tokyo, 1999**

Submitted to the Department of Civil and Environmental Engineering  
in Partial Fulfillment of the Requirements for the Degree of


**Master of Science in Transportation**  
at the  
**Massachusetts Institute of Technology**  
June 2007



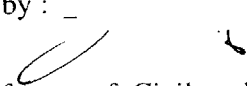
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## **ABSTRACT**

This thesis explores and evaluates the application of the lean enterprise concept to the expansion and development of the high speed railway industry in Japan. The basic idea of the lean enterprise is increasing value-added processes, eliminating waste, and creating equitable value delivery throughout the enterprise. It also focuses on both radical change and continuous improvement. The application of the lean enterprise concept to the railway industry, a service industry, is the first such example. Therefore, the aim is not only to consider the future strategy of the new high speed rail in Japan, but also to assess whether lean enterprise architecting is applicable to the new construction projects of railway industry.

First, this thesis looks back at the history of the Japanese railway system and examines the details of the present Shinkansen railway system. It then makes an international comparison with the United Kingdom and German railway systems to be utilized it in the later analysis.

Next, the Enterprise Value Stream Mapping and Analysis (EVSMA) is applied to the new extended Shinkansen projects in Japan, providing suggestions that for strategy that can offer the projects some advantages from the lean enterprise perspective.

The results suggest that the lean enterprise concept is very suitable for the development of railway industries to enhance the total enterprise performance, because of the need for large capital investment and its complexity and high technology. Some barriers exist, such as political interventions, but if the lean approach is applied by the representatives of existing stakeholders, it will greatly help the slow growth Japanese railway industry to prosper.

The lean enterprise concept is further tested and validated through application to Portugal's high speed rail construction project. An appropriate strategy for construction of high speed rail, derived from this analysis, generates some useful ideas for the future.

Thesis Supervisor: Joseph M. Sussman

Title: Professor of Civil and Environmental Engineering and Engineering Systems



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---

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Nobuhiro Iwamura  
Cambridge, Massachusetts  
May 2007



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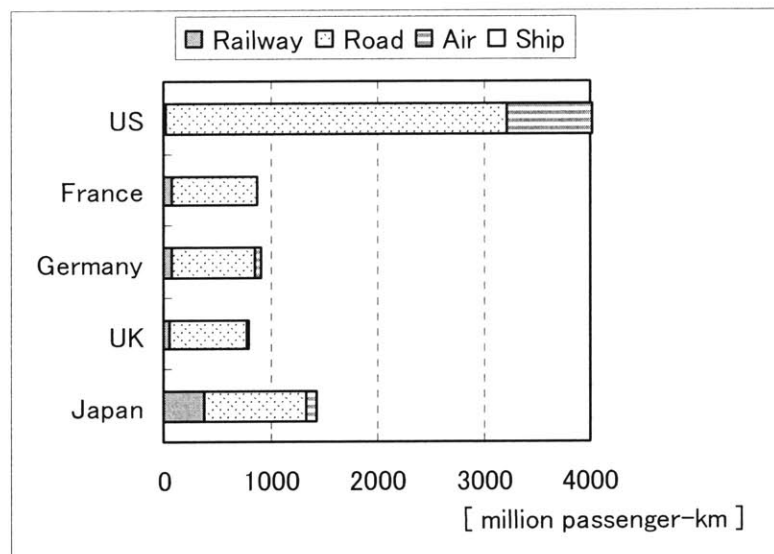


# Chapter 1. Introduction

## 1.1. Background and Outline

The high speed rail industry is evolving in the world. Recently high speed rail in Taiwan introduced the Japanese technology there, and China is now choosing the technology among Japan, Germany and France [1]. In Europe, there are some extension projects in Germany, Spain and France.

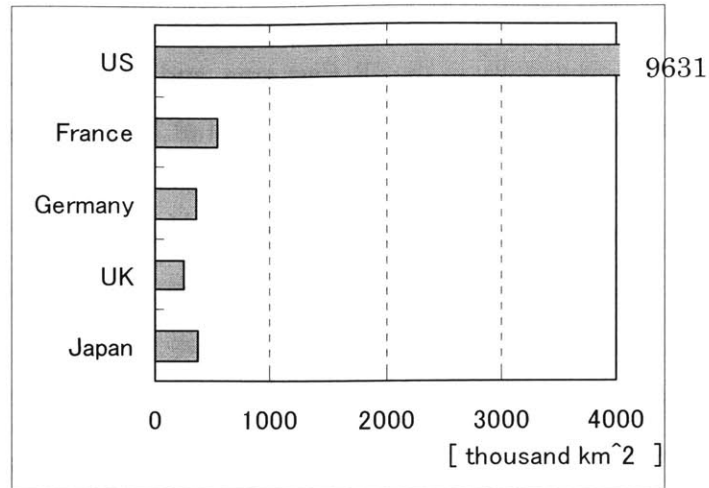
In Japan which was the first country to have high speed rail, the technology for improvement in speed is developing and extensions of high speed rail (Shinkansen<sup>1</sup>) are continuing. Considering the small size of the country and relatively big share of railways among modes in Japan (Figure 1-1, Figure 1-2), it is not an exaggeration to say that the Japanese Railway Industry is still in a favorable situation to have further extension of Shinkansen lines.



Source: JR East [2]

**Figure 1-1 Passenger Transportation by mode**

<sup>1</sup> The Japanese term for high speed rail is “Shinkansen”, literally “New Trunk Lines”, on which maximum speed in operation is 275 km/h and average speed is more than 200 km/h.



Source: Statistics Bureau & Statistical Research and Training Institute [3]

**Figure 1-2 Area of each country**

Although huge capital investment is necessary, the Shinkansen is capable of providing high volume, efficient and precisely scheduled transportation and is good for the environment. Also if the construction plan is successful, there is a huge impact on the local economy.

However, with the decline in population and trends toward greater use of the road transportation mode, a careful decision making process is necessary for extension projects. Additionally, the system of the new extended Shinkansen lines is not vertically integrated. Operations are separated from infrastructure, which is different from the vertically integrated system of the existing lines. In the system of newly extended Shinkansen lines, infrastructure is owned by governmental organizations and there is a lease contract between the government and operators. This new type of railway system organization is more like that of European countries such as Germany and the U.K. This thesis compares them internationally to assess the organization of the new extended Shinkansen lines in Japan and to utilize the assessment in the later analysis.

Then this thesis explores and evaluates the Shinkansen expansion and development in the JR East<sup>2</sup> area in Japan. Because of the need for large capital investment and its complexity and high technology, it is necessary to enhance the total enterprise performance in ways

<sup>2</sup> JR East : East Japan Railway Company, one of the six biggest railway companies in Japan. The area is in the eastern part of Honshu, the main island, and includes the Tokyo area.

similar to the LAI project<sup>3</sup> (Refer to Chapter 5). This thesis will apply the ideas of LAI to Japanese railway industry, especially in the JR East area, and suggest a new lean enterprise (Refer to Chapter 5 and 6) [4] for the further development of Japanese high speed railways.

Since this application of the lean enterprise concept toward railway is the first time, this thesis will assess the usefulness of lean enterprise concept for the development of high speed rail. Finally, as another example of applying the lean enterprise concept, Portugal's case study is discussed.

## **1.2. Research Objectives**

This thesis aims to accomplish five steps: (1) Look back to the Japanese railway system in history and examine the details of the present Shinkansen railway system (2) compare with the United Kingdom and German railway systems to utilize it in the later analysis, (3) apply the Enterprise Value Stream Mapping and Analysis, EVSMA [5], (Refer to Chapter 5 and 6) to the new extended Shinkansen projects in Japan, (4) provide suggestions for strategy of Japanese Shinkansen extension projects to become a lean enterprise, (5) assess whether the new lean enterprise architecting concept is applicable to the development of high speed railway industry, (6) propose an appropriate approach toward the construction of high speed rail in Portugal.

The main part of this thesis is the application of lean enterprise concept for new high speed railway in Japan. Lean enterprise concept is usually used for manufacturing companies and now beginning to be used in the aerospace industry in the U.S. The focus of the study is expanding but the application toward the railway industry is the first trial. Therefore, it is not only to suggest the future strategy of high speed rail industry in Japan, but also to assess whether lean enterprise architecting is applicable to new high speed rail projects.

---

<sup>3</sup> LAI : Lean Aerospace Initiative, a consortium dedicated to enterprise performance of aerospace industry in the U.S. [4]



### **1.3. Thesis Structure**

Chapter 1 provides general information on Japanese high speed railway industry and a small introduction of lean enterprise concept. Chapter 1 also identifies the purpose and structure of this thesis.

Chapter 2 starts with describing recent history of Japan's nationwide railway network and its system through the break up of the Japanese National Railways in 1987.

Chapter 3 provides basic information on the several types of Shinkansen lines in Japan. This includes existing lines built to full Shinkansen standards, extensions on which smaller-profile cars are used, and new extended Shinkansen lines, some of which are still under construction or planning. It also describes the relationship with the Japanese government.

Chapter 4 discusses case studies of the United Kingdom and Germany, and compares them with the new Japanese extended Shinkansen industry in system terms, to utilize them in later analysis.

Chapter 5 introduces general information on lean enterprise architecting and EVSMA (Enterprise Value Stream Mapping and Analysis) that is used at MIT [5] and LAI.

Based on Chapter 2 through 5, Chapter 6 emphasizes and utilizes the lean enterprise architecting concept and EVSMA as a tool for developing the new extension of Shinkansen lines in Japan efficiently. It is strongly focused on the new Shinkansen extension projects in Japan. Finally Chapter 6 also identifies how the ideas work for the railway industry in general, based on the analysis in this chapter. This is the first application of the lean enterprise concepts to the railway industry; they have already been applied to the aerospace industry in the U.S.

Chapter 7 also suggests how one would design a lean enterprise for high speed rail in Portugal by putting together about some facts about Portugal, case studies of European

countries and lean enterprise architecting analysis in Japan.

Based on the results of the analysis, Chapter 8 gives conclusions concerning the usefulness of lean enterprise architecting for railway industries and future suggestions of strategy for the Shinkansen extension projects in Japan. It also gives some suggestions for the high speed railway in Portugal.

Figure 1-3 provides a graphic illustration of the thesis structure.

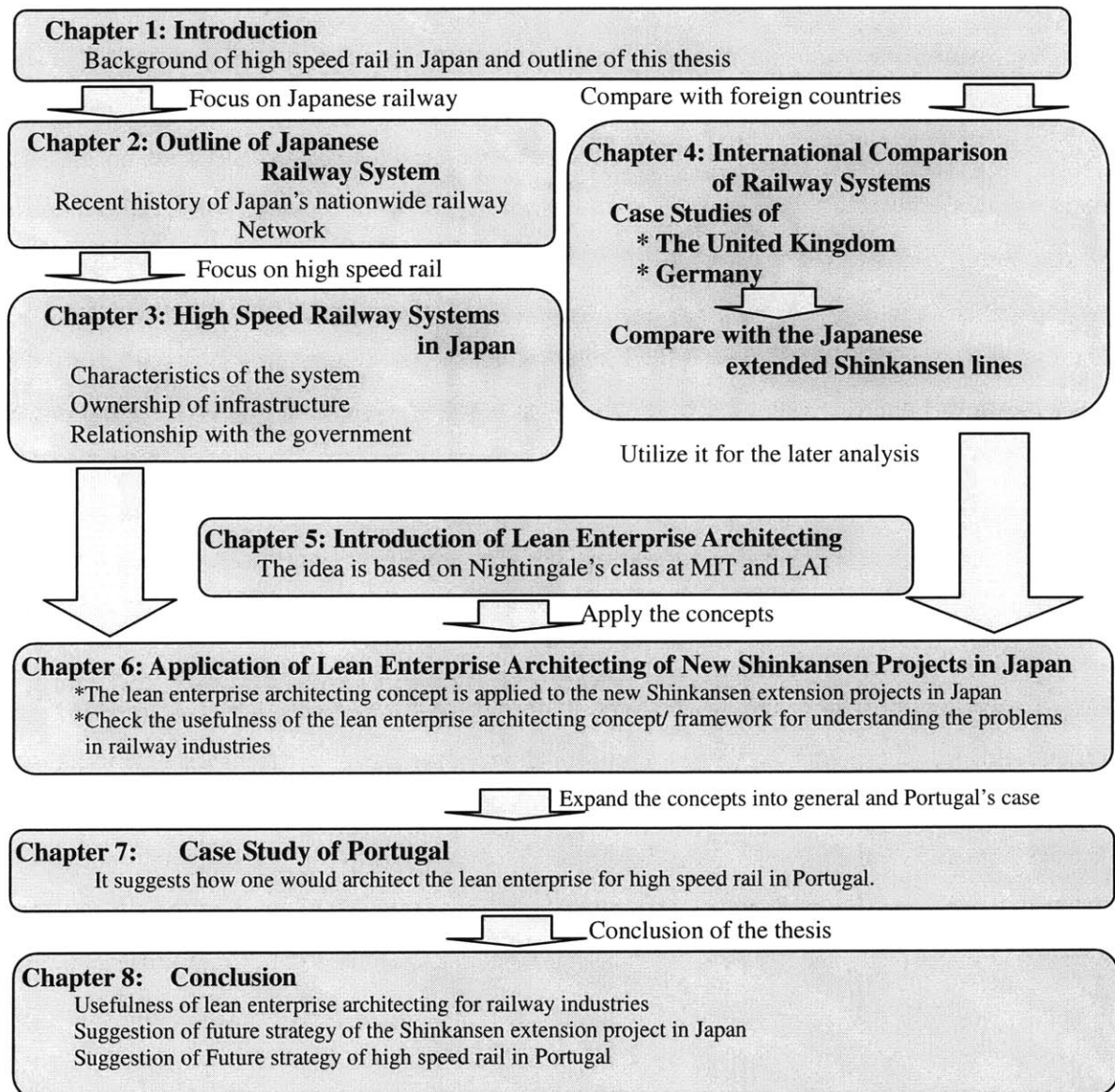


Figure 1-3 Graphic Illustration of the Thesis Structure

## **Chapter 2. Recent History of Japan's Nationwide Railway Network**

The JNR (Japanese National Railways, a public corporation) was established in 1949 [6]. 80 percent of Japan's railways were JNR, while 20 percent were and are regional, local and urban railways outside of the national government system.

Since the break up of JNR, the JNR was separated into six JR passenger railway companies (the Japan Railway companies: JR East, Central, West, Shikoku, Kyushu, and Hokkaido) and the nationwide freight railway company, JR Freight. The maintenance of infrastructure / locomotives / trains and the operation in each of the six regions is managed by the region's passenger railway company. The infrastructure includes almost everything such as tracks, maintenance facilities, stations and buildings. In terms of the ownership of infrastructure, the Shinkansen lines are owned by either JR companies or a governmental organization with a lease contract, and all other conventional lines are solely owned by JR companies.

On the other hand, the freight rail company has very little of its own rail infrastructure. Except for short freight-only branches and terminal facilities, JR Freight operates on lines owned by passenger railway companies and has to pay the charge for this usage. This is a difficult situation. This relationship between the passenger rail and freight rail company is the opposite situation from the U.S relationship. It is a result of the weaker competitive position of railway freight in Japan.

Following are the key factors of the history of the recent history of Japan's nationwide railway network.

## **2.1. Era of JNR (Before the break up in 1987)**

Before the reform in 1987, 80 percent of the Japanese railways were owned and operated by the fully integrated monopoly railway entity, JNR from 1949. Total capital and operating cost of JNR developed during the 1960s and the government had carried extensive debt for the considerable cost until the reform in 1987. JNR had two characteristics which made the management worse. First, JNR was a public, governmental organization. Second, it was a huge management organization which was uniform in all areas [2]. These two elements made JNR unable to cope with the changing circumstances surrounding the railway industry. Specifically:

### **<<Problems in terms of the nationwide big organization >>**

#### **1. Too big organization which exceeds the capacity for management**

JNR was too big for managers to keep up on the situation of each worksite and this caused difficulty in carrying out their policy. Then the corporate loyalty and vitality among workers drastically dwindled and JNR lost control for its organizational management.

#### **2. Uniform Operation all over Japan**

Railway operation should be different from area to area to adapt to the economy and traffic situation in each area. However, the basic policy for such as fares, wages, and timetables was determined uniformly by head office.

#### **3. Cross-Subsidy within JNR**

The accounting management was not separated by area or department. Each area or department had become interdependent by cross-subsidy. This cross-subsidy reduced the incentives for the organization to reduce costs and aim for a certain profit target and finally let the management of JNR become less efficient.

#### **4. Lack of competitive consciousness**

JNR was much bigger than any other railway company in Japan and this in turn led to a lack of competitive consciousness. As a result, JNR lacked the ability to respond to the highly competitive transportation market while automobile use was growing.

## <<Problem in terms of the public organization>>

### **1. External Interference and lack of management autonomy**

The most important issues for management such as budget, fare and selection of executives were influenced by government and politicians. Especially, politicians often forced JNR to construct new railways and new stations for the benefit of their election districts. Even though some construction was unprofitable for JNR, JNR could not avoid these unprofitable, inefficient investments since the budget and personnel were determined by the government. In this situation, management autonomy was eliminated and it became ambiguous who should be responsible for the management and investment of JNR.

### **2. Unstable Labor-Management Relationship**

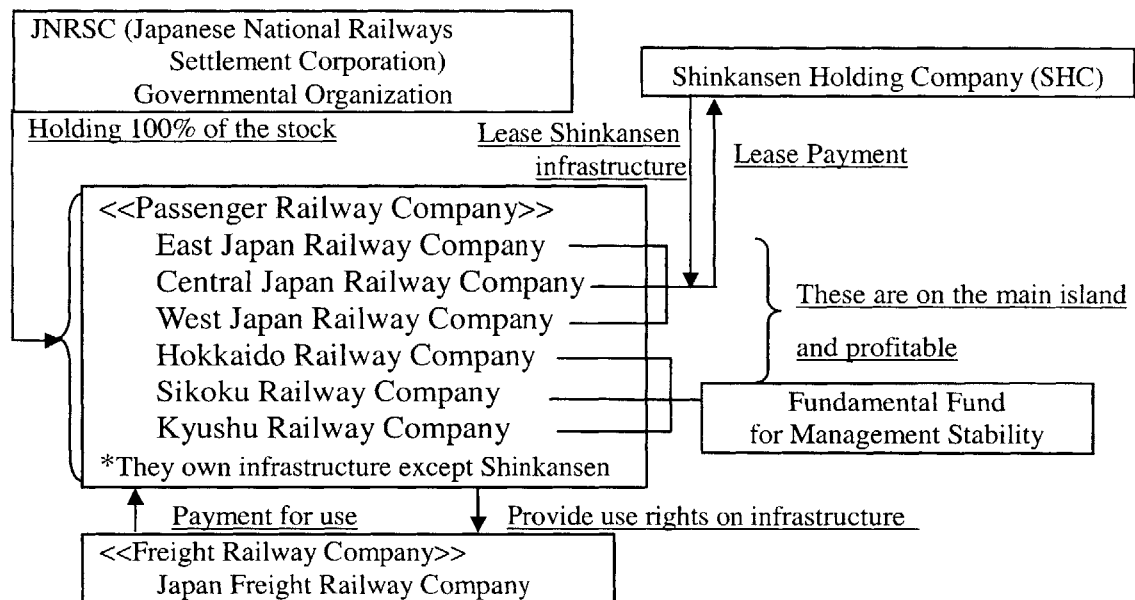
There was a lack of ability to solve problems between labor and management. For example, JNR could not make decisions in terms of wages, which are one of the most important components of working labor conditions, because changing wages needed approval by the Diet. Furthermore, employees and labor unions thought JNR would never go bankrupt because JNR was a public sector corporation owned by the government. In this way, motivation was decreased, the discipline rules were ignored, and the relationship between labor and management got worse.

### **3. Restrictions of the area of business for JNR**

The business of JNR was restricted to railways and supplemental transportation (buses and ferries) because it was not a private company. Therefore, it was difficult to have diversified and flexible business activity other than transportation even though this could have increased corporate revenue.

## 2.2. Break Up / Reform of JNR in 1987

To solve all these problems, JNR was divided and privatized. Figure 2-1 shows the overall organizational structure right after the reform of JNR in 1987. JNR was broken up into 6 private passenger rail companies based on the six distinct geographic regions and a nationwide freight rail company. Both infrastructure and operation were managed by each of the six private passenger rail companies. In this early stage, all the railway companies were special companies owned by JNR Settlement Corporation, a governmental organization. But all of the stock was intended to be sold in the stock market to obtain the independent management from the government as a pure private company. Nowadays, all of the profitable companies, JR East, Central, West on the main island, have been fully privatized through sale of the corporate stock. However, the other three unprofitable companies (Shikoku, Kyushu, Hokkaido Railway company) has not been privatized yet.



Source: JR East [2]

Figure 2-1 Organizational structure of Japanese railway right after the reform in 1987

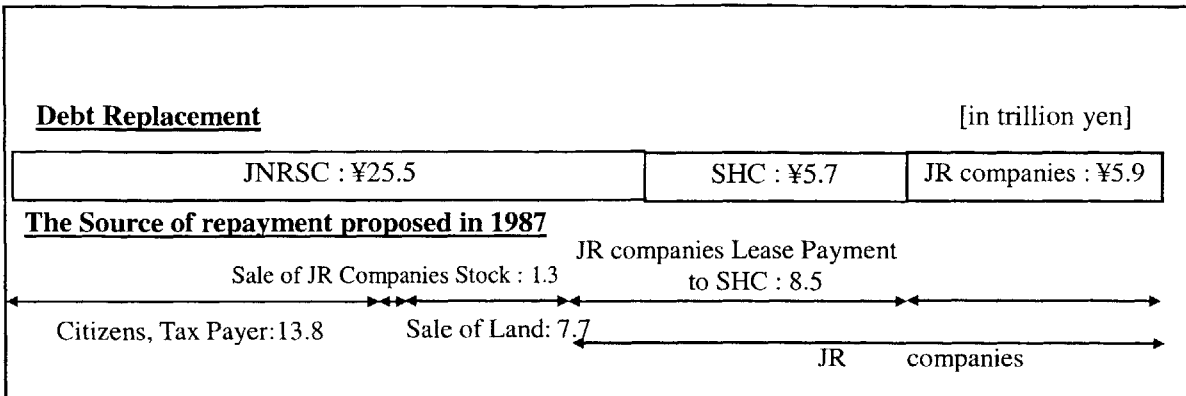
## **Infrastructure**

Each private passenger railway company owns the infrastructure / locomotives / trains and the operation in each separated area. The infrastructure includes almost all fixed facilities such as tracks, maintenance facilities, stations and buildings. Each passenger railway company also maintains and operates the railway in its geographic area. On the other hand, JR Freight has very little of its own infrastructure and pays a relatively low government-determined access fee, kept low as a form of subsidy.

However, for the existing Shinkansen lines in this early stage, the SHC (Shinkansen Holding Company), a governmental organization, owned them while the conventional lines were owned by the JR companies. JR East, West and Central had to pay the lease payment based on frequency of usage to the SHC. The lease payment was used for paying back the debt which JNR had created and for the adjustment and leveling of profit among passenger railway companies that held the Shinkansen lines. (Even though there is a cross subsidy inside each company, there is a difference in terms of the profitability because some lines are very profitable and some are not.) As indicated in Chapter 3, this SHC has not existed since 1991 because all the infrastructure of the existing Shinkansen lines were purchased by the three JR companies on the main island.

## **Financial Issues**

The JNR accumulated about ¥37 trillion of long-term debt. ¥25.5 trillion was assigned to a newly created entity, the JNRSC (Japanese National Railways Settlement Corporation), ¥5.9 trillion was assigned to the three JR companies in the main island and JR Freight and ¥5.7 trillion was assigned to SHC. Figure 2-2 shows the debt replacement and the source of repayment proposed in 1987. Total JR companies' payment was supposed to be 14.5 trillion in which ¥8.5 trillion was supposed to be paid as lease payment from JR companies through SHC.



Source: JR East [2]

**Figure 2-2 The Debt Replacement and the Source of Repayment Proposed in 1987**

In 1991, the JR companies in the main island acquired the existing Shinkansen lines at the transfer price of ¥9.1 trillion. The amount of ¥8.5 trillion of the principal payment minus ¥0.5 trillion of the four and a half years lease payment by the JR companies is ¥8.0 trillion. This amount has been paid as amortization payment of 25.5 years for the repayment of the long-term debt. However, an additional ¥1.1 trillion was charged to JR companies by a government decision to raise the assessed value of the assets. This additional ¥1.1 trillion has been paid as an amortization payment based on the 60 years equal payment method and used for the newly extended Shinkansen projects.

### **Subsidies**

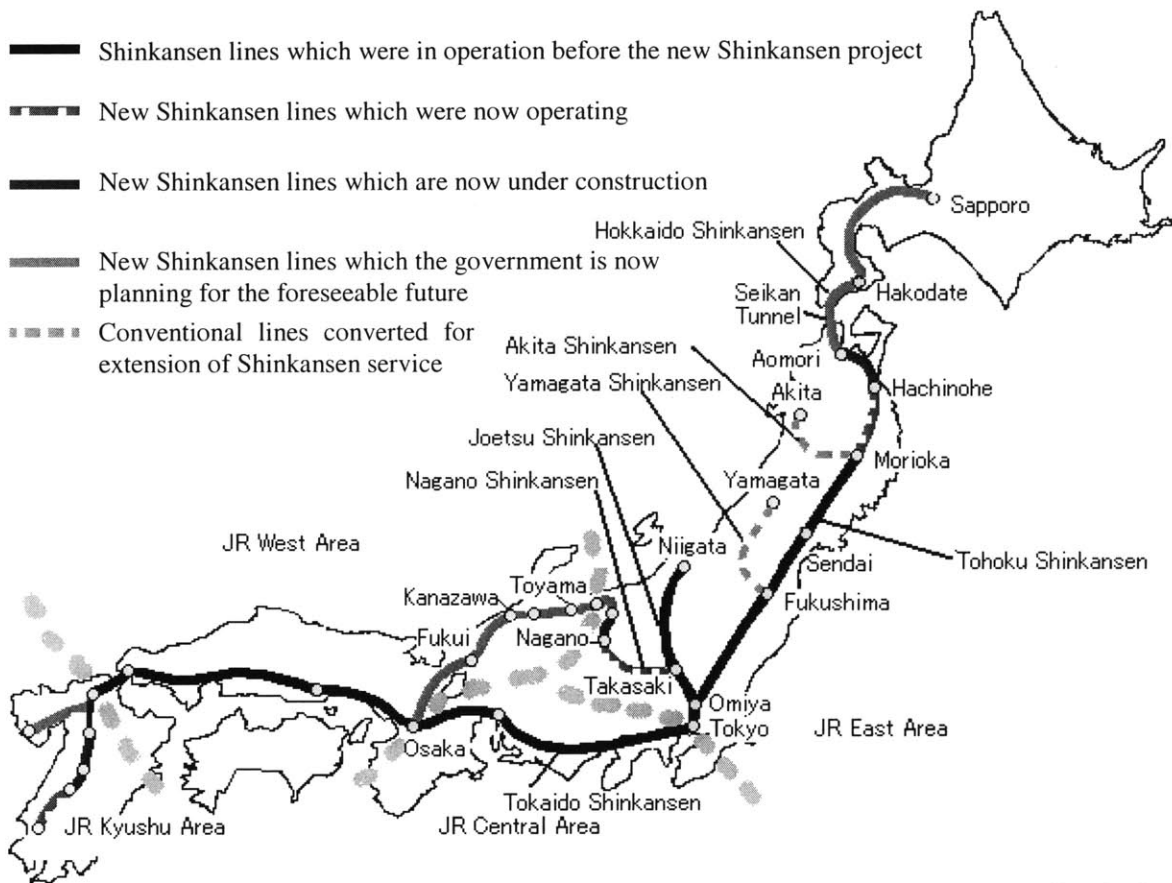
There are no subsidies for the JR East, Central, West. JR Freight doesn't have any direct subsidy but pays relatively low government-determined access fees for using the tracks of passenger railway companies. On the other hand, the three other unprofitable companies are allowed to have a one-time Business Stabilization Fund which was given in 1987 as a subsidy. They are not allowed to draw down the principal; only the interest or profits from investment are allowed to be invested for operations and capital improvements. In this way, in terms of the reform, there are still some problems for the JR Freight and the passenger railway companies on the smaller islands.

This chapter focuses on the Japanese recent history of Japan's nationwide railway network. The next chapter offers various schemes for high speed rail in Japan.



### Chapter 3. Schemes for Pre-existing Shinkansen Lines, New Shinkansen Lines and Extended Shinkansen Lines in Japan

Figure 3-1 shows existing Shinkansen lines and ongoing projects for new and extended Shinkansen lines in Japan [7].



Drawn by Author

Figure 3-1 Shinkansen Lines and Ongoing Shinkansen Projects

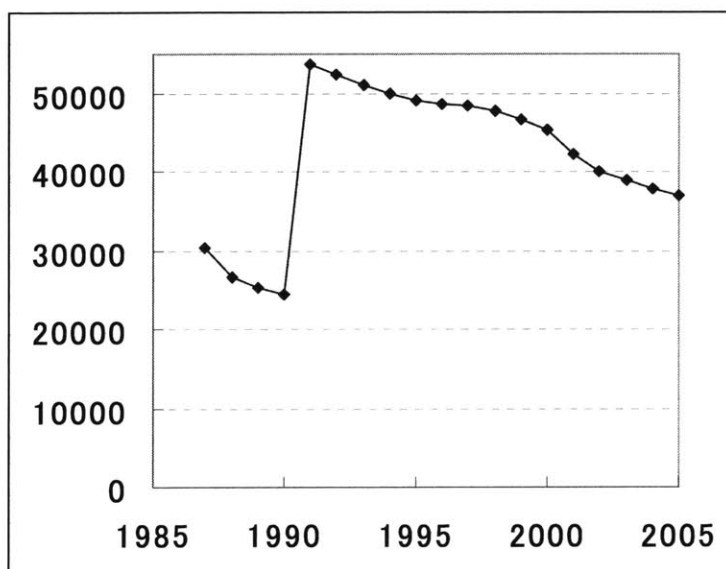
### 3.1. Schemes for Pre-existing Shinkansen Lines

Pre-existing Shinkansen Lines are the lines which had already constructed by JNR before the privatization. The first Shinkansen, Tokaido Shinkansen line was opened in 1964 and the construction cost was huge [8]. Also the maximum speed was 200 km/h while the fastest speed of operating trains in the world was 160 km/h in France [8]. 547 million dollars was budgeted, but the actual construction cost was 1058 million dollars (1 dollar=360 Yen) which was very huge at that time [8]. It was also financed by debt including the 80 million dollars of loan from World Bank since the interest rate was low at 5.75 %. (The payback was completed in 1981.)[8] This development was possible due to the power of JNR as a governmental organization and cooperative relationship between JNR and the government. Then, the Tohoku and Joetsu Shinkansen lines opened in 1982. After the privatization of JNR, these Shinkansen lines were operated under a 30-year lease contract between SHC (Shinkansen Holding Company) which is a governmental organization and JR. The lease payments were intended to allow SHC to pay back the ¥8.5 trillion of debt [2]. These lines were acquired by JR East, Central, West in 1991. JR East acquired the Tohoku and Joetsu Shinkansen Lines for the following reasons.

- \* After the 30 year lease term, the infrastructure of these lines was intended to be transferred into JR companies, but the contract did not include the information whether the transfer is without charge or not. Furthermore, allocation rate of lease payment for each JR company can be changed under the lease contract and the JR companies could not be certain of the amount of asset and debt, which is a disadvantage for the later full privatization.
- \* Depreciation expense could not be recorded since the infrastructure is not the asset of JR companies even though the maintenance and renewal was supposed to be done by JR companies.

The Japanese government agreed with these reasons, aiming for the listing of stock, and the JR companies in the main island acquired the existing Shinkansen lines at the transfer price of ¥9.1 trillion [2]. In the operators' point of view, it has huge impact on the finance. For example, JR East paid ¥3.1 trillion and acquired Tohoku and Joetsu Shinkansen Lines [2].

However, the large amount of debt, approximately ¥3 trillion issued in 1991 has huge impact on the budget of JR East [2]. It is almost the same amount as ¥3.3 trillion that JR East inherited as a debt from JNR when the JNR broke up in 1987 [2]. (In JR East, the consolidated annual revenue is about ¥2.6 trillion, retained earnings are ¥270 billion and net earnings are ¥158 million in 2005) Figure 3-2 shows the long-term debt of JR East after the break up of JNR and Table 3-1 outlines the long-term debt for acquiring Tohoku and Joetsu Shinkansen in 1991. Therefore, in terms of the financial issues, there are still problems to be solved after the reform.



Source: JR East [9]

Figure 3-2 Long-term Debt of JR East after the break up of JNR [in10<sup>8</sup> Yen]

Table 3-1 Long term debt for acquiring Tohoku and Joetsu Shinkansen in 1991 [in 10<sup>8</sup> Yen]

Repayment Term	Repayment Method	Interest Rate	Principal	Outstanding Balance in 2005
1991.10 – 2017.3	Principal and interest equal repayment by every six month installments	4.5 %	21018	9597
1991.10 – 2017.3		6.35%	6385	3984
1991.10 – 2051.9		6.55%	3665	3544
Total			31069	17125

Source: JR East [10]

### **3.2. Schemes for the Small-sized new Shinkansen Lines**

The Yamagata Shinkansen has been operated since 1992 and the Akita Shinkansen since 1997 [11]. The scheme of these newly extended lines was different from the usual scheme for Shinkansen extensions. JR East changed the track gauge of the existing lines from 1067 mm to the Shinkansen gauge of 1435 mm of Shinkansen lines, which allowed operations direct from the existing Shinkansen lines to each of the new destinations. This method was used to reduce the construction cost. However, the maximum speed of trains on these sections is only 130 km/h which is not much different from local trains. The infrastructure is owned by JR East and the operation is also done by JR East. In this scheme, the local government and Japanese government injected interest-free public money into the construction cost for these lines in the form of loans.

### **3.3. Schemes for New Shinkansen Lines**

New Shinkansen lines are planned as the extension project by the Japanese government under the new Shinkansen law. The new Shinkansen lines are either operating or under construction or planned for construction in the foreseeable future by the government. In JR East, there are two big new Shinkansen projects, Hokkaido and Hokuriku Shinkansen projects, both of which need mutual operation with neighboring railway companies.

Hokkaido Shinkansen is a new Shinkansen project, an extension of Tohoku Shinkansen from Morioka to Sapporo. The section between Morioka and Hachinohe has already been constructed in 2002 and is now operated by JR East. The section between Hachinohe and Aomori is now under construction. The section between Aomori and Hakodate which will be the area of JR Hokkaido has recently begun to be constructed and it will be completed before 2015 [7]. This new line will allow travel between Tokyo and Hakodate in three and half hours and the market will be competitive with the air [7]. The flight time is 80 minutes but there is much more waiting time associated with air travel. Further construction for the section between Hakodate and Sapporo, the capital of Hokkaido may be scheduled after 2010 and JR East and Hokkaido will be better able to compete with airline industry more.

The Hokuriku Shinkansen line is under the new Shinkansen project between Tokyo and Osaka along the Hokuriku Route. The section between Takasaki and Nagano which is now called Nagano Shinkansen line is an extension branch of the existing Joetsu Shinkansen Line. This section was constructed in 1997 for Nagano Olympics. The section between Nagano, Toyama and Kanazawa is now being constructed and the section between Kanazawa, Fukui and Osaka is not yet budgeted. This new Shinkansen line is very convenient for the connection between Kanazawa or Toyama and Tokyo. Also, if the line is connected to Osaka, this line will compete in some travel markets for the Tokaido Shinkansen line of JR Central, as well as with airlines.

All of the new Shinkansen lines are operated or will be operated under the lease contract between JR companies and the Japanese Government by the new Shinkansen law. Some details of the contract were made by negotiation between JR companies and Japanese Government. JR companies lease the infrastructure from JRJT<sup>4</sup>, operate with their own rolling stock, and maintain all the leased infrastructure. Table 3-2 shows the characteristics of the lease contract.

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<sup>4</sup> JRJT : Japan Railway Construction, Transport and Technology Agency. This agency was a governmental organization. It has recently become the Independent Administrative Legal Entity.

**Table 3-2 Characteristics of the lease contract for New Shinkansen Lines, revised in 1997**

Construction Agency	JRTT : Japan Railway Construction, Transport and Technology Agency
Planning Agency	Japanese Government The agreement with JR companies and JRTT is necessary.
Budget Allocation	Before Construction: Japanese Government : Local Government = 2 : 1 After Construction : JR East will repay the Lease Repayment. The amount of repayment per year is determined by and within the profit from the constructed line.
How to compute the lease payment	Fixed price will be used for 30 years. → The changing revenue caused by the construction of the new Shinkansen line  + Deficits of conventional railway lines paralleled by the new Shinkansen line
Lease Term	30 years
After the Lease Term	This will depend on negotiation between JR companies and JRCPC
Other Agreement	* The construction will not negatively impact the management of JR companies. * Separate the management of local railways parallel to the new Shinkansen line from JR companies. (Allows JR East to reduce cross subsidy to the unprofitable lines.)
Other conditions	In case of disasters which exceed the coverage of the civil engineering completed risks insurance, JR companies and JRCPC will negotiate with each other.

Source: Ministry of Land Infrastructure and Transport [7]

This chapter focuses on the various schemes for high speed rail in Japan. The next chapter offers international comparison of the railway systems among Japan, Germany, and the U.K.

## **Chapter 4. International Comparison of the Railway Systems**

Before considering the lean enterprise in the development of the Shinkansen in Chapter 6, international comparisons are necessary to understand the general characteristics and potential problems associated with the railway industry. These will point out the common goals that we need to aim at and serve as an important reminder about reform and development when introducing the lean enterprise concept.

Before reforms in the 1980s and 1990s, most national railways were considered to be political instruments and there were interventions reflecting the regional interests of politicians [12]. Politically-directed decision making was one of the major factors in the negative economic performance of national railways. National railways in Japan and Europe needed to be reformed to remedy low productivity and efficiency, financial problems like large liabilities and long-term debts, and weak competitiveness which resulted in low shares of the passenger and freight transport markets. After the reforms, each national railway had a different privatization level and railway system. In this chapter, the cases of the United Kingdom and Germany are compared with the general railway system and the system of the new Shinkansen lines in Japan.

### **4.1. EU Directive 91/440/EEC**

The reform of railways in European Unions has a strong relationship with the EU Directive 91/440/EEC. The strong influence of this directive can be seen in the German railway reform of 1994.

In 1991, EU Directive 91/440/EEC was promulgated.<sup>5</sup> [12] Under this directive, all EU railway companies were obliged to ensure that international groupings in the EU could access their railway network in order to create a single transport market.

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<sup>5</sup> It was amended in Directive 2001/12/EC in 2001

To achieve this goal, EU Directive 91/440/EEC prescribes the following:

- \* Increase the independence of railway companies
- \* Restructure and build a strong financial base
- \* Make a vertical separation between infrastructure and operations to improve competitiveness

The minimum requirement of this directive was to create separate divisions in terms of accounting within a single railway entity. Cross-subsidy between operators and the infrastructure entity was forbidden. Only a few members of the EU went beyond the minimum requirements for vertical separation of infrastructure and operations.

As a result, in EU countries, it became necessary to open the market to third parties in order to build a single united transportation market. Therefore, in any future reforms or railway construction in EU countries, EU Directive 91/440/EEC must be considered as a constraint.

## **4.2. Germany**

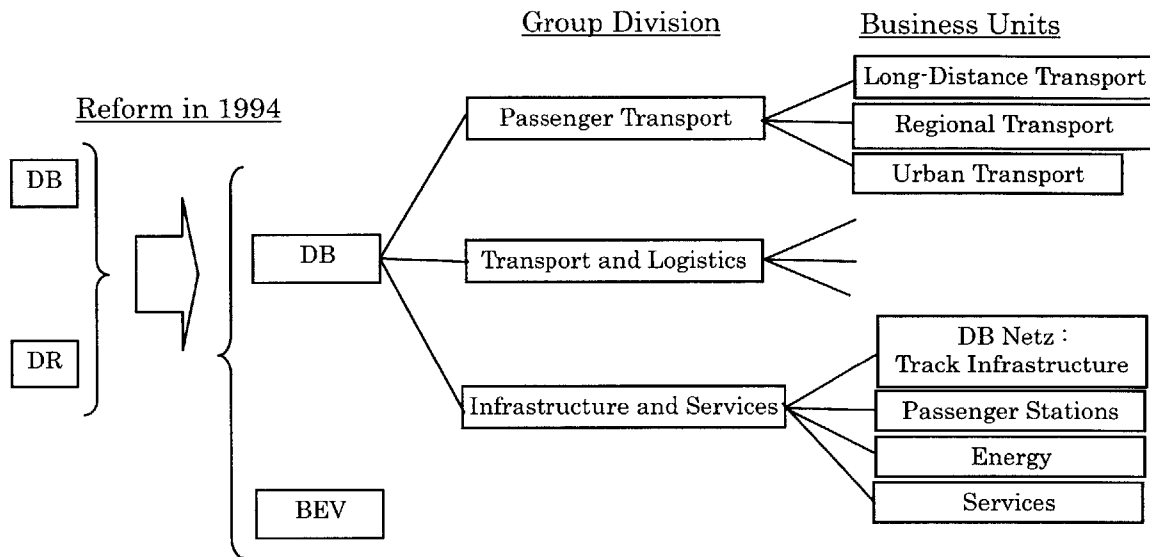
### **4.2.1. The Reform of DBAG in 1991**

Before the railway reform of 1994, German railways had serious problems of a decline in the railway share of the total transport market, inefficiency, and political intervention concerning unprofitable lines. In 1993, the total amount of loss in DB (Deutsche Bundesbahn) in West Germany and DR (Deutsche Reichsbahn) in East Germany was 15.6 billion DM (¥1.9 trillion) and their total outstanding debt had reached 70 billion DM (¥4.9 trillion), which was larger than total DB assets by 1.3 billion DM. It was estimated that the continuation of this current railway system would make the total burden of the federal government increase by 570 billion DM (¥39.9 trillion) from 1994 to 2002 [12].

In 1994, Germany merged the two national railway properties, DB in West Germany and DR in East Germany, into the Federal Railway Property Agency (BEV). The commercial section of BEV was separated and transformed into DBAG, a state-owned joint-stock holding company. The present structure of DBAG is shown in Figure 4-1. There are three



major group divisions, “Passenger Transport” for operations, “Transport and Logistics” for the freight railway, and “Infrastructure and Services” for maintaining the infrastructure [13].



**Figure 4-1 Present Structure of DBAG**

In the reform, DBAG started without any past debt since the German federal government relieved DBAG of 70 billion DM (¥4.9 trillion) and transferred the responsibility for paying and managing the debt to BEV. Additionally, the federal government paid about 19 billion DM (¥1.3 trillion) per year to BEV for debt relief and other administrative responsibilities [14].

**Operations and Access Fees**

Since the infrastructure and operations are separate business units with separate financial accounting, both passenger and freight rail are open to competition. For example, there are 300 different operators providing rail service in Germany [14]. However, DBAG operates most of the rail service in Germany, and we can say that it is not a completely competitive market.

One of the major characteristics of the 1994 reform was the funding system for regional passenger rail operations. National government funding for the short distance passenger railway service goes directly to the Länder (German federal states) and not directly to the operators. There are bids to choose operators, but Länder do not have to tender the service to multiple operators and they can also let DB continue operations. The contracts are usually for 10 to 15 years. This delegation of local railway operation to local governments makes the decision making about local service better since the payer and the contracting party are both the Land (federal state), which means that the contracting party has to have responsibility for both the service and the financing. It also eliminates the cross-subsidy within an operator. The national government provides 7 billion euros (\$8.9 billion) to the Länder annually [14]. This subsidy to the Länder comes from the fuel tax in addition to the conventional transportation improvement fund (GVFG) [12].

Long-distance rail operators have to pay infrastructure access fees. These access fees are based on the following equation and were supposed to be equal for all operators [12].

$$\text{Access Fee} = \text{Basic Charge} * (\text{Modification Coefficient})$$

Basic Charge: This is based on the types of track and trains.

Types of Trains: Passenger train is from P1 to P7, freight train is from G1 to G5

The class is based on the speed, weight and quality.

Types of Track : The quality of the track and the and traffic density

Modification Coefficient : The coefficient of heavier trains like heavy freight trains is more than one since they require more track maintenance. On the other hand, the coefficient of lighter trains and trains which do not need to operate reliably on schedule is less than one. A longer distance of runs and longer-term contract periods both reduce the coefficient.

In most EU member countries, a governmental regulator sets the fees. However, DBAG sets the fees by itself and then receives approval from the Federal Railway Office (EBA) [14]. Only when agreement can not be reached will the EBA arbitrate it.

## **Infrastructure**

German rail infrastructure is owned by a single state-owned private-stock company, DB Netz (Network). DB Netz is one of DBAG's corporate business units and owns most of the rail infrastructure network in Germany.

The income of DB Netz is the rail access fees and the subsidy from the German government. DB Netz receives 2.5 billion euros of subsidy per year for the maintenance of current infrastructure and 1.5 billion euros per year for renewal and new infrastructure [14]. (The infrastructure includes stations.)

In the original plan for the reforming of the German railway system, each operating unit and DB Netz were supposed to be separated into different companies based on the EU Directive 91/440/EEC. However, the operating units and the infrastructure units are still under DBAG, a holding company, and DBAG is now aiming for an integrated railway system because the integrated system strengthens the entire DB system competencies [13]. Although DBAG has the highest technology in Europe, they still try to learn from foreign countries. For example, in Germany, the reliable on-time performance of the Japanese railway system is highly regarded and DBAG tends to learn from the Japanese railway under a cooperative relationship with the JR companies. In this sense, they have chosen to have an integrated system and just satisfy the minimum requirement in which the operations and infrastructure are separated in financial accounting as in the EU Directive 91/440/EEC.

Currently there is ongoing debate whether DBAG should continue to be a state-owned private-stock company or become a publicly traded company. The biggest debate now is whether the initial public offering of DBAG will include its share of DB Netz. DBAG officials consider that the infrastructure of DB Netz should be in an initial public offering for financial reasons. Government officials also expect great financial benefits to public from a joined initial public offering, but there are concerns that this system will make DB Netz less able to "influence infrastructure decisions" than it is today [14].

#### **4.2.2. Benefits associated with the new system**

Even though the reform was not a rapid change as in the U.K and Japan, there have been some benefits from the reform, as follows:

- \* **Efficiency:** From 1996 to 1998, the divisions of DBAG were reduced in number and restructured into integrated business units. Also, the number of employees has been decreased from 322,383 in 1996 to 220,343 in 2005 [12] [13]. There is potential to have further efficiency gains in the future.
- \* **Introduction of access fees:** access fees were introduced to make the railway industry a competitive market. Yet there is still monopoly involved [12]. This system of separation between infrastructure and operation satisfied the EU requirement and has a potential to encourage a more competitive market, which may increase efficiency.
- \* **Each railway line has an entity clearly responsible for it, and this entity wants to continue the line in operation or construct a new line.** If the line is profitable, DBAG is completely responsible for the line. If it is unprofitable but in the public interest, states or the federal will be responsible for whether the line will exist or not and they will have to pay the subsidy. In other words, each line has independent financing and there is no cross subsidy inside DBAG. Under this new policy, total operating length of DBAG decreased from 41,300 km in 1994 to 34,200 km in 2005 [13]. Cross subsidy between lines makes the necessity and desirability of lines unclear. Germany's reformed system has more opportunity for the railway industry to restructure unprofitable railway lines correctly with less political intervention than reforms in Japan.

### **4.2.3. Problems associated with the new system**

#### **Problems Associated with the Investment**

In Germany, the federal government is obliged to gather most of the necessary capital investment for railway. The federal government has to take care of the finances of the railway infrastructure while railway companies such as DBAG have to cover the maintenance costs. However, if the newly constructed line is absolutely necessary for the operation of the railway companies, railway companies have to pay at least an amount that is the same as their depreciation expense for the capital cost. If the construction is for the public interest, the railway companies pay either a portion of the depreciation expense or zero. The portion of payment from the railway companies to the federal government depends on negotiation [12]. This rule makes the political intervention less since DBAG can make its own decision.

However, this vague rule may encourage a strategic action by DBAG, in which DBAG can get the federal government to invest in new lines for the public interest by denying that the new lines are needed by DBAG. On the other hand, if there is some political pressure on DBAG, DBAG may have to pay some portion of the investment even though the new line is not necessary for DBAG. The negotiation base rule includes some risks associated with the vagueness.

#### **Problems Associated with the Access Fee**

In Germany, since the reform of 1991, the access fee has been based on the depreciation expense of the infrastructure [12]. For this estimation, asset evaluations are very important.

At the establishment of the balance sheet of DBAG in 1991, the assessment of total assets was reduced to lower the depreciation expense, because rail operators might not have set fares low enough to compete with other transportation modes if the access charge had been higher and included all the maintenance costs [12]. Also, under the commercial law, business enterprises have to assess their assets at the lowest level and they have the right to depreciate economically inefficient assets. However, in 1991, the assets of DBAG were

assessed at the extremely low value of 20 billion DM (¥1.4 trillion), which was reduced from the real value by 80 billion DM (¥5.6 trillion) [12]. In fact, DBAG ignored actual recent investment costs and set the capital cost too low. For example, it cost 15 billion DM (¥11 trillion) to construct the sections for high speed rail between Mannheim and Stuttgart (99km) and between Hannover and Wurzburg (327km), which began to be operated at that time [12]. Under the new laws, DBAG was able to reduce the value of their assets to an exaggerated degree, especially economically efficient high speed rail links mentioned above.

After the reform, when the new infrastructure was constructed, subsidies reduced the reported value of DBAG's assets so that the access fees would be lower. These subsidies, in the form of investment grants for railways, had been authorized for the purchase or construction of fixed assets and are still distributed mainly by the federal government [13]. In the financial accounting, the investment grants do not affect the income statement but they can reduce the acquisition or construction costs of DBAG, and this reduction can lower the reported asset and depreciation expenses. The intention of the investment grants is to lower the access fees over the entire useful life of assets.

As a result, this underestimation of the value of DBAG's assets has made the access fee low enough to be competitive with other modes of transportation. However, in the long term perspective, DBAG will have to invest in the existing lines for maintenance and replacement. This actual cost in the future will be substantial in comparison to the total revenue from access fees which were set in accordance with the reduced depreciation calculation. The present underestimation of the value of the assets will probably make the DBAG financially unstable in the long run.

To solve this future problem, DBAG should change the access fee that is mainly based on the depreciation expense of the infrastructure. If DBAG does not change it and gets subsidies for the future maintenance or replacement, these additional subsidies may ruin the hope of full efficient privatization. Therefore, the access fee should be based on the cost to maintain the assets at their original value. However, this decision requires trade off between those higher access fees and the competitiveness with other transportation modes. If

competition with other transportation modes does not allow the access fees to be increased, it may be necessary to reduce the number of unprofitable lines or the quality of assets. Actually, several of the money-losing long-distance routes that were in operation have been shut down by DBAG in compliance with public laws [14]. The reduction of money-losing routes is a very appropriate way to make the railway industry prosper.

#### **4.2.4. Summary of German Railway System and its Reform**

The reform of German railways since 1991 did not make any radical changes and it kept the integration of the system by separating the operations and infrastructure only in financial accounting and in units, which was the minimum requirement of EU Directive 91/440/EEC. Through the reform, the system obtained more efficiency to some extent, introduced access fees, and was freed from the excessive financial burden of the unprofitable lines. The system established for each unprofitable line a corresponding federal state responsible for ensuring payment and making the decision whether the line will be continued or not.

However, there remain many problems. First, subsidies, especially for capital investment, may result in less effort of DBAG toward efficiency and increase the tendency to rely on subsidies. Also, a lower reported asset value (depreciation expense) and its consequent lower access fees will probably make the DBAG financially unstable in the long term, although lower access fees allow railways to compete with other transportation modes.

In Germany, the federal government needs to continue to reform the railway industry, taking into consideration the competition from other transportation modes, well-balanced profit and cost for each stakeholder, asset evaluation and adequate access fees, and more fully specified schemes for subsidies.

In the next section, the most radical reform of railways, the reform of British railways, will be introduced, in contrast to the soft reform of the German railways.

## **4.3. The United Kingdom**

### **4.3.1. The Reform of British Railways**

In the first seven years after the privatization of BR (British Railways) in 1994, there were many separate companies, as below [12] [15].

1. ROSCOs: three separate companies in charge of maintenance of rolling stock and engines.
2. TOCs: 25 passenger train operating companies which leased trains from ROSCOs
3. Four freight companies.
4. Railtrack : the owner of the rail tracks, stations and other infrastructure. Railtrack charged access fees to the train operators.
5. Thirteen separate companies that contracted with Railtrack to provide their services. They originated from the BR's engineering and maintenance divisions.

After the reform, all of the organizations were supposed to work together under the contracts and the government regulations in the new competitive market.

#### **Some Compromises in the Transition Period**

However, the governing political party at that time, the Conservative Party, was uncertain about the interest of buyers and wanted to allay the fears of the bidders, who were concerned about the negative effects of fierce competition [16]. In order to make sure that sale of each section of BR would be successful, the government did as follows:

First, all of the railway companies bought their portions of the railway at discounted prices. Actually, their stock price was higher after the sell-off from the government. For example, the government wrote off most of Railtrack's debt, selling Railtrack at the very low share price of £3.90, and the price of these shares rose to £17.68 in 1998 [16]. Another example is that the government sold one of three ROSCOs at £527 million and then a new ROSCO, Stagecoach, later bought it at £824 million pounds [12]. In this way, only these private



companies got vast profits in this transition period and the citizens who paid taxes and used the rail did not receive any benefit from the reform.

Second, the government gave to some extent local monopolies to operators and gave valuable subsidies to lines that were not profitable. Under the agreement of OPRAF,<sup>6</sup> the government could grant a subsidy equal to the amount of operating expenditure minus fare revenue for TOCs. In return, TOCs and Railtrack were forced to operate the unprofitable lines for political reasons even though they were private companies. As a result, Railtrack and TOCs were monopolies to some extent, because there was no true competition in the system. This system did not reflect the original purpose of privatization.

### **Accidents after the Privatization**

In just a few years, many organizational problems appeared. As a result of contracts and government regulation, the only incentive for railway companies was to seek increased revenue. Trains and facilities like stations got dirty and overcrowded and the passengers complained much more than before [16]. The new private companies were not interested in improving these problems since these did not directly affect the ridership figures and revenue.

Partly as a result of the poor management by new private companies, 38 people died in railway accidents in the first three years (42 deaths in the first four years) in contrast with only eight rail fatalities from 1990 to 1997 [16]. On October 17, 2000, an accident occurred in Hatfield. Four people were killed by a train derailment because a cracked rail “shattered” into 300 pieces, a crack that Railtrack had known about but had not fixed. After the accident, they decided to have speed limits of 20 mph at 1286 places where there was evidence of cracking [16]. The overreaction was due to the lack of knowledge about the condition of its assets. This decision led to many delays and cancelled services, which seriously damaged Railtrack’s financial condition. Under the terms of its contracts and its consequences, Railtrack had to pay the TOCs penalties for each of the delays under the

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<sup>6</sup> Office of Passenger Rail Franchising, a governmental corporation which regulates all the private companies in the railway industry.

terms of its contracts. Railtrack lost a total of £534 million pounds from the Hatfield accident while the profit in the previous year was only £360 million [16]. Finally, Railtrack increased its debt to £3.3 billion.

### **4.3.2. Benefits of the Reform**

Even though the reform in the U.K. has had adverse effects, there have also been some benefits from the reform, as follows:

- \* Fares: some fares were reduced and new fare systems such as off-peak pricing were set up.
- \* Efficiency: more constructive negotiation with the labor unions reduced staffing inefficiencies. For example, in Freightliner, the crew of four was reduced to just one driver with the introduction of containers [12]. Through such negotiations, drivers got higher salaries while the total cost was reduced.
- \* Investment in better quality of service by TOCs: some of the TOCs invested substantially in new rolling stock and the new West Coast Line [12]. Good market research and investment made the railway industry prosperous.

### **4.3.3. The Problems of the Reform**

#### **Inequitable Contracts**

The contracts between Railtrack and TOCs were inequitable in that they were not adequate to provide sufficient value to each of the stakeholders, especially financially. In its contract, since 90% of the access fees that TOCs paid to Railtrack were fixed, Railtrack had no incentive to invest in increasing the capacity, while the TOCs had an incentive to increase the service. Since it is common knowledge that rail damage and extent of maintenance work required is determined by the tons of rolling stock that pass on the rails, this fixed charge was not fair to Railtrack. As a result, there was no incentive for Railtrack to plan capital investment to adapt to changes of circumstance. Then, the increased operation

which was introduced by TOCs exceeded the capacity of the railway and caused rail congestion. Actually, because of the booming economy between 1996 and 2000, the usage of railways increased by 30% [12]. The TOCs responded by increasing the number of trains, putting on a thousand extra runs from 1997 to 1999 [12]. The contract let operators adapt to the changes and worked well. However, Railtrack underestimated the increase in delays caused by the increased service. TOCs blamed Railtrack for not investing in new capacity, but this was because of Railtrack's lack of incentive and of enough budget for investment. In an equitable contract, variable access fees would be charged based on the number of trains operated on each section, in order to prevent congestion and maintain the safety of the rail for through investment.

Additionally, for the measurement of railway congestion, the contract should have included the maximum frequency on each section and incremental fees to pay for the investment to increase the rail capacity.

In any events, two of the major accidents could have been avoided with advanced safety equipment and adequate maintenance/investment. Railtrack could not invest adequately because of the lack of the required capital that resulted from the inequitable contracts.

### **Lack of integration of the entire railway system**

Separation between operation and infrastructure and its competitive market for the railway turned out to be much more difficult to manage than for the gas, telecommunications, and electricity industry. Constraints from the necessary interrelationships among the sections of the railway system prevent the expected management changes.

The unbundled structure – the separation of infrastructure and operations – reduced the cooperative relationship between Railtrack and operators that was necessary for the safety and on-time performance of the operation. Also, even though TOCs were subject to the physical constraints of the railway, the competitive market of TOCs reduced the cooperation between them. In fact, when accidents or delays happened, Railtrack and TOCs often blamed each other and did not try to find a future optimal solution together; they just

tried to reduce their penalties rather than improving the situation. The lower integration of the unbundled structure shifted the entire system toward blame rather than improvement.

In summary, the railway system became “dis-integrated” by the separation between operation and infrastructure, and by the contracts between different organizations associated with the separation. The non-integration reduced the safety and on-time performance of the U.K. railways.

### **Lack of Government Management Ability**

In addition to the problems of contracts, one of the reasons why the accidents happened was the low investment for maintenance before privatization. The quality of the assets was very poor because the government had made the investment toward the railways extremely low before the reform. The government, especially the Conservative Party, was highly focused on road investment instead of railways. Also, the British government reduced their subsidy to railways by 50 % from 1983 to 1990 in order to achieve its financial goals [12]. The BR coped with the situation by selling off their important assets and doing less investment in maintenance, safety, congestion avoidance and convenience, even though consequences for the safety and the quality of maintenance would become evident several years later. As a result, the very poor maintenance and investment in the railways before the reform put the privatized companies in a financially difficult situation.

After the privatization, the government continued to lack an effective management. The Office of Passenger Rail Franchising, the Office of the Rail Regulator, Her Majesty’s Railway Inspectorate, the British Railway Board, the Rail Passengers Council, and the Transport Secretary had overlapping responsibilities, and this, in turn, led to turf battles instead of working cooperatively. In 2001, SRA (the Strategic Rail Authority) was established, but it turned out to be simply one more layer of bureaucracy [15].

In the British railways, the government did not manage properly before the reform because of the inadequate government subsidy. Since the reform, the government has had no ability to regulate the complex system in which there are so many private companies involved.

### **Organizational Culture Problems**

There were also organizational culture problems. BR had an integrated command structure like a military organization [15] [16]. However, the radical change under the contracts with payments and penalties created an adversarial system which did not work. The rapid change destroyed the existing culture and reduced morale.

Additionally, Railtrack owned the tracks but it did not own the maintenance companies, and the maintenance companies did not own the companies which actually repaired the tracks. Railtrack, which had no effective internal engineering, could not supervise the contractors. Many managers in important positions had no experience in railway management and they did not understand the business [16]. Railway management must rely heavily on experience and the lack of management experience was apparent. This was an example of too much outsourcing causing management problems.

### **Problems at the Service Level**

Because of the successful marketing strategy of TOCs, congestion problems increased after the reform. For example, chronic congestion on the GNER East Coast line between Edinburgh and London resulted from the marketing success of the private operating companies.

In addition to overcrowding on the trains, delays and cancellations were increased by the reform because of the problems mentioned above. The reform has brought no essential improvements in the service levels and people suffered from a lower service level.

#### **4.3.4. Second Reform associated with Railtrack**

On October 7, 2001, Railtrack went into insolvency and was sold for £500 million to Network Rail, a nonprofit private company [15]. There are no stockholders and all the profit is used for investment. Six directors are overseen by 100-120 specialists from the railway industry. Network Rail is said to be a renationalization because of its governance structure. In 2003, Network Rail decided to maintain the tracks internally instead of outsourcing. Revenue is from the rail usage charge to the TOCs and SRA subsidy. (In 2004, the charge was £3,164 million and the SRA subsidy was £1,279 million [17]. In 2006, the subsidy swelled up to £4,600 million. This was partly because of the lack of investment in maintenance for years.) The debts are kept off the public balance sheet and the government is repaying the debt. Until 2002, revenue and ridership decreased, and delays and deficit increased. But recently the system has improved in terms of ridership, performance, and reliability by increasing subsidies.

This renationalization has not worked well in terms of efficiency. However, the capital investment on a long term-basis has been improved. The biggest investment project is the WCML (West Coast Main Line) improvement [17]. It is premature to evaluate the present organizational structure, but time will tell whether it is successful or not.

#### **4.3.5. Summary of the U.K. Railway System and its Reform**

In the early stage, a true privatization was not achieved because of the distorted value of BR assets, subsidies and local monopolies. Only private companies got vast profits in this transition period while there was not much apparent improvement in service.

Additionally for seven years before the second reform in 2001, fatal accidents happened and finally Railtrack went into insolvency. This failure was because of the inequitable contracts (unfair access fees caused unbalanced incentives toward capital and maintenance investment), non-integration of the system, and lack of management ability of each company and the government.

In 2001, Network Rail began to maintain the rail infrastructure. It was a nonprofit private company and it received more subsidies than before. The new organization did not have an advantage in efficiency, but it could invest more for capital and maintenance, and this increased the safety and on-time performance.

In the next session, international comparison of the railway system will be analyzed, based on the information in section 4.2 and section 4.3.

#### **4.4. Comparison of the Railway Systems**

Comparing the reforms in Germany, the U.K., and Japan, we find that there have been common issues associated with these reforms:

##### **Reduction of Political Impact and Correct Decision Making**

The reforms we have described in Chapters 2 to 4 reduced to some extent the huge political impact which existed before the reforms. Political elements led to construction of new lines and to operating them without considering the profitability of these lines.

In Germany, the establishment of DBAG reduced the politically motivated construction and operation of unprofitable lines. To avoid political pressures on the DBAG, subsidies are applied to the construction of unprofitable lines which are in the public interest. Also, the operation of each line is independently discussed with the local government or federal government for possible subsidy and some lines are abolished when they are thought to be unnecessary. Therefore, there is no cross subsidy inside the DBAG and there is less political intervention. However, this system may include the risk of being too generous to the DBAG.

On the other hand, in the U.K., too many unprofitable lines were constructed and the long-term investment in the railway industry was much less than needed before the privatization. This ruined the railway system and finally, after the reform, the lack of investment and rapid organizational change has caused the fatal accidents and the collapse of Railtrack. Nowadays, Network Rail has government control of investment, maintenance, replacement, and construction of new lines. As a governmental organization, it is hard for it to avoid political intervention. On the other hand, some of the unprofitable TOCs are subsidized by OPRAF or PTE for each line. TOCs are selected based on the bidding system. The budget constraint and the bidding system for the private companies have reduced the amount of politically-based decision making. However, this system may also include the risk of being too generous to the TOCs and Network Rail or may result in the lack of long-term investment because of political intervention through subsidies.



In Japan, full privatization made the political intervention in the railway industry much less. However, there is huge cross subsidy inside a private company and it makes the profitability of each line unclear.

On the other hand, new Shinkansen lines in Japan are subject to political intervention because these lines are owned by government and are not fully privatized as in Germany and the U.K.. In this case, the intervention from the government may increase toward these lines and JR companies need to establish the appropriate relationship between the government and JR companies. It is clear from the German case that political intervention can be eliminated by the combination of privatization and financial responsibility. Even though cross subsidies can cover all the unprofitable lines in Japan now, it is necessary to determine the profitability of each line and to consider not only whether new lines should be constructed but also whether unprofitable existing conventional lines should be abolished.

### **Competitiveness**

It is necessary for the railway industry to have both competition between railway companies for efficiency and customer-oriented service, and competitiveness with all transportation modes for its stability.

In the U.K., monopolies are involved to some extent by the bidding strategy and the government regulation, but there are multiple operators involved in profitable lines. On this point, competition between railway companies in the U.K. increased the most among the three countries: there are more than 25 operators involved. However, the competitiveness worsened a congestion problem of both the number of trains using the tracks and the number of passengers on trains. It also made the on-time operation unreliable. Government regulation may solve these problems in the future. On the other hand, competitiveness with the other transportation modes is maintained by the subsidies to TOCs of the unprofitable lines and Network Rail, and by the fixed low access fees set by the government. Also, the increased efficiency from privatization has improved the competitiveness to some extent.

In Germany, the competition between railway companies is almost nil since most of the lines are owned and operated by DBAG. But all railway lines are open to any private companies and there is a potential to increase the competition. The reform followed the minimum required by EU Directive 91/440/EEC but did not focus on the competition between railway companies. More effort toward efficiency is necessary for DBAG, but more competition may not be necessary since reliable on-time operation continues in Germany. On the other hand, the competitiveness with the other transportation modes was increased because of the subsidies to new lines in the public interest and local unprofitable lines, and the unduly low access fees. Subsidies themselves are against the reform policy, but the clear delineation of financial responsibility made the industry competitive with other transportation modes.

In Japan, as part of this reform, the government introduced the “Yardstick Competition”<sup>7</sup>, which was a competition among geographically separated railway companies. This met the concern that fierce competition on the same lines would ruin the stability of the railway service. As a result, there was not much competition involved in Japan. There is some tax reduction for railway assets, but there are no direct subsidies involved for the original lines. Competitiveness against other transportation modes has decreased somewhat as new highways and airports are constructed, but still remains at a higher level than European countries (Figure 1-1), because of the higher population density in urban areas, road congestion problems, and high toll charges on the highways. Privatization increased the railway company’s efficiency and stability, and the circumstances in Japan kept the industry competitive with the other transportation modes. However, new Shinkansen lines, especially the Hokkaido Shinkansen line, will be more vulnerable to airline competition, and their situation will be like the German one, where airline service is more popular than

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<sup>7</sup> “Yardstick Competition” introduces the principle of competition to regional monopoly enterprises by comparison on the basis of various performance measures to see how well they do, in order to obtain further efficiency. Thus, they do not really compete with each other. When monopoly enterprises were not in the same geographical regions and needed more efficiency, some regulators introduced this “Yardstick competition”. The Japanese government has used this method at the privatization of telecommunication companies.

in Japan.

To sum up, more increased competition among railway companies would be undesirable because of its predictable adverse effects such as congestion problems and a lower level of service. On the other hand, the competitiveness with the other transportation modes is much more important for the railway industry, whose market is shrinking. For example, subsidies, government regulations, and closing down of unprofitable lines are involved in Germany. In Japan, further competitiveness with other transportation can be achieved not only by restructuring organizations in a company, but also by changed government regulations on all transportation modes and the restructuring of the total railway network, which includes the closing down of unprofitable lines.

### **Transportation and economy in Japan, and environmental issues**

These are fundamental reasons that most developed countries keep or develop railways even though many railways are not as competitive in service or as prosperous as other transportation modes.

For total coordination of transportation, having the number of modes we now have, but stronger transportation modes are essential, not only in Japan but also in the U.K. and Germany. Also the convenience will make the transportation flexible and the economy stronger.

Additionally, if the business attracts enough ridership, the railway can be much more efficient than traveling by air or cars. Government officials in the U.K, Germany and Japan consider that the railways can solve environmental issues, such as emissions of CO<sub>2</sub> and NO<sub>x</sub>. For example, according to the Ministry of Land, Infrastructure and Transport in Japan, CO<sub>2</sub> emitted from a car, bus, or airplane to carry one person for 1km will be 7.5, 3.17 and 5 times as much as CO<sub>2</sub> from a Shinkansen train [7]. The environmental issue is one of the reasons why many European countries and Asian countries invest in railways even though some are not profitable.

### **Integration of the system**

In the U.K., the most radical privatization and the separation of operations occurred with the reform. It proved to be difficult to integrate all the separated entities, although the U.K. government tried to have a contract that connected each organization together. A structure with infrastructure and operations completely separated is very difficult to manage, because this orients various companies' attitude toward blame rather than toward improvement. Additionally, the poor management control by the government made the integration worse. Because there was no incentive for cooperation in this scheme, what was needed was a governmental organization that would audit and would plan long-term capital investment. The railway has a public nature and an organization like the Office of Rail Regulator was supposed to be appropriate. However, the problem was that this organization did not have sufficient ability to control the situation. To sum up, both an integrated system for the long-term policy and adequate competition for efficiency are necessary, but with this lack of adequate government regulation and leadership, the system could not be integrated.

In Germany, the reform followed the minimum requirement of EU Directive 91/440/EEC and separated infrastructure and operations into different units of DBAG for the financial accounting system. They focused more on the integrated system in DBAG than the competition between railway companies [13]. As a result, the reform did not destroy the integration of the system.

In Japan, the reform split the entire system into several railway companies in different geographic regions, but the vertical integration between operations and infrastructure was kept at the same level. There were no integration problems as in the U.K case. However, the new Shinkansen lines are, or will be, owned by the government and we need to consider whether there will be any problems associated with the vertical separation between infrastructure and operations.

### **Equitable Contracts**

If there is vertical separation between infrastructure and operations, equitable contracts are one of the key elements for a successful railway system. Equitable contracts should be considered for the long-term investments in railway infrastructure.

In the U.K., the track asset was owned and maintained by Railtrack, not the operators. The contracts between TOCs and Railtrack, which included the access fees and liability rules, did not prove to be equitable. The original access fees were supposed to be equitable to both operators and Railtrack. However, after the traffic increased, the fixed access fees no longer provided the contracting parties with proper incentives and finance conditions. The TOCs had incentives to increase services, but Railtrack had no incentives or budget to invest in increasing the capacity and in the long-term maintenance plan. Railtrack needed higher access fees for the capital investment and finally the lack of these funds caused many delays and accidents. Then, penalties to Railtrack were executed under the government regulation, but overly severe penalties ruined Railtrack. The vertical separation made the liability rules difficult and gave less incentive for long-term safety investment. The fixed charge and liability rules could not cope with the changing circumstances or provide long-term stability.

In Germany, there are access fees between operators and infrastructure units, but most of the lines are both operated and owned by DBAG. The access fees are therefore usually applied to the different units in DBAG for financial accounting. On the whole, the contract usually exists within the DBAG's accounting and does not have a negative effect on the long-term investment plan. However, the access fees are based on the reduced reported value of the DBAG's assets and DBAG may face some investment problems decades later when the infrastructure has become too old for continued use.

Considering the U.K and Germany cases, contracts should be equitable and flexible enough for all organizations that are involved in the railway service. Especially if the contract includes charges, penalties and incentives, these should be fair, precise, and flexible for any changes of circumstances. Also, contracts should not omit incentives for long-term investment for safety at all times.

In Japan, railway lines other than the new Shinkansen lines are vertically integrated between infrastructure and operation. In this original scheme, there were no contracts between infrastructure and operating sections. However, in the new Shinkansen scheme, the assets are or will be owned by the government, and JR companies will operate and maintain infrastructure or are already doing this. The lease payment will be fixed at an amount that is almost the same as the incremental profit of the first year's operation. The government is now considering the additional charge to an operator for the profit that will be generated in its area by the extension of a new line to another operator's area. This fixed lease charge may result in unfair contracts in the future when circumstances change, such as by competition with the air transportation mode. Additionally, there is no framework for how to deal with the assets after the 30 years of the lease term; there is no rule for the depreciation expense or the value of the assets after 30 years. In this scheme, it is very difficult to have equitable contracts between government and JR companies for the long-term. The contract needs to have valuable, flexible lease payment and to track the depreciation expense and maintenance cost of JR companies for the accurate evaluation of the assets. This method will ensure that the contract is equitable and takes long-term investment into consideration.

#### **4.5. Summary of the International Comparison**

The reform of railway systems in the U.K and Germany was researched, and then these railway systems were compared with the Japanese railway systems. The common key factors contributing to success in railway systems are as follows:

- \* Reduction of political impact and better decision-making on future policies and regulations
- \* Competitiveness with other transportation modes
- \* A strong economy in which transportation is an important factor
- \* Recognition by government and society that environmental issues are important and that railways are more environmentally-friendly than other modes
- \* Integration of the system
- \* Equitable contracts

These factors are going to be important inputs for the lean enterprise architecting in Chapter 6. All these issues should be considered concerning the strategy of the enterprise when architecting the lean enterprise. Now we proceed to Chapter 5 to introduce the lean enterprise architecting.

## Chapter 5. Concept of the Lean Enterprise Architecting

### 5.1. What is Lean Enterprise Architecting

According to the Lean Aerospace Initiative, “a lean enterprise is an integrated entity which efficiently creates value for its multiple stakeholders by employing lean principles and practices” [18]. The following figure shows the historical industrial paradigm. “Lean” is the elimination of waste and efficient creation of enterprise value. The early lean message of 1990 emphasized the Lean Production and imitated the Toyota Production System of 1955. After 1990, the lean message evolved beyond lean production to an extended lean enterprise which emphasized value added activities in addition to the elimination of waste.

1885...	1913...	1955...	1993...
<b>Craft Production</b>	<b>Mass Production</b>	<b>Toyota Production System</b>	<b>Lean Enterprise</b>
Machine then harden Fit on assembly Customization	Parts inter-changeability Moving production line Production engineering “Workers don’t like to think”	Worker as problem solver Worker as process owner enabled by: – Training – Upstream quality – Minimal inventory – Just-in-time Eliminate waste Responsive to change	“Lean” applied to all functions in enterprise value stream Optimization of value delivered to all stakeholders and enterprises in value chain
Highly skilled workforce Low production rates High cost	Unskilled labor High production rates Low cost Persistent quality problems Inflexible models	Low cost Improving productivity High quality product	Low cost Improving productivity High quality product Greater value for stakeholders

Source: Nightingale [18]

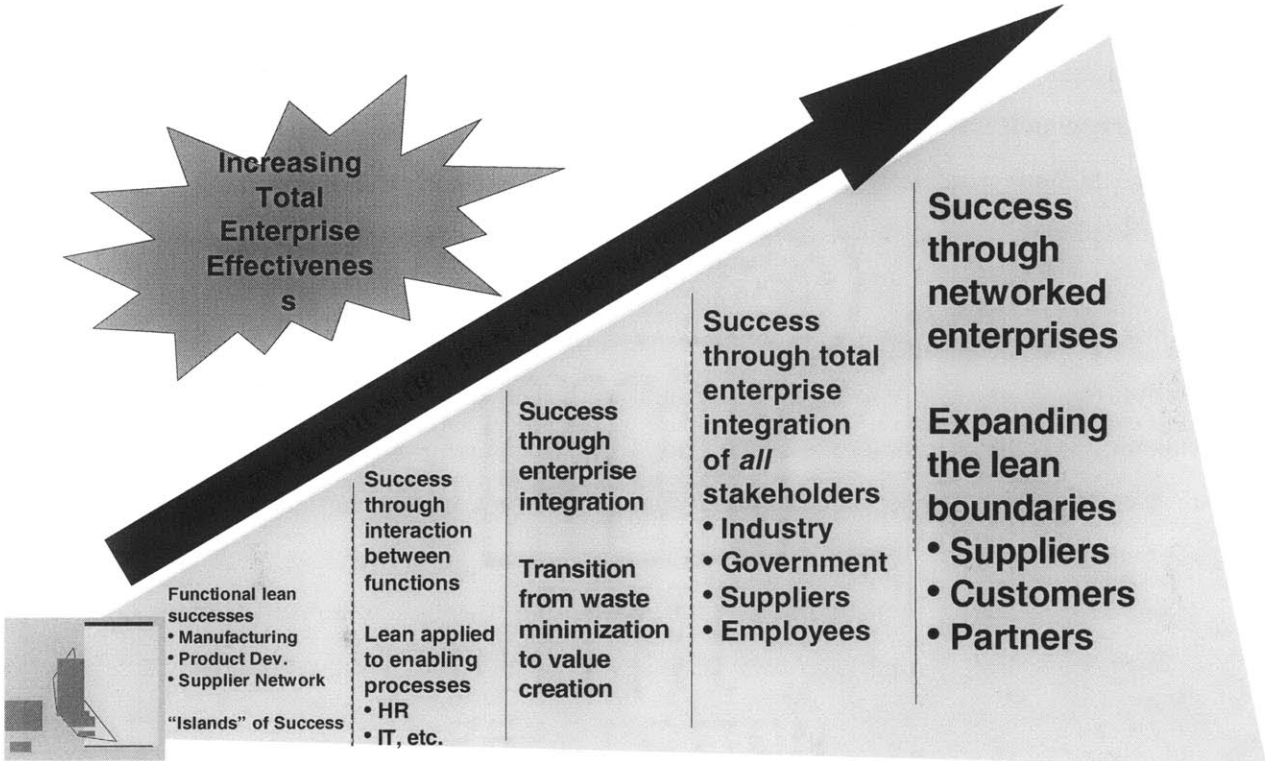
Figure 5-1 Historical industrial paradigm and lean enterprise

An enterprise is defined as “one or more persons or organizations that have related activities, unified operation or common control and common business purpose.” (Black’s Law Dictionary, 1999.) There are three different levels of enterprises: Program, Multi-Program and National or International Level [4]. For example, a multi-program



enterprise would consist of Boeing, USAF, Lockheed Martin and a national level enterprise would consist of prime manufacturing companies, suppliers and government. The focus is expanding now and Figure 5-2 shows the evolution of lean enterprise thinking.

Lean enterprise now requires the integration of process, people, organization, information and technology and treats an enterprise as a total system taking a holistic view.



Source: Nightingale [18]

**Figure 5-2 Evolution of the Lean Enterprise Concept**

## **5.2. Introduction of “Enterprise Value Stream Mapping and Analysis”**

Within the LAI at MIT, “Enterprise Value Stream Mapping and Analysis (EVSMA)” has been developed as process for the analysis of the enterprise architecting [5]. This system of analysis evaluates the value exchange between an enterprise and each stakeholder, the current process flow, interactions between stakeholders, interactions between processes, the alignment of strategic objectives, metrics, key processes and stakeholder values. It also predicts the enterprise degree of waste that exists in a given enterprise. In this thesis, the process was customized and used to analyze the new high speed rail lines in the railway industry, which has not been using any of these lean concepts. Based on the EVSMA [5], important steps were extracted and the analysis follows these steps:

### **Step 1: Define the Enterprise**

Define the enterprise that needs to be analyzed. The definition includes a description of stakeholders. “A stakeholder is any group or individual who directly or indirectly affects or is affected by the level of achievement of an enterprise’s value creation processes” [19].

Then, set strategic objectives for the enterprise through interviews with company executives, a study of company reports and general information about the business.

### **Step 2.1: Current State of the Enterprise: Enterprise Costs**

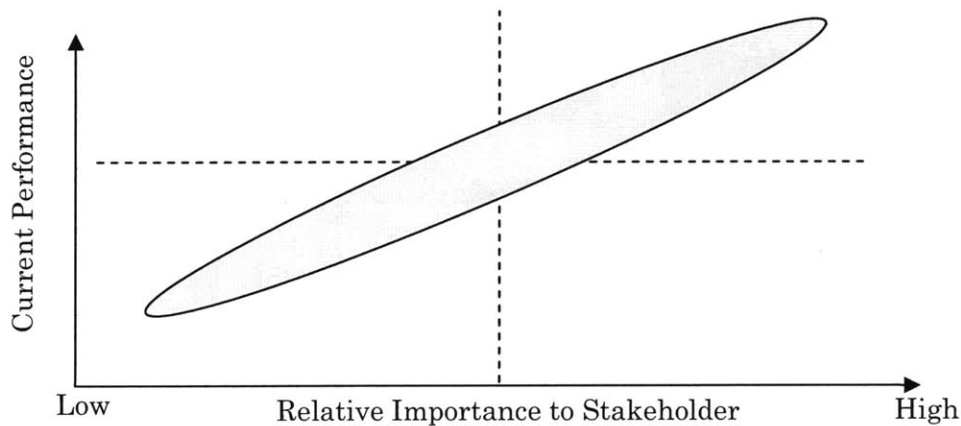
Analyze the cost and the major sources of cost in the enterprise. They are analyzed both in each process and on the whole in terms of construction cost, budget allocation of the government, debt, subsidies, lease payment and so forth. This data will be utilized in the steps that follow.

### **Step 2.2: Current State of the Enterprise: Value Exchanges**

Assess the value exchange between each stakeholder and the enterprise. Various stakeholders find particular value, worth, or benefit in exchange for their contributions to

the enterprise. This step will analyze, first, value delivery from the enterprise to a stakeholder, taking into account relative importance to the stakeholder and current performance of the enterprise, and second, value delivery from a stakeholder to the enterprise, considering relative importance to the enterprise and current contribution by the stakeholder to the enterprise.

The value exchange is well balanced when values can be plotted in terms of the area as shown in Figure 5-3. If, however, items are actually plotted far above or below that area, that means too much or little for the stakeholder for a good balance to be achieved and the balance needs to be improved. This analysis aims to satisfy both the enterprise and all stakeholders.



**Figure 5-3 Appropriate position of the value exchange in the lean enterprise**

### **Step 2.3 Current State Perspectives: Value Stream in the Process**

To have a desired future enterprise architecture, value creation and elimination of waste in the processes are fundamental. The value stream mapping was originally used for eliminating waste to decrease the cost and time of producing products for the demand of customers in the manufacturing process. In this thesis, we focus not only on the individual processes but also value creation and elimination of waste in the flow of processes in the broader enterprise level.

**Step 2.4 Current State Perspectives: Process Interactions**

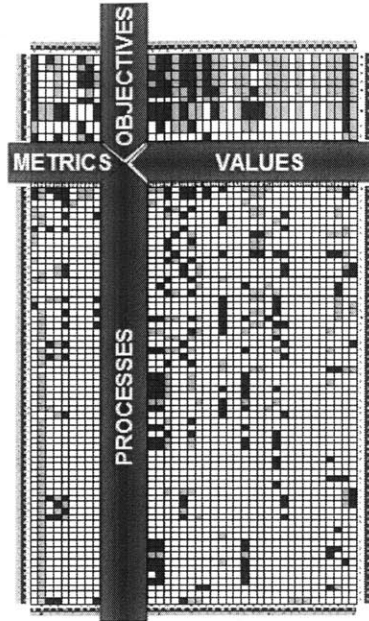
Analyze current enterprise process performance by looking at the process interactions. In the process interactions, information, cooperation, and financial resources will be identified, and each interaction will be analyzed in terms of stability, timeliness, accuracy, completeness, usefulness, and so on.

**Step 2.5: Construct Current-State Perspectives: X-Matrix Evaluation**

Evaluate the alignment of strategic objectives, metrics, key processes, and stakeholder values by using the “X-Matrix” as below. Strategic objectives are from Step1, stakeholder’s values are from Step 3, and key processes are from Step 4. Enterprise metrics are indexes that are currently being used to monitor enterprise performance. For example, if the enterprise is a laboratory, metrics are patents, internal reports and external papers. Then the evaluation will be started from the upper left quadrant and be moved around the matrix in a counter-clockwise direction. All the interrelationships of these key areas are evaluated as below [5]:

- \* Alignment of metrics with strategic objectives: how the metrics accurately assess the enterprise performance for strategic objectives;
  
- \* Alignment of metrics with key processes: how the metrics are utilized in the enterprise to measure process performance;
  
- \* Alignment of key processes with stakeholder values: how each process delivers the stakeholder values for the enterprise.
  
- \* Alignment of strategic objectives with stakeholder values: how stakeholder values are represented by the strategic objectives.

Each alignment will be evaluated by indicating blue for strong, orange for weak, or white for no interaction. Numbers of weak, strong, and total interactions in the row or column are shown by the numbers outside the edge of the grids.



Source: Nightingale [18]

Figure 5-4 Sample of X-Matrix

### **Step 3 : Future-State Vision**

Describe the future-state lean enterprise vision for approximately five years. It is necessary to give consideration to all the results from Steps 1 to 2 and optimize them: well-balanced value possession by enterprise and stakeholders, less waste, productive interactions, emphasis on critical processes and functions. It would also be worth drawing a new value stream map of the future enterprise, based on a comparison with the old one.

### **Step 4: Transformation Plan**

Prioritize areas of focus to the potential opportunities for significant improvement, and cope with any barriers. Then describe the transition plan, how the enterprise can change from the current state to the lean one in Step 3. This transition plan can be used by enterprise executives or managers to pursue the goals of the envisioned lean enterprise.

In this chapter, the concept of lean enterprise architecting was introduced. Now we will utilize this framework for the new Shinkansen project in Japan in the next chapter.

# Chapter 6. Lean Enterprise Architecting of New Shinkansen Projects in Japan

## 6.1. Introduction to the Enterprise of New Shinkansen Projects

### Definition of the Enterprise

In this thesis, the enterprise is a high speed railway industry, especially for the new Shinkansen project in which the Shinkansen lines are expanding under the leadership of government. The enterprise consists of a large and varied number of stakeholders (Figure 6-1). This is because the leadership role of the government is extremely high and the enterprise should be led from the national level.

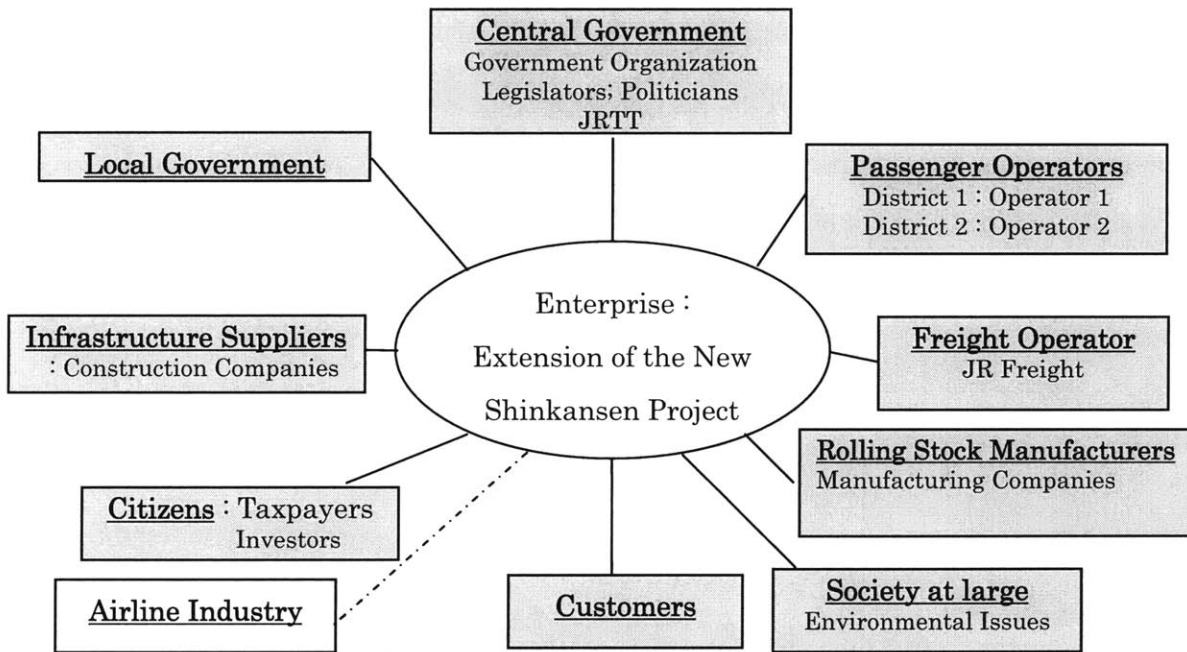


Figure 6-1 The New Shinkansen Enterprise and its stakeholders

The following table identifies each stakeholder group of the enterprise. (Refer to Section 6.2.3) Note that in each group, there are also many indirect stakeholders who are important for the success of each stakeholder group and the enterprise, but do not directly interact

with the enterprise. Therefore, in this thesis, these indirect stakeholders are included in the discussion of some of the direct stakeholder groups.

**Table 6-1 Stakeholders of the New Shinkansen Enterprise**

<b>Stakeholder Group</b>	<b>Stakeholders</b>	<b>Description</b>
Central Government (Leadership of the enterprise)	Ministry of Land, Infrastructure and Transport	Leadership of the enterprise
	Ministry of Public Management, Home Affairs, Postal and Telecommunications	Liaison to local government
	Ministry of Finance	In charge of finance
	Legislators, especially Politicians in ruling parties	Ruling Party Politics and Adjustment Meetings affecting the new Shinkansen law
	JRTT	Owner of construction Owner of the infrastructure Control of lease contract
Local Government	Local governments of districts which the new Shinkansen serves.	Investor Future owner of conventional lines parallel to new Shinkansen lines.
	Politicians	Ruling parties affect the project
(Passenger Rail) Operators	Infrastructure Divisions	Each operator serves a particular region. Trains will operate through between regions and operators.
	Operating Divisions	
	Other divisions	
	Labor Unions	
Freight Rail Operator	JR Freight	Contract affects the freight rail operators.
Rolling Stock Manufacturer	Manufacturing Companies of Rolling Stock	Competitive Market New technologies involved
Infrastructure Supplier	Construction Companies	Bidding System involved Cost Reduction
Customers	Future passengers	
Citizens	Taxpayers	Indirect Investors
Society at large	Japanese Society	Transportation Functions: Capacity and Flexibility Environmental Issues for both passenger and freight transportation
Competitors	Airline Industry	Not a stakeholder but affecting this enterprise.

Source of Format: Nightingale [18]

## **Strategic Objectives**

Based on the general characteristics of railways and high-speed railways and the international comparison of the British, German, and Japanese railways, the strategic objectives of the enterprise should be the following:

### **Strategic Objective 1: Strengthening of transportation and economy in Japan, and tackling of environmental issues**

These are fundamental reasons for Japan to keep or develop railways, even though many railway lines are not as competitive on service or as economical as other transportation modes. Based on the total coordination of transportation, additional transportation modes are essential for Japan. Also the transportation flexibility will increase the convenience and make the economy stronger.

Additionally, if the business attracts enough ridership, the railway can be much more efficient than traveling by air or cars. Environmental concern is one of the reasons why many European and Asian countries are investing in railways even though some are not profitable.

### **Strategic Objective 2: Make the level of service and safety high on a long-term basis**

It is also necessary to have a high level of service and safety on a long-term basis. Level of service can be characterized by reasonable fares, frequent trains, reduced travel time, and reliable schedules.

### **Strategic Objective 3: Increase the competitiveness in relation to other transportation modes**

Competitiveness of the railway with other transportation modes is very important for making the railway industry prosper, since railways have been losing modal share for decades.



#### **Strategic Objective 4 : Integration of the total system**

To achieve strategic objectives 2 and 3, a railway has to have an integrated total system that is based on the cooperative relationship among stakeholders. Especially for the railway industry, safety and competitiveness with other transportation modes can be enhanced by this integration.

#### **Strategic Objective 5 : Reduction of political intervention**

To achieve strategic objectives, 1, 2, and 3, it is necessary to have a process for accurate decision making as to whether or not we need each of the new Shinkansen projects. Appropriate selection of lines to be constructed and concentration on a manageable number of construction projects is essential for better utilization of assets and budget.

#### **Strategic Objective 6 : Equitable contracts and regulation**

To achieve strategic objectives 2 to 5, equitable contracts and regulation are critical for railway operation, especially when operation and infrastructure are separated. The process of pursuing equitable contracts and regulation also needs to continue even after the operation begins, so as to make small but important adjustments possible.

## **6.2. Current State of the Enterprise**

### **6.2.1. Background and Necessity for Lean Enterprise Architecting**

#### **Background**

Under the traditional management structure, six private companies (JR companies) have owned infrastructure and operated in their geographic territories. Under this scheme, the management role of the government has been extremely low. By contrast, in the extension railway lines in the new Shinkansen projects, the role of government is high since the new Shinkansen lines are owned by government although they are operated and maintained by private companies. The extension also requires mutual operation with the neighboring district and a complicated relationship between freight railway and passenger railway companies (Refer to Section 6.2.3, “Freight Railway Company”).

Additionally, financial issues complicate the enterprise. Because the new Shinkansen project needs huge capital investment for the construction and each of the stakeholders has different values, the project may not be adequately integrated and a lot of waste and risk may result.

Although the new Shinkansen project has potential to increase the ridership and revenue, the enterprise must also face other difficulties. First, the number of people in Japan is decreasing, which means the number of customers is decreasing. Second, these lines will face fierce competition with the airline industry because people will tend to use air for the longer distances from Tokyo to the new line destinations. Success of any mode of transportation depends on frequency, travel time, fare and accessibility of all modes. The critical problem is that there is no coordination among the highway, airline and railway industries for the new Shinkansen projects in Japan. This coordination is necessary to have stability since both railway and airline industries are economy of scale businesses. In this aspect, the role of the government has a huge impact on each industry.

With the extension project of new Shinkansen lines and the increased complexity of the circumstances described above, the need for coordination is more prominent than before.

### **Necessity for the New Lean Enterprise Architecting for the New Shinkansen Projects**

Because of the complexity of the new Shinkansen enterprise, it is necessary to have a broad view of the whole enterprise and to design collaborative relationships within the enterprise. However, the enterprise of the newly extended Japanese high-speed rail industry is not a lean enterprise. There are many stakeholders involved. While each stakeholder or organization has good internal planning, improvement and development, there is a need for integration and planned coordination to ensure the stability and the future success of the whole railway industry.

The lean concept is expanding from the production lines to the whole enterprise level within the aerospace and airline industry in the U.S., which is now trying to achieve it through LAI [4]. In the aerospace industry in the U.S, many stakeholders are involved and this situation created no problems when there was a huge demand and a large budget. However, budgets have tightened since the cold war ended and competition among airline companies has become more fierce [4]. The LAI is exploring ways to improve the enterprise architecture of the aerospace industry and the same approach can be applied to the new Shinkansen enterprise.

In fact, the new Shinkansen enterprise needs huge investment. However, there is only a small portion of government budget available for the new Shinkansen project and it is very hard for the government to increase it. (Refer to 6.2.2) When we are in an era of high growth, there is plenty of capital and the construction can proceed easily. However, Japan is just recovering from recession, and lean enterprise architecture [4] is necessary to utilize its limited resources to maximize the positive impact on the economy and environmental issues.

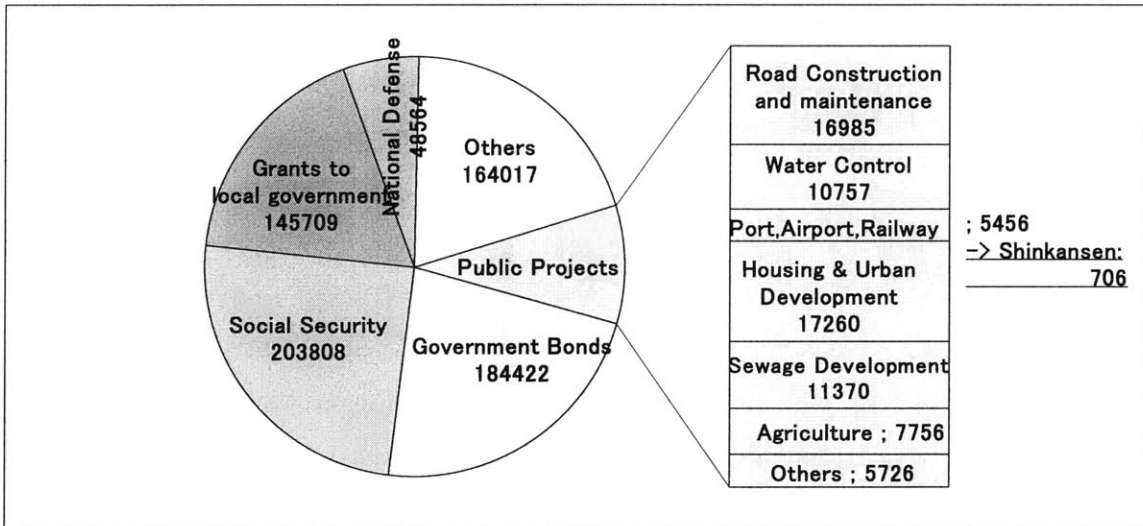
Lean enterprise architecting [18] enables an enterprise to achieve greater efficiency and effectiveness in total. When many stakeholders are involved and budgets are extremely limited, integrated planning by all stakeholders is necessary to reduce risks and the waste of investment. Appropriate lean enterprise architecture should enable the railway industry to be more efficient, stable and prosperous. In this thesis, the EVSMA analysis and future vision will be implemented.

## 6.2.2. Analysis of Enterprise Costs

### Budget and Cost at the National Level

The process of the construction of new Shinkansen was decided by government and the ruling parties.

In the national expenditure, Figure 6-2 shows the budget allocation. As a result of the central government decision, the budget for the new Shinkansen Project in 2005 was ¥70.6 billion, which is a small portion of the total national expenditure of ¥82 trillion. Furthermore, the whole budget allocation for public works projects was ¥7.4 trillion and the budget allocation for road maintenance and construction was ¥1.7 trillion in 2005. This shows that the central government focuses more on road construction rather than railroad development.

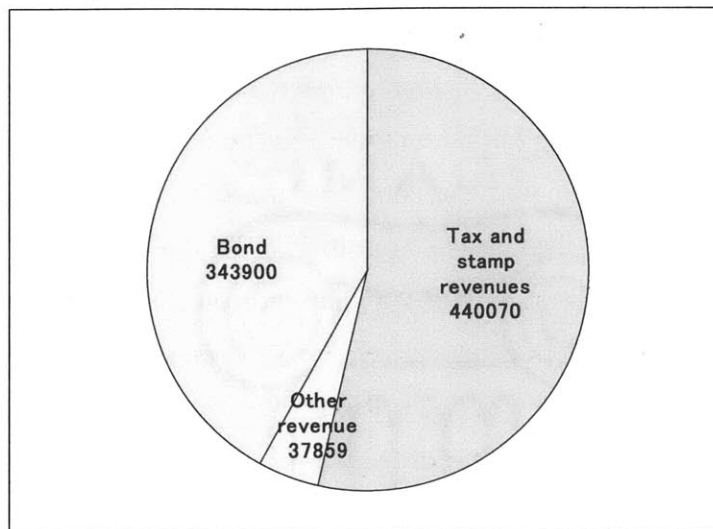


Source: Ministry of Finance Japan [20]

**Figure 6-2 Budget Allocation of the national expenditure [10<sup>2</sup> million yen] in 2005**

However, this does not simply mean the government should increase the expenditure for the new Shinkansen project. Japanese government finance now relies heavily on bonds (42 % of total general revenue, ¥34.4 trillion in 2005) and the outstanding balance of local and central government bonds is ¥770 trillion, which is 152.8 % of the GDP in 2005 (Figure 6-3), while the outstanding balances of local and central government in Germany, U.K, France, Canada and the U.S are between 50 and 80 % of their annual GDP [21].

Considering this severe fiscal circumstance, the budget allocation of national expenditure for the new Shinkansen project may decline in the future.



Source: Ministry of Finance Japan [20]

**Figure 6-3 Government general revenue [10<sup>2</sup> million yen] in 2005**

## **Budget and Cost at the Enterprise Level**

The total amount of the new Shinkansen budget for local and central governments was ¥219.5 billion in 2005. Table 6-2 shows the 2005 budget allocation for the new Shinkansen project.

**Table 6-2 Budget Allocation for New Shinkansen Project in 2005 [in billion yen]**

Government(146.3)			Local Government (73.2)	
72.4 (a)	70.6 (b)	3.3 (c)	71.5 (d)	1.65 (e)

Source: Ministry of Land Infrastructure and Transport [7]

- (a) Financial resource based on a portion of JR companies' amortization payment for the acquisition of existing Shinkansen lines in 1991
- (b) Budget allocation of public works projects by the central government
- (c) Debt secured by the portion of (a) which will be paid from 2013 to 2017. (The total principal payment is ¥330 billion)
- (d) Budget allocation of public work project by local government
- (e) Additional budget allocation by local government (half of the amount of (c))

The debt was added in 2005 by government decision and is secured by the portion of (a) which will be paid from 2013 to 2017. (The total principal payment is 330 billion yen). This total amount will be allocated to each area under construction. Even though there will be future interest payments of ¥35 billion on this debt, the total estimated cost still exceeds the total budget by ¥200 billion. This decision was made for the following reasons. [22] (The total construction cost for the construction sites is ¥1170 billion)

- \* A smaller budget allocation will lengthen the construction term. This debt is the only way to make the opening earlier. Earlier opening makes the asset utilization efficient.
- \* At least ¥145 billion of cost reduction will be made by the improvement of the construction method.
- \* An additional ¥2 billion of national expenditure and ¥1 billion of local government expenditure is planned to cover the shortage in the budget. This means that the citizens will have the burden of this portion.

After the construction, the amount of lease payment per year is determined by and is within the profit from the new line and operators will pay this fixed amount for 30 years. Construction cost, length and lease payment for each newly constructed section is shown in Table 6-3. In this scheme, the lease payment will determine how central government can collect the money for construction cost which was covered by national expenditure. Additionally, if the new line is profitable enough, this system allows the central government to have enough budget for further construction. Actually, in terms of the Nagano Shinkansen line between Takasaki and Nagano, the lease payment is a fairly big amount in comparison to the construction cost. In this way, the estimation of demand and the lease contract will affect the recovery of past national expenditure and the future projects.

On the other hand, the burden of the local government is approximately 18 % of the total construction cost. As mentioned before, total budget of the local government is 1/3 of the total construction cost. But there is a local allocation tax grant that will cover half of the repayment of the bond issued for the 90 % of the total budget of the local government. (The

local government will repay the bond for 20 -30 years.) At any rate, it is clear that local government is also one of the big stakeholders in this project. In other words, this project has to satisfy not only operators and central government, but also the local government as well.

**Table 6-3 Construction Cost, length and lease payment for each newly constructed area**

	Construction Cost			Operation Length	Construction Cost/km	Lease (30 years)	Lease (one year)
	Central Government	Local Government	Total				
Morioka – Hachinohe	3200	1600	4800	96.6	49.7	2379	79.3
Hachinohe – Aomori	3067	1533	4600	81.8	56.2	2100	70
Aomori – Hakodate	2800	1400	4200	148	28.4	-	-
Hakodate – Sapporo	7400	3700	11100	212	52.4	-	-
Aomori – Sapporo	10200	5100	15300	360	42.5	-	-
Takasaki – Nagano	5616	2808	8424	117.4	71.8	5250	175
Nagano – Joetsu	2000	1000	3000	59.7	50.3	2400	80
Joetsu – Kanazawa				165	-	9750	325
Nagano – Fukui	15300	7650	22950	301.4	76.1	13000	433.33
Fukushima – Yamagata	-	Interest Free Loan to JR East: 320		87.1	3.7	-	-
Yamagata – Shinjo	-	Interest Free Loan to JR East: 280		61.5	4.6	-	-
Morioka – Akita	-	Interest Free Loan to JR East: 660		127.3	5.2	-	-

Source: Ministry of Land Infrastructure and Transport [7]

(\*) Nagano-Fukui includes the section of Nagano-Joetsu, Joetsu-Kanazawa, and Kanazawa-Fukui.

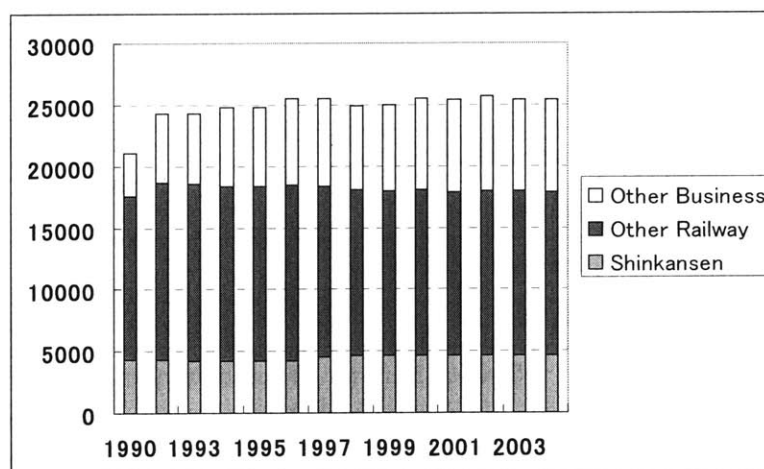
(\*) Total Line Length of JR East is 7538 km. Of this, 1053 line-km are Shinkansen.

(\*) Costs are given in 10<sup>2</sup> million yen.

## Revenue and Cost at the Operation Level

Population in Japan and the revenue from railway operation is decreasing slowly every year. (Figure 6-4 and Figure 6-5 show the revenue from railway, Shinkansen, and other businesses in JR East.) On the other hand, the revenue from other business has increased every year and the total consolidated revenue has been at almost the same level since JR East has been focusing on further efficiency in the railway business and diversifying businesses to increase profit. However, the growth rate of profit from other business has been decreasing recently, and the Japanese government has decided to raise the fixed asset tax rate on space in stations that is used by other business from one third of the normal fixed asset tax rate to the full rate that is applied to out of station space. If this decision is implemented, the revenue from non-railway businesses in stations will decrease and JR East will need to focus more on the railway business.

Revenue from railway lines other than Shinkansen is decreasing because of the decline in the population (and therefore in the number who commute to work) and the increasing share of cars as the transportation mode. On the other hand, 25% of the revenue in the railway business is from the Shinkansen and the revenue has not been decreasing in the way that other railway revenue has been in the past 10 years.<sup>8</sup>

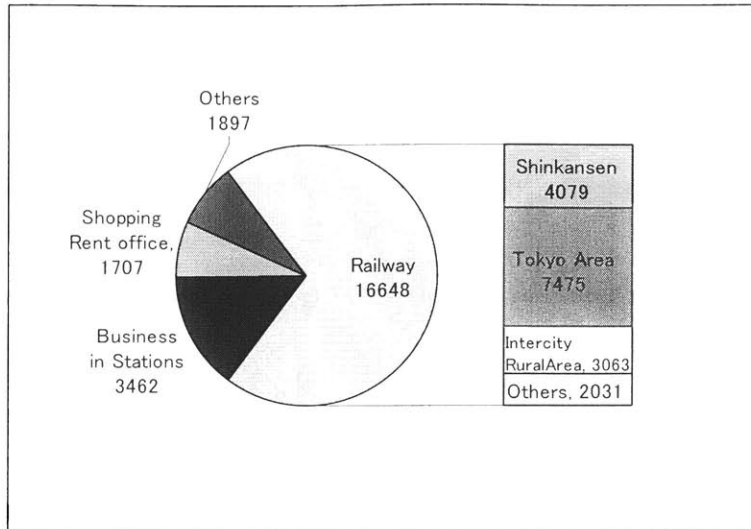


Source: JR East [9]

**Figure 6-4 Revenue from railway, Shinkansen, and other businesses [in 10<sup>8</sup> Yen]**

<sup>8</sup> Also, the average passenger-trip length (km) has been steadily increasing.





Source: JR East [9]

**Figure 6-5 The revenues of each business in JR East in 2005 [in 10<sup>8</sup> Yen]**

In this tight situation, appropriate new Shinkansen projects that will attract people and increase ridership are necessary for operators to avoid further decline in the Japanese railway industry even though the new Shinkansen projects are determined by political issues. Once appropriate new Shinkansen lines are constructed, the revenue from Shinkansen will be much more than 25% of railway business revenue, and the projects also have the potential favorable effect of attracting people to railway service and thereby increasing the ridership on other lines.

However, this does not mean that every proposed extension of the Shinkansen is desirable. Shinkansen business is very important in the financial results of operators now and an inappropriate extension will ruin the present good financial condition of the operating railway company. Table 6-4 shows the operating revenue, expense and profit of Shinkansen and conventional-line service in JR East. Shinkansen service is now fairly profitable while conventional-line railway service is not as profitable as the Shinkansen service. This is because the conventional lines include many unprofitable lines in rural areas and there is a cross subsidy between rural and urban areas in JR East. In JR Central, more than 80 % of revenue is from Shinkansen business. In this situation, no matter how political intervention is involved in the projects, new Shinkansen lines should be profitable instead of requiring a new cross-subsidy from other lines to the new lines, and should be independent from the

government since the operating profit from Shinkansen service has a huge impact on the corporate finance of operators.

**Table 6-4 Operating Revenue, expense and profit of Shinkansen and conventional lines  
in JR East in 2005 [in 10<sup>2</sup> million yen]**

	Operating Revenue	Operating Expense	Operating Profit
Shinkansen Service	4824	2900	1924
Conventional line service	13366	12117	1249

Source: JR East [10]

### **Summary of the Analysis of Cost Factors**

Following is the short summary of the factors that affect costs. These will be discussed in the later analysis.

- \* The budget of national expenditure is very limited because of the huge amount of government issued bonds and its policy.
- \* Lease contracts are a key factor for long-term success of the project.
- \* Local governments are important stakeholders as investors.
- \* How much the central government receives for its investment is determined by the lease payment, which means that the lease payment affects the burden of Japanese people for the construction.
- \* Under the very limited budget, the key factor is the profitability of the new lines.
- \* Budget allocation and responsibility for the projects are very complicated.
- \* Shinkansen business now has a very important role in the financial situation of operators. If the choice of construction and lease contract is inappropriate, it will ruin the operators which have been successful since the restructuring in 1987.

### **6.2.3. Stakeholders' Value and Value Exchanges**

Each stakeholder expects particular worth, utility, benefit, or reward in exchange for its respective contributions to the enterprise. In this section, value exchange between the enterprise and each stakeholder will be identified with its importance and performance level. Additionally, based on value exchange analysis, we will compare how well each stakeholder satisfies its values.

Note that the following analysis is based on the information gathered in Chapters 1 to 5 and the analysis may be different from researcher to researcher since it is hard to be quantitative. However, it does provide incentives to change the enterprise into a lean one.

#### **Customers**

Customers are the future passengers who will use the new Shinkansen Lines. High speed rail will be used by many Japanese people, and most of them will not be regular commuters on the Shinkansen.

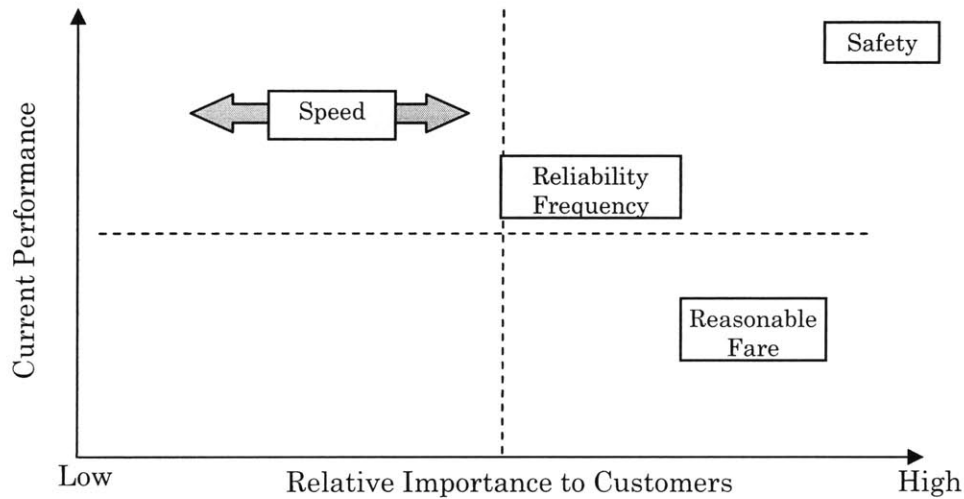
Table 6-5 shows the value exchange between customers and the enterprise. The following figures show, first, value delivery from the enterprise to customers by relative importance to customers and current performance of the enterprise, and second, value delivery from customers to the enterprise by relative importance to the enterprise and current contribution by customers to the enterprise.

The major values of customers are safe, reliable service and reasonable fare. Users care more about safety and its technology than about improvement in speed. However, where there is competition with air transportation, a customer may consider that the speed of travel is also important for the choice of the transportation mode. Additionally, the current contribution of the customers to the enterprise for ridership and profitability of the lines can be changed by future potential demand and the competition with air transportation.

**Table 6-5 “Value Exchange” between Customers and the Enterprise**

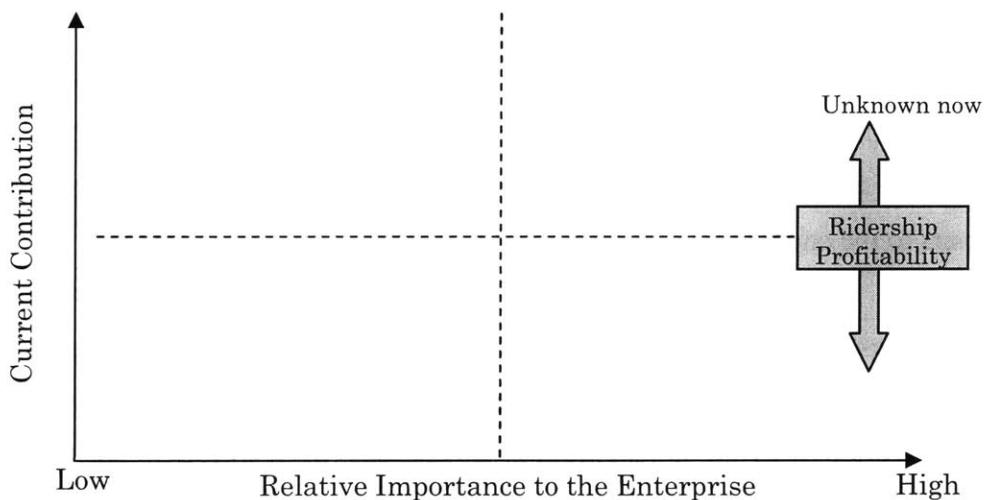
Value that customers expect from the enterprise	Stakeholders	Value contributed to the enterprise by customers
# Safety # Reliability # Frequency # Reasonable fare # Speed	<b>Customers</b> Future Passengers	# Ridership and profitability -- Long-term stability

Source of Format: EVSMA 1.0 for LAI member use only [23]



Source of Format: EVSMA 1.0 for LAI member use only [24]

**Figure 6-6 “Value Delivery” from the Enterprise to Customers: Relative Importance to Customers and Current Performance of the Enterprise**



Source of Format: EVSMA 1.0 for LAI member use only [24]

**Figure 6-7 “Value Delivery” from Customers to the Enterprise: Relative Importance to the Enterprise and Current Contribution by Customers to the Enterprise**

## Citizens

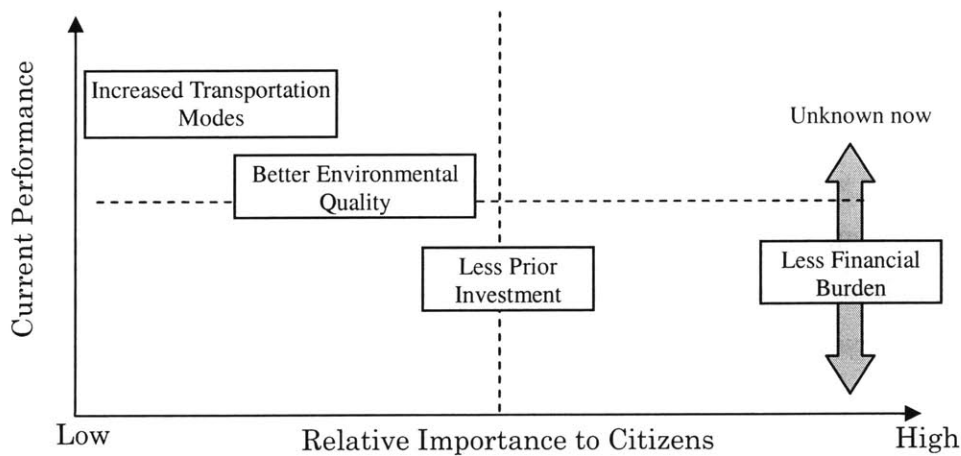
Citizens are stakeholders who pay taxes for the national expenditures and they are the indirect investors for the project. As taxpayers, they expect the least national expenditure for the enterprise. Japanese people usually do not have a positive view of the construction of new Shinkansen lines since this may require more national expenditure that comes from taxes that they pay. A relatively small number of people along the lines are pleased about the construction since it will benefit them most.

Table 6-6 shows the value exchange between citizens and the enterprise. The following figures show first, value delivery from the enterprise to citizens by relative importance to citizens and current performance of the enterprise, and second, value delivery from citizens to the enterprise by relative importance to the enterprise and current contribution by citizens to the enterprise.

**Table 6-6 “Value Exchange” between Citizens and the Enterprise**

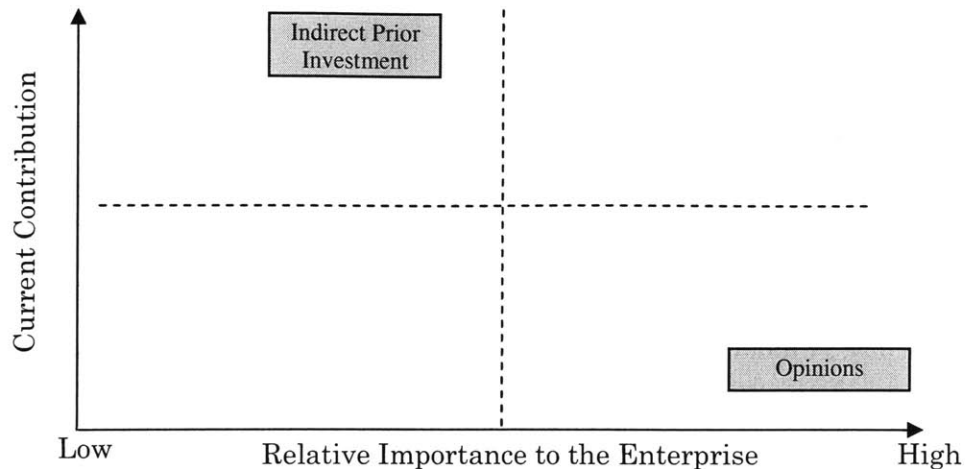
Value that citizens expect from the enterprise	Stakeholders	Value contributed to the enterprise by citizens
# Less prior investment # Lower financial burden # Increased transportation modes # Better environmental quality	<b>Citizens</b> Japanese People who pay taxes	# Indirect prior investment through tax # Opinions through mass media or politicians (Most of the citizens are negative if the lease payment will not cover the national expenditure well. The government should understand this fact.)

Source of Format: EVSMA 1.0 for LAI member use only [23]



Source of Format: EVSMA 1.0 for LAI member use only [24]

**Figure 6-8 “Value Delivery” from the Enterprise to Citizens: Relative Importance to Citizens and Current Performance of the Enterprise**



Source of Format: EVSMA 1.0 for LAI member use only [24]

**Figure 6-9 “Value Delivery” from Citizens to the Enterprise: Relative Importance to the Enterprise and Current Contribution by Citizens to the Enterprise**

### **Society at Large**

Society at large is Japanese society which is concerned about the big picture, economical and environmental issues. Government opinions must include this societal point of view.

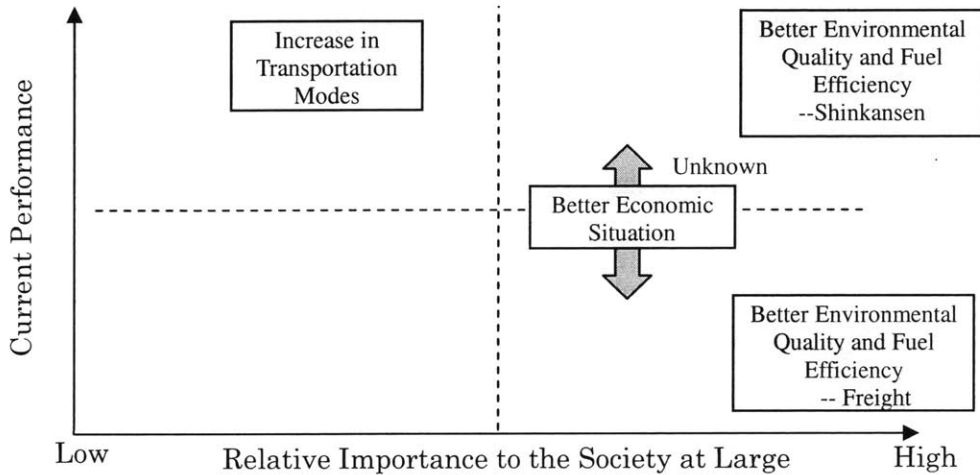
Table 6-7 shows the value exchange between society at large and the enterprise. The following figures show, first, value delivery from the enterprise to society at large by relative importance to society at large and current performance of the enterprise, and second, value delivery from society at large to the enterprise by relative importance to the enterprise and current contribution by society at large to the enterprise.

From the point of view of society as a whole, total coordination of freight and passenger rail is very important. However, although the contract involves the paralleling conventional lines which continue to be used by JR Freight, the enterprise tends to consider passenger rail, the Shinkansen, without regard to the issues of freight rail. This process lowers the quality of the choice of conventional lines whose operation will be transferred to local government. The enterprise should not shrink the freight rail market. (refer to section 6.2.3 “Freight Rail Operator”)

**Table 6-7 “Value Exchange” between Society at Large and the Enterprise**

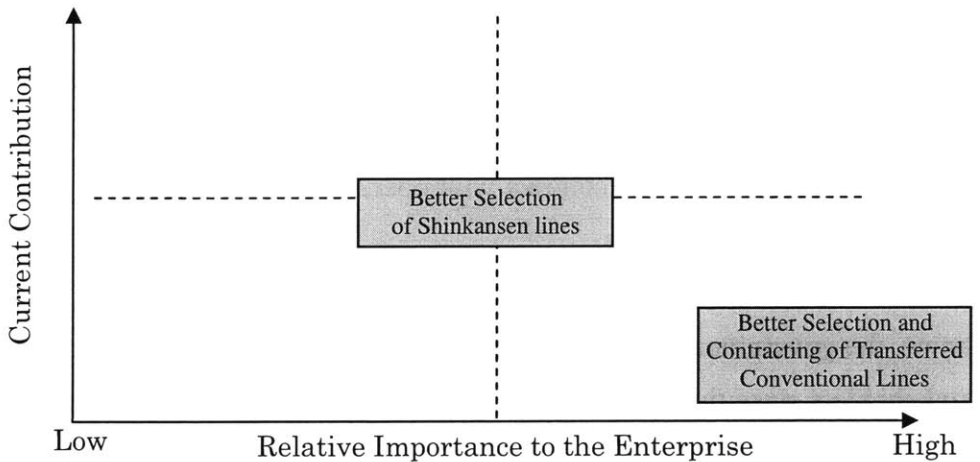
Value that society at large expects from the enterprise	Stakeholders	Value contributed to the enterprise by society at large
# Better environmental quality and fuel efficiency -- Freight Rail vs Trucks (CO <sub>2</sub> and NO <sub>x</sub> ) -- Shinkansen vs Air Transportation (CO <sub>2</sub> and NO <sub>x</sub> ) # Better economic situation for society along the lines -- Attract people and companies to the region -- Increased employment -- Tax revenue # Increase in transportation modes -- Stability of transportation in Japan	<b>Society at large</b> Japanese society,  Societal point of view	# Better Selection of the projects according to environmental, energy, and economic points of view  # Better selection and contracting from the environmental and economical point of view of conventional lines for which operation will be transferred to local governments

Source of Format: EVSMA 1.0 for LAI member use only [23]



Source of Format: EVSMA 1.0 for LAI member use only [24]

**Figure 6-10 “Value Delivery” from the Enterprise to Society at Large: Relative Importance to Society at Large and Current Performance of the Enterprise**



Source of Format: EVSMA 1.0 for LAI member use only [24]

**Figure 6-11 “Value Delivery” from Society at Large to the Enterprise: Relative Importance to the Enterprise and Current Contribution by Society at Large to the Enterprise**

## **Central Government**

This stakeholder group consists of the government ministries, legislators, and JR TT. The government ministries and the ruling parties have decision making authority for the new Shinkansen project. The central government enacted the new Shinkansen law to develop both the national and the local economy, expanding the living area by linking major cities with high speed rail which operates at speeds more than 200 km/h [7]. For this national-level project, this stakeholder group, the central government, is a strong promoter of the projects.

However, the central government is also greatly affected by political intervention. The new Shinkansen law and important decision making concerning contracts was determined by consultations with the government and ruling parties. Since politicians are greatly involved in these projects, the decision making process has a high level of political intervention.

An independent administrative legal entity, JR TT (Japan Railway Construction, Transport and Technology Agency), is usually appointed as the leader for construction by the Minister of Land, Infrastructure and Transport. Many executives in JR TT are from the central government [25] and we can guess that JR TT is highly affected by the central government. This is the domain of central government, especially the Ministry of Land, Infrastructure and Transport. For the construction, JR TT outsources to private companies. The contracts between JR TT and construction companies will determine the terms, quality, and cost. When it has a construction budget from government planning, JR TT will negotiate with construction companies [7]. There is a bidding system before construction. After the construction, JR TT will have a lease contract with operators negotiated by the government. JR TT will own the assets for 30 years.

In this scheme, the governmental ministry, JR TT, and legislators (politicians) can be in one group of stakeholders since they support the same policy, even though they are supposed to be organizations that can contend with each other.

Their policy is to promote the new Shinkansen lines. However, in the total public budget



(7531 billion yen), ¥1699 billion of the public budget is spent on roads and ¥7 billion, which is only 0.1 %, on the new Shinkansen Project (Figure 6-2). Additionally, part of the ¥7 billion is from the lease payments for other leased Shinkansen lines. This suggests that the central government is not placing priority on the construction of the new Shinkansen lines. With other financial resources, the central government was able to adopt the pay-as-you-go method for the new Shinkansen projects and finally covered its 2/3 of the total construction cost every year (Table 6-2). However, a big portion of the total payment will be financed by JR companies' lease payments for 30 years. The central government decreases the financial risk of operators by its huge capital investment for new Shinkansen lines, but it does not intend to allocate the budget as a subsidy to operators, but rather to collect as much as possible from the operation revenue. This vague method was used because the central government desired to have new lines, yet there was the huge amount of issued government bonds.

Additionally, the opening of each new Shinkansen line will not be early enough to utilize the assets quickly, since the central government has allocated only a small portion of its budget to each line of the new Shinkansen projects. The long construction term reduces the total revenue period since the asset will become old as time goes by and it will generate revenue only after all of the line is constructed. The government has expanded the projects too much, given the tight budget, and has recently decided to have the debt secured by the financial resource from future repayment of JR companies for existing Shinkansen lines between 2013 and 2017.

In 2005, the ruling parties of the government began to consider that “the lease payments within the benefit” should include the increased profit of the existing Shinkansen lines which will be generated by increased ridership caused by the extension of new Shinkansen lines. For example, the government expects \$390 million/year from the construction of the Hokuriku Shinkansen and \$220 million/year from the Hokkaido Shinkansen, which are incremental benefits from existing lines caused by the extension of the Shinkansen lines [22].

Especially for the Hokkaido Shinkansen line, the central government wants to cover not

only the construction cost but also the costs for the 53.8 km tunnel under the sea which connects Honshu and Hokkaido islands. This tunnel was built by the government, and the cost was high enough that it cannot be profitable. The government retains ownership of the tunnel and only leases it to JR Hokkaido. The lease payment is based only on the tax and administration expense and will not cover the depreciation expense of the asset. Additionally, a huge maintenance cost is anticipated in the future. The new line includes this tunnel and it is reasonable that the government wants to gain an additional lease charge for this section.

In general, ruling parties and government organizations want to promote the construction, but the huge debt that the government owes undercuts the project. In this situation, it is natural that the central government tries to extract as much money from operators for the resource as possible to help it expedite and complete the construction.

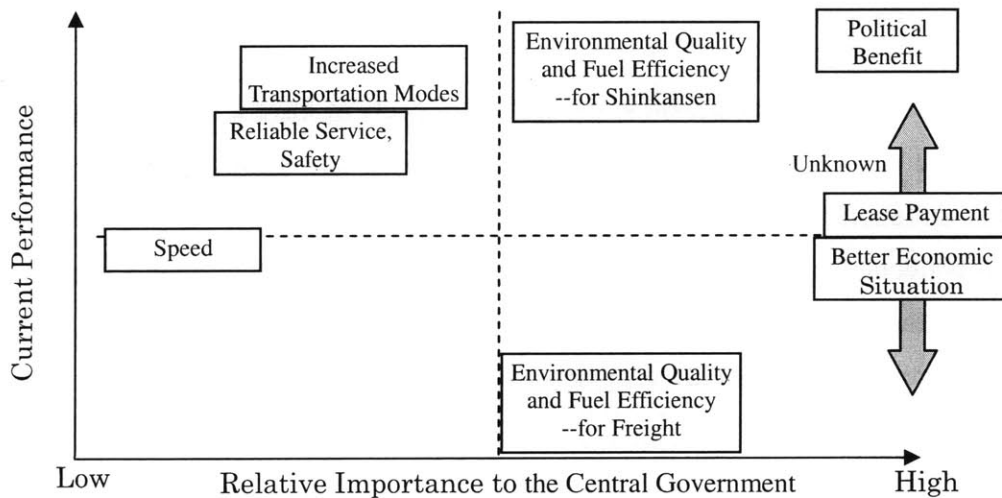
Table 6-8 shows the value exchange between the central government and the enterprise. The following figures show, first, value delivery from the enterprise to the central government by relative importance to the central government and current performance of the enterprise, and second, value delivery from the central government to the enterprise by relative importance to the enterprise and current contribution by the central government to the enterprise.

Central and local governments take it for granted that operators have a reliable, safe service with fixed price; they expect the same level under the regulation as before and they focus more on the financial issues. To expedite the construction despite such a tight budget and minimize criticism of the project, the government wants to reduce its budgetary burden. Therefore, the lease contract with JR companies will be one of the critical issues for the government. Adding more projects is the most important goal for the politicians, but not for the whole group of stakeholders.

Table 6-8 Value Exchange between the Central Government and the Enterprise

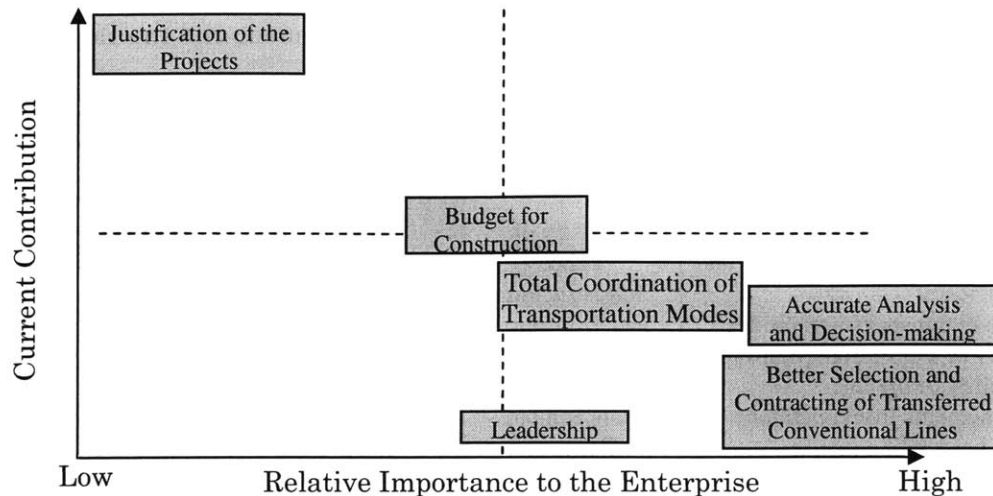
Value that the central government expect from the enterprise	Stakeholders	Value contributed to the enterprise by the central government
# Political benefit # Better economic situation -- Rise in tax payments -- Public satisfaction # Better environmental quality and fuel efficiency # Increase in transportation modes --Stability of transportation in Japan # Profitability of the line # Lease payments from operators -- Less burden of expense # Higher speed # Reliable and sustainable service # Safety	<b>Central Government</b>  Ministry of Land, Infrastructure and Transport, Ministry of Public Management, Ministry of Finance, legislators (politicians), JRTT	# Total coordination of transportation modes # Accurate investigation and analysis from environmental, energy, economic points of view for decision making about the selection of lines  # Justification of the projects  # Budget for construction  # Leadership  # Better selection and contracting from the environmental and economic points of view of conventional lines whose operation will be transferred to local government

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Source of Format: EVSMA 1.0 for LAI member use only [24]

Figure 6-12 “Value Delivery” from the Enterprise to the Central Government: Relative Importance to the Central Government and Current Performance of the Enterprise



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**Figure 6-13 “Value Delivery” from the Central Government to the Enterprise: Relative Importance to the Enterprise and Current Contribution by the Central Government to the Enterprise**

## Local Government

A local government is a stakeholder group that expects to have a new Shinkansen Line in its area. The objective of a local government is that the Shinkansen will improve the economic situation in its local area, and that politicians in the area will reap greater support from the residents if the construction is undertaken. In spite of the tough financial situation nationwide, the population in local areas is decreasing and local governments need policies to stop this trend and to help the declining local economies.

Local governments have hired consultants to do research promoting the Shinkansen extension projects. The decision should not be based only on their opinions since they are the stakeholder group that wants to have the extension and the research tends to be optimistic about the future customer base and to include many assumptions. For example, some prefectures insist that the increased revenue from taxes after the construction and the lease payment by JR companies will make a profit for the central government [26]. Local governments urge the central government to construct the new Shinkansen lines and to allocate funds for the construction. However, the analysis of the economic impact includes questionable assumptions since it is unclear how new Shinkansen lines will attract people

and companies. Transition from air mode to rail mode does not affect the local economy, which needs to attract more people. Careful investigation will be necessary for the justification.

Additionally, as mentioned in the cost analysis, they will still have to repay 18 % of the total construction cost even though some portion of the debt will be repaid by the local allocation tax grant. They will also have to operate unprofitable lines in which JR companies transfer to the local government assets and operations paralleled by the extended Shinkansen lines. This transition of assets and operations will worsen the local budgetary situation.

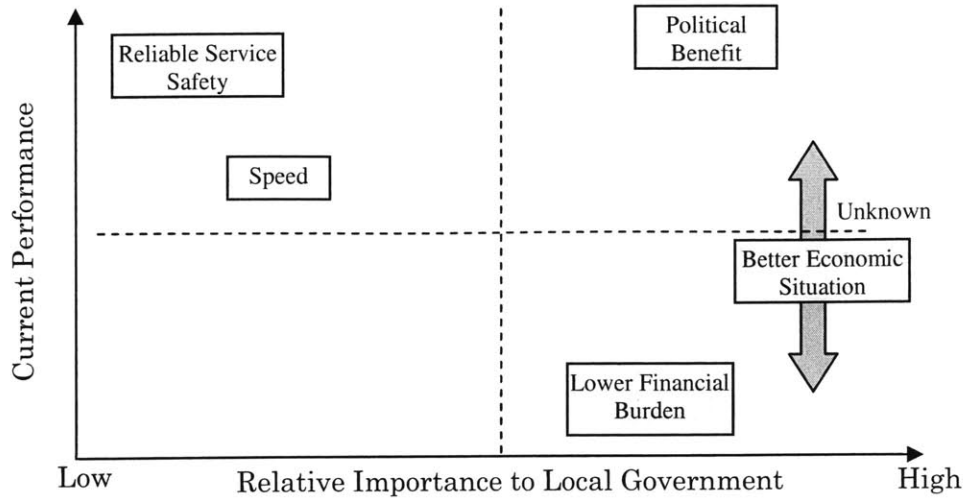
What it comes down to is that local governments are eager to have the new Shinkansen lines, but this business has a high financial risk and may result in a low return. Therefore, careful and equitable, unbiased analysis is necessary for the decision making about the new Shinkansen lines.

Table 6-9 shows the value exchange between local government and the enterprise. The following figures show, first, value delivery from the enterprise to local government by relative importance to local government and current performance of the enterprise, and second, value delivery from local government to the enterprise by relative importance to the enterprise and current contribution by local government to the enterprise.

**Table 6-9 Value Exchange between Local Government and the Enterprise**

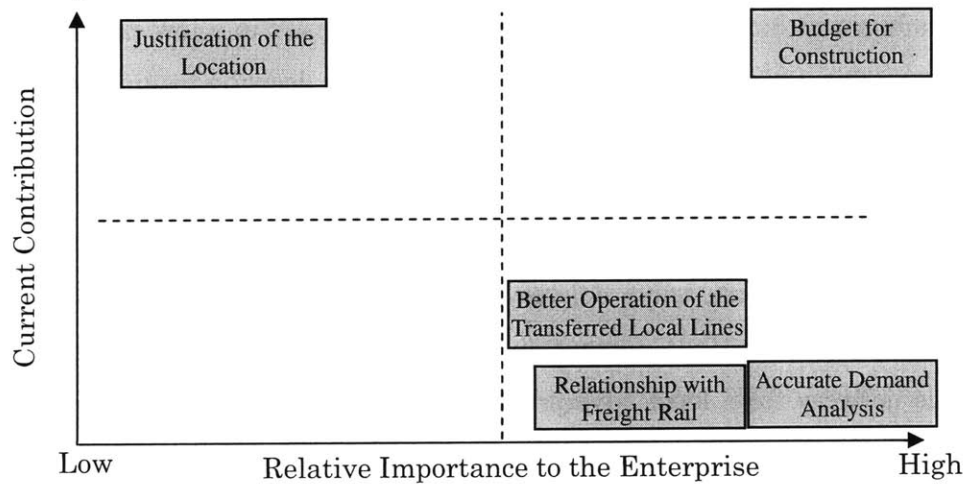
Value that local government expects from the enterprise	Stakeholders	Value contributed to the enterprise by local government
# Political benefit # Better economic situation in the future -- Rise in tax payments -- Public satisfaction # Lower financial burden # Higher speed # Reliable service # Safety	<b><u>Local Government</u></b>	# Justification of the project -- for selection of the location -- for rapid construction with sufficient budget # Budget for construction # Accurate demand analysis for decision making about the construction # Better operation of the transferred conventional lines # Relationship with freight rail

Source of Format: EVSMA 1.0 for LAI member use only [23]



Source of Format: EVSMA 1.0 for LAI member use only [24]

Figure 6-14 “Value Delivery” from the Enterprise to Local Government: Relative Importance to Local Government and Current Performance of the Enterprise



Source of Format: EVSMA 1.0 for LAI member use only [24]

Figure 6-15 “Value Delivery” from Local Government to the Enterprise: Relative Importance to the Enterprise and Current Contribution by Local Government to the Enterprise

## **Passenger Rail Operators**

In Japan, passenger rail operators are in charge of passenger rail operations and maintenance of infrastructure and rolling stock. In terms of the value relation to such a big project, employees, shareholders, labor unions, and the company have almost the same interest and we can represent these stakeholders as operators. Also, the new Shinkansen lines will include mutual operations and multiple operators are involved.

For the decision making process, government proposals need to be approved by operators. One of the reasons why JNR broke up was the reckless construction of railways by the decisions of government and politicians. This approval process is supposed to avoid such reckless construction being mandated by the politicians. Profitability of the operation is definitely necessary to succeed in the new Shinkansen project.

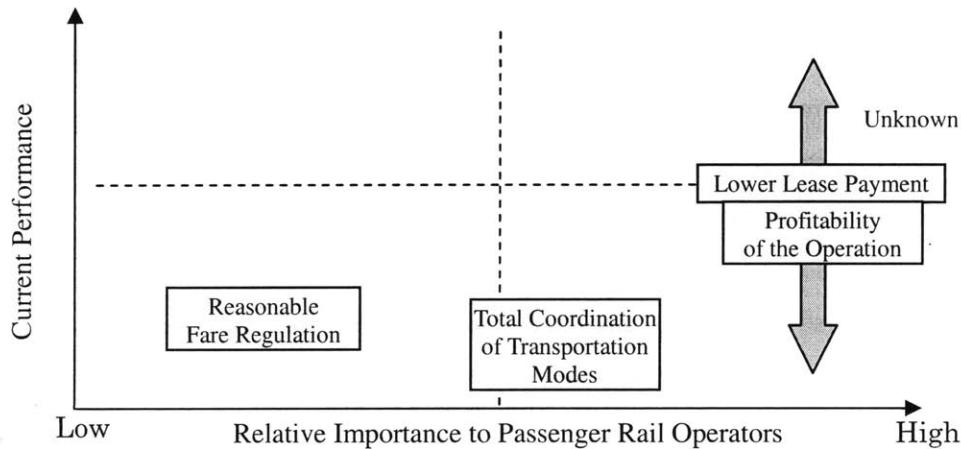
In terms of the construction cost, operators want to minimize the risk of having too much debt and a negative impact on their finances. Consequently, they expect their investment for maintenance and replacement and operation costs to be covered by the future revenue. Another important value for operators is stability and profitability of the service. Stability includes enough generated cash flow for the future increased maintenance expenditure. In other words, operators are expecting more cash flow from the line to invest for the safety and future maintenance plan, since maintenance cost will rise as the infrastructure gets old. Also, as private companies, operators expect more profit in exchange for the longer service. As a result, the lease contract between operators and central government has a very important role in the value exchange about the financial issues.

Table 6-10 shows the value exchange between passenger rail operators and the enterprise. The following figures show, first, value delivery from the enterprise to passenger rail operators by relative importance to passenger rail operators and current performance of the enterprise, and second, value delivery from passenger rail operators to the enterprise by relative importance to the enterprise and current contribution by passenger rail operators to the enterprise.

**Table 6-10 Value Exchange between Passenger Rail Operators and the Enterprise**

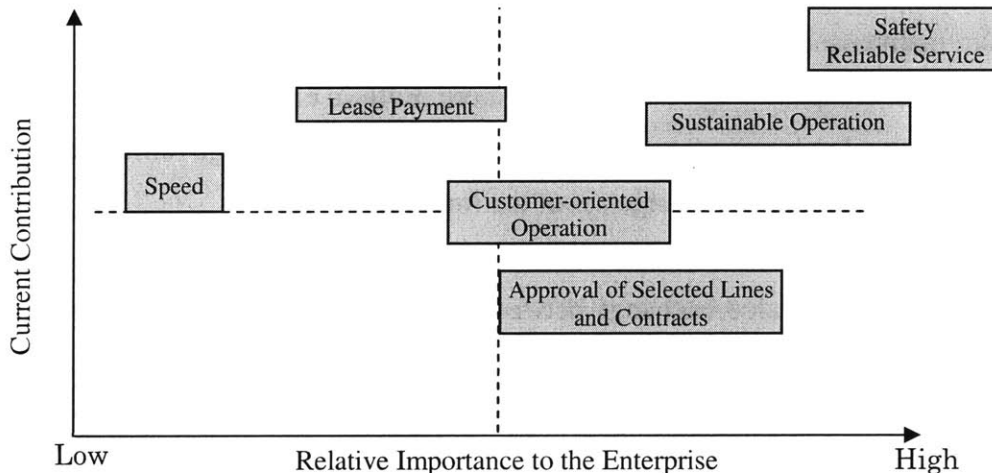
Value that passenger rail operators expect from the enterprise	Stakeholders	Value contributed to the enterprise by passenger rail operators
# Stable, sustainable operation # Lower lease payment (Less cost burden) # Profitability of the operation # Reasonable fare regulation # Total coordination of transportation modes -- Between air and rail	<u><b>Passenger Rail Operators</b></u>  JR East JR Central JR West JR Hokkaido JR Kyushu	# Safety # Reliability # Stable, sustainable operation # Lease payments from operators mean less construction burden for the enterprise # Higher speed # Approval of selected lines and contracts # Customer-oriented operation

Source of Format: EVSMA 1.0 for LAI member use only [23]



Source of Format: EVSMA 1.0 for LAI member use only [24]

**Figure 6-16 “Value Delivery” from the Enterprise to Passenger Rail Operators: Relative Importance to Passenger Rail Operators and Current Performance of the Enterprise**



Source of Format: EVSMA 1.0 for LAI member use only [24]

**Figure 6-17 “Value Delivery” from Passenger Rail Operators to the Enterprise: Relative Importance to the Enterprise and Current Contribution by Passenger Rail Operators to the Enterprise**



## **Rolling Stock Manufacturers**

Development of rolling stock is ongoing in each manufacturing company, supported by different operators. The development cost will be partly covered by operators, but rolling stock manufacturers expect huge future revenues when the new lines are inaugurated. If they succeed in the bidding and the new Shinkansen lines are prosperous, they will have more orders and future sales of parts for maintenance. There is a high level of competition among the manufacturing companies although all are guaranteed some share so that they will remain viable. New technology with higher speed, cost reduction, and safety enhancement will be necessary to win the largest shares of the future market.

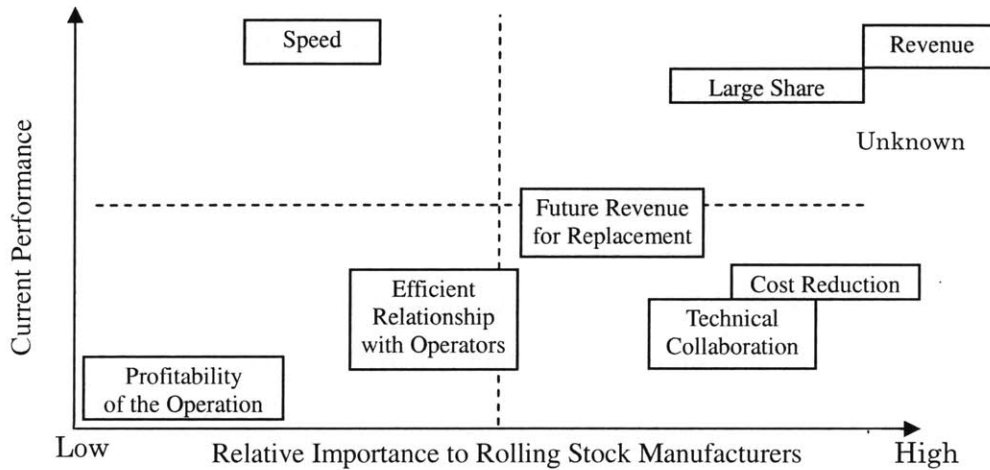
There is almost no cooperation among JR companies or among manufacturing companies. For example, the development for speed-up and safety enhancement is conducted by JR companies separately with each of several contracted manufacturing companies. In terms of the development cost and future supply chain management, increased partnership among manufacturing companies and operators may become necessary since the market of the railway industry is shrinking and a collaborative relationship would be better for cost reduction to compete with air and road transportation.

Table 6-11 shows the value exchange between rolling stock manufacturers and the enterprise. The following figures show, first, value delivery from the enterprise to rolling stock manufacturers by relative importance to rolling stock manufacturers and current performance of the enterprise, and second, value delivery from rolling stock manufacturers to the enterprise by relative importance to the enterprise and current contribution by rolling stock manufacturers to the enterprise.

**Table 6-11 Value Exchange between manufacturers and the enterprise**

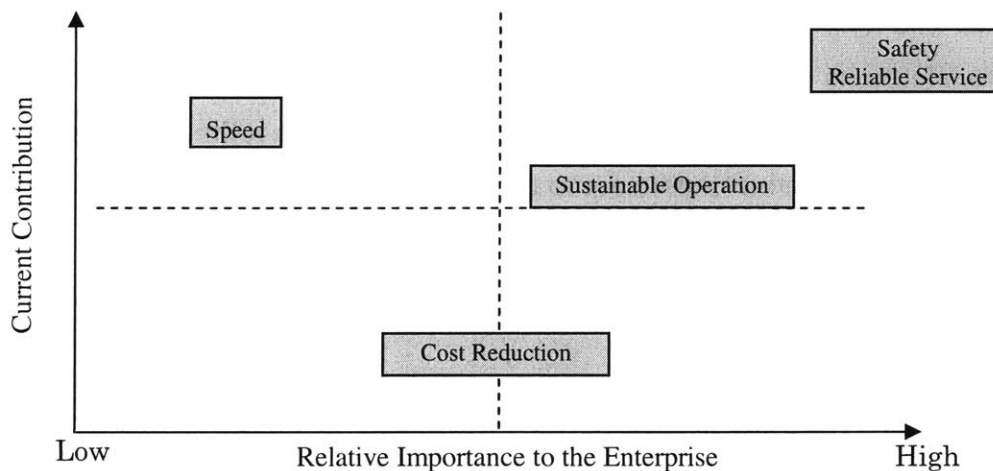
Value that rolling stock manufacturers expect from the enterprise	Stakeholders	Value contributed to the enterprise by rolling stock manufacturers
# Larger share among transportation modes # Revenue from manufacturing new trains # Profitability of the operation # Future revenue for maintenance, replacement # Efficient relationship with operators # Cost reduction, technical collaboration -- Efficient supply chain management -- Development cost savings	<u><b>Rolling Stock Manufacturers</b></u>  Companies Manufacturing Rolling Stock	# Safety # Reliability # Cost reduction -- includes maintenance # Higher speed

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Source of Format: EVSMA 1.0 for LAI member use only [24]

**Figure 6-18 “Value Delivery” from the Enterprise to Rolling Stock Manufacturers: Relative Importance to Rolling Stock Manufacturers and Current Performance of the Enterprise**



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**Figure 6-19 “Value Delivery” from Rolling Stock Manufacturers to the Enterprise: Relative Importance to the Enterprise and Current Contribution by Rolling Stock Manufacturers to the Enterprise**

## Freight Rail Operator

In Japan, freight trains operate on conventional lines but not on the Shinkansen tracks.<sup>9</sup> The nationwide rail freight carrier, JR Freight, owns only short sections of track that serve its own terminals and other facilities. Line-haul freight movement is on tracks owned by the passenger railway companies, under a lease or trackage-rights arrangement. The share of rail freight in Japan is not as high as in the U.S or Europe, largely because most Japanese heavy industry is located in port cities and much of the raw material used is imported by sea. Other problems are that JR Freight, because it does not have much of its own infrastructure, does not have priority for its trains, and that government policy after the privatization has focused too much on passenger railways. For the environmental problems with truck emissions, NO<sub>x</sub> and CO<sub>2</sub> in Japan, we also need to consider the freight rail operator [27] and the new Shinkansen project must not disadvantage the freight railways.

Actually, as JR Freight does not have line-haul infrastructure, it cannot reduce infrastructure costs by developing its own lower-cost track maintenance methods. The only option is cost reduction for the operations. However, the extremely inexpensive price of truck freight has defeated the freight rail and the latter's share is small.

Because of the avoidable cost rule [8],<sup>10</sup> JR Freight has paid less than the amount needed to cover the maintenance cost for the lines. However, after the construction of new Shinkansen lines, by the new Shinkansen law and the agreement among central government, ruling parties, local government, and operators, conventional lines which are parallel to the new Shinkansen lines will be operated by quasi-public corporations ("third sector", whose

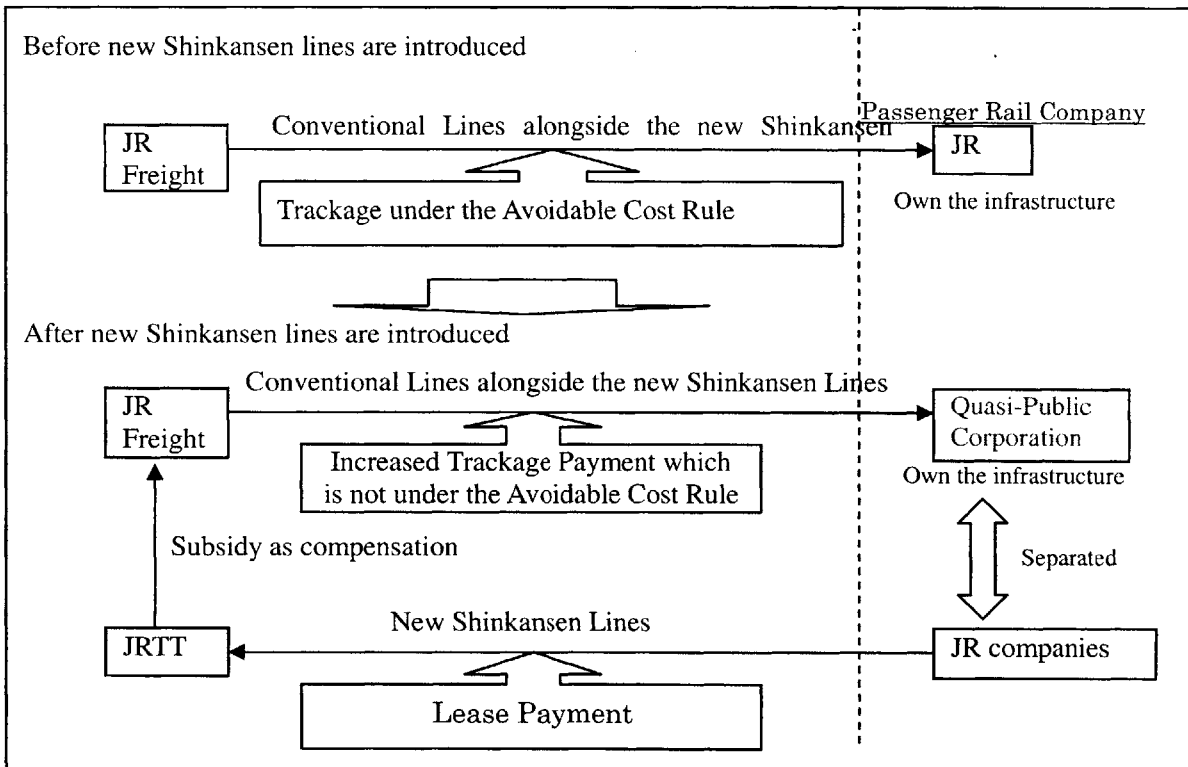
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<sup>9</sup> In Japan, the width of the Shinkansen track is 1435 mm, the same as standard gauge track in North America and most of western Europe. Conventional line track is 1067mm gauge. The use of 1435mm gauge for the Shinkansen eliminates the problems of operating both high-speed and slower-speed trains on the same tracks, and allows different standards of track maintenance to be used for the Shinkansen and for conventional lines.

<sup>10</sup> Avoidable Cost Rule: JR Freight is only charged for the expenditure which is associated with the wear of the track and which could be avoided if freight trains were not operated. After the privatization of JNR, this rule has been applied between JR companies and JR Freight. This is less than the actual maintenance cost and is like a subsidy from JR companies (operators) toward JR Freight.

owners are primarily local governmental organizations) and local governments have announced that they will begin to charge more than the avoidable cost [28]. This change has already been made on some lines. Changes could be made because of the vague contracts which did not deal with the details of the future operation of conventional lines. Additionally, the flexibility of the operations became less since freight operator had to go through more territories of different passenger railway companies.

After negotiations with the central government, JR Freight has become able to get subsidies to cover the difference between the new charge and the avoidable cost. Figure 6-20 shows the new scheme. The government was beginning to change the Japanese new Shinkansen law to provide that the lease charge can be used not only for construction of new Shinkansen lines but also for this subsidy. However, the quasi-public corporations are still in financial trouble and may insist on higher charges, because there is no way that they can cross-subsidize within their organizations as the passenger JR companies can do.



Source: Ministry of Land Infrastructure and Transport, Japan [29]  
**Figure 6-20 New scheme for the subsidies to JR Freight**

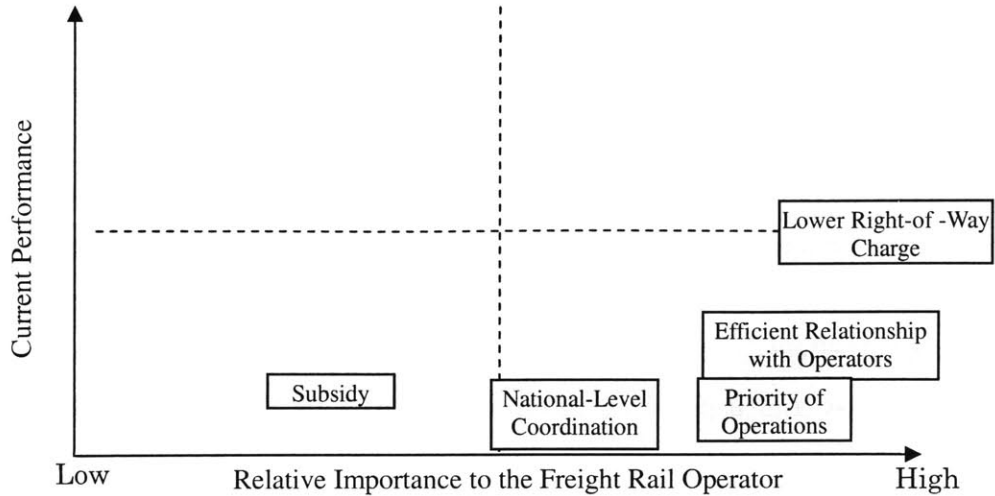
Another problem affecting the Hokkaido Shinkansen is that the 53.8 km tunnel under the Tsugaru Strait will be used by both freight and Shinkansen trains. The government owns the tunnel and now leases this facility to JR Hokkaido, and passenger and freight trains running through the tunnel are both 1067mm gauge. Track in the tunnel is designed to be converted to dual-gauge (1435mm and 1067mm). When this begins, Shinkansen trains will have priority for operations in the tunnel and this may cause freight trains to be slower or interfere in other ways. Also, since the tunnel maintenance cost is likely to be large in the future, both operational priority and the charge from JR Freight to JR Hokkaido will become controversial issues.

Table 6-12 shows the value exchange between the freight rail operator and the enterprise. The following figures show, first, value delivery from the enterprise to the freight rail operator by relative importance to the freight rail operator and current performance of the enterprise, and second, value delivery from the freight rail operator to the enterprise by relative importance to the enterprise and current contribution by the freight rail operator to the enterprise.

**Table 6-12 Value Exchange between the freight rail operator and the enterprise**

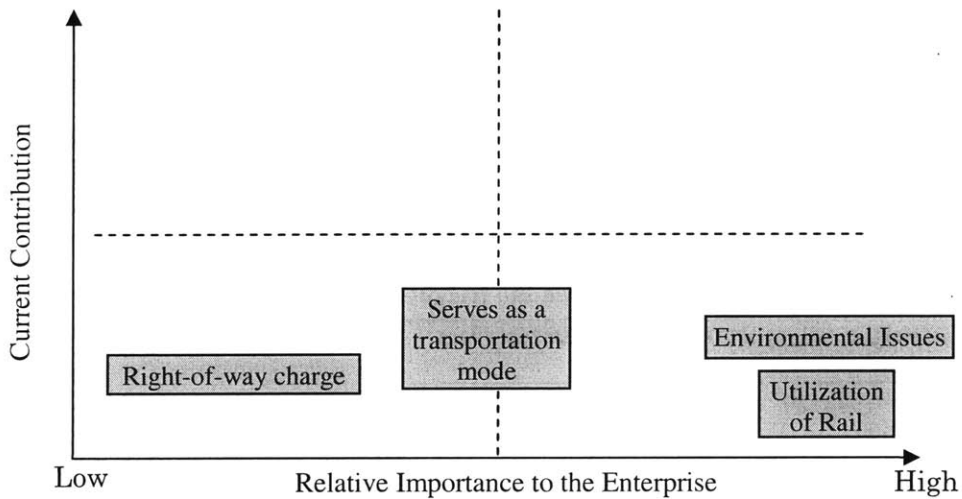
Value that the freight rail operator expects from the enterprise	Stakeholders	Value contributed to the enterprise by the freight rail operator
<ul style="list-style-type: none"> <li># Lower right-of-way charge</li> <li># Priority of operation</li> <li># Subsidy</li> <li># National-level coordination</li> <li># Efficient relationship with operators</li> </ul>	<p style="text-align: center;"><b><u>Freight Rail Operator</u></b></p> <p style="text-align: center;">JR Freight</p>	<ul style="list-style-type: none"> <li># Better environmental quality and fuel efficiency</li> <li># Serves as a transportation mode</li> <li># Utilization of rail</li> <li># Right-of-way charge</li> </ul>

Source of Format: EVSMA 1.0 for LAI member use only [23]



Source of Format: EVSMA 1.0 for LAI member use only [24]

**Figure 6-21 “Value Delivery” from the Enterprise to the Freight Rail Operator: Relative Importance to the Freight Rail Operator and Current Performance of the Enterprise**



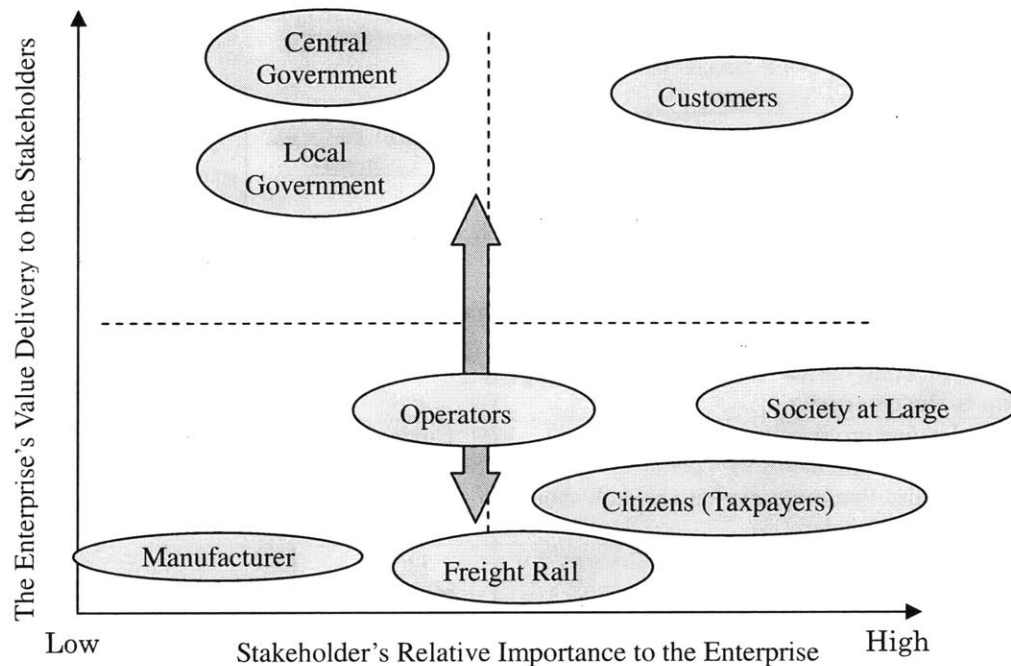
Source of Format: EVSMA 1.0 for LAI member use only [24]

**Figure 6-22 “Value Delivery” from the Freight Rail Operator to the Enterprise: Relative Importance to the Enterprise and Current Contribution by the Freight Rail Operator to the Enterprise**

## Summary of the Value Exchange

Given the information about each stakeholder's point of view and the value exchange analysis, the following figure shows the relationship between the stakeholder's relative importance to the enterprise and the enterprise's value delivery to the stakeholders.

Also, Table 6-13 shows the additional value that needs to be delivered to the stakeholder group and the value that needs to be delivered to the stakeholder group. Table 6-14 shows the additional value that should be contributed from the stakeholder group to the enterprise and the value that apparently need not to be delivered to the enterprise to so much an extent.



Source of Format: EVSMA 1.0 for LAI member use only [24]

**Figure 6-23 The relationship between the stakeholder's relative importance to the enterprise and the enterprise's value delivery to the stakeholders**

**Table 6-13 Values that are of major importance to the stakeholder group and values of less importance**

<b>Additional values of major importance that need to be delivered to the stakeholder group</b>	<b><u>Stakeholders</u></b>	<b>Values of less importance that could be delivered to the stakeholder group</b>
# Reasonable fare	<b><u>Customers</u></b>	(# Speed)
# Lower financial burden	<b><u>Other Individuals</u></b>	
# Better environmental quality and energy efficiency by freight railways # Better economic situation	<b><u>Society at Large</u></b>	
# Better Economic situation	<b><u>Central Government</u></b>	# Political benefit
# Lower burden of expense # Better economic situation	<b><u>Local Government</u></b>	# Political benefit
# Total coordination of transportation modes -- Between air and rail # Profitability of the operation # Lower Lease Payment # Stable, Sustainable Operation	<b><u>Operators</u></b>	
# Cost reduction, technical collaboration -- Efficient supply chain management -- Development cost savings	<b><u>Manufacturers</u></b>	(# Improvement in Speed)
# Lower right-of-way charge # Priority of the operation # National-level coordination # Efficient Relationship with operators	<b><u>Freight Railway Company</u></b>	

**Table 6-14 Values that are of major importance to the Enterprise and values of less importance**

<b>Additional values of major importance that should be contributed from the stakeholder group to the enterprise</b>	<b><u>Stakeholders</u></b>	<b>Values of lesser importance that could be delivered to the enterprise</b>
# Ridership and profitability # Needs and Requirements for operation This implies that more market research should be done by the enterprise.	<b><u>Customers</u></b>	
# Opinions through mass media or politicians -->More attention to politics Data should be readily available to the public.	<b><u>Other Individuals</u></b>	
# Better selection and contracting of transferred conventional lines	<b><u>Society at Large</u></b>	
# Leadership # Accurate investigation and analysis for The selection of the new lines # Total coordination of transportation modes	<b><u>Central Government</u></b>	# Justification of construction
# Accurate demand analysis for the selection of new lines # Better Relationship with freight rail	<b><u>Local Government</u></b>	# Justification of construction # Operation of conventional lines
# Analysis for operation # Decision making process	<b><u>Operators</u></b>	
# Cost reduction	<b><u>Manufacturers</u></b>	(# Higher speed)
	<b><u>Freight Railway</u></b>	# Better environmental situation # Utilization of rail



Following is a short summary of the result from the value exchange analysis:

- \* Environmental and economic issues are important, but we need to reduce the national expenditure. We need to define how much we can use the national expenditure for each issue.
- \* Leadership of the central government is necessary in order to proceed. However, this does not mean the directorship, but rather the coordination of a lean enterprise. For example, the coordination between the airline and railway industries is necessary to stabilize both of these businesses that depend on economies of scale.
- \* For processes of deciding whether the construction is appropriate or not, accurate investigation and data analysis are necessary. We need to eliminate “political” motives from the enterprise as much as possible. Profitability is the critical issue for the success of the enterprise, and if the project is not profitable, the ability to stop the project is necessary.
- \* Lease payments should be defined to satisfy all the stakeholder groups. We should define how to set an equitable lease payment in the early stages. It is necessary to have a scheme to share the profit and cost from the new lines in a balanced manner with all stakeholders every year.<sup>11</sup> It should be variable each year since the demand is unpredictable.
- \* Freight railways should be considered more seriously in the earlier stages. Because of the present management structure, the freight railway is at a disadvantage, and this new enterprise also makes its situation harder in terms of the priority of operation and right-of-way charge. For example, the relationship between JR Freight and local governments is being made worse by this project and it may hurt the freight railway operations. Freight railways have potential to increase the usage of rail and to ease environmental concerns. The enterprise should not undermine the industry and should consider national-level coordination with the freight railways.

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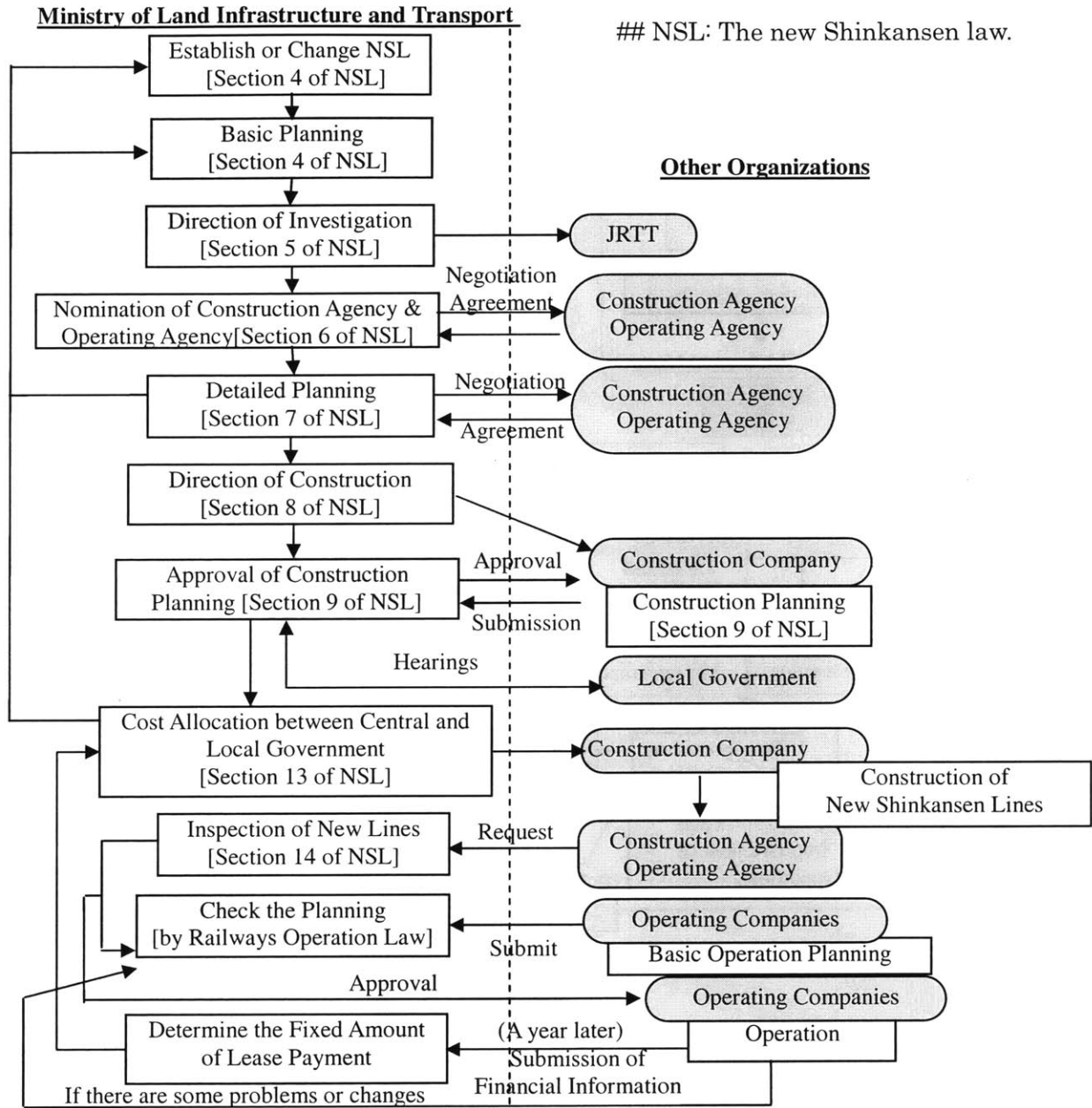
<sup>11</sup> Governments are non-profit organizations, but they also need some benefit from the enterprise for use in further projects or to recover the past construction costs.

\* Manufacturers and operators need technical collaboration for reduction of development costs and efficient supply chain management. This reduces the total cost of the enterprise and enhances the competitiveness with air and road transportation.

This section analyzed the value exchange between enterprise and stakeholders to explore the concept of the lean enterprise. In the next section, we are going to discuss the process of the project in order to make the process leaner.

## 6.2.4. Process Analysis

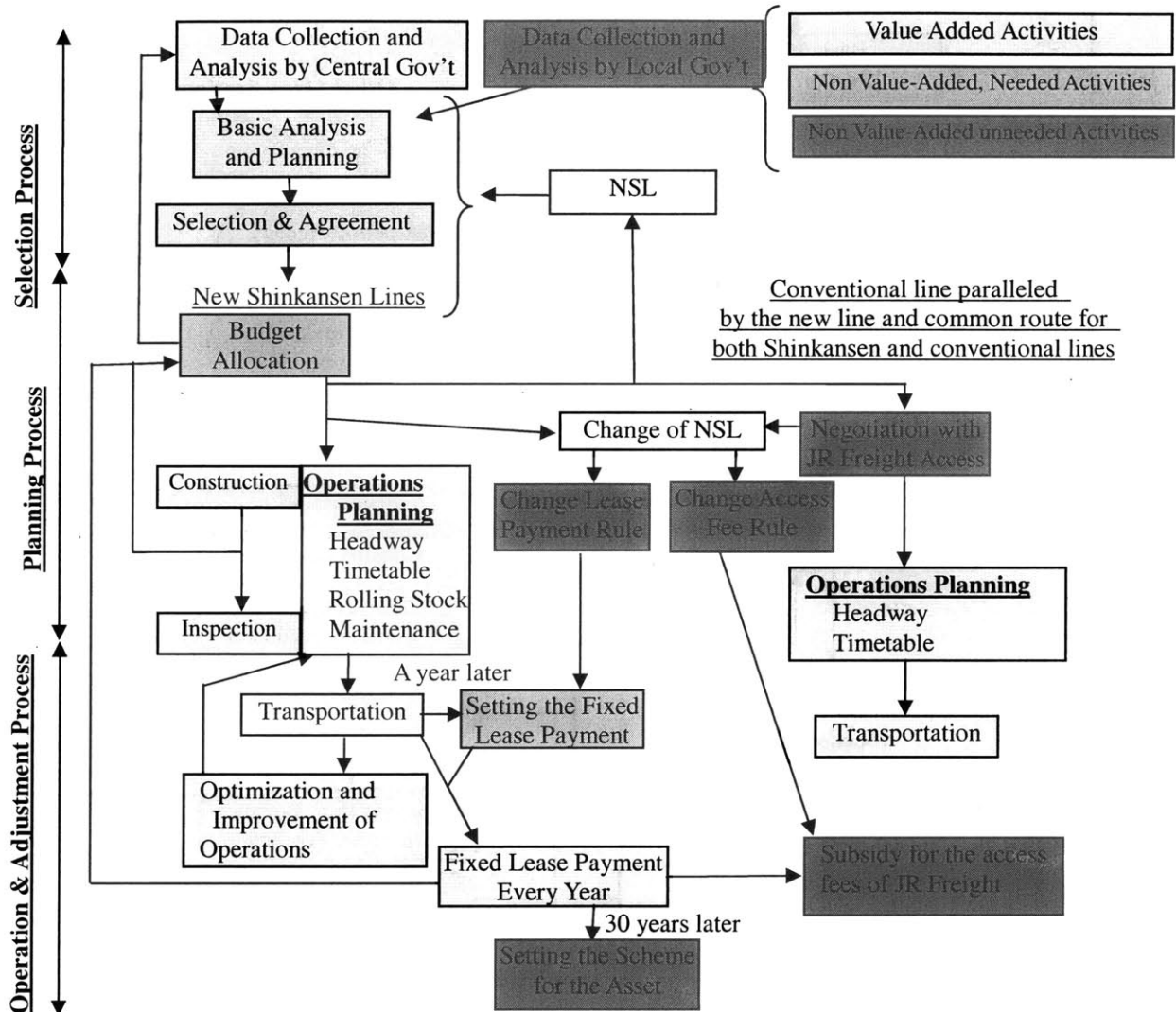
According to the Ministry of Land, Infrastructure and Transport website [7], the basic scheme of the enterprise processes in the early stage was as shown in Figure 6-24.



Source of Format: Ministry of Land Infrastructure and Transport Report Website, arranged by author[22]

**Figure 6-24 The Basic Scheme of the Enterprise Processes in the Early Stage**

This thesis utilizes the EVSMA method for eliminating waste and creating better value-adding processes. Figure 6-25 shows the value stream mapping by sequence, based on the information above and what actually happened in the past [7][30]. There are three kinds of activities: value-added activities, non-value-added needed activities, and non-value-added unneeded activities.



Source of Format: Nightingale [18]

Figure 6-25 Value Stream Map as the Enterprise Currently Operates

The activity of the new Shinkansen enterprise consists of the selection process, followed by a basic planning process, and finally an operation and an adjustment process. The original framework with the new Shinkansen law and government regulations was expected to work well but the actual process did not work well: the framework included many processes that were non-value-added unneeded activities and value-added activities whose performance was not good enough.

### **Non Value-Added Unneeded Processes: late adjustment of contracts and the new Shinkansen law**

Most of the non-value-added processes were associated with the late adjustment of the lease contract and the new Shinkansen law. All stakeholders agreed to the construction project based on the new Shinkansen law, consultation, and the contract in the selection process. Therefore, too many radical changes after the selection process made the balance of the value exchange among stakeholders and the enterprise worse.

First, the late change of a fundamental element of the contract, the lease payment, has been controversial. The central government and JR East came into a conflict with each other about the additional lease charge<sup>12</sup> in the contract after the further extension to the other operator's area was budgeted. JR East, one of the operators, is now opposing the additional payment for the following reasons. First, if this provision had existed when JR East agreed to the construction of new Shinkansen lines, JR East would not have accepted it since this additional payment is against its business judgment as a private company. JR East assumed that the construction would not have a negative impact on its finances and therefore approved of the construction of new Shinkansen lines without the additional lease charge. Second, if there is more profit in the future, the profit should be returned to the government through the corporate income tax and not through such a method as an additional lease charge. On the other hand, the government considers the additional charge reasonable since the resources for the construction project came from the citizens and everyone should enjoy the results of the new Shinkansen lines. (The government officials have said that this profit

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<sup>12</sup> The government is now considering the additional charge to an operator for its profit that will be increased in its area by the extension of a new line into another operator's area.

will be used for further extension projects in Japan.) This conflict occurred partly because it is the first time that the extension will involve two different operator areas, but it was apparent that it will involve the two areas and the enterprise should have negotiated before. We can say that the later change was because of the lack of consideration and negotiations. Additionally, the same conflict will surely occur when they set the scheme for the asset treatment at the lease term's end point, 30 years later. The vague contract about the asset treatment was partly because of the uncertainty of the profitability, but we can imagine that the government avoided the conflict at that time for the purpose of promoting the new lines. Thus, a late radical change of contract will spoil the value balance of the stakeholders and nullify the cooperative relationship.

Second, the other non-value-added process is the late process in which the new Shinkansen law was changed for the subsidy to the JR Freight. After the construction funding was appropriated, local governments suddenly set the freight rail access fees of the conventional lines parallel to the newly constructed Shinkansen line much higher than JR companies did. Because JR Freight had been in poor condition and facing financial difficulties after the privatization, having no indirect subsidy for paying these higher access fees might have led to financial collapse of the freight railway. Finally, the central government decided to grant a subsidy from the profit of the new Shinkansen line to JR Freight, which made the cross-subsidy between stakeholders more complicated. As a result, only the local governments can charge JR Freight a higher access charge, while JR companies still have to charge less to JR Freight as an indirect subsidy, and also must provide cross subsidies from profitable lines in the urban area to support unprofitable lines in the rural areas of these local governments. In contrast, in Germany, the federal states have to pay charges as subsidy to the operators when they want to continue unprofitable lines. From this point of view, the Japanese local governments ultimately succeeded in increasing the value delivery from the enterprise, because they could get the new lines, could charge more to JR Freight as the access fees for using the transferred conventional lines, and did not lose any of the unprofitable conventional lines.

Additionally, there will be no guarantee to the freight rail operator of having operational priority on the transferred conventional lines or through the Seikan Tunnel, which will be

used by both freight rail and Shinkansen.) It is because the enterprise as a whole tends to give first priority to the passenger high speed rail. Later negotiation about the priority and access charge will put the freight rail company in a much weaker position. The negotiation process between JR Freight and the enterprise should be done earlier to insure that it become a value-added process that enhances the balance of the value exchange.

To sum up, the radical changes in the contract and laws, occurring after the selection process, have spoiled the balance of the value exchange among stakeholders and enterprise, and it was a consequence that resulted from nothing other than political interventions. To make the process a value-added one, all the processes above should be negotiated before the selection of lines and stakeholders. Then, under the fully specified scheme, the enterprise can and should pursue the goal of being a cooperative, lean enterprise.

#### **Problems of value-added activities: no efforts to anticipate other potential problems**

In the selection process, especially before all stakeholders are involved in the project, there has also been no effort to settle other potential problems that may arise after the operation. Since stakeholders expect completely different values, and political interventions easily occur in the railway industry, only earlier treatment of the potential future problems allows the enterprise to become a lean one.

For example, congestion problems on the rails may crop up as in the U.K. reform. For example, local government, one of the investors, and JR Hokkaido will be likely to insist on increasing the number of direct trips to Tokyo for the Hokkaido Shinkansen line. Now all the Shinkansen lines of JR East will go to the urban area between Tokyo and Omiya, where the frequency is nearly at capacity now. It is apparent that the Tokyo-Omiya section will be overcrowded and the enterprise will have to consider the risk of an increased chance of disruption, as in the situation of Railtrack in the U.K. There were no incentives for Railtrack to increase the capacity and that caused the later terrible disruption. A plan is needed in the early stage to cope with the future capacity problems.

**Problems of value-added activities: problems of data collection and analysis in the selection process**

Central and local governments have performed data collection and analysis independently, which is wasteful. Integrated data collection and analysis with the cooperation of all stakeholders will decrease both costs and political intervention, and increase the accuracy and neutrality of conclusions. Additionally, cooperation with a university or other organization which has no preference for a particular stakeholder, like LAI, may be appropriate to keep the research neutral.

The data collection and analysis also has lacked sensitivity analysis by frequency, travel time, and competition with airlines. It should also estimate the waste of asset utilization caused by lengthy construction times. Constructing several planned lines at the same time makes the construction time longer, given budget constraints. Sensitivity analysis will enable the enterprise to judge whether new lines are appropriate or not, and utilize the capital investment best for all stakeholders. As the project process goes on, more stakeholders should be involved in the data collection and analysis in a cooperative manner.

**Problems of value-added activities: late operations planning**

Operations planning should be discussed at the end of the selection process to more fully specify the contract. Operations planning includes frequency, timetable, fare, and similar factors. Specified operation planning agreed to by all stakeholders allows the enterprise to predict potential problems. It also helps with the future demand analysis.



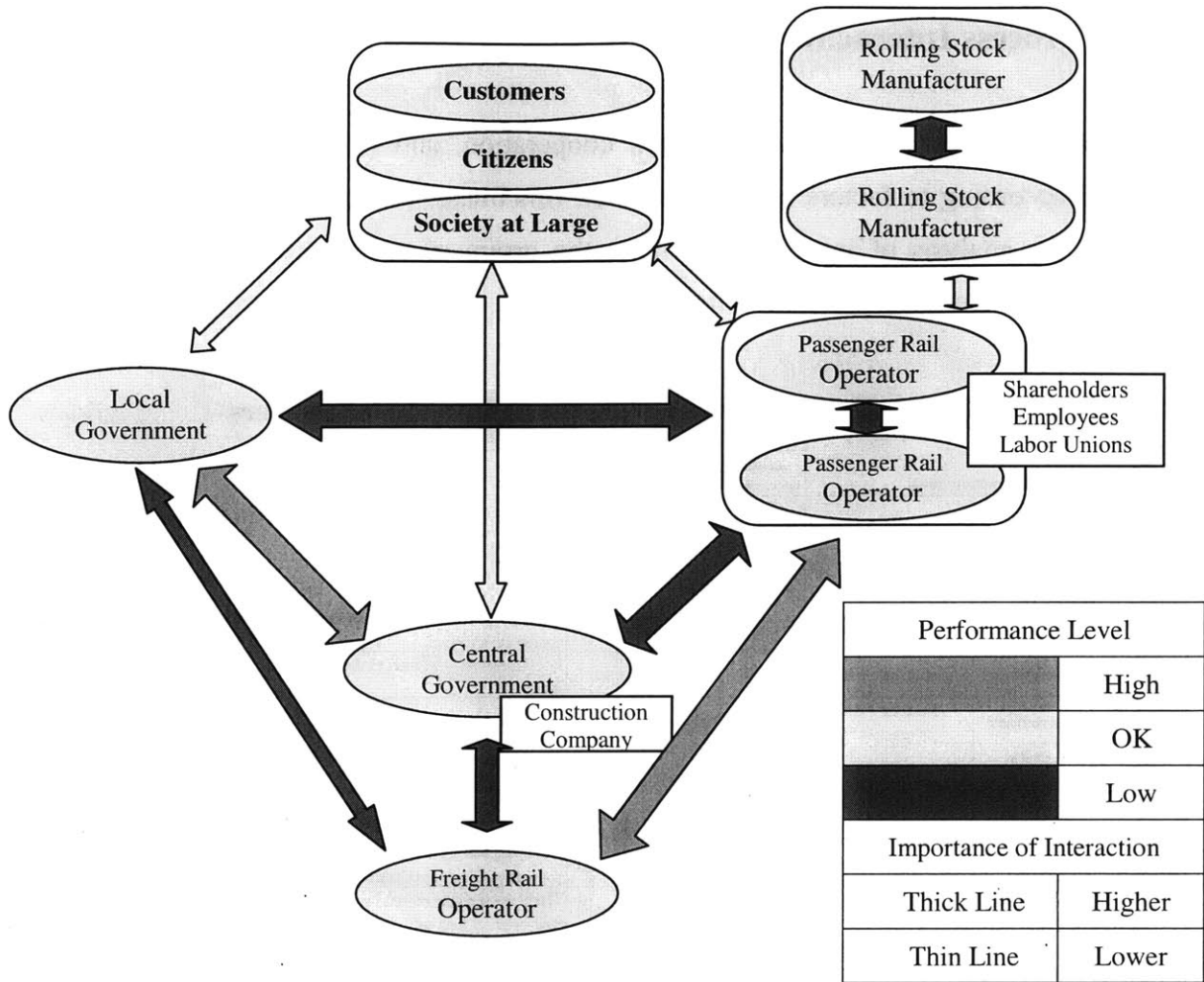
## 6.2.5. Process Interactions

In this section, key flows of information, cooperation, and financial resources will be analyzed according to factors such as stability, timeliness, accuracy, completeness. Table 6-15 is the analysis of interactions among the group of stakeholders and Figure 6-26 shows a simplified visual version of the result.

Table 6-15 Interactions among the Groups of Stakeholders

Importance of Level of Interaction	Interaction goes:		What flows in this interaction?								Note			
	From	To	Information	Cooperation	Finance	Proactive	Reactive	Stability	Timeliness	Accuracy		Completeness		
	Central Government	Local Government	x	x	x	x			h	h	h	h	Local grants and subsidies from the central government will cover most of the construction cost.	
	Local Government	Central Government	x				x		h	h	h	h	Local government outsources the research work and promotes the project most.	
	Central Government	Passenger Rail Operators	x				x		m	l	l	l	Interactions are through consultation and somewhat imprecise contracts.	
	Passenger Rail Operators	Central Government	x	x	x			x	l	l	m	l	Need to have cooperative relationship, but also need to avoid interference by politicians.	
	Local Government	Passenger Rail Operators						x	l	l	l	l	The lines to be transferred were selected by law and there was no discussion which lines should be selected.	
	Passenger Rail Operators	Local Government						x	l	l	l	l	JR companies did not show any data on unprofitable lines when the conventional lines are transferred to local government.	
	Customers, Citizens, Society at large	Central and Local Government	x		x			x	m	m	m	l	This is not the only reason why people vote for some certain politicians and their opinions may unfortunately not be represented by politicians.	
	Central and Local Government	Customers, Citizens, Society at large						x	m	m	l	m	There is no sensitivity analysis in the planning process and not much publicly available data on the results of the new operation.	
	Customers, Citizens, Society at large	Passenger Rail Operators	x		x	x			m	m	m	m	After the new operations begin, this information is very important for succeeding in the competitive market.	
	Passenger Rail Operators	Customers, Citizens, Society at large	x				x		m	m	h	m	Continuous information of the new operations needed for increasing the ridership figures.	
	Freight Rail Operator	Central Government	x	x					x	l	l	h	l	JR Freight should have negotiated about the access fees of local lines before the new Shinkansen project was executed.
	Central Government	Freight Rail Operator							x	l	l	m	l	Late response regarding access fees and operational priority may threaten the management of JR Freight.
	Freight Rail Operator	Local Government							x	m	l	h	l	There were no interactions between JR Freight and local government. They need to negotiate about the increased access fees of the local government.
	Local Government	Freight Rail Operator							x	l	l	l	l	Local government should have discussed the increased access fee with JR Freight before construction of new Shinkansen lines.
	Passenger Rail Operators	Freight Rail Operator	x	x	x				x	m	m	m	h	There was a low access fee to JR Freight and operators kept the same fee in their lines.
	Freight Rail Operator	Passenger Rail Operators	x	x					x	m	m	h	h	There was a low access fee to JR Freight and operators kept the fee in their lines.
	Passenger Rail Operators	Passenger Rail Operators	x	x	x				x	m	l	m	l	This relationship should be established in the selection process, but it happens too late to influence the project selection process.
	Passenger Rail Operators	Rolling Stock Manufacturer	x	x	x	x			m	h	m	m	m	For new lines, new specifications of trains may be necessary, requiring a product development process.
	Rolling Stock Manufacturer	Passenger Rail Operators	x	x					x	m	h	m	h	In the development, communication and cooperation is involved.
	Rolling Stock Manufacturer	Rolling Stock Manufacturer							x	l	l	l	l	There is almost no interaction because of competition.

Source of Format: EVSMA 1.0 for LAI member use only [31]



**Figure 6-26 Interactions between stakeholders**

As a result, to become a lean enterprise, this new Shinkansen enterprise needs to have higher performance levels for the following interactions, which are of higher importance and for which the performance level is low.

**Interactions between Central Government and Passenger Rail Operators**

Interactions are now through consultation, regulation, and the contracts. The enterprise needs to avoid interference by politicians, but also to have a cooperative relationship between government and private companies.

First, the regulation and the lease contract should have a very important role in the

separation between the government and the railway operator, to insure the management autonomy and good financial condition of a private company. The government and operators now have lease contracts which show independence from the government, since one of the reasons why the JNR (Japanese National Railways) was divided and restructured in 1987 was the external interference from the government and lack of management autonomy. This lease contract prevents JR companies from accepting construction of unprofitable lines and bearing too much construction cost or debt for these lines. Therefore, this contract plays the role of separating private operating companies from the government and political decisions.

In addition to that, the consultation and contract should also enhance the integrity of the whole enterprise later. Once the contract has functioned appropriately regarding both separation and integrity at the first stage, continuous effort toward the lean enterprise ideal should allow all stakeholders to have a cooperative relationship to achieve their goals. After the meaningful negotiation of the fully specified contract, all stakeholders can continue to strive for an ever better lean enterprise.

However, the lease contract is imprecise, not fully specified (refer to section 6.2.4) and thus includes potential problems. Also, once a new line has been selected, there has been no framework or organization to aim at the lean enterprise ideal to maximize the enterprise level for the satisfaction of all stakeholders. The cooperative relationship between central government and operators is a key to succeeding in pursuing this aim.

### **Interactions between Local Government and Passenger Rail Operators**

Even though the central government is the leadership of the enterprise, local governments and passenger rail operators are also important stakeholders and their interactions are important for obtaining optimal solutions at the level of local details. For example, the lines to be transferred from JR companies to local government were selected by law and there was no discussion about which lines should be transferred, even though many sections of the law were being changed as problems occurred. If there had been interactions between local government and passenger rail operators, they could have negotiated with each other

about which line should be transferred from JR companies to local government or might even have changed the most unprofitable lines in the local area from rail operation to bus operations because bus operating cost is much lower than the cost of railway service. Such interaction will allow the enterprise as a whole to obtain better solutions at the local detail level and thereby support the enterprise better.

### **Interactions between Passenger Rail Operators**

This relationship should be established in the selection process, but it can often happen too late to influence the project selection process, since detailed operational planning affects the future demand and profit. Also, earlier negotiation will reduce the risk of future trouble in terms of each stakeholder's value. Frequency, fare policy, rolling stock development plans, and maintenance should be discussed before concluding agreement on the project. Frequency, especially, may cause congestion problems on the railway lines in urban areas and needs to be clarified in the contract. After the beginning of operation, cooperative interaction and well balanced value exchange must be sustained for safety and high quality of service.

Additionally, each JR company researches and develops faster trains independently and there is no collaboration with each other or with the government. No integration exists and this is one of the aspects of the waste in the whole enterprise architecture. For example, JR East is now working alone to develop the world's fastest steel wheel train (operational maximum speed: 360km/h) without any subsidy, and JR Central is also trying to improve the speed as well as researching maglev trains by itself. The research and development is being done independently by each JR company and the role of government is extremely low. Government does not want to involve itself in the project because of its huge debt, but also JR companies want the government out of the process from the point of a private company. Considering the difficult situation caused by the modal shift to automobiles from railway transportation, it is appropriate for government to be in the process for high-cost innovative development like maglev trains and higher speed railways, in order to make the development integrated. For example, the most innovative development of the first Shinkansen in 1964 was accomplished through government involvement in the process.

This waste and non-integration should be eliminated, from the point of view of the entire enterprise.

### **Interactions between the Freight Rail Operator and the Central Government**

JR Freight should have actively negotiated about the access fees of conventional lines which are paralleled by the new Shinkansen lines before the new Shinkansen project was executed, since the local government could suddenly charge much higher access fees because there were no pertinent agreements in the contract. Central government has now changed the law to protect the freight railway, but the operational complexity has increased because the freight has to run on the tracks of many different operators and the freight and passenger trains will have to coordinate operations on the same tracks through the Seikan Tunnel. Further negotiation should proactively be done, since the passenger railway usually has higher priority in operations. Late responses regarding access fees and operational priority may threaten the financial stability of JR Freight.

### **Interactions between Rolling Stock Manufacturers**

Development is ongoing in each manufacturing company, sponsored by different operators. The development cost will be partly covered by operators but they expect huge future revenue when introducing the new trains. There is competition among manufacturing companies to some extent, and new technology with cost reduction and safety is necessary to win in future bidding. Therefore, there is almost no cooperation among manufacturing companies. They are eager to succeed in the development so as to sell more rolling stock at a higher price. If they succeed in the project and the new Shinkansen lines are prosperous, they will have more orders.

However, in terms of the development cost and future supply chain management, partnership among manufacturing companies and operators is necessary since the railway industry is not as big as other industries. This cooperation can be achieved by the leadership of operators.

## 6.2.6. X-Matrix Evaluation

The X-Matrix is an evaluation of the interrelationship between key processes, stakeholder values, strategic objectives and metrics. This evaluation shows whether all items are working together or not.

### Definition of Metrics

In this section, we complete our definitions with those of metrics. The new Shinkansen projects are based on the new Shinkansen law and government plays an important leadership role in the enterprise. For such national projects, the metrics should be in government publications and documents. According to the government official website [22], the following metrics are tracked:

#### **\*Economic effect [Yen] for 30 years, and economic effect / construction cost**

This metric is, first, used to show whether the new line is worth constructing or not. If this amount is big enough, central government will get more tax and get some profit from this project. This metric is also important for citizens to check whether the project is appropriate or not.

#### **\*Change in travel time**

Travel time depends on the track and on development of rolling stock. This metric is one of the elements to estimate the future demand.

#### **\* Ridership**

Given that the fare is almost fixed, ridership directly affects the revenue of railway companies and also affects their lease payment to the government.

#### **\* Change in profitability for an extended line over 30 years**

Metrics of profitability are usually used for fixing the amount of lease payment after the first year operation.

#### **\* Total Construction Cost**

Total construction cost is one of the constraints when deciding whether the new line will be constructed or not.

## **X-Matrix Evaluation**

This section will evaluate the alignment of strategic objectives, metrics, key processes, and stakeholder values by using the “X-Matrix”. The strategic objectives are from section 6.1, stakeholder’s values are from section 6.2.3, and key processes are from section 6.2.4.

### **1. Alignment of metrics with strategic objectives**

Figure 6-27 shows how the metrics accurately assess the enterprise performance for strategic objectives. Many strategic objectives are not well captured by any of the metrics:

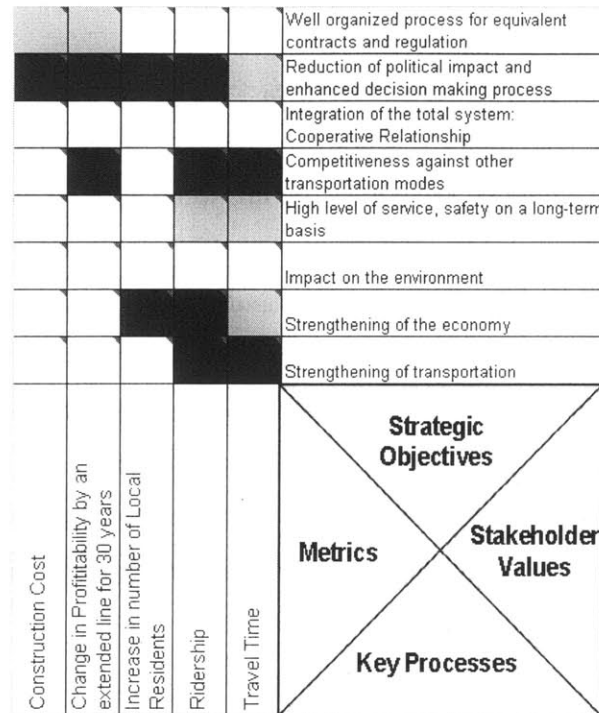
First, a strategic objective –equivalent contracts and regulation– needs some metrics that can be measured. Suggested metrics would be how the enterprise provides sufficient value to each stakeholder as in the value exchange analysis (section 6.2.3). The standard of sufficient value depends on each stakeholder’s contribution to the enterprise and it is difficult to measure quantitatively. However, through a continuous enterprise level committee (section 6.3), the enterprise can achieve the optimal value exchange in the enterprise.

Second, a strategic objective –integration of the total system– has no related metrics. This objective is also hard to measure but it should be tracked through evaluation by each stakeholder.

Third, a strategic objective –safety on a long-term basis–, can be measured by the safety performance and the condition of the infrastructure. Now we do not have the metric, but it should be continuously used after the opening of the operation.

Fourth, a strategic objective –solve the environmental problems – is also hard to measure, but we need to have approximate estimates to decide the investment priority and to track the result from the investment. The investment priority can be measured by the ratio of the government investment from the budget to the investment in road construction and maintenance that is the largest part of national expenditure for transport. It shows the

government intention toward the environmental issues. Also, better environmental quality from the investment, such as reductions in CO<sub>2</sub>, NO<sub>x</sub>, and energy consumption, should be the metrics to recognize the validity of the project. These metrics should be measured not only for the Shinkansen service but also for freight railways since total improvement is the true output from the project.



Source of Format: EVSMA 1.0 for LAI member use only [32], refer to session 5.2  
**Figure 6-27 Alignment of metrics with strategic objectives**

Other problems associated with the metrics are the accuracy and continuity of the measurement. Before construction, all the presently used metrics are based on the research funded by the government. We may need some equitable organization funded or overseen by all stakeholders, which means that everybody has a voice in decisions and there is no bias in the organization. Also, after the construction, all the measurement for metrics tends to be considered less seriously because the local and central governments focus mainly on decision making for the construction and the lease payment which is determined in the first year. To sum up, the enterprise needs to track the metrics carefully and equitably, both before and after the construction.



## 2. Alignment of metrics with key processes

Figure 6-28 shows how the metrics are utilized in the enterprise to measure process performance. Most of the processes are measured by the current metrics, but this analysis tells us that the budget allocation process needs some metrics.

Construction Cost	Change in Profitability by an extended line for 30 years	Increase in number of Local Residents	Ridership	Travel Time	Strategic Objectives Metrics Stakeholder Values Key Processes
■	■	■	■	■	Research
■	■	■	■	■	Selection & Agreement
■	■	■	■	■	Basic Planning for Construction
■	■	■	■	■	Budget Allocation
■	■	■	■	■	Planning for Details Including Operations
■	■	■	■	■	Operation
■	■	■	■	■	Adjustment Process

Source of Format: EVSMA 1.0 for LAI member use only [32], refer to session 5.2  
**Figure 6-28 Alignment of metrics with strategic objectives**

Budget allocation process should include the sensitivity analysis to maximize the asset utilization. This lack of metrics caused the enterprise to have an unmanageable number of railway lines under construction at the same time. The longer construction time is, the less the revenue from each line will be, since the opening will be later and some sections of infrastructure which have already been constructed will have deteriorated from age.

## 3. Alignment of key processes with stakeholder values

Figure 6-29 shows how each process delivers the stakeholder values for the enterprise. Some problems that we need to focus on are as follows:

Key Processes	Strategic Objectives		Stakeholder Values		Metrics						
	Better Economic Situation	Increased Transportation Modes and total coordination of transportation	Better Environmental Quality and fuel efficiency for Shinkansen and Freight	High level of service(Frequency, Reliability, Reasonable fare),	Safety	Profitability of the lines	Appropriate Lease payment	Better operation of the transferred local lines	Better or Status Quo Freight Operation	Association and efficient, integrated relationship	Less right of way charge and priority of operation for freight
Research	■	■				■					
Selection & Agreement	■	■			■						
Basic Planning for Construction											
Budget Allocation											
Planning for Details Including Operations				■	■			■		■	■
Operation				■	■						■
Adjustment Process				■	■		■	■		■	■

Source of Format: EVSMA 1.0 for LAI member use only [32], refer to session 5.2  
**Figure 6-29 Alignment of metrics with strategic objectives**

First, total coordination of the transportation should also be analyzed more, especially with air transportation. There was no sensitivity analysis in terms of fares, frequency and travel times. Each mode is an economy of scale business and a new strategy for regulation may be necessary for both industries.

Second, environmental issues are not analyzed well at any of the processes. The governmental officials considered it important, but there are no specific metrics for the projects. Before selecting the new lines, the extent of the environmental effects should be considered. Also, how much the government should spend instead of investing in road construction is an important question.

Thirdly, freight rail should be considered in the earlier process since the freight rail operator is a stakeholder that may lose its operational priority and will be affected by the higher access charges by the enterprise. The metric is hard to define but the estimated change should be mentioned as a metric and this needs agreement in the early process of the project.

Finally, there are no processes to access the association and efficient, integrated relationship



### 6.3. Future State Vision

Based on the analysis Figure 6-31 shows the suggested value stream map of the future enterprise.

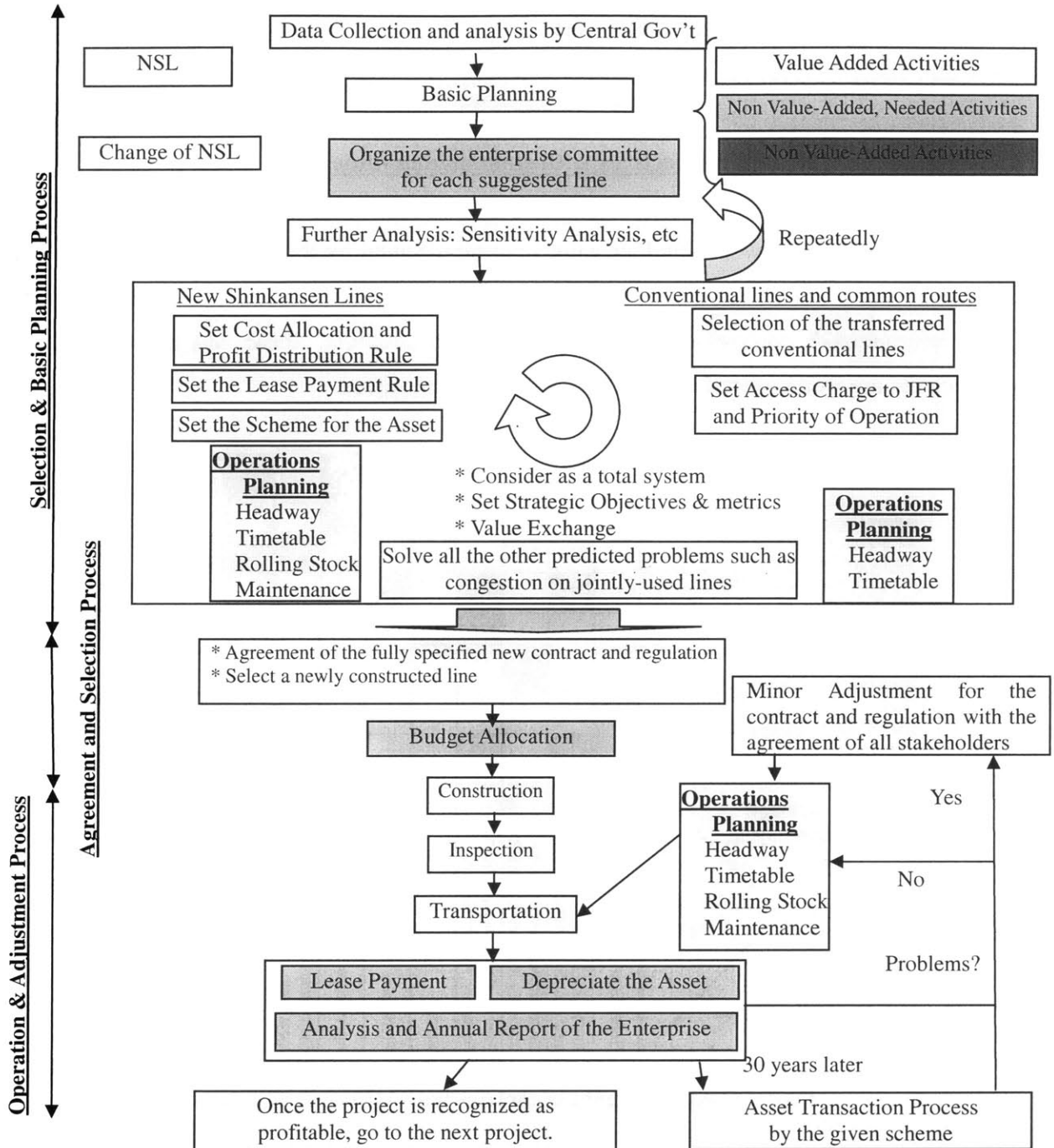


Figure 6-31 The Suggested Value Stream Map of the Future Enterprise

Based on the analysis in section 6.2, the new vision is as follows:

### **Basic Analysis and Basic Planning Process**

At the beginning, the central government will be in charge of the first, basic “big picture” analysis and planning. The enterprise is at a national level and government should have the leadership.

### **Organization of the New Enterprise Committee**

As a typical recommendation when introducing the lean ideal, it is suggested that a special committee team that worries about an enterprise-wide should be organized to aim at the lean ideal. Even though the project is at the national level, an enterprise committee should consist of representatives of all stakeholders for each proposed line (instead of only a committee that mainly consists of central government and ruling parties). Such new committees can equitably represent all stakeholders and allow the enterprise to create a plan that provides sufficient value to each stakeholder, based on the way that each stakeholder contributes to the enterprise. (Section 6.2.3)

### **Further Analysis conducted by the New Enterprise Committee**

Then, further analysis should be managed by the enterprise committee to insure research that is as objective as possible, instead of research being managed only by the government. The choice of assumptions and focus of the research should be made with the agreement of all stakeholders.

Important matters such as estimating future demand include many assumptions and depend partly on the involved stakeholders' intentions. For example, local and central government officials forecast that the share of Hokkaido Shinkansen between Tokyo and Sapporo will be 45 %, with air at 55 % [33]. This figure was used to estimate the profitability of the new line and the expected lease payment from operators. Table 6-16 shows the comparison between air and rail for trips from Tokyo, and Figure 6-32 shows the statistical relationship between distance and the relative share of Shinkansen to total passengers. By using simple

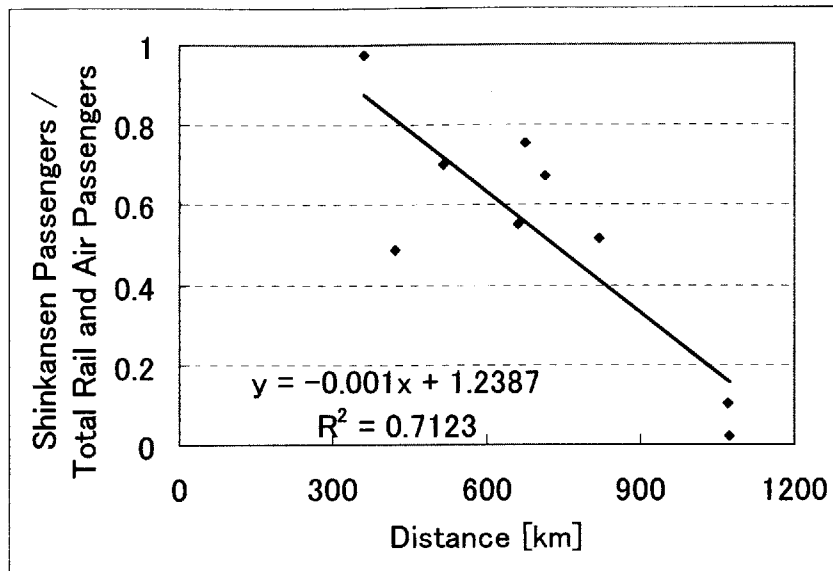
regression analysis, the expected share of Hokkaido Shinkansen between Tokyo and Sapporo is forecast to be only 10% of the total, the same as for the similar distance between Tokyo and Fukuoka. Even on the shorter 500 km Tokaido Shinkansen section between Tokyo and Osaka, there is a fierce competition between air and rail and the Shinkansen share decreased from 85% in 1993 to 70% in 2005 [34]. Transportation between Tokyo and Hokkaido is also one of the most profitable routes for the airline industry and we can anticipate the same situation for the Hokkaido Shinkansen line as is now the case for the Tokaido Shinkansen. Also, the Japanese government is now planning to construct an additional runway and to expand the capacity of Haneda Airport through the government subsidy, which will make the competition fiercer [35] [36].

**Table 6-16 Comparison between Air and Rail for Trips from Tokyo**

Section	Mode	Number of Passengers	Distance	Time [min]
Tokyo-Aomori	Train	1,979,000	713.7	239
	Air	958,000		183
Tokyo - Akita	Train	1,292,000	662.6	230
	Air	1,048,000		173
Tokyo - Sakata	Train	358,000	421.4	271
	Air	378,000		178
Tokyo - Yamagata	Train	2,394,000	359.9	150
	Air	58,000		176
Tokyo Area - Hokkaido Area	Train	470,000	-	-
	Air	23,030,000		-
Tokyo - Sapporo (before through Shinkansen construction)	Train	156,000	1073.7	660
	Air	7,631,000		210
Tokyo - Osaka	Train	14,000,000	515.4	161
	Air	6,000,000		162
Tokyo - Okayama	Train	1,179,000	676.3	180
	Air	386,000		178
Tokyo - Hiroshima	Train	1,831,000	821.2	240
	Air	1,711,000		213
Tokyo - Fukuoka	Train	895,000	1069.1	300
	Air	7,631,000		213

Source: JR East [9]

Note: The data for Tokyo-Sapporo and Tokyo Area - Hokkaido Area Sections are for the present, when the sections north of Tokyo-Hachinohe are conventional lines.



Data Source: Table 6-16

**Figure 6-32 Statistical relationship between distance and the relative share of Shinkansen to total passengers of air and Shinkansen**

Thus, we can say that the government research has many optimistic assumptions and that an enterprise committee will be an appropriate organization to determine accurate information. Also, the committee should do a sensitivity analysis instead of making just a point estimate as at present, because there are many unknown factors that can change future demand and profitability: the travel time, frequency, reliability, government policy, original fare, fare policy, and marketing strategies. Anticipated situations that some stakeholders are concerned about should be included in the sensitivity analysis for the equitable value exchange. In this way, designing lean enterprise architecture should help a better analysis and decision making process.

Second, focus of the data collection and analysis should be made with the agreement of all stakeholders. For example, if there is such a committee, some stakeholder would surely insist on the necessity of the analysis for the construction planning before selection and budget allocation of a new line. Sensitivity analysis for the construction and budget planning will also tell us the optimal selection of lines to be constructed and what is a manageable number of construction projects in order to maximize profit. Usually, such

choice and the increase of total budget will shorten the construction time, which will allow the enterprise to earn a profit earlier. The selection of lines or a line, construction planning, and budget allocation should be done based on the sensitivity analysis. To sum up, designing lean enterprise architecture allows us to choose the necessary research for the project and enhance the project.

### **Basic Planning Process**

Based on the sensitivity analysis, the enterprise committee needs to do the EVSMA, as in the sections from 6.2.3 to 6.2.6 to design the lean enterprise architecture. For the strategic objectives, the enterprise should optimize the value exchanges, metrics, and processes. The metrics that should be set in the enterprise would, by the judgment of author, appear to be as follows:

- \* Economic effect [yen] for 30 years, and economic effect/construction cost
- \* Change in travel time
- \* Ridership
- \* Change in profitability for a line extension during 30 years
- \* Total construction cost
- \* Equitable contracts and regulation from the discussion of the value exchange analysis
- \* Safety investment and potentially necessary investment over the long term
- \* The ratio of the government railway investment to the budget for road investment
- \* The change in environmental indexes such as CO<sub>2</sub>, NO<sub>x</sub>, and energy consumption

The X-metrics analysis for strategic objectives, metrics, processes, and stakeholders' value should be continuously done to check the status and to pursue the ideal lean enterprise (refer to section 6.2.6). This continuous checking system is one of the beneficial important of the lean enterprise concept.

Also, the sensitivity analysis indicates that the next thing for the enterprise to do is to try to make a fully specified scheme before the selection of a new line. A scheme which is made in the earlier stage allows the enterprise to pursue the goal of being a cooperative,



lean enterprise after the construction. Based on the stakeholders' value exchange analysis (session 6.2.3), the contract and regulations should be designed to provide sufficient value to each stakeholder. The importance of the value delivery to stakeholders depends on how stakeholders contribute to the enterprise. The main stakeholders are the freight operator, passenger operators, and central and local government. A suggested contract and regulations are as follows:

### **1. Lease Contract**

Central and local governments, as representatives of taxpayers, have the right to collect the construction cost from operators. However, they should not collect more than the construction cost minus increased tax revenue generated by the construction for the purpose of further construction of Shinkansen lines, because it will be a cross-subsidy to the other operator's area. Also, local government should not increase the access charge to freight operators later since that changes the value exchange balance. The capital investment of the Seikan Tunnel has been subsidized by the government, and the additional lease payment can be used for the maintenance for the tunnel, because the safety level of the Tunnel is very important for the Hokkaido and Tohoku Shinkansen lines.

On the other hand, operators have a right to earn profit from the operations. In the competitive market with the airline industry, the revenue can be changed every year by strategies which include travel time, reliability, headway, and fare policy (basic fare and discount fare) of both railway and airline companies. In this case, if the lease payment is fixed for 30 years at the level based on the increased profit of the first operational year, distribution of the increased profit will not be equitable for 30 years. Especially in the most competitive markets, the price and ridership will change every year. If such fixed charge is established, only operators will bear the risks associated with potential changes in revenue.

Additionally, operators also have the right to have enough cash flow for long-term safety investment for infrastructure. This maintenance budget should not be eliminated by the excessive lease payment to be used for the construction of other lines. In the privatization in the railway industry, long-term investment is essential to enhance safety. A private

company does businesses on the pay-as-you-go basis and the increased revenue should also be used for its capital investment plan. If operators own the asset, the depreciation expense allows them to keep enough cash flow for the future investment, but there is no such cash flow in the lease contract. In Japan, since further safety enhancement is demanded by customers, huge capital investment and maintenance costs are required. If this charge turns out to be equitable, operators enjoy enough cash flow, which allows the operators to invest for further safety with a long-term perspective. In New Frontier 2008 [37], the five year planning of JR East focuses more on operating cash flow than on free cash flow, because it focuses on the positive capital investment that will generate profit and enhance safety in the long-term.

In terms of the additional lease payment for the next construction between Aomori and Hakodate on the Hokkaido Shinkansen line, it is recommended to transfer some portion of the additional profit per year that JR East will earn (as a result of construction in the JR Hokkaido area) as lease payments to other stakeholders. The percentage should be based on the value exchange analysis within the enterprise and also be able to cover all anticipated problems, based on the sensitivity analysis and the agreement with all stakeholders. We need to search for the best distribution of profit to operators, government and other stakeholders. The degree to which the major stakeholders suffer or benefit from the project should also be shared.

Finally, at the end of the lease term, ownership of the asset should be specified in the contract to make the contract equitable as a whole. A vague, indefinite termination process in the contract can spoil all the equity of the provisions of the contract above, since the total burden of the construction cost and distribution of profit from the project should be equivalent. There are two options after the 30 years: government will continue to own the infrastructure or government will transfer the infrastructure. If the line is profitable enough, the lease contract should be terminated and the asset should be transferred to the private operators, for a payment equal to the asset value as reduced by depreciation. The asset value should be obtained automatically by provisions which are made in this early stage. On the other hand, if the line is not profitable, the government should continue to hold the asset and to keep the lease contract, since the government has estimated the line is

profitable and it should be responsible for the project. As many future possibilities as possible involving the profitability should be covered precisely in the contract to keep the value delivery to stakeholders equitable and to avoid possible later conflict.

## **2. Regulations**

In terms of the equitable value exchange, regulation should be clarified in the early stage for freight railways and conventional lines whose operation will be transferred to the local government. Equivalent value delivery and allocation of responsibility to all stakeholders can be provided partly by these regulations. Further regulation should deal with the competition between railways and air transportation.

First, the freight rail operator should not suffer from the transfer of the operation of conventional lines to the local governments, or from the sharing of the tunnel by both Shinkansen and freight rail. Since the freight operator is in a weak position, it should get the right established before construction begins to have operational priority and an equal or less expensive lease charge in order to protect the freight railways. (The value exchange analysis in section 6.2.3 explained its weak position in the project and in the railway industry.) It is very important to protect the freight railways, because freight railways have the potential to take truck trips off the road if they have stronger positions and strategic logistics planning is allowed. Since the freight railways have also effect on the environmental issues as in the strategic objectives of the enterprise, the enterprise needs to consider the total effect on the environment of freight and passenger railways even though the project is for the passenger high speed rail.

Second, the enterprise should be able to choose which lines will be transferred, or at least to have a voice in this selection. The new Shinkansen law has a provision that the operation of the conventional lines paralleled by the new Shinkansen line should be transferred to the local government. This paralleled line or lines is usually a trunk line in the conventional network, and even though the transferred operation will not usually be economically viable after the new Shinkansen opens, the remaining level of passenger traffic on the paralleled

lines will be higher than traffic on connecting secondary and branch lines in rural areas. Also, the paralleled line, as a trunk line, is likely to be used by the freight railway and the transfer of operation will affect the freight railway company. If the enterprise can choose which lines will be transferred among the conventional lines in the area served by the new Shinkansen line, it would naturally include the least viable lines. The local government then should be able to choose whether it will continue the rail operation or replace some or all lines by bus service, which has a lower operating cost. In cases where the new Shinkansen line is not expected to be profitable, it would be appropriate for local and central government to evaluate the trade-off between A) having the unprofitable new Shinkansen line and changing to bus operation on some of the most unprofitable lines, and B) cancelling the new Shinkansen project and continuing the existing unprofitable lines in the rural area. The central and local governments are responsible for the project, and this kind of provision would increase their responsibility for promoting the project and reduce the chance of politically motivated uneconomic construction.

Third, we need to consider the regulations for the competition between air and rail transportation. Pricing regulation will especially affect the relative share of ridership between air and rail. Under the present law, railway fares cannot be increased without proper reasons and if the government considers increases inappropriate, it can force the fare to remain unchanged [38]. Below the upper limit, operators can change fares without approval, but operators have to submit their fare policy to the government and the government has the right to change it when it is not reasonable [30] [38]. For example, if the fare change is judged to be detrimental to the competitors, users, or the public good, the government can force operators not to change the fare. As a result, fare is almost entirely based on distance and revenue management is not allowed in the Japanese railways, while airlines are allowed to decrease fares by 50 % based on each airline's decision [36]. Given the fierce competition with the airline industry in the future, fare policy and its regulation will determine the future revenue and stability of the railway business. There are two choices in the future competitive market: to have basically fixed prices under the existing regulations or to have revenue management, as in the U.S airline industry. Amtrak also has a kind of revenue management: the price changes with time of day [39]. Regulations should be changed in early stages to aim at the situation where the enterprise can estimate the

future demand more easily and can have appropriate strategies to serve the long-term stability of the total Japanese transportation system.

For all concerned, more detailed negotiation is necessary for regulation. Designing the lean enterprise architecture should be one of the ways to have equitable regulation.

### **3. Iteration of the basic planning processes**

Value delivery from the enterprise should be equivalent for all stakeholders. Also, if there is no agreement for the fully specified contract, the enterprise should not begin to construct the lines. Iteration of research, by EVSMA analysis and negotiation among all stakeholders will enable the contract to be almost fully specified.

With this iteration, anticipated problems can be found, such as the rail congestion problem in the Tokyo area. The headway determines how much the total operating cost is and whether further capital investment is necessary in the Tokyo area to increase railway capacity. Therefore, such iterative analysis can tell the enterprise the maximum and minimum headway that should be defined in the contract. If the frequency that is desired by central and local government or another operator is higher than the track capacity, the enterprise profit should be used for investment to increase the traffic capacity in the urban area before distributing the profit to all stakeholders. In this way, the lean enterprise would find other anticipated problems in the early stage and solve them in a cooperative manner.

### **Selection and Budget Allocation Process**

After the iteration, more sophisticated contracts for the suggested new lines will be obtained and then the government should select some or one of the most profitable and sophisticated projects. Nowadays, the government has chosen too many new Shinkansen lines and it should concentrate on a manageable number of construction projects to maximize the asset utilization.

In the budget allocation process, it is necessary to obtain more money from the budget

allocated for the road construction because of the greater economic and environmental effect of the new railways. Since the government has huge debts, it needs to prioritize among highly-evaluated projects in the transportation budget. For example, there was no input from the local governments about the priority of railway, highway and airport construction. We need to prioritize which modes of transportation should be increased under the limited budget and if the local and central governments consider the road more important, the new Shinkansen project should not be executed. The lean concept will allow them to optimize the budget allocation process toward the strategic objectives and metrics for the enterprise.

### **Operation & Adjustment Process**

With constructive negotiation and its consequent fully specified contract, the enterprise can enjoy a cooperative relationship, and the total railway network can be prosperous and stable. Then, the leanness of the enterprise should be checked by continuous analysis of the metrics. Even though the enterprise tried to obtain fully specified contract, it is still necessary to adjust details to be equivalent. Therefore, minor adjustments to the contract and regulations are allowed in the enterprise. However, the basic concept of lease payment and asset transaction process should be the same and stakeholders should basically just follow the rule of the provisions. Finally, some years after the operation, the government should consider the next project so that the next project can utilize the data and anticipated problems from the previous project.

#### **6.4. Usefulness of the Lean Enterprise Architecting Concept to Railway Industry**

The lean enterprise concept has usually been used in the manufacturing companies and recently LAI has begun to use this concept for the airline industry in the U.S. This thesis applied this concept first to the extension project of the high speed railways in Japan, and it proved that the lean enterprise concept is also effective for the railway industry, which is a service industry, not a manufacturing industry.

First, value exchange analysis is very important for development of the railway industry. Many stakeholders are involved in the railways and each has different desired values from the enterprise. Additionally, political intervention is higher than in other industries, since railways have the potential to improve the local economy. Recently, in Japan, Britain, and Germany, railways tried to limit political interventions by privatization. However, all the railways may still need collaboration with the government, especially for further construction, major capital investment for the maintenance and replacement, and operation of unprofitable lines in the rural areas. The necessity of government involvement can be understood by the fact that the present highly networked railway system could not have been established just by private companies. Additionally, the railways need an integrated system among many stakeholders for safe and reliable service. In this situation, the railway industry needs collaboration, the integration and the elimination of political intervention. Collaboration conflicts with the elimination of political interventions, but the politicians or governments are also one of the stakeholders and the railway industry needs to consider them as stakeholders, which means political issues cannot be completely eliminated.

Thus, the concept of lean enterprise allows us to have well-balanced relationships among stakeholders. Equivalent value delivery and reduction of political interventions to some extent can be obtained by the value exchange analysis as mentioned above. If all stakeholders negotiate for the optimized value exchange under the lean enterprise concept, the railways can satisfy all stakeholders, while some political interventions can be reduced. Thus, in this value exchange aspect, the lean enterprise concept is appropriate to apply to the railway industry.

Second, if we apply the lean enterprise concept to the railway industry, collaborative relationships can be obtained and also waste can be eliminated. The ridership and the national expenditure for railways are decreasing, because of the trend toward the car and air transportation. In this difficult situation, the railway industry needs to have a collaborative relationship and eliminate waste in the entire industry to acquire the further efficiency and obtain the power to win the competition.

Third, with the lean enterprise concept, we can easily build the strategic objectives and metrics in a broad point of view and pursue them continuously. If there is an organization that has certain strategic objectives and metrics, it is easy to pursue the objectives with all stakeholders. This systematical assessment by all stakeholders allows us to assess the total system on a long-term basis, which is very important for railway industry.

Lastly, the lean concept will tell us how the processes work and we can eliminate waste from processes and create value added processes effectively. Also, the lean concept focuses not only on radical change, but also on gradual change on a long-term basis. The railway industry can not be restructured quickly because of its complexity and breadth, so the lean concept has the potential to improve the system well.

We can conclude that the lean enterprise concept is appropriate for the railway industry. Many stakeholders have different desired values, but need to integrate with each other. Governmental intervention should be reduced, but the railway industry needs some collaboration with the government. In this complicated situation, there were many non-value-added processes in the extension project in Japan as well as much waste. Moreover, the railway industry is shrinking because of the trend toward the other transportation modes. The lean enterprise concept will surely help improve the complicated situation.



## **6.5. Difficulties Executing the transition toward the Lean Enterprise**

However, even if all stakeholders understand the effectiveness of the lean enterprise concept, there is a big barrier when we actually apply the concept to the Shinkansen extension project in Japan. The new railway extension projects have been highly connected with politicians and it is related to the turf battles among the government divisions and politicians: the construction itself needs a huge amount of money and the new line has the potential to make the local economy better. In the real world, a stakeholder cares about itself without considering the total enterprise.

For railway operators, the most important issues are profitability of the new lines and better financial and safety situation caused by the further construction. Since the lean enterprise delivers desired values to all stakeholders, the lean enterprise is an appropriate choice for them to be prosperous. On the other hand, politicians pursue the political reasons, and obtaining the budget for construction is the first priority for them. So, they tend not to consider the operation. The government and politicians has power to change the law when necessary and they do not need the lean enterprise concept.

In this situation, the first step toward the lean enterprise is that the government realizes the effectiveness of the lean enterprise concept for the long-term basis for their finance and policies, too. This may be achieved by the operators' effort to develop the lean enterprise initiatives project first. One of the ways to introduce the lean concept, first, is to persuade the government to integrate the data collection and analysis which was independently done by stakeholders. Operators' proactive persuasion to the government will lead the railway industry toward the lean enterprise.

## 6.6. Summary

The Enterprise Value Stream Mapping and Analysis (EVSMA) is applied to the new extended Shinkansen projects in Japan. Value exchange analysis is important to satisfy both the enterprise and all stakeholders, based on how they contribute to or bear costs from each other. Processes are optimized to increase the value-added activities and to eliminate waste, and interactions between stakeholders are improved to meet the enterprise's needs. Finally, the alignment of the strategic objectives, metrics, key processes, and stakeholder values are evaluated by X-Matrix analysis for the entire enterprise to make it leaner and able to aim at the strategic objectives better. EVSMA provides suggestions for future strategy that can offer the projects some advantages from the lean enterprise perspective.

The results imply that the lean concept is very suitable for the development of railway industries so as to enhance the total enterprise performance, because of the need for large capital investment and the complexity of the relationship among stakeholders and high technology. Systematic analyses, as in EVSMA, enable the complex enterprise to pursue the lean ideal more easily.

However, there are some difficulties when executing the transition toward the lean enterprise, such as the strong influence of government and political interventions. The first step toward the lean ideal is the operators' effort to build the lean enterprise initiatives project team at the outset in order to persuade the government and politicians to realize the effectiveness of the lean approach. If the lean approach is applied by the representatives of existing stakeholders, it will greatly help the gradually declining railway industry to prosper more.

In the next chapter, the lean enterprise concept is further tested and validated through application to Portugal's high speed rail construction project. An appropriate strategy for construction of high speed rail, derived from this analysis, generates some implications.

## Chapter 7. Case Study of Portugal

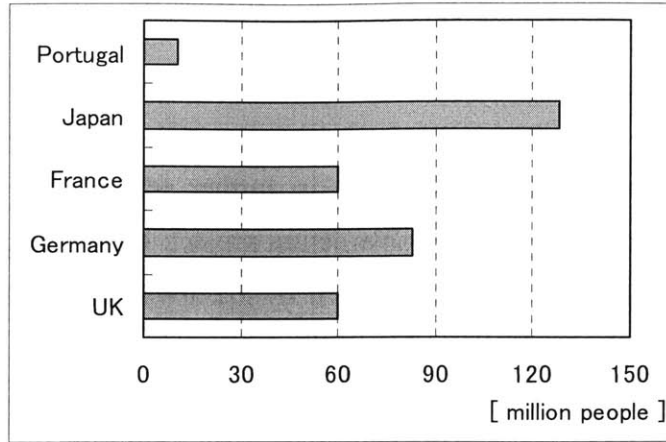
In this chapter, the lean enterprise concept is further tested and validated through application to Portugal's high speed rail construction project. International comparison will be discussed (Section 7.1, Section 7.2), followed by the application of the lean enterprise ideal to the Portuguese railways (Section 7.3).

### 7.1. International Comparison of Portuguese Railways

Before applying the lean enterprise concept, we need to analyze the situation in Portugal by international comparison to define the potential opportunities of Portuguese railways. Since Portuguese railways are in the developing stage, comparative data are important for demand analysis and estimation what will be likely to happen in the future. The German and Japanese railway systems are the two most advanced and most profitable passenger-oriented railways in the world and it is worthwhile comparing them with Portugal for assessment of the future opportunities.

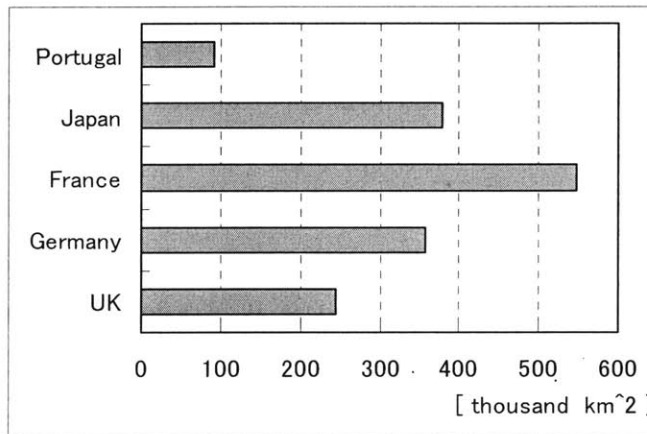
Because Portugal's absolute population(Figure 7-1), area(Figure 7-2), passenger-kilometers per year(Figure 7-3), and railway line length (Figure 7-4) are relatively small, it is appropriate to make comparisons by using the following ratios:

- \* Population density [people / km<sup>2</sup>]
- \* The length of railway line in use per capita in each country [m/people]
- \* The railways' ratio of passenger-kilometers per day [passenger\*km/day] to railway line in use [km], [people/day]



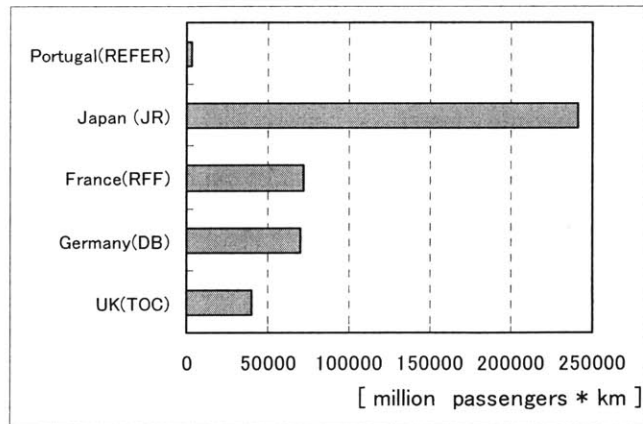
Source: Statistics Bureau & Training Institute [3]

**Figure 7-1 Population of Each Country**



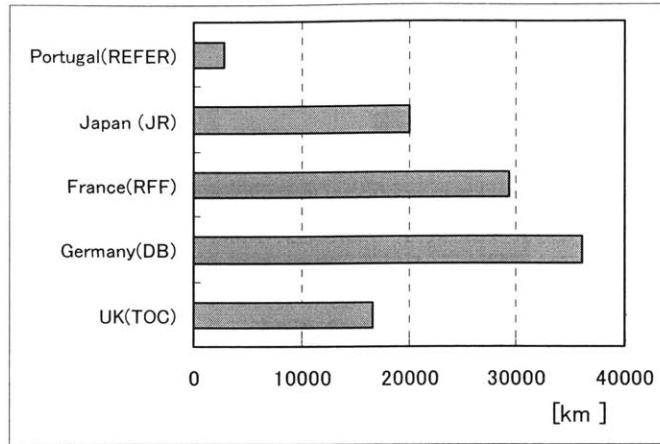
Source: Statistics Bureau & Training Institute (Japan, 2007) [3]

**Figure 7-2 Area of Each Country**



Source: International Union of Railways (UIC) [40]

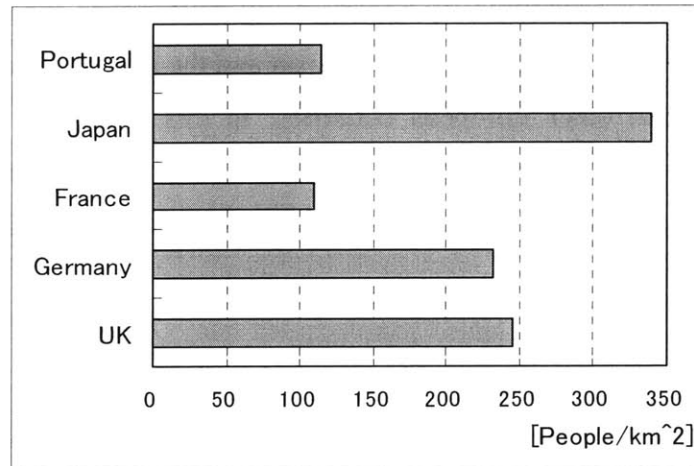
**Figure 7-3 Passenger-kilometers of Railway travel of Each Country in 2003**



Source: International Union of Railways (UIC) [40]

**Figure 7-4 Railway line-km used by major passenger carriers in Each Country**

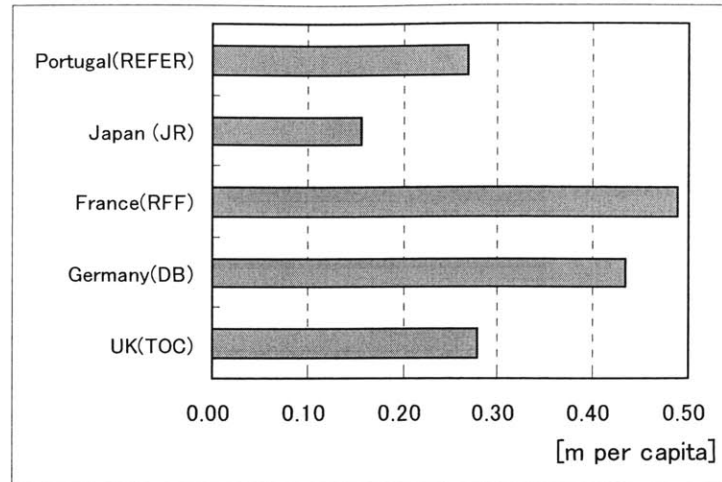
Population density in Portugal is as high as in France, but not as high as in Germany, U.K. and Japan, which implies less opportunity to increase potential domestic passengers. (Figure 7-5)



Source: Figure 7-1 and Figure 7-2

**Figure 7-5 Population Density of Each Country**

However, the railway line length in use [m] per capita in Portugal is not as high as in France and Germany, but closer to that of the U.K. (Figure 7-6)

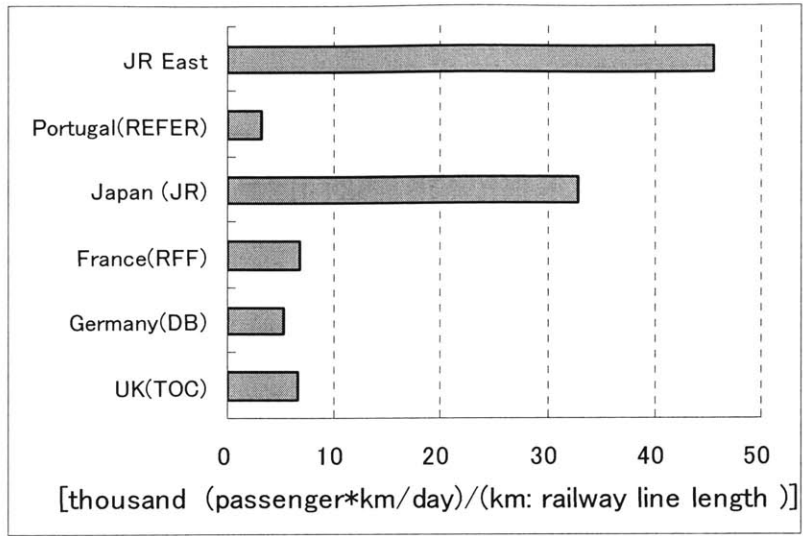


Source: Figure 7-1 and Figure 7-4

**Figure 7-6 Railway Line-m per Capita for Each Country**

People in France and Germany are relatively widely distributed throughout those countries and the railway systems broadly cover the countries' entire areas. On the other hand, most of the people in Japan are in the urban areas and the length of railway line in use does not have to be so long, which aids the railway's profitability. In Portugal, the length of line per capita is the same as in U.K., is closer to that of Japan and the size of the railway system is more manageable than in other European countries. In this case, with careful demand analysis and concentration of construction projects, avoiding too much construction, Portuguese railways have great potential to be successful with expanded operation of railways.

Finally, the Portuguese railway's ratio of passenger-kilometers per day to operation length [people/day] is almost half as high as in France and Germany (Figure 7-7). Even though DBAG in Germany has some profit from operation, there are some subsidies for the unprofitable lines. On the other hand, the Japanese railway system, which is one of the most profitable passenger-oriented railways in the world, has a ratio several times higher than those of European countries. Before initiating construction projects, the Portuguese government therefore should not be overly optimistic about the profitability. Newly created demand or shifts from other transportation modes such as cars and air will also be key factors for the success of new railway lines.

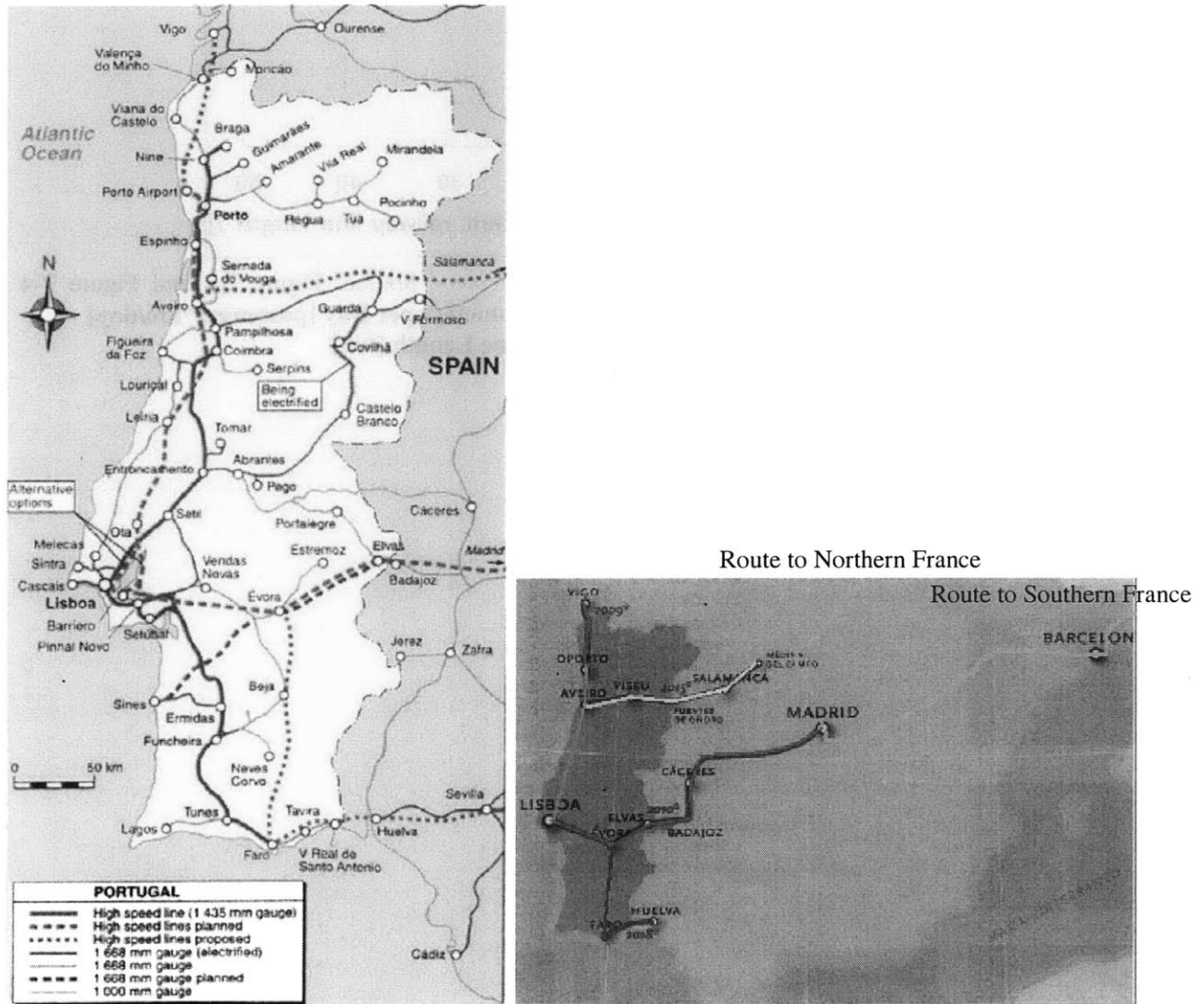


Source: Figure 7-3 and Figure 7-4

**Figure 7-7 The Railways' Ratio of Passenger-kilometers per Day [passenger\*km/day] to Total National Railway Line Length [km]**

## 7.2. Existing Railways and New High Speed Rail Plan in Portugal

The Portuguese government is now planning to build a Lisbon - Porto domestic line and Lisbon – Madrid international line of new HSR (High Speed Rail), as shown in Figure 7-8.



Source: Boyana Petkova [41]

**Figure 7-8 Proposed HSR links in Portugal and connections to Spain and France**

The Lisbon - Porto section (336km) is the major trunk line of Portuguese railways [42]. The frequency of fast through trains, the Alfa Pendular service, is 11 trains each way per day on the existing conventional line, and travel time is approximately 180 minutes [43]. There is an ongoing project for improvement in speed on the conventional line and 70 % of the line has already been modernized [42]. The expected frequency of the new HSR is 33 trains



each way per day and the expected travel time is 90 minutes [43], [44].

On the other hand, the Lisbon - Madrid section (453.8km) will be a major trunk railway connection between Portugal and Spain [43]. There is only one through passenger train service between Lisbon and Madrid, an overnight train taking approximately 10 hours [43]. The planned frequency of the new HSR is 14 each way per day and the planned travel time will be 165 minutes [43] [44].

### **7.3. Applying the Lean Concept**

This section shows a conceptual example of how the lean enterprise idea would be applied to Portugal's HSR projects, and shows some of the processes to achieve the lean enterprise ideal, based on general knowledge and data for Portuguese railways. Lack of data limits the analysis, but finally we have general conclusions that might be developed for the HSR projects.

#### **7.3.1. Necessity for Lean Enterprise Concept for the HSR projects**

Under the OPAT (the Accessibility and Transport Operational Program) agreement between the Portuguese government and the EU in 2004, certain EU funds will be expected for the project [41]. However, it seems that there is conflict among stakeholders over how to choose and coordinate new lines. Because there are so many stakeholders involved, equitable value exchange –a key aspect of the lean enterprise concept- is very important for success in the project for the long term.

Additionally, the railway industry in Portugal is not profitable now, and the real competition is with other transportation modes such as air and automobiles. In order to maximize the performance of the projects given limited resources, total coordination and a cooperative relationship between stakeholders are essential to eliminate waste and increase the value-added processes.

Also, since the project is just at the planning stage and it is almost equivalent to the Japanese high speed rail construction projects, the lean concept is also applicable and desirable here. For example, the strategic objectives of Japanese high speed rail construction projects can basically be used for the Portugal's HSR project, although it needs to be revised by the Portuguese people to adapt to the characteristics of their own railways.

Therefore, even though it is a governmental project, it is appropriate to use the lean enterprise concept to enhance the HSR project in Portugal.

### **7.3.2. Stakeholders and Value Exchange**

This enterprise is an HSR project that consists of the following stakeholders:

- \* EU (European Union)
- \* Portuguese Government
- \* REFER (Infrastructure Company) [42]
- \* CP (Comboios de Portugal) or other operators like Fertagus [42]
- \* Freight Operator
- \* Spanish Government
- \* Manufacturing Companies
- \* Travelers who will use this system
- \* Urban Planners who considers how the project is integrated with various cities
- \* Construction Companies
- \* Laborers who will do jobs associated with the projects
- \* Shippers

Following is the description of some of the stakeholders as examples, and the value they expect from the enterprise and the value contributed by each stakeholder to the enterprise, based on references [42], [43] and the author's judgment. Further discussion and analysis in detail for all other stakeholders is necessary for fully utilizing the lean concept ideal.

### **EU (European Union)**

The EU is an investor in the HSR project through the TENs (Trans-European Networks) program budget, EU Cohesion Fund, and ERDF (European Regional Development Fund). The budget will cover 20 % of the total cost [44]. The aim is to boost the economies of poorer countries and better integrate them into Europe by accomplishing the following [43]:

- \* The reduction of travel time in the rail network across Europe
- \* A shift to the railways from road and air transportation by increasing the capacity and quality of service of railways
- \* Utilizing the infrastructure maximally by combining freight and passenger railways
- \* Expanding the use of European standard gauge, which is necessary to improve international transportation

### **Portuguese Government**

The government includes the INFT (Instituto Nacional do Transporte Ferroviário, a regulator). Their major concern is for the convenience, safety, and stability of Portugal's transportation. They consider that the Lisbon-Porto HSR line would be valuable if the new airport at Ota is built. Additionally, although the government was pressured by the Spanish government to choose the routes, the Lisbon-Madrid route was finally chosen for the new planned HSR line, because the highest demand for both passengers and freight is from Spain [43].

The government is also concerned about the budget from the EU since the fund is the best opportunity to develop the Portuguese railways. "The Portuguese government is expected to suggest that the Lisbon-Porto passenger project could be mixed with freight to maximize its profitability" to meet with an EU requirement [43].

### **REFER (Infrastructure Company)**

REFER will continue to invest substantially in upgrading the conventional system. However, REFER cannot cover all the expense only from the operators' track charges now [41]. We infer from these facts that REFER considers that the construction of the new Lisbon-Porto HSR line may not be favorable, because of the risk associated with the uncertainty of future demand. Upgrading the conventional line will reduce the risk of the project, since total maintenance cost will not increase significantly. Additionally, 75 % of the conventional Lisbon-Porto route has already been modernized [41]. REFER may need a subsidy from the Portuguese government after the construction of the new HSR, if the total passengers between Lisbon and Porto does not increase enough. On the other hand, for the Lisbon-Madrid HSR line, there is no existing convenient conventional line [refer to 7.2] and some benefits are expected from the line.

### **CP (Comboios de Portugal) or other operators like Fertagus**

Operators are ready to run faster trains if the conventional lines are improved, but it is not certain that they can pay enough track charge to REFER to cover the expense. Other operators are allowed to enter the market, but we cannot anticipate that there will be new entrants and true competition, because the market may not be profitable enough. Especially on the Lisbon-Porto 336 km route, the present travel time is 184 minutes and the expected time of HSR will be 90 minutes. Operators need to run trains frequently and reliably to differentiate the new line from the conventional line enough to attract people to it and make it profitable. They will surely insist that freight should not operate on the new HSR track between Lisbon and Porto during hours when passenger trains run, to prevent interference with the speed, reliability, safety, and frequency of passenger HSR.

On the other hand, regarding the international connection between Lisbon and Madrid, these operators do not expect to run service directly to France, because of the long distance and different gauge. Generally speaking, air transportation is better than rail when the distance is more than 800 km. Therefore, focusing on the Madrid-Lisbon route for the HSR project is a favorable choice for passenger railway operators.

### **Freight Operator**

Between Porto and Lisbon, the freight operator is satisfied with the existing conventional line, since most sections of the line have already been upgraded. However, if the railway becomes too crowded, they will need the HSR to increase the overall capacity between Lisbon and Porto. On the other hand, between Lisbon and Madrid, if they are allowed to operate on the HSR track, it will be favorable since the travel time will decrease, but freight operations may interfere with the HSR passenger service.

The biggest problem is the track gauge. It is not appropriate to use free gauge freight trains<sup>13</sup> because of the high manufacturing and maintenance cost. If the new line is standard gauge and freight trains operate on it, they will not be able to continue on wide gauge tracks, such as the tracks between Madrid and the border on the route to northern France as in Figure 7-8, for connecting to other European countries.

### **Spanish Government**

The Spanish government is also being encouraged to invest in the HSR project in Spain through the TENs program. The Lisbon-Badajoz-Madrid route is one of the HSR projects in Spain. “PI 2000-2007 (Infraestructuras 2000-2007)” [45] announced that they will construct the five new corridor lines which include the Lisbon-Badajoz-Madrid route. Therefore, there will be no chance for the Portuguese government to choose another connecting line between Portugal and Spain without negotiating with the government of Spain.

For international connections to France, the Spanish government had planned to change the gauge to the standard gauge used on its domestic TGV network, but the plan was abandoned because of its huge cost [11]. Instead, free gauge trains are now used to solve the gauge-difference problem, but this increases the manufacturing and maintenance cost and is not desired by the other European railway companies. We can guess that the reason why they decided to not make this investment was that the Spanish government gave

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<sup>13</sup> A free gauge train such as the Talys passenger trains can change their gauge to adapt to the different gauges of rail track between France and Spain.

priority to passenger railways inside Spain, which are short-distance and profitable for railways. However, they may have plans to change the gauge of the track to the French border in the future, because there is a tendency for the Spanish government to use standard gauge for new tracks. For example, according to the PI 2000-2007, the Spanish government is planning to build all the new lines to standard gauge so that they will be eligible to get funds from EU as TENs projects [45].

### **Manufacturing Companies**

The Alfa Pendular trains, made by Fiat, did not have an established record of reliable operation, and breakdowns have caused many delays [41]. Manufacturing companies tend to show new technology to attract orders, but the buyers may focus too much on the new technology rather than on durability and reliability. The manufacturers are highly dependant on the buyers' intentions.

### **7.3.3. Equitable Value Exchange**

It is essential to have value exchange analysis and adjust the original plan to satisfy all stakeholders based on their contribution to the enterprise. Allocation of both responsibility and rewards should be considered in the early stages. More specific data is necessary for an analysis in detail, but based on the information and author's judgment, I recommend the following, from the standpoint of equitable value exchange;

### **Financial Value Exchange**

The value exchange between stakeholders and enterprise is very important in terms of finance. As mentioned in the Japanese case, the enterprise needs to show clearly the amount that each stakeholder can expect to pay for the future maintenance cost and operation cost.

From the railway companies' point of view, considering the insufficient revenue coming

from all the track charges of existing conventional lines, REFER and CP need to have careful demand analysis and strategy to increase the share of passengers. In the early stages, the enterprise should recognize how much each stakeholder will be responsible for and pay for the deficit of the operational, maintenance, and replacement costs. Since there are some conventional lines which are parallel to the new lines and demand will be reduced by the new lines, the cost is not only for the HSR lines but also for all the other parallel conventional lines whose demand may be affected by the new HSR projects.

The Portuguese government will especially need to define the subsidies for the lines, given how much it can afford, considering the public nature of railways and the environmental and economic point of view. The railways in France and the U.K. now have large subsidies and German railways also have some subsidies for unprofitable rural lines even though DBAG increased profit recently. This project is driven by the Portuguese government, and the enterprise needs to have careful unbiased risk analysis for equitable cost allocation in the future.

### **Value Exchange Among Spain, Portugal, and EU**

Another route, Avero-Salamanca (Figure 7-8), might be a good connection to other European countries through France [41], and the budget from EU might be easy to acquire, but the Porto-Madrid line was chosen partly because of the strong Spanish government preference. The compromise between the Spanish and Portuguese governments was a good choice for both countries. Rather than having a hostile relationship, they need to have an effort to define a contract that delivers value to each country equitably before the construction begins. The contracts should include both the passenger and freight railway operations, and connection routes from Portugal to other European countries through Spain (Figure 7-8).

From the EU point of view, if the new HSR is well connected with the airport at Ota and with Spain, then the EU will gain some benefits from the project. However, in exchange for the funding, EU will surely want not only the domestic Porto-Lisbon line and the Lisbon-Madrid international line, but also the expansion of the network to reach to the

other EU countries, in order to improve the entire EU rail network.

For Portugal, there is a potential to increase the Portuguese freight traffic to other European countries, if the Spanish government decides to change the wide gauge track to standard gauge between Madrid and the French border on the route to northern France, as in Figure 7-8. This would enhance the value delivery to Portugal, since it would enable freight trains to operate directly from Portugal to other European countries. Additionally, to satisfy the EU demand in order to get the funds, it is desirable to have good connections with other European countries through France (as shown in Figure 7-8) in the future. It is uncertain that the Spanish government will decide to change the track gauge of existing lines to standard, but an enthusiastic Portuguese government push may succeed in getting the gauge changed.

#### **Value Exchange Between Freight and Passenger Railways on the HSR line**

The track gauge for new construction should be standard gauge to satisfy the EU and facilitate further potential extension to the French border (Figure 7-8). This selection of standard gauge for the extension to the French border is mainly for freight railways, because the long distance of more than 2000 km is unappealing for passenger travel but highly advantageous for freight railways. Even in Japan whose passenger railway share is much higher than in European countries, there is only a 10 % of rail share between air and rail at 1000 km distance (Refer to Figure 6-32). On the other hand, freight railways are strong when the distance is longer than approximately 1000 km. If direct freight operation on HSR track between Madrid and Porto is allowed, the total distance is only about 800 km [42]. Further extension is necessary for the freight railways, and the change in gauge of tracks between Madrid and the French border with Spain is the best way to increase revenue from freight railways and to satisfy the EU requirements.

However, the mixed operation of HSR and freight railways on the same track is a controversial issue. If freight trains operate on the HSR track during the time that passenger trains are running, the safety, frequency and average speed of HSR will be greatly reduced. In Japan, freight railways are not allowed to operate on the HSR track



because of the high demand for passenger travel and because night hours, when passenger trains do not run, are needed to maintain track at the level necessary for smooth, safe, and reliable HSR service. One of the most important values of the enterprise, competitiveness, will depend a great deal on the average speed, frequency, comfort and reliability of the HSR service. The decision whether freight railways are allowed to run on the HSR track is very important.

In order to cope with the future passenger demand and to compete with air, the frequency of passenger HSR and freight railways on the new HSR track should continue to be optimized periodically before and during the operations. The optimum depends on the passenger railway frequency, on signal constraints, and on track maintenance requirements. Because the HSR projects highly depend on the Spanish railways policy, all possible options for the future should be discussed with Spain in the initial stages. Otherwise, there will be conflicts between the Spanish and Portuguese governments and the ongoing railway projects and operations will be far from the lean enterprise ideal.

### **Equitable Contracts and Regulation**

When the Madrid-Lisbon HSR is built, the Portuguese and Spanish railway companies will operate on the same track, although there are different regulations in each country. Additionally, freight railways may be operated on the same track. Equitable contracts and regulation between freight and passenger railways and between Portuguese and Spanish railways will be necessary to prevent conflicts.

### **Importance of Reliability and Durability of Rolling Stock**

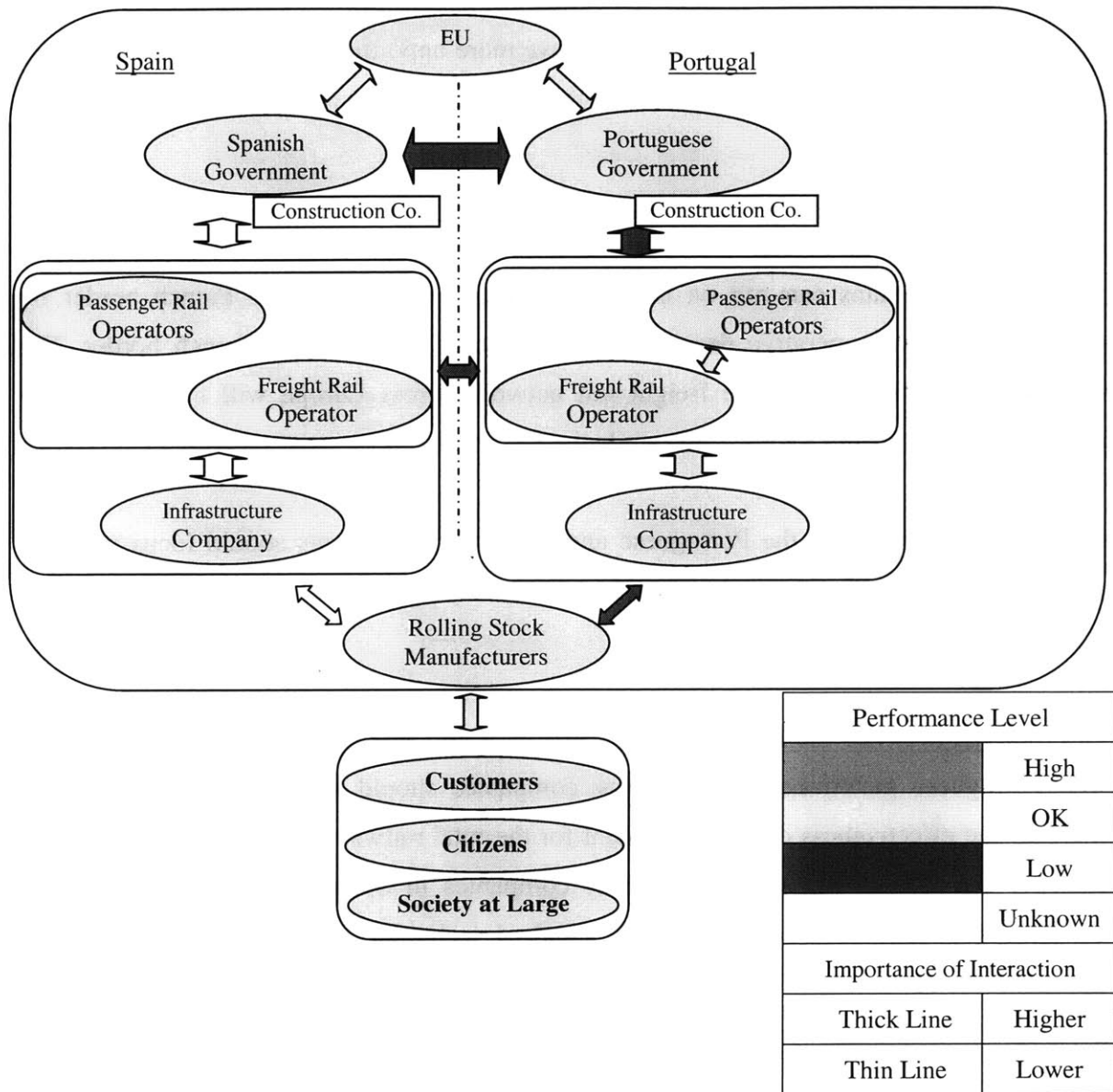
Because trains will usually be used more than 20 years and require technology with long-term reliability and durability, JR East, as an operator, places great importance on these criteria. Compared with Alfa Pendular, the Siemens rolling stock like ICE which has demonstrated reliability and durability would have been better for achieving reliable operation for the long term. Operators and manufacturing companies should focus on the reliability and durability as important values.

Recently, France has achieved the fastest train speeds in the world [46] and others are also advancing the new technology of rolling stock. However, the maximum and average operational speed is much lower than the testing speed and the enterprise needs to focus on the operational speed and reliability. This is partly because the maximum and average operation speeds highly depend on the combination of infrastructure conditions and the characteristics of rolling stock. Additionally, rolling stock introduced for the new HSR also needs to have a long testing time for durability and reliability. For example, JR East usually does testing for several years.

Therefore, the value delivery in terms of the reliability and durability of rolling stock is very important for ensuring the reliable service that attracts people, and the enterprise should focus more on the reliability and durability of the rolling stock. This value delivery depends highly on the operators' attitude to introducing the rolling stock in HSR.

### 7.3.4. Interactions for Cooperative Relationships

A more detailed analysis would be desirable, but based on the author's judgment, the interactions between some of the stakeholders are shown in Figure 7-9.



**Figure 7-9 Interactions between Stakeholders**

To become a lean enterprise, the enterprise of the HSR project needs to have improved performance levels for the following interactions, which are of higher importance and for which the performance level is now judged to be low.

### **Interactions between the Spanish and Portuguese Governments**

The interactions between the Spanish and Portuguese governments look weak in this project. EU funding is related to the aim of a better international network, but the total railway coordination of Europe will first require coordination with the Spanish railways. If the interactions between the Portuguese and Spanish governments progress in a cooperative manner, Portuguese passenger railways will have more opportunity to increase the potential international passenger ridership, even if there is no significant potential for increased domestic ridership.

Additionally, freight is important for European railways, and they should determine whether freight trains can run on the HSR line and continue to the French border by making an early, cooperative decision about the track gauge to the French border. The reduction of travel time of the freight rail network across Europe will be significantly enhanced by such better interactions, while the EU will be more satisfied with the projects.

In the early stages, both the Portuguese and Spanish governments should focus more on their relationship for both passenger and freight railway purposes.

### **Interactions between the Portuguese Government and Railway Companies**

The Portuguese government and railway companies should have more interactions to increase the effectiveness of the investment for the total railway system in Portugal and to improve the relationship with the railway companies in Spain. Both rolling stock and infrastructure need to have a common standard technology for efficient and reliable operation.

### **Interactions among railway companies in Portugal and Spain**

Under EU440, separation of operation and infrastructure is necessary, and both the Portuguese and Spanish railways have satisfied the minimum requirements. Given EU 440 and this unbundled system, the integration of the total system is all the more necessary. Also, operational integration between Portugal and Spain is important for through train

operation between the Portuguese and Spanish railways.

### **Interactions among Railway Companies, Rolling Stock Manufacturing Companies, and Infrastructure Instrument Companies**

Better interactions among railway companies, rolling stock manufacturing companies, and infrastructure-component manufacturing companies are necessary, because, except for the railway companies of Portugal, these companies will be foreign ones with different languages, distant headquarters, and culture differences. For example, reliable transmission of signals between ground infrastructure and rolling stock needs coordination, and the speed highly depends on the combination of track conditions and the characteristics of the rolling stock. Also, the support system provided by manufacturers is critical for the reliability of operations. Careful selection of these companies is necessary, as is cooperation with them.

### **7.3.5. Process Optimization**

To become a lean enterprise, all processes should be value-added and need to eliminate waste. The suggestions below are from the author's judgment, based on the Japanese case study.

#### **An Initial Process to have Equitable Contracts**

As a typical recommendation when introducing the lean ideal, a special committee team that consists of all stakeholders and that worries about as enterprise-wide should be organized first. It enables the industry to conduct equitable, unbiased data analysis and a better decision-making process. The regulations, operational contracts and schemes for access charges should be decided on before construction, so that, as proposed in the Japanese case study, cooperative relationships and prevention of political intervention can be accomplished when the construction begins. Especially, the negotiation process with the Spanish government will be one of the earliest processes for the equitable value exchange and cooperative relationship thereafter.

### **Data Analysis Process**

In the planning process, now, the Portuguese government expects higher demand after the construction of new HSR lines. Operators and REFER should also be involved in sensitivity analyses of the future demand and profitability of total railway systems to ensure good decisions without any bias. Reimbursement to the Portuguese government, EU, and others for huge replacement and future maintenance costs of total railway system, will, in addition to construction costs, need to be covered by future operations. The project should focus not on construction, which will be partly funded in the future by EU and the Portuguese government, but, as much as possible, on long-term profitability.

### **Investigating Process**

When investigating the future technology and system, the enterprise needs to refer to the good examples of Germany and Japan, which have the most advanced technology in terms of the precision and reliability of the railway operation.

Even though the Japanese railway system is different from European systems, Portugal can learn from the Japanese system as Germany did. For example, to increase the acceleration, all cars should have motors, not just cars at the ends of each train. In Japan, all HSR trains have used this method since 1964 and recently ICE and other European railway systems have begun to introduce this method because of the high acceleration. This allows a great increase in the frequency of trains and reduction of the travel time. Learning from the technology and management system from the Japanese railway system may be worthwhile for the future reliable operation.

However, the Japanese system is so different that it is not recommended for the HSR project in Portugal unless there is enough time for thorough testing. For example, the Japanese signal system technology is different from the standard technology of European countries.

Considering the similar circumstances in European countries, the German railway system

may be the best prototype for the future HSR operation in Portugal, though it is also worthwhile to learn from Japanese railway systems.

### **Testing Process for New Rolling Stock and Infrastructure Components**

A long testing time is necessary for the reliability of the operation, which is very important for the value exchange in the project. If the HSR will open within several years, rolling stock manufacturing companies and infrastructure instrument companies should be selected in the earlier stages, so that they can have enough testing time. For example, the stable transmission of signals between ground infrastructure and rolling stock needs long testing. We recommend that the enterprise should choose the combination of rolling stock and infrastructure (such as track, electric power supply, and signals) that use established technology to prevent future problems. Additionally, the maximum and average operation speeds highly depend on the combination of track condition and rolling stock characteristics. As soon as a section of the lines is constructed, the enterprise should start testing the new rolling stock and the infrastructure.

### **Lower Risk Processes for Accomplishing the HSR Project In Portugal**

Lower risk processes of the HSR project are necessary because of the huge investment.

First, between Lisbon-Madrid, we can assume that the long travel time and extremely low frequency inclines people to use air and cars instead of rail, and that this inconvenient transportation also loses many potential customers. In Japan, 70% of people use the 500 km HSR line between Tokyo and Osaka and this has proved that high reliability, frequency, and speed with a reasonable fare can increase the railway share among modes over this distance. Since there is no good railway connection between Lisbon and Madrid and 453.8 km is a favorable length for a new HSR project, reliable HSR service would be likely to succeed in changing the major mode from air to rail.

On the other hand, between Porto and Lisbon, there are fewer potential customers. In addition to the fact that Portugal's population density is much lower than those of Japan

and Germany, the populations of Porto and Lisbon are only 1.8 million and 2.7 million [47] while there are 61 million people in Japan's three big metropolitan areas, Tokyo, Nagoya, and Osaka [12]. In this case, it is very hard to anticipate a great increase in demand from domestic sources. Also, the connection with an airport will be necessary to satisfy the EU and the Portuguese government. However, the necessity for the new line depends on the density of current operations. If analysis by REFER forecasts that congestion will come to exist on the conventional line, then a new HSR line should be constructed between Lisbon and Porto. The analysis should be discussed by all stakeholders and should suggest who should be responsible for the demand estimation, so as to eliminate bias. On the other hand, if congestion on the conventional line is not expected in the future, the HSR should be considered as a possible later project after the construction of the Lisbon-Madrid HSR route because future increased demand from Spain may change the situation. Improvement of signals and of the condition of the existing tracks may be the low-risk way to increase the reliability and capacity of rail under limited demand.

To sum up, it is very important to increase the international demand. Given the strong connection with Spain for both the economy and tourism, the HSR project between Lisbon and Madrid is a desirable one to create a new demand for railways. Therefore, the Lisbon-Madrid HSR project should be constructed first, because there is a higher uncertainty about increase in demand on a Lisbon-Porto HSR line. The effort to improve the existing line between Lisbon and Porto should be done first and it may be wise to delay the construction of a Lisbon-Porto HSR line until the enterprise can consider how the Lisbon-Madrid HSR project affects the demand for railways and can predict additional demand for an extension from Lisbon to Porto. Concentrating only on the Lisbon-Madrid project will also shorten the construction time and generate the revenue to repay the investment earlier. Thus, the Lisbon-Madrid HSR project should be accomplished first, taking into consideration the possible future extension of direct operation from Madrid to Porto through Lisbon.



### **7.3.6. Continuous Effort toward the Lean Ideal**

To approach the lean ideal, it is very important for all stakeholders to examine whether interrelationship between key processes, stakeholder values, strategic objectives and metrics is appropriate or not. If the analysis is done by the enterprise, it will be helpful for better utilization of the limited resources and for improvement of coordination of railways in Europe. To create a lean railways system, the Portuguese members should examine the alignment of key processes, stakeholder values, strategic objectives and metrics as in the X-Matrix analysis of the Japanese case study, after the detailed value exchange analysis and establishment of processes.

### **7.3.7. Summary of the Portuguese Case Study**

This chapter shows a conceptual example of how the lean enterprise idea would be applied to Portugal's HSR projects. Lack of data limits the analysis, but finally we have general conclusions that might be developed for the process optimization of HSR projects.

Because Portugal's high speed rail project has just begun, we highly recommend the application of the lean enterprise concept in more detail and with more complete data. This could be performed first by a university or another disinterested organization that has access to the voices of stakeholders. It is best to have a joint effort with as many stakeholders as possible. Utilizing the lean enterprise concept will allow the railway system to make the best use of limited resources and reduce the risk of the HSR projects in Portugal.

We emphasize that the outcomes of this chapter are based on limited sources of data and this is a conceptual example of the application of the lean enterprise concept, which might be useful for the HSR projects. Detailed analysis by Portuguese project members will surely provide more valuable findings.

The next chapter offers a summary of the entire thesis and ideas for future research.

## **Chapter 8. Conclusion**

This thesis mainly explores and evaluates the application of the lean enterprise concept to the expansion and development of the high speed (Shinkansen) railways in Japan. In addition, we consider high speed rail in Portugal although not at the level of detail that we consider in Japan. In this concluding chapter, the implications of the major findings from the application of the lean enterprise ideal to the railway industry will be discussed (section 8.1), followed by suggestions for the next steps in the future to make that industry still leaner (section 8.2).

### **8.1. Summary**

#### **The Present Situation and the Importance of the Lean Concept**

The lean enterprise concept, presented in MIT classes [18], has proven useful in a manufacturing context. The basic idea of the lean concept is to increase value-added processes, to eliminate waste, and to create equitable value delivery throughout the enterprise. It also focuses on both radical change and continuous gradual improvement. In this thesis, we applied the lean enterprise concept to the high speed rail environment.

In Japan, new Shinkansen lines are being planned and constructed as a governmental project. There are many stakeholders involved, but cooperative relationships and integration of the project are not at the highest possible level and the project is not lean. When the budgets are extremely limited, integrated planning by all stakeholders is necessary to reduce risks and waste of investment. We argue and demonstrate that the lean enterprise concept can also be useful in this context.

The major differences of the high speed rail application from the manufacturing application is that more stakeholders are involved, more integration and collaboration is necessary for the entire system, and more equitable value exchange is important, since the critical point

for a reliable and safe railway system is the integration of the entire system. In the author's judgment, there is more need for the lean ideal for the development of high speed rail projects than in the manufacturing industry.

Portugal is also now planning to construct new high speed rail lines and it is essential to organize the best system for these new projects. The lean enterprise concept can be further tested and validated through application to Portugal's high speed rail construction project. Although the data are limited, an appropriate strategy for construction of high speed rail, derived from this analysis, still generates some clear implications. It turns out that the lean concept is also applicable here and desirable, since the project is just at the planning stage and it is almost equivalent to the Japanese high speed rail construction projects.

### **Application of the Lean Concept**

The goal of this thesis is to apply the idea of the lean enterprise, which usually is associated with manufacturing companies, to this service industry, the railway industry. This is the first application of the lean enterprise concept to the new high speed rail construction projects. So, this thesis has not only considered the future strategy of the newly constructed high speed railways in Japan and Portugal, but has also assessed whether lean enterprise architecting is applicable to the new high speed rail construction projects throughout the railway industry.

First, to utilize the lean concept, the strategic objectives must be defined clearly so they can be pursued by all stakeholders. Even though the strategic objectives should be determined by the enterprise itself, it is a good start to review the history and make international comparisons, and to seek to inductively derive the strategic objectives of the enterprise as an academic undertaking. Accordingly, this thesis first looks back at the history of the Japanese railway system and examines the details of the present Shinkansen railway system. It then makes an international comparison with the United Kingdom and German railway systems. There were reforms to improve the railways in these countries, but they have still common serious problems: inequitable contracts and regulations, political interventions,

and integration problems. Based on the common strategy and difficulties of the reforms in the U.K., Germany, and Japan, the strategic objectives of the extension of the high speed railway project in Japan were defined as the following;

(Strategic Objectives)

- 1: To strengthen transportation and economy in Japan, and to reduce environmental impacts
- 2: To make the level of service and safety high on a long-term basis
- 3: To increase the competitiveness of railways in relation to other transportation modes
- 4: To integrate the total railway system

(Ways in which strategic objectives 1, 2, 3, and 4 can be achieved)

- 5 : By reducing political intervention
- 6 : By achieving equitable contracts and regulations

These strategic objectives basically can also be used for the Portugal's HSR project, though they need to be revised by the Portuguese people to adapt to the characteristics of their own railways.

Then, the lean enterprise concept is applied to the new high speed rail construction projects in Japan and Portugal. In the EVSMA (Enterprise Value Stream Mapping and Analysis), value exchange analysis is important to satisfy both the enterprise and all stakeholders, based on how they contribute to or bear costs from each other. Processes are optimized to increase the value-added activities and to eliminate waste, and interactions between stakeholders are improved to meet the enterprise's needs. Finally, the alignment of the strategic objectives, metrics, key processes, and stakeholder values is evaluated by X-Matrix analysis for the entire enterprise to make it leaner and able to aim at the strategic objectives better. EVSMA provides suggestions for future strategy that can offer the projects some advantages from the lean enterprise perspective. These are some of the most important specific recommendations to the new high speed rail projects of Japan and Portugal from the analysis of the lean concept in Chapter 6 and Chapter 7;

## **1: Value Exchange Analysis**

Equitable contracts and regulations should be settled in the early stage, after considering as many future possibilities as possible, in order to keep the value delivery to stakeholders equitable and to avoid possible later conflict. The lean enterprise concept will help them to become equitable, especially through the value exchange analysis.

- \* In Japan, ignoring railway freight transportation is inconsistent with some of the strategic objectives, such as strengthening of transportation and economy and reduction of environmental impacts. Priority of operation in the Seikan Tunnel and on conventional lines should be decided first to prevent the project's harming the freight railways.
- \* In Japan, transfer of the operation of the parallel conventional lines could be replaced by changing the most unprofitable lines to bus operation. The enterprise should consider the well-being of the total railway system and allocate the responsibility for these unprofitable lines accordingly.
- \* In Japan and Portugal, given the competition with the airline industry for the new high speed rail lines, regulation of the operation and fares of both industries will determine the future revenue and stability. Sensitivity analysis of future demand and profitability is highly affected by these regulations and it should be considered in the early stages.
- \* In Japan, the lease contract should be equitable, based on the value exchange analysis. Additional charge later in the process and uncertainty of treatment of ownership of the asset at the end of the lease term will change the value exchange balance, and it should be settled before construction.
- \* In Portugal, equitable contracts and regulation between freight and passenger railways and between Portuguese and Spanish railways will be necessary to prevent conflicts.
- \* In Portugal, because revenue from track charges on existing conventional lines in

Portugal is not sufficient, REFER and CP need to have careful demand analysis and strategy. In the early stages, the enterprise should recognize how much each stakeholder will be responsible for and pay for the deficit of the operational, maintenance, and replacement costs.

- \* In Portugal, the contracts should include both the passenger and freight railway operations, and connection routes from Portugal to other European countries through Spain. The enthusiastic Portuguese government push may succeed in getting the track gauge of existing lines to the French border changed to standard gauge.
- \* In Portugal, new construction should be standard gauge, not just to satisfy the EU, but also to facilitate further potential extension to the French border, mainly for freight traffic. The decision whether freight railways are allowed to run on the HSR track should be done in early stages and the frequency of passenger HSR and freight railways on the new HSR track should continue to be optimized periodically before and during the operations.
- \* In Portugal, the value delivery in terms of the reliability and durability of rolling stock is very important for ensuring reliable service, and the enterprise should focus more on the values of the stability and durability of the rolling stock.

## **2. Interactions Analysis**

In Japan, interactions among passenger operators, local government, and central government are especially important, but the performance level has often been low. The interactions between the freight rail operator and the central government, between rolling stock manufacturers should also be improved.

In Portugal, given the unbundled system and through train operation between two countries, the integration among railway companies in Portugal and Spain is important. Second, if the interactions between the Portuguese and Spanish governments progress in a cooperative manner, Portuguese passenger railways will have more opportunity to increase the potential

international passenger ridership and freight transport. Also, they should determine whether the freight can run on the HSR line or not by solving the gauge problem of tracks to the French border in the early stages by cooperative interaction. Finally, better interactions among railway companies, rolling stock manufacturing companies, and infrastructure instrument companies are necessary, because all of these except for the railway companies will be foreign ones with different languages, distant management, and culture differences.

### **3: Lean Process**

In Japan and Portugal, as a typical recommendation when introducing the lean ideal, it is suggested that a special committee team concerned about issues that are enterprise-wide should be organized to aim at the lean ideal. Then, data collection and analysis should be done, conducted by the committee to eliminate any bias. Sensitivity analysis includes assumptions that can be manipulated, but the lean concept decreases the bias and increases the accuracy of the analysis.

- \* In Japan and Portugal, the basic planning, which includes the construction planning, contract, and regulations, needs iteration of analysis and negotiations among stakeholders. Through the iteration, possible problems can be anticipated and prevented, such as the congestion of track in the Tokyo area in Japan.
  
- \* In Portugal, for development of the future technology and system, it is essential to refer to good examples. Considering the similarity of circumstances in European countries, the German railway system may be the best prototype for the future HSR operation in Portugal, while it is also worthwhile to learn from Japanese railway systems.
  
- \* In Portugal, the selection of technology in early stages is essential for reliable operation since it needs long testing time. As soon as a section of the lines is constructed, the enterprise should start testing the new rolling stock and the combination of the infrastructure components.

\* In Portugal and Japan, lower risk processes of the HSR project are necessary because of the huge investment. After establishing the fully specified contract and regulations, the enterprise should concentrate on a manageable number of construction projects at the same time to maximize asset utilization. For example, in Portugal, the Lisbon-Madrid HSR project should be accomplished first, taking into consideration the possible future extension of direct operation from Madrid to Porto through Lisbon. At the same time, the effort to improve the conventional line between Lisbon and Porto should be completed first, since they have already invested a great deal for the improvement of the conventional line. Concentrating only on the Lisbon-Madrid project will also shorten the construction time and generate the revenue to repay the investment earlier. After getting data on how the Lisbon-Madrid HSR project affects the demand for Portuguese railways and considering how the conventional line has been improved, the necessity and risk of the proposed Lisbon-Porto HSR should be discussed thoroughly. Also, the enterprise should discuss with the government the priority of the development of railway, highway, and air transportation, since the budget is limited.

#### **4: Lean Process and Value Exchange**

Then, following the constructive negotiation and its consequent fully specified contract, the enterprise could begin construction and operations, based on the regulations and contract. Adjusting the contract and regulations is allowed for equitability, but should not be major, since major changes that might be sought by strong stakeholders such as governments would have the potential to upset the value balance. (Japan, Portugal)

#### **5: General Lean Concept**

In Japan and Portugal, as a typical recommendation when introducing the lean ideal, continuous effort by all stakeholders is also essential to the lean ideal. Systematic EVSMA analysis and self-assessment should continuously be done by the enterprise to become leaner.



Those conclusions are based on the analysis in Chapter 6 and Chapter 7. Although some of the conclusions can also be considered as general concepts, this systematic analysis has logical flows to the conclusions and it allows the complex enterprise to aim easily at the lean ideal and to avoid having hostile relationships. The results imply that the lean concept is also suitable for the development of railway industries, so as to enhance the total enterprise performance, because of the need for large capital investment and its complexity of the relationship among stakeholders and high technology. Systematic analyses, as in EVSMA, enable the complex enterprise to pursue the lean ideal more easily. The key factors in the usefulness of the lean enterprise concept for railway industries are as below:

- \* Value exchange analysis for equitable value delivery
- \* Improvement of weak interactions which are important for the enterprise
- \* Optimization of the alignment of strategic objectives, metrics, processes, and stakeholders' value to pursue strategic objectives
- \* Increase of value-added processes and elimination of waste

### **Difficulties of the Lean Approach**

However, there are some difficulties when executing the transition toward the lean enterprise, such as the strong influence of government and political interventions. The first step toward the lean ideal is the operators' effort to build the lean enterprise initiatives project team at the outset in order to persuade the government and politicians to realize the effectiveness of the lean approach. If this succeeds, the government could be a leader toward the lean enterprise ideal. If the lean approach is applied by the representatives of existing stakeholders, it will greatly help the railway industry to move toward prosperity.

To sum up, the lean concept is very suitable and desirable for the development of the high speed railway industry as in Japan and Portugal. The concept will enhance the total enterprise performance in a cooperative and efficient manner and enable conflicts among stakeholders that often occur today to be prevented.

## 8.2. Future Research

Suggestions for further research on the application of the lean enterprise concept to the railway industries are provided in this section.

In this thesis, there are no interviews with any of the stakeholders, since there has been no contact with any of the governments or even with JR East. The EVSMA from 6.2.3 to 6.2.6 is based on the judgment of the author, and the result might have been different if we had some input from representatives of each stakeholder.

EVSMA analysis is not limited only to a university research setting, but is applicable to and developed for the real world. For example, equitable contracts will be enhanced by the value exchange analysis by stakeholders themselves and subsequent negotiation. EVSMA is a better process when the input includes all stakeholders' voices. As a typical recommendation when introducing the lean ideal, it is highly recommended that a special committee team whose scope of concerns is enterprise-wide should be organized. So, we strongly suggest that further research involve interviews with representatives of stakeholders. This thesis can provide a strong basis for such interviews.

Additionally, we need to have further research to examine how effective the lean concept and EVSMA are, if stakeholders of the new high speed rail projects do this analysis and utilize the lean concept for future planning by themselves. As a part of the research, it would be valuable to compare how the stakeholders' EVSMA is the same as or different from the EVSMA produced without the input from all stakeholders' voices.

In Japan, the reform in 1987 increased the independence of each company and this turned out to be successful for better operation of the existing lines, but the total coordination and collaborative relationship among stakeholders was apparently reduced. The lean concept for the further extension and development of the railway industry is especially needed to eliminate this side-effect of the 1987 reform of Japanese railways.

We also suggest that the effectiveness and limitations of the lean concept for railway

industries in other countries should be examined. The lean enterprise concept has won global acclaim in manufacturing, but this thesis is the first to apply the lean concept to the railway industry. It should be worthwhile for universities and research institutions to examine the effectiveness and limitations of the EVSMA analysis and the lean concept as potentially applied by the stakeholders of the new construction projects of world's railway industries.

For the Portuguese HSR project, the analysis needs to be done in more depth by stakeholders since we had less access to data and information. Additionally, Portugal's high speed rail project has just begun, and we highly recommend that research in EVSMA should be done, first, by a university or another disinterested organization that has access to the voices of stakeholders. It is best to have a joint effort to utilize the lean enterprise concept. In the next stage, the institution should suggest that the stakeholders themselves establish an organization like LAI to aim for the lean enterprise ideal before the value delivery becomes inequitable and political interventions become too strong for an appropriate decision about future HSR projects. At this stage, the university or other disinterested organization should also continue to be involved in the organization in order to monitor and evaluate the effectiveness of the first application of the concept to the railway industry and to ensure balanced equitability.

We hope the research is valuable to the railway people in Japan, Portugal and other countries. It will be very interesting to apply this new idea of lean concept to existing industries, especially for the development of high speed rail. We hope that the people will find some values from the lean concept in their own railway industries.

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