ISSUE KOTI Knowledge Sharing Report

07

Korea's Best Practices in the Transport Sector

Korea's Railway Development Strategies

Edited by Jinsu Mun, Hun KIM

THE KOREA TRANSPORT INSTITUTE

Korea's Best Practices in the Transport Sector

Korea's Railway Development Strategies

The Korea Transport Institute (KOTI):

KOTI is an official research agency for the government of the Republic of Korea (South Korea) and a leading think tank for Korea's transport policies. It has been committed to building a safe, convenient, efficient and environmentally sound transport system for the nation since 1987. It is a pioneer in providing new ideas and future perspectives about transport issues in Korea, while positioning itself as one of the world's leading transport research institutions.

KOTI Knowledge Sharing Report: Korea's Best Practices in the Transport Sector
Issue 7: Korea's Railway Development Strategies

Edited by Jinsu Mun, Hun Kim

Published by the Korean Transport Institute (KOTI)
315, Goyangdaero, Ilsanseo-gu, Goyang-si, Gyeonggi-do 411-701, Republic of Korea
Phone +82-31-910-3114
Fax +82-31-910-3222
Hompage: www.koti.re.kr
Contact email: info@koti.re.kr

This book is reprinted under the approval of Ministry of Strategy and Finance(MOSF) and Ministry of Land, Infrastructure and Transport(MOLIT).

Not for sale
ISBN 978-89-5503-559-9 93530

ISSUE

KOTI Knowledge Sharing Report

07

Korea's Best Practices in the Transport Sector

Korea's Railway Development Strategies

Edited by Jinsu Mun, Hun Kim

THE KOREA TRANSPORT INSTITUTE

• Preface

Korea strode toward the miracle on the Han River for the past 40 years with consistent provision of transport SOCs such as roads, railways, airports and ports and the introduction of the Five-Year Economic Development Plans and the Special Account for Transport Facilities (SATF). Such an efforts and achievement attracted attention of the world.

Particularly, transition from a recipient country to a donor country after 1990s promoted its public image to developing countries and inspired Korean people to have pride in their homeland. Its aid recipient countries has been gradually expanded from Asian countries to African, Middle East and South American countries and types of aid has been diversified from economic development planning consulting to new town construction, infrastructure construction, and technical assistance.

Recently, developing countries pay strong interest on Korea's transportation development. Their main points of interest are domestic KTX production technology, world's best international airport operation knowhow and transportation reform which is represented by intelligent transport systems (ITS) based on top-notched information and communications technology (ICT), compatible transportation card use systems over the nation and bus rapid transit (BRT).

Knowledge sharing program (KSP) to share Korea's development knowledge and experience was started in 2004 and has shown outstanding performance in the transport sector. This was because of its nature—a backbone of the economy. For this reason, many developing countries ask KOTI to offer training programs to share Korea's knowledge and experience.

This report deals with Korea's urban railway development history and relevant policies in detail as well as coping strategies used against difficulties.

I believe that sharing knowledge and experience on transport development will offer us an open platform on which we can establish sustainable transport policies and cope with climate change, resources depletion and many other common global issues. I expect that KOTI knowledge sharing reports will be a channel for all readers to find useful information and knowledge.

Lastly, I appreciate Ministry of Land, Infrastructure and Transport (MOLIT), Ministry of Strategy and Finance (MOSF) and Korea Development Institute (KDI) to allow us to republish this book.

Gyeng Chul Kim
President
The Korea Transport Institute

• Authors and Editors

Jinsu Mun

Affiliation: The Korea Transport Institute (KOTI)

He is now working at regional sustainable development department, Asian Development Bank as a secondee since September 2012. He has around 10 years of working experience as a research fellow at the Korea Transport Institute since 2012. He has conducted various research projects related to railway feasibility study, railway freight policy, and railway policy in Korea; and also railway feasibility study in Asian countries, such as Myanmar, Thailand, Vietnam amongst others. He also has one year of research experience at Seoul Development Institute (SDI) as a researcher in 1997 and 1998, where he was involved in a transport database project.

He has been involved in several governmental committees as an advisor to railway policy in Korea. He has experiences of being a lecturer at several universities in Korea. His expertise was recognized through his name being published as a railway expert in the 2011 edition of Who's Who in the World.

He obtained B.A. at University of Seoul in urban engineering; and M.A. at Seoul National University in urban & regional planning respectively. He obtained PhD at the University College London, UK, in the field of transportation planning in 2002.

Hun Kim
Affiliation: The Korea Transport Institute (KOTI)

Dr. Kim is a research fellow in the Department of Railway Research at the Korea Transport Institute. He received a Ph.D. in the Department of Civil Engineering at the Seoul National University in 2000. In graduate school, he had interests in transportation planning and traffic management. So he studied the transport planning of roads, railways, and airports. And his doctoral dissertation investigates the traffic management model in urban freeway corridor. He has worked for the KOTI and has published research reports on Korea's railway policy since 2001. Now the major portion of his research has focused on railway planning and operations.

Part - Ⅰ

[2011 Modularization of Korea's Development Experience]

Urban Railway Development Policy in Korea

Contents

Contents _ List of Tables

Contents

Contents _ List of Figures

Chapter 1.

Background and Objectives of the Urban Railway Development

1. Construction of the Transportation Infrastructure for Economic Ggrowth

When a country's economy grows, the expansion of the secondary and tertiary industries in the urban area generally creates a demand for new laborers, triggering the explosion of the urban population. The outsized socioeconomic power of the central city often leads to the creation of a metropolitan area as some of the city's key functions will be expanded to its satellite cities. In the process, the central city will be faced with an increase in the urban and metropolitan traffic, which will lead to an increased demand for an adequate transportation system.

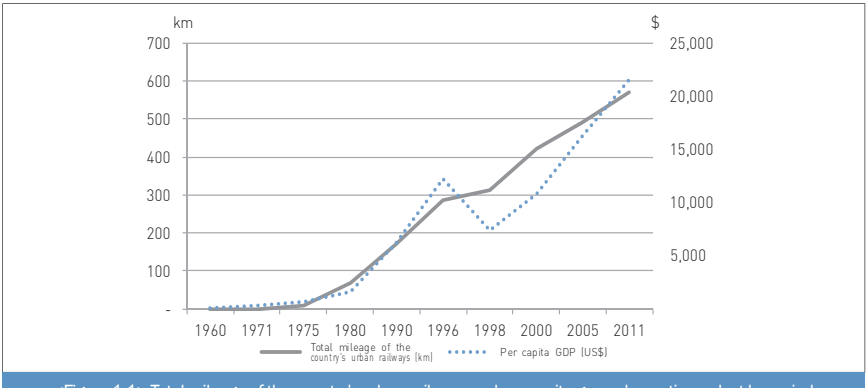
If the supply of the transit infrastructure cannot catch up with the traffic increase, it will set off traffic congestion as the city's locomotivity will vary according to the region and time. The congestion will aggravate the traffic, increasing the transit hours while worsening people's punctuality. This is also detrimental to the country's industrial efficiency as it will shrink the practical commuting radius, lower the productivity, and increase the overall logistic cost.

To address these problems, the developed countries, over the course of their economic development, have devised various transportation methods that would meet the changing need at each stage of the socioeconomic development, and have invested much money in the transit infrastructure. The biggest payoff of investing in transportation is the expansion of the potential scale of human movement, which is achieved by lowering the transit cost and expanding the opportunity for movement.

In the process, cities will get increasingly linked with the other regions in the vicinity, boosting the labor flexibility and efficiency needed for easy access to jobs. It will also foster concentration of the economic activities, thus promoting urban clustering.

Following the successful completion of the 1st Five-Year Economic Development Plan (1962-1966), the 2nd Five-Year Economic Development Plan (1967-1971) kick-started the country's industrialization, prompting rapid economic growth. In the process, the country's urbanization was accelerated while the population of Seoul, the country's capital, exploded. Coupled with the brisk industrial activities, the population growth triggered a massive demand for urban public transportation. The number of registered automobiles skyrocketed, worsening the traffic congestion.

Faced with the prospect of an inevitable clustering of people living in the metropolitan areas, the government finally realized the urgent need for improved urban transportation. It was also concluded that the metropolitan traffic network would have to be expanded as the lack of housing in Seoul would set off an explosion of people commuting from the satellite cities. Although the government was struggling with insufficient funds to finance the expansion of the industrial-production facility, it still went ahead and built the transportation infrastructure that required a massive investment as it believed that the improvement of the geographic access was closely linked with the population increase and economic growth in a virtuous cycle. The government was convinced, in particular, that strengthening the standing of a central city such as Seoul was the basis of the country's economic growth.



<Figure 1-1> Total mileage of the country's urban railways and per-capita gross domestic product by period

It was proven, for instance, that the increase in the total mileage of the country's urban railways was closely correlated with the growth curve of the country's per-capita GDP, which again testifies to the close relationship between the country's building of the urban railway infrastructure and its economic growth.

2. Supply of Public Transportation Facilities in the Urban Areas

In the urban areas, the traffic tends to peak in the morning and late afternoon, and to be congested in certain spots, whereas the type of traffic is marked mostly for short-haul trips. The central city, in particular, tends to be congested even more during the peak hours, as it has to deal with the added flow of the metropolitan traffic streaming from the nearby satellite cities. Accordingly, the public transportation, with its capacity to deal with the traffic demand and to improve the transportation efficiency, is crucial in this regard.

London, which is the birthplace of the Industrial Revolution but has limited space, built underground railways in 1863 to deal with the growing intra-city traffic caused by the massive population inflow since the industrialization. The move was spurred by the conclusion that building ground transportation in the cramped space alone would not be sufficient to handle the ever-growing traffic demand. Other European cities that had an urban structure similar to that of London jumped into the bandwagon, building underground rails between the late 18th and early 19th centuries. Even now, well after the popularization of automobiles, metropolitan cities the world over are still adding more urban railways to their existing network to solve their urban traffic problems.

The trams and buses satisfied the key public transportation needs in Seoul between the 1950s and 1960s. With the rapid expansion of the urbanized areas, however, the trams soon phased out and were gradually replaced by buses, which transported a growing number of commuters to the city center. Expanding the roadways fast enough to accommodate the ever-growing number of buses and cars, however, was not realistic. The elevated railway or subway was recommended as a long-term and environment-friendly alternative that would potentially ease the road traffic as it

could transport a massive number of people while snaking through the city center that is densely packed with high-rises without any difficulty.

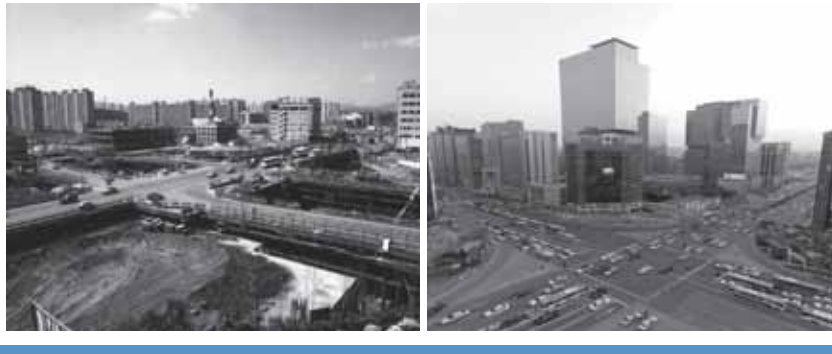
<Figure 1-2> Bus-centric urban transportation in Seoul in the 1960s

The urban railway, with its characteristic multi-train car ride along the dedicated tracks, excels compared to other mass transits in terms of transportation efficiency and punctuality. It is also comparably better than automobiles in lowering the air pollution while ensuring energy efficiency and traffic safety, prompting the country's metropolitan cities to consider it the most promising solution to the problems concerning the intracity traffic.

This is why other metropolitan cities started to pursue their own urban railway projects since the 1980s. The urban railway can play a central role in the public transit once completed, but its construction is a huge burden on the municipal coffers as it costs an enormous sum. Should it fail to attract the target number of passengers, it could pose a fiscal challenge to the operator. To address these issues, it became necessary, beginning in the 1990s, to also shift the focus of the urban rail policy from the conventional midsized trains to the light rails, which would correspond better to the size and characteristics of the city's urban traffic.

3. Support for the Development of New Cities

The urban railways need the construction of stations, which can trigger the crammed development of the surrounding land and the subsequent building of linkup transits around them, leading to the creation of the "railway station sphere," a key platform for the future urban growth. In general, the amount of usable lots near a station is frequently limited. To meet the growing demands for land, the competent authority can create a space bristling with diverse commercial activities by proactively accommodating those functional needs. The country has long pursued the development policy to turn the underground space created from the urban railway project into a key commercial district in a given area. It worked especially well in an area where the urban railway has a competitive edge over other public transits, as the demand for the development of a "railway station sphere" prompted the growth in the area.



<Figure 1-3> Changes in the Gangnam Station area

While the central city grows, a series of large-scale cities or industrial complexes will be popping up around it, prompting a demand for metropolitan transportation. The metropolitan traffic consists of longer commutes rather than urban transportation, and it tends to show a much higher concentration in the peak hours. In many of the metropolitan transit axes along which the traffic is concentrated, the mass transit is usually supplied by the metropolitan railways. In the developed countries, the dedicated metropolitan railways or a few sections of the existing intercity railways are used to deal with the traffic between the central city and the suburban towns scattered around it.

The country saw the need for metropolitan transit connecting Seoul and its satellite cities as many residents in the farming regions migrated to Seoul. To cope with the growing demand, the government operated commuter trains in the 1950s in some sections of Gyeongin, Gyeongbu, and Gyeongwon Line, which were designed as the main-line railway. To effectively handle the growing demand for metropolitan transit, however, it was important to expand the capacity of the existing lines. The handling of metropolitan traffic is as important as the handling of urban traffic, as was proven in the case of the Seoul Metro Line 1 construction project, where the existing metropolitan railways were also expanded into double-track electric rails. Seoul has grown into a world-class city, with its economic development. The government built a series of new cities around the South Korean capital to move the key urban functions concentrated in Seoul to those cities. In the process, the government also built some new metropolitan railways as it believed that the transit link connecting Seoul and these new cities is critical for the success of the project.

Today, many developed countries strive to build the so-called “megacity regions” to sharpen their competitive edge. The key factors that decide the competitiveness of a megacity region are the people, space, and industry as well as the integration of all these. Transportation links people, space, and industry and is considered an integral element in the advancement of regional competitiveness. Looking back, the South Korean government's decision to invest heavily, despite its tough fiscal condition, in the construction of transit infrastructure to improve the urban and metropolitan mobility is deemed a prescient move.

This report aims to introduce South Korea's experience in the successful development of urban railways to other developing countries that aspire to build their own urban railway in the future. The report, henceforth, intends to introduce the history and policy of the country's urban railway project, followed by the barriers it encountered and triumphed over in the course of the project as well as the implications for the future projects.

Chapter 2.

History of the Urban Railway Development in South Korea

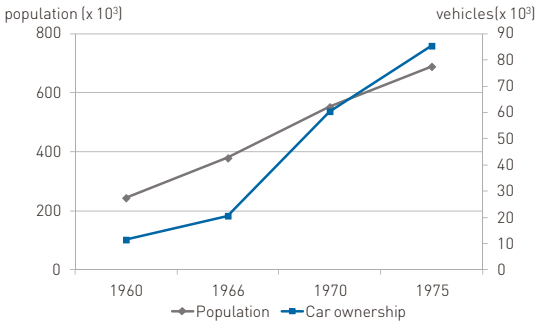
1. History of the Urban Railway Development in Seoul

1.1 Need for the Construction of an Underground Railway

Gyeongin Line[1] the country's first railway connecting Noryangjin and Incheon, opened in 1899, followed by the rapid expansion of such trunk lines as Gyeongbu, Gyeongui, and Gyeongwon Line and other industrial lines built to exploit the resources buried deep in the country's interior. As these railways were built mainly for the intercity traffic rather than the urban traffic, the share of the railways on the urban transportation was not high.

The accelerating industrialization of many cities and the subsequent migration of the farming population to the urban area in the late 1920s created a demand for the mass transit that connects downtown Seoul and other surrounding areas. To meet the demand, commuter trains were operated in Gyeongin Line as well as in some sections of the trunk lines, including Gyeongbu and Gyeongwon Line, which depart from Seoul. The population of Seoul, however, had rapidly increased from 900,000 in 1945 to 1.69 million in 1950 and 2.44 million in 1960. By the time the 1st Five-Year Economic Development Plan (1962-1966) was completed, it almost touched the 4 million mark. Given its difficulties in expanding the roadways, it was obvious that Seoul would be unable to resolve its traffic dilemmas in the city center by relying on such conventional ground transportation means as trams and buses.

1) A key trunkline railway connecting Seoul and Incheon, it is regarded as having played the role of a metropolitan railway.



<Figure 2-1> Rising curve of the socioeconomic index in Seoul

<Figure 2-2> Roadway traffic in Seoul in the 1960s

To address Seoul's traffic issue, the government studied a plan to expand the national railways within Seoul to a double-track rail, and to connect the sections crossing the city center with an underground or elevated railway. In 1961, National Railroad Administration[2)] laid out a plan to construct a subway line connecting Seoul Station and Cheongryangri Station with a 9.8-km-long track with 10 stops along the line. Having more urgent projects in the pipeline, however, such as the building of new industrial lines and the capacity expansion of the existing trunk lines, the administration had to scrap the plan due to the difficulty of obtaining a fiscal line.

2) A central government authority responsible for the construction and management of the national railroads, it was divided into KORAIL and Korea Rail Network Authority in 2004.

In 1964, the National Assembly formally asked the mayor of Seoul to come up with a plan to remedy the city's worsening traffic. By then, the population of Seoul was about 3.3 million, prompting the Seoul municipal government to conclude that the single-level ground transportation system alone would not resolve the city's deteriorating traffic. In response to the request, the mayor proposed a multi-level transit infrastructure as a feasible solution, saying that the construction of a subway line is inevitable despite its huge estimated costs.

In 1965, the Seoul municipal government announced the city's 10-Year Master Plan, where it laid out a roadmap for a comprehensive study to build subways totaling 51.5 km in ten years. Among these, the municipal government said that it will start the construction of two lines -Seoul Station-Jongro-Cheognrayngri Station Line and Seosomun-Uljiro-Dongdaemun Line-totaling 14.88 km. Based on the projected demand, the city came up with Seoul City High-Speed Electric Railway Construction Plan, in which it focused on linking the city center with six sub-centers in an organic fashion by building four lines totaling 65 km. Among those planned lines, Seoul Metro Line 1 would be constructed between 1967 and 1971, with about 45% of the project budget financed by foreign loans. The plan was included again in Seoul City Urban General Plan, which was published in 1966, but it was not executed as envisioned due to the indifference of the central government to it. It was preceded by other civil engineering projects.

1.2 Establishment of the Subway Construction Plany

The city's population and registered number of automobiles kept growing during the period of the 2nd Five-Year Economic Development Plan (1967-1971), causing the further deterioration of the roadway traffic. To address the issue, the Seoul metropolitan government came up with Subway Construction Plan in 1970 and submitted it to the Ministry of Construction while at the same time announcing the Ordinance on the Establishment of an Office for the Construction of Seoul Subway. In May of the same year, President Park Chung Hee ordered the drafting of a construction plan for the public transit infrastructure, including the subway, which he hoped would permanently solve Seoul's severe traffic congestion problem. Helped by the presidential order, Seoul City started the project in earnest by installing the subway construction office under its urban planning bureau.

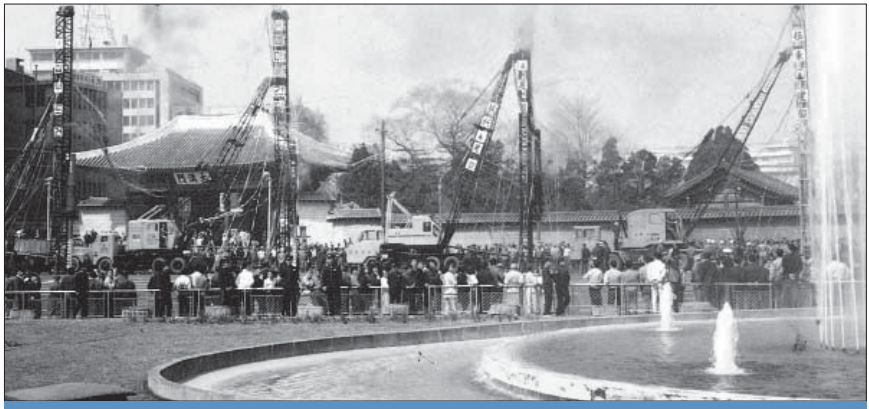
In the Korea-Japan Cabinet Meeting held in July 1970, some potential ways to muster financial and technological support from Japan for the Seoul subway project were discussed. Following the meeting, a team of Japanese specialists submitted a technical report after conducting a comprehensive survey on the construction of Seoul subways and the electrification of the connecting national railroads. The report assumed that a total of five metro lines would be laid out, each connecting the city center and two areas out of the ten suburban areas currently populated or scheduled to be developed in the future. The five lines totaled 133 km - 209 km if the national railroads directly connected to them would be counted - and included an about 61-km underground section. It was proposed that an 8-km-long track of Seoul Metro Line 1 be constructed first, and that the metropolitan railways between Seoul Station and Suwon, Incheon, Cheongryangri and Seongbuk Station be electrified. In addition, Seoul Metro Line 1 would be directly connected with the metropolitan railways.

In March 1971, the Seoul metropolitan government finally confirmed the construction plan of Seoul Metro Line 1. The total length of the track was 9.54 km, with an additional 0.77-km-long track for railcar inspection, which would be eventually used as part of Seoul Metro Line 2 - currently the Seongsu extension. The initial budget consisted of 19.8 billion won domestic financing and USD19.39 million worth of foreign loans.

1.3 Construction of Seoul Metro Line 1

In April 1971, the construction of Seoul Metro Line 1 started. The engineering work consisted of 15 construction sections, each proceeded by stage. Except for some sections that crossed streams, the excavation method from the surface was employed as it required no specialized construction equipment and was easy to apply. As the local contractors had rich design and engineering experience, the earthwork met no serious hitches, except for the passages under some buildings and the prevention of the construction vibration near some cultural properties, such as Namdaemun and Dongdaemun.

Double-track rails were laid out along the length of Seoul Metro Line 1, except for the Jonggak-Shinseoldong signaling station section, where one additional set



<Figure 2-3> Groundbreaking ceremony of Seoul Metro Line 1

of double-track rails can be laid out in case a new line will be built in the future. Accordingly, Jonggak, Jongro 3ga, Jongro 5ga, and Dongdaemun Station each has two separate platforms facing the double track in the middle, and can be reconfigured in the future to accommodate two additional platforms and four-track rails. Seoul and Cheongryangri Station each has a Y-type siding track laid out in the station to allow a loop and the siding operation of the trains. Additionally, siding tracks were laid out in Seoul, Jonggak, and Cheongryangri Station to allow the emergency operation of railcars and service trains.

All the railcars for Metro Line 1 were imported from Japan and were financed by foreign loans. Manufactured by Hitachi Ltd., they could run on both alternate and direct currents. Each train set consisted of a minimum of six cars but could be reconfigured to an eight- or ten-car train set. By the time of the inauguration, a total of 186 cars - 60 cars owned by the Seoul metropolitan government and 126 owned by National Railroad Administration - were ready for operation.

In August 1974, three years and four months after the start of their construction, Seoul Metro Line 1 and the metropolitan railway opened on the same date. Seoul City established Subway Operation Bureau independently from the subway construction headquarters to operate Metro Line 1. The bureau consisted of the administration, sales, operation, maintenance, and supply departments and was responsible for the staff training and train operation of Metro Line 1. As of its inauguration, the subway trains operated for 201 runs a day, but as of 1978, a total of

294 railcars operated up to 526 runs a day.

<Figure 2-4> Inauguration ceremony of Seoul Metro Line 1

1.4 Construction of Seoul Metro Line 2

Seoul City announced a revamped urban development plan in 1975, consisting of three cores: the old urban center responsible for the key functions, the Yeongdeungpo district for business and finance, and the Yeongdong-Jamshil district for housing and residence. The centerpiece of this revamped scheme was Metro Line 2, a belt line that would connect Seoul's three urban cores.

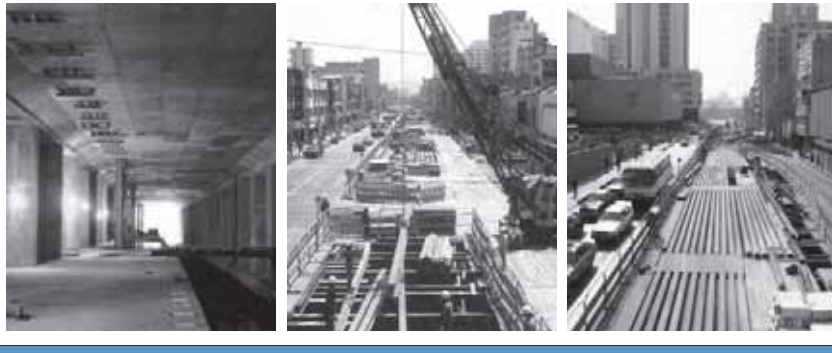
The feasibility study conducted on Metro Line 2 proposed to build up to 48.8 km of track by 1984 while constructing the entire line in four stages depending on the demand and budget. In the first stage, the City Hall-Wangshimni section, crossing the city center, would be built, followed by the City Hall-Dangsan section (second stage) and the Wangshimni-Yeongdong section (third stage). Finally, the fourth-stage construction (Dangsan-Yeongdong) would mark the completion of the belt line. The Japanese engineers advised the South Koreans to build the Gangbuk section first as it already had a huge traffic, and to consider building the Gangnam section later, in the future.

The Seoul Metro Line 2 project was included in the 4th Five-Year Economic Development Plan, but the financing of the project was put on hold for years as the government did not actively provide fiscal support to it. The Seoul municipal government decided to build the line

on its own and obtained approval from the central government to do so in 1977. As a connecting mass transit to the Yeongdong district, which was still underdeveloped back then, was deemed most urgent, it was decided that the Gangnam section linking Guro, Sadang, Jamshil, and Shinseoldong should be constructed first instead of the Gangbuk section. The total length of the Gangbuk section was 35.4 km, including a siding track to the car depot, with some 13- km -long section being constructed as a surface or an elevated rail track.

In March 1978, the groundbreaking ceremony for the Gangnam section was held, followed in March 1979 by the construction of the Gangbuk section. The construction cost swelled as some sections that were originally planned to be elevated tracks were changed to underground tracks. Metro Line 2 shared the car depot of Metro Line 1, obliging the operator to choose the direct current, which is compatible to Metro Line 1. Its train sets were initially planned to be eight-car trains, but with the higher-than-expected population growth, they were changed in the middle of the construction to ten-car trains, prompting an improvised extension of the platforms to match the longer trains.

The tunnel boring construction method was introduced to the Metro Line 2 project on top of the conventional excavation-from-the-surface method. The tunnel boring method minimized the disturbance to the ground traffic while eliminating the cause of the civil complaints as the constructor did not have to tear down buildings on private lands. The tunnel boring method that was employed in the design and construction of Metro Line 2, however, was the conventional ASSM (American Steel Support Method).



<Figure 2-5> The excavation-from-the-surface method used in Seoul Metro Line 2

Following the opening of Seoul Metro Line 1, the number of subway passengers jumped, forcing the operator to purchase additional railcars. National Railroad Administration also had

to purchase additional railcars as it was converting the existing six-car train sets to eight-car train sets to meet the growing demand. By then, Daewoo Heavy Industry and Hyundai Precision Industry both had their own homegrown technologies for building railcars while the domestic manufacturers of railcar parts had sufficiently grown to produce chassis, bogie, and motor block, except for the core technology. Accordingly, all the railcars purchased for Metro Line 2 were produced by local manufacturers.

Unlike Metro Line 1, various passenger convenience facilities, such as toilets, air conditioners, and escalators, were installed in the stations of Metro Line 2, and the ventilation of the subway tunnels was accomplished by mixing the natural and motorized ventilation systems. Metro Line 2, whose construction Seoul City had led, saw the completion of its first-stage construction between Shingseoldong and Sport Complex on October 1, 1980, followed by the completion of the entire line in May 1984.

1.5 Construction of Seoul Metro Line 3 and 4

The population of Seoul had grown to eight million by the late 1970s while its commercial and residential areas sprawled rampantly along the hillsides, resulting in the highly packed development of the city center, which was barely over 6.4 ㎢ in size. The congestion in the city center was testing the limits of Seoul's roadway capacity, with the average cruising speed of passenger cars stalled at 10-15 km per hour, according to one survey. To address the overcrowding and congestion in the city center, Metro Line 2 was constructed to spread the traffic all over the city. Seoul's vision for the multi-core city, however, could not be realized in the short run.

Given the radial road system and the sprawling urban development of Seoul, Metro Line 2, which was designed as a belt line, could not solve the congestion or contribute to the balanced development of the city. The commuters from Sadang, Bongcheon, Seocho, and Yangjae, for instance, had to make a detour to a long route to the city center if they were to ride Metro Line 2, resulting in the limited use of the line. Hence, there was a need for Metro Line 3 and 4, which would pass the city center in a radial fashion. It was hoped that the commuters from the aforementioned areas would maximize the use of Metro Line 2 while at the same time increasing the overall share of the subway in the urban traffic.

In the early stage of the project, Seoul City considered involving private investors in the

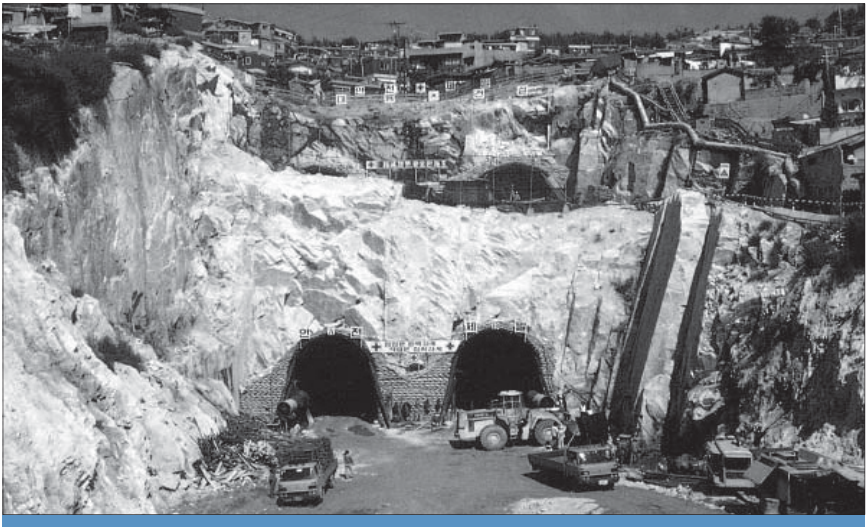
construction of Metro Line 3 and 4. Daewoo Group proposed a plan for the private construction project on the condition that 50% of the construction cost would be financed by low-interest soft loans, and that there would be a tax break in terms of the customs, corporate, and value-added taxes. The government approved the proposal in 1979 and announced the enactment of the Law for Promoting the Construction of Underground Railways. After seeing the need for the early completion of the project and the problems in providing fiscal support to it, the government changed the nature of the project to allow the participation of multiple contractors in it.

In February 1980, 23 companies joined forces to establish Seoul City Subway Construction Co., Ltd. The company started the construction after signing an agreement with the Seoul metropolitan government on the delegation of the construction and operation of the subway. The participating companies, however, hesitated to dedicate themselves to the project as they found various stumbling blocks along the way: the limited investment capacity of the participating companies, difficulty in supervising the construction because the shareholders were also contractors, and the limited profitability of a public project. The prospect of real estate development, one of the prime income sources for the private investors in the construction of urban railways, was not good either due to a government regulation to restrict the real estate investment by conglomerates. Seoul City thus changed Seoul City Subway Construction Co., Ltd. to a public corporation after obtaining a government approval for such in 1981. As a result, Seoul Metro Line 3 and 4 were built not by Seoul City's subway construction headquarters but by Seoul City Subway Corporation, which was later renamed "Seoul Metro."

Metro Line 3 was designed as a 34.2-km-long line that would connect Byukje-myun, Goyang-gun, Gyeonggi-do, located well past the city limits, to Yangjae-dong, Seoul. In the first-stage construction, a 28.9-km-long track connecting Shindo-eup, Goyang-gun, Gyeonggi-do, and Yangjae-dong, Seoul would be laid out. Metro Line 4 would connect Gwacheon-myun, Shiheung-gun, Gyeonggi-do, and Sanggye-dong, Seoul with a 37.5-km-long line, with the 30.3-km-long section between Sanggye-dong and Sadang Station being built first.

The proposed route of Metro Line 3 and 4 had to cross the old town as the streets there were quite narrow while the roadways were riddled with buildings on the surface and with pipes and cables underground. Moreover, as the Metro Line 3 and 4 passed under Metro Line 1 and 2, an even deeper excavation from the surface could aggravate the city's already deteriorating traffic. Furthermore, the poor geological quality of the construction site required additional buttressing to prevent a cave-in during the tunnel boring, which may incur cost overruns and may bring

about safety worries. To address these issues, the NATM construction method, a tunnel boring technology co-developed by an Australian and Japanese engineering firm, was introduced.



<Figure 2-6> Construction in the tunnel section of Seoul Metro Line 3

As Metro Line 3 and 4 crossed the city center with a combined track of 59.2 km, it required special attention during the construction to many complicated operational elements along the track. For a more scientific project management, a project management information system (PMIS) was introduced for the drafting of a comprehensive engineering roadmap, which was derived by carefully weighing the cross-relationship among the earthwork, construction, track, electricity, signal, and railcars. Thanks to this advanced project management method, the five-year-and-eight-month long project was successfully completed in 1985.

The competent authorities that governed the management of the subways during the construction of Metro Line 3 and 4 were as follows: Subway Operation Office, managing Metro Line 1; Subway Construction Headquarters, managing the construction of Metro Line 2, and Seoul City Subway Corporation, responsible for the construction of Metro Line 3 and 4. The unique structure of Seoul's subway authorities - that of being divided between construction and operation - raised concern about its low management efficiency. With the completion of Metro Line 2, the Subway Construction Headquarters was dismantled, and the management of the first-phase Seoul metro lines - Metro Line 1 to 4 - was entrusted to Seoul City Subway Corporation.

1.6 Construction of the Second-Phase Seoul Metro Lines

The massive debt incurred during the construction of the first-phase Seoul metro lines, coupled with the mounting loss due to the less-than-expected passenger turnout, emerged as a pressing social issue. Under such social circumstances, it was difficult to start a discussion on another round of subway construction. Fortunately, however, the number of subway passengers increased by 9-16% annually, thanks to the proactive sales efforts of Seoul City Subway Corporation, the worsening traffic congestion due to the rapid proliferation of automobiles, and the gradual acclimatization of the citizens to subway rides. Beginning in the late 1980s, the Seoul metro subway cars began to be crowded with passengers to an intolerable point.

With the urban traffic congestion still looming large as one of the most pressing social issues, all the presidential candidates in the 1987 election pledged to expand the city's subway network. With the sociopolitical circumstances ripe for another round of subway construction projects, the Seoul municipal government established a plan to build the second-phase Seoul metro lines. The second-phase lines would consist of four news lines totaling 145- and 15-km-long extensions of the existing lines. Moreover, Seoul Subway Construction Headquarters was set up to handle the construction. The office was staffed with Seoul city officials armed with subway construction experience, and with construction specialists on loan from Seoul Subway Corporation.

Despite the consensus on the need for the second-phase metro lines, the construction plan for all the lines had yet to be established due to the difficulty of lining up fiscal support for the project. Seoul City announced a plan to build a 15-km-long extension of the existing lines and a 32-km-long track of Metro Line 5 with a municipal budget in the first stage, followed by the second-stage construction of the remaining 113-km-long tracks on a long-term basis. With the exploding roadway traffic of over one million registered automobiles in Seoul in the 1990s, the government laid out a plan to support Seoul City in the construction of the new metro lines.

The plan specified that the 51.5-km-long track originally scheduled to be built in the long run would be completed by 1993, with the construction of the remaining tracks to be started right away, and that a fiscal line-up amounting to about 25% of the total cost would be guaranteed by the central government. The Seongnam section of Metro Line 8, however, would be financed entirely by the government as it was pursued as part of the government's metro city transportation scheme.

The second-phase Seoul Metro project expanded the use of the tunnel boring method to minimize the inconvenience of the Seoul citizens. The share of the tunnel boring method in the first-phase Seoul Metro lines was 16.9%, but it jumped to 49.3% in the second-phase lines. Moreover, for the sections that employed the excavation-from-the-surface method, the excavation and cover-up was done in a phased manner.

<Table 2-1> Construction method in the first- and second-phase Seoul Metro lines

(unit: km)

Line	Total Length	Excavation-from-the-Surface Method	Tunnel Boring Method	Overground Rails
First-phase Seoul Metro lines	124.5 (100%)	72.5 (58.2%)	21.0 (16.9%)	31.0 (24.9%)
Second-phase Seoul Metro lines	174.8 (100%)	81.4 (46.5%)	86.0 (49.3%)	7.4 (4.2%)

Source: Homepage of Seoul City Urban Infrastructure Office

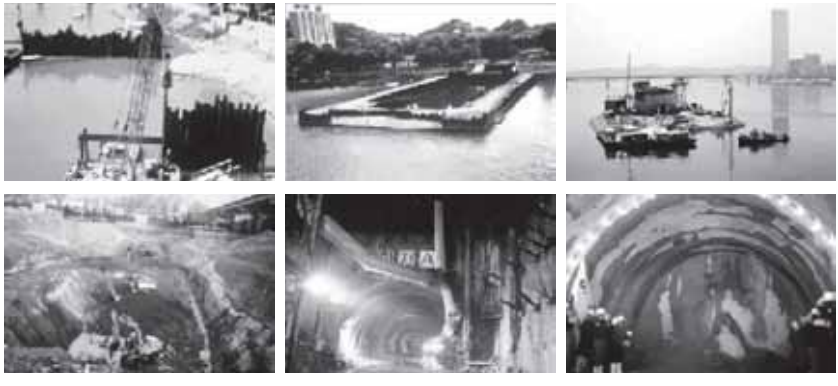
So as not to repeat the mistake of having invested excessively in the railcars that can run on both alternate and direct currents, the second-phase lines were designed from the outset without any consideration of a potential connection with the metropolitan railways. The electric system was designed in such a way that the extension of the lines at both ends of Metro Line 6, 7, and 8 would be possible, while Metro Line 5 and 8 and Metro Line 6 and 7 could be flawlessly matched up, respectively. The signaling system of the second-phase Seoul Metro lines employed an ATO type that allows unmanned operation, reducing the number of locomotive engineers to one from two.

The Yeoui Naru-Mapo Station leg of Metro Line 5 was designed to pass under Han River by boring a tunnel, but the local engineering firms had no experience in constructing underwater tunnels. The tunnel was to be 1,580 m long and was to be built 15-37 m below the riverbed. Even the foreign engineers were convinced that the construction was unlikely as the section is riddled with underground water and had a fragmental zone of faults. Despite all the challenges involved, the tunnel was built after six years of relentless construction, all with local technologies.

The Gangdong section of Metro Line 5 opened in 1995, followed by the opening of the Gangseo section in 1996, and the first stage of Metro Line 7 opened in 1996, followed by the second stage in 2000. Metro Line 8 opened its first- and second-stage sections, respectively, in 1996 and 1999, followed by the opening in 2000 of Metro Line 6, the last of the second-phase

Seoul Metro lines. Meanwhile, the Seoul municipal government established Seoul Metropolitan Rapid Transit Corporation in 1994 to manage the second-phase Seoul Metro lines, based on the results of an independent study that was conducted to decide the operating body of the second-phase Seoul Metro lines.

While a local government usually consigns the management of a rail to a single public enterprise, Seoul has two: Seoul Metro for the first-phase lines and Seoul Metropolitan Rapid Transit Corporation for the second-phase lines. What led the Seoul municipal government to choose the dual management system is the fact that the first- and second-phase lines have different levels of operation efficiency. The second-phase lines needed fewer operating staff than the first-phase lines as the Seoul Metro management was automated by employing the automatic fare collection and automatic train operation systems. Another reason for the separation of the management of the Seoul Metro rails is to free the second-phase lines from the massive financial burdens carried over from the building of Seoul Metro Line 3 and 4.



<Figure 2-7> Engineering stages of the underwater tunnel for Metro Line 5 built under the riverbed of Han River

1.7 Construction of the Third-Phase Seoul Metro Lines

To help prepare for the multi-core development of the city and the looming expansion of the greater metropolitan area, the Seoul municipal government proposed a plan for the third-phase subways that would permanently shift the balance of the public transportation to the urban rails. The construction plan, which included the construction of four new lines totaling 117- and 3-km-long extensions of Metro Line 3, aimed to serve the areas that were still underserved by the urban railways even after the completion of the second- phase metro lines. The Asian financial

crisis that hit the country in 1997, however, made it hard to finance the entire project. As a result, in 1998, the government recommended a comprehensive review of the third- phase Seoul Metro project to ensure the uneventful completion of the second-phase metro lines, leaving only Metro Line 9, which cuts across the Gangnam area east to west, and an extension of Metro Line 3, completed as envisioned in the original master plan.

For the first time in the history of the South Korean urban railways, Metro Line 9 operates the express train sets together with the slow trains that stop only at the key transfer stations, hence boosting the scheduled speed. Towards this end, siding tracks were laid out in a few stations, and to save on the project cost, mid-sized train sets with narrower bodies and shorter lengths compared to the existing train sets running in the Seoul subways were introduced. This decision, however, made it hard to operate the trains directly along the tracks of the new airport railway, which only operates large trains. Accordingly, it was planned that the transfer between the two lines be done on the same level as in Gimpo Int'l Airport Station.

Excluding the cost of building the superstructure and compensation for the affected lands, Metro Line 9 was partly financed by private investors in the construction of the first-phase tracks and stations, and through the acquisition of rolling stocks. As Metro Line 9 has plenty of transfer stations, the line's private operator cannot raise the fare arbitrarily. Furthermore, the current private operator was selected on the precondition that they would not change the current fare system. A private consortium including Hyundai Rotem was chosen as the operator and was given the right to run Metro Line 9 for 30 years after its opening in return for its investment in the rolling stocks and its construction of tracks and stations, which would amount to 53% of entire cost.

Metro Line 9, a privately funded project that started the construction of the first-stage leg (27 km) in 2001, opened to the public in 2009. The Yoido leg of Metro Line 9 consists of soft soil like sand and gravel while the key facilities, such as the National Assembly Building, Olympic Expressway, and other streams, are scattered along the line. To safely bore the 3.6-km-long tunnel, the shield tunnel boring method was employed. The construction engineers had to overcome various hurdles along the line with their own technology, especially in Express Bus Terminal Station, where the Gangnam underground shopping arcade and the existing Metro Line 3 posed some difficult engineering challenges. The second-stage (4.5 km) and third-stage (9.1 km) legs of Metro Line 9 are currently under construction, financed entirely by the government.

<Figure 2-8> A tunnel in Yoido of Seoul Metro Line 9 under construction

2. History of the Urban Railway Development in Regional Cities

2.1 Construction of the Busan Urban Railways

Busan, the second largest metropolitan city in the country, saw a jump in the traffic demand in the 1970s due to the continued growth of the population and of the economic activities in the region. The city's insufficient road system, however, soon revealed its limits in handling the passenger traffic and the freights being exported and imported via Busan Port. Accordingly, the Busan municipal government sought to develop a new urban transit system based on subways. In 1979, Busan City launched the Busan City Subway Planning Team under the urban planning bureau, and came up with the urban high-speed railway plan that included building five metro lines.

In 1980, a plan to build the 32.5-km-long track of Busan Metro Line 1 along Joongangro, the city's key traffic axis, was confirmed, followed by the launch of Busan Subway Construction Headquarters in January 1981. Busan Metro Line 1 was constructed in four stages, with the first stage (16.2 km) starting in June 1981 and completed in July 1985, and the final and fourth stage (6.4 km) starting in July 1990 and opening in July 1994.

As Joongangro was congested while passing the city center, the excavation-from-the-surface method was primarily used to minimize the holdup and the damage to the adjacent buildings. The excavated sections, however, had to pass the reclaimed ground and were located under the seawater, making it necessary to introduce the slurry wall method during the excavation for the first time in the country. Also for the first time in the country, mid-sized trains were introduced to

Busan Metro Line to maximize the economic feasibility, while their body was made of stainless steel, increasing the persisting period against the salts in the air and underground, and lowering the maintenance cost and dry weight.

<Figure 2-9> Inauguration of Busan Metro Line 1

The opening of Busan Metro Line 1 eased the congestion in Joongangro while the traffic along the other key inner streets of the city was continuously deteriorating. The massive debt incurred from building Metro Line 1, however, made it difficult to finance the construction of additional urban railways. To help relieve the financial burden of the city and to build more urban railways, the government established Busan Urban Transit Authority in July 1988 after the enactment of the Law on Busan Urban Transit Authority. The corporation set up a plan in 1990 to build Busan Metro Line 2, which would connect the eastern and western sides of the city. The construction of the first-stage leg (21.7 km) of the line started in November 1991 and was completed in June 1999 while the second-stage leg (16.3 km) was completed in August 2002, about eight years after the start of the construction in October 1994. In December 2001, the construction of the 8-km-long extension of Metro Line 2 to Yangsan-si, Gyeongsangnamdo started. It opened to the public in January 2008.

Following the opening of Busan Metro Line 1 and 2, the urban railway rose as the key public transit in the city, but the roadway congestion persisted as the share of the urban railway in the public transit remained below the 20% point. This was happening because the total mileage of

the urban railways was not long enough to cover the entire city. Therefore, the city embarked on a plan to build Busan Metro Line 3. The line was designed to complete the Busan urban railway network by connecting Metro Line 1 and 2 while at the same time establishing a metropolitan public transit network by connecting Gimhae Light Railway and Gyeongbu and Donghaenambu Line. A Y-type line consisting of two separate sections (Daejeo-Suyeong: 18.3 km; Minam-Anpyeong: 12 km), it was designed to accommodate both mid-sized trains and light railcars because by so doing, it would ensure economic feasibility even for the sections with a low traffic demand. The Daejeo-Suyeong leg of Metro Line 3 was completed in November 2005, about eight years after the start of its construction in November 1997.

As the Minam-Anpyeong leg of Busan Metro Line 3 was designed as a light railway, it was later renamed "Busan Metro Line 4." The first line in the country to have light railcars running on the track, its construction started in December 2003 and was finished in March 2011. The train set - named "K-AGT" - consisted of rubber-wheeled cars developed by domestic firms, with each train set consisting of six cars. A guide track is laid out in the middle of the main rails, and complete unmanned operation is possible along the line.

<Figure 2-10> K-AGT light railcars running on Busan Metro Line 4

Meanwhile, as part of the metropolitan area transportation scheme, the government studied the possibility of building light railways to connect the metropolitan city and its surrounding areas, followed by the decision in 1992 to build Busan-Gimhae Light Railway, the first pilot track that would connect Busan and Gimhae, the city located west of Busan. The project was intended

to be funded by private investors but saw an insufficient number of prospective participants. To stimulate the participation of private investors in the project, the government introduced the minimum revenue guarantee scheme, in which the local government is required to compensate the private investors for the difference if the actual revenue falls below 90% of the projected amount, as stipulated in the working agreement. As the actual number of passengers was projected to be lower than the initial estimate, debates raged on how to ease the financial burden of the local government, delaying the start of the construction to 2006 and the project completion to September 2011. The total length of the elevated track was 23.45 km, with steel-wheeled AGT train sets consisting of two railcars made running on the track. The railcars were made by Hyundai-Rotem.

<Figure 2-11> Railcars running on Gimhae-Busan Light Railway

2.2 Construction of Daegu Urban Railway

A single-core city, Daegu has most of its urban functions concentrated in the city center while all its roadways radiate to and from the downtown, resulting in the inevitable traffic congestion over the course of its urban development. The Daegu municipal government formed a subway planning team in September 1989, followed by the establishment in January 1991 of the Master Plan on the Construction & Operation of Urban Railways. The plan stated that three subway lines would be built in the first stage, followed by the construction in the second and third stages of three additional lines, including a belt line.

Daegu Metro Line 1, designed to connect the southwestern and eastern parts of Daegu via the city center, saw the start of construction in December 1991. On April 28, 1995, well into the full-fledged construction of the line, LNG gas leaking from a broken gas pipe flew into the Sangindong construction site through the sewer and exploded after being ignited by a still unconfirmed source, killing 101 persons and injuring 201. Following the tragedy, some parts of the subway structure were either demolished or retrofitted after the conduct of a safety inspection on the superstructure. The first 10.3-km-leg of Daegu Metro Line 1 opened to the public in November 1997, followed by the opening of the entire line (24.9 km) in May 1998. In 1996, in the middle of the construction, a decision was made to extend Metro Line 1 by 1 km. The construction was finally completed in May 2002.

On February 18, 2003, well after the opening of Metro Line 1, a 50-year-old demented man set a train on fire in Joongangro Station, killing 192 persons and injuring 148. It was a simple case of arson, but the absence of a subway safety management system combined with the inflammable materials used in the interior of the railcars worsened the accident by an order of magnitude. Thus, after the disaster, the government ordered the changing of the interior materials of the urban and metropolitan railcars to non-flammables, and tightened the safety standards of the urban railway.

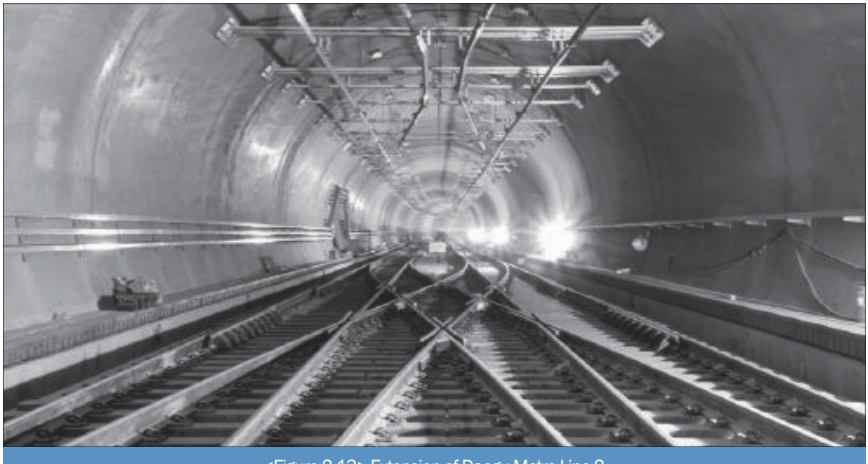
<Figure 2-12> Fire in Daegu Metro Line 1

Daegu Metro Line 2 was designed to connect the western and southeastern parts of Daegu via the city center, with many key roadways bustling with traffic crisscrossing the line. To relieve the congestion during the construction, the entire section crossing the city center was

constructed using the tunnel boring method, except for the exits and construction holes. Even when the excavation-from-the-surface method was employed, the sidewalks were narrowed while expanding the roadways to allow a smooth stream of traffic. As an elevated roadway was planned on top of Metro Line 2, an additional stress from the upper weight was factored in during the construction of the superstructure.

The contractors who would build Daegu Metro Line 2 were selected through an international bidding process while "turnkey base" bidding was introduced as well, in which the bidders were obliged to bid for both the design work and the construction. The construction started in January 1997 along the entire route of Daegu Metro Line 2, and the 28-km-long line was completed in October 2005. To apply the lessons learned from the disaster in Metro Line 1, the railcar bodies were made of stainless steel while the interiors and bottoms of the cars were fitted with non-flammable or highly flame-resistant materials. Moreover, to prevent the smoke from flowing into the stations in case a fire breaks out in the railcars or inside the tunnels, topnotch fire prevention technologies like the water screen were installed in the stations. Meanwhile, the city started the construction of a 3.3-km-long extension of Metro Line 2 to Gyeongsan-si, Gyeongsangbukdo in July 2007, which is targeted for completion in October 2012.

Daegu Metro Line 3 was designed as a monorail-type light railway that will connect the northwestern and southeastern parts of Daegu via the city center. As train sets consisting of three railcars each will be running along the elevated monorail tracks, its construction cost is estimated to be much lower than that of the subways. The construction started in July 2009 along the entire route, and is targeted for completion in 2014.



<Figure 2-13> Extension of Daegu Metro Line 2

2.3 Construction of Incheon Urban Railways

A single-core city with an about 2.5 million population that had grown along the port, Incheon was evolving into a multi-core city due to the proliferation of housing projects and industrial complexes. Moreover, thanks to the city's geographic proximity to Seoul, the demand therein for metropolitan transit was also growing. Despite this, Gyeongin Expressway and Gyeongin National Railroad, the two key transit axes of the city, were laid out along the east and west axes to enhance the city's linkage with Seoul. As a result, the traffic had grown congested in the new towns built in Gyeyang-gu and Yeonsu-gu, which are located off the main transit axes.

The Incheon municipal government planned to build the Gyulhyeon-Dongmak leg of Incheon Metro Line 1 (total length: 24.6 km; commercial operation: 21.9 km), with an aim to reconnect the northern and southern parts of the city divided by Gyeongin Line, while at the same time easing the congestion in the city center by rerouting part of the traffic concentrated on the surface to the underground. Unlike the Seoul subways, the railcars of Incheon Metro Line 1 were mid-sized trains, each made up of eight cars.

The construction of the planned section of Incheon Metro Line 1 was started in 1993 and was completed in 2005, but in the process of its construction, the construction of Gyeyang Station in the Airport Railway was confirmed. To allow transfers at Gyeyang Station between Incheon Metro Line 1 and the Airport Railway, the construction of the 1.3-km-long extension of Metro Line 1 started in December 2002, before opening to the public in March 2007. In addition, to provide rail services in Songdo International Business District, a 6.5-km-long extension between Dongmak and Songdo International Business District was added to the line after construction between January 2003 and June 2009.

Meanwhile, Incheon City has been building Metro Line 2 (29.2 km) to cope with the growing traffic in Geomdan New Town northwest of Incheon as well as with the traffic in the old city center. Steel-wheeled light rail trains, each consisting of two cars, will be running on the track driven by an autopilot. Metro Line 2 is targeted to open to the public in 2014.

On the other hand, it was proposed that a new railway be constructed to ease the overcrowding of Gyeongin Line as well as to connect the cities west of the metropolitan area and the Gangnam district in Seoul. Accordingly, a plan to extend Seoul Metro Line 7 up to Incheon-si and Bucheon-si was set up so that the passengers can travel directly to the Gangnam district while

avoiding a detour along Gyeongin Line. The 10.2-km-long extension between Onsu Station and Bupyeong-gu Office Station is targeted to open to the public in late 2012, about seven years after the start of its construction in 2005.

Incheon City has been working to build an urban maglev test track as part of the national research and development endeavor. A 6.1-km-long test track connecting Incheon International Airport and its surrounding areas, it is targeted to open to the public in late 2013, about three years after the start of its construction in 2010. The maglev train, designed with homegrown technologies, can cruise up to 110 km/h without making noise and without any vibration, thanks to the levitation of the train set. There are only two maglev trains that are currently under commercial operation: a German-developed high-speed maglev train running between Shanghai Pudong International Airport and the new town center, and a low-speed Japanese maglev train running in Nagoya. All the urban maglev trains developed in the country are low-speed trains, and the test track was built in the region to publicize the excellence of the domestic technologies as well as to help support the development of the areas surrounding Incheon International Airport.

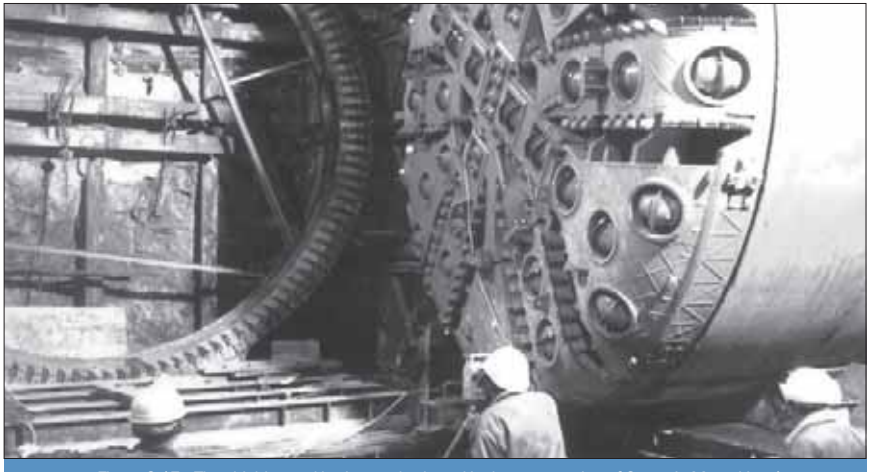
<Figure 2-14> Construction of the Incheon Metro Line extension to Songdo

2.4 Construction of Gwangju Urban Railways

Urban transportation rose as one of the pressing concerns in Gwangju as the city merged with Gwangsan-gu and Songjeong-si in 1988, and the growing number of automobiles and

the subsequent rise in the traffic in the city center added more worries. To address the issue, the city pushed for TSM (traffic systems management), but simply supplying more roads soon revealed limitations, prompting the city to consider the construction of urban railways. The city established a master plan for the construction and operation of Metro Line 1 and 2, which was approved by the government in March 1994.

It was hoped that Gwangju Metro Line 1, designed to connect the eastern and western parts of the city via the city center, would ease the traffic congestion in the downtown and would help promote the balanced growth of the city. The tunnels of Gwangju Metro Line 1 had to pass below the underground malls and packed buildings in the city center. To prevent cave-in or cracks, a shield tunnel boring machine with a 7.38-m-radius shield attached to it, the largest in the history of South Korean construction, was used. In the Dosan and Pyeongdong Station leg where the tunnel crossed under the Honam Line national railroad, a construction method that minimized the sinking of the earth was used for the first time in the country.



<Figure 2-15> The shield tunnel boring method used in the construction of Gwangju Metro Line 1

To improve the maintenance efficiency, railcars made by Hyundai-Rotem were purchased on the precondition that the key parts of the train sets should be localized. The railcar bodies were built with aluminum for the first time in the country, making them tightly sealed and about 20% lighter than the conventional trains.

To ensure the safety of the passengers, various firefighting equipment and emergency power supply units were installed, and the subway platforms were monitored by closed-circuit

television cameras. In case a fire breaks out, the ventilators installed between the platforms and the tunnel would be turned on to effectively suck out the smoke, and the air curtains would block the smoke blowing from the fire in the tunnel. In some stations, artworks were installed and spaces for exhibitions and small-scale performances were created, turning the stations into cultural arenas.

The first-stage leg between Nokdong and Sangmu Station (11.96 km) was scheduled to be completed by July 2002, about six years after the start of its construction in August 1996, but its opening was delayed to April 2004 in the wake of the Asian financial crisis. The second-stage leg between Sangmu and Pyeongdong Station (8.14 km) opened to the public in April 2008, about eight years after the start of its construction in April 2000.

2.5. Construction of Daejeon Urban Railways

Daejeon City saw continued population growth, thanks to some massive housing projects and the subsequent changes in the urban environment until the city's administrative district was expanded in 1995. The growing local economy, coupled with the rising personal incomes, triggered an explosion of registered vehicles as well as an expansion of the urban area, which brimmed with a variety of activities. The subsequent rise in urban traffic caused some serious problems throughout the city, including congestion, parking headache, and difficulty in using the public transit. Such problems were weakening even the city's core functions, and the expansion of the city was worsening the problems even more as it attracted new traffic. Accordingly, Daejeon City pushed for a public transit policy centered on the subway and light railway, which transport a massive number of people punctually, safely, and speedily. By shifting the focus of the transport system to mass transit, it was believed that the roadway traffic was successfully absorbed and that the problems related to the city's urban transportation were solved.

In February 1996, Daejeon City announced a master plan to build its own urban railway network composed of five lines totaling 102.3 km. Daejeon Metro Line 1 was designed as a 22.6-km-long line connecting the old and new town centers. The line was scheduled to be completed by 2003, about seven years after the start of its construction in October 1996. The opening date was pushed back, however, due to a series of obstacles: the financing difficulty in the wake of the Asian financial crisis, the civil complaints against the construction, and the insufficient construction time due to the procrastinated negotiations for compensation. In

March 2006, the first-stage leg connecting Panam and Government Complex Station (12.4 km) opened to the public, followed by the opening in April 2007 of the second-stage leg connecting Government Complex and Banseok Station (10.2 km). To ensure the safety of the passengers, screen doors were installed in all the stations of Daejeon Metro Line 1.

<Figure 2-16> Screen doors installed along the platforms of Daejeon Metro Line 1

3. History of the Metropolitan Railway Development in the Greater Seoul Area

3.1 Retrofitting the Existing Railways

The government set up a plan to electrify the metropolitan railways in a move to ease the congestion in Seoul and to expand its urban reach while at the same time spreading the urban population to the other surrounding areas. In 1968, construction to upgrade the Yongsan-Seongbuk leg of Gyeongwon Line (18.2 km) to an electrified double-track line started, followed by the completion in May 1971 of the Cheongryangri-Seongbuk leg and of the Yongsan-Cheongryangri leg in December 1978. The Seongbuk-Uijeongbu leg (13.1 km) was also upgraded to an electrified double-track line in 1982, to spur urban development and ease the congestion east of the metropolitan area. The entire Gyeongwon Line opened to the public in September 1986, pushing up the track capacity from 28 to 246 runs a day. By late 2006, the line had been upgraded all the way up to Dongducheon.

Gyeongbu Line, the country's key trunk line, suffered from a chronic rail capacity shortage as the rails were shared by the metropolitan trains running on the Seoul-Suwon leg as well as the intercity trains running along the Seoul-Busan axis. It was concluded that double-tracking alone

would not be able to cope with the transportation demand in the 1980s as the traffic between Seoul and Suwon was rapidly growing. Thus, a project involving upgrading the 32.3-km-long section to a four-track railway was commenced. The upgrade was completed in December 1981, about four years after the commencement of the project, dramatically increasing the number of train operations and thus improving the quality of passenger service. By 2005, the Suwon-Cheonan leg was upgraded to four-track rails, allowing the metropolitan trains to run all the way down to Cheonan.

<Figure 2-17> Six-track section of Gyeongbu Line

The Seoul-Guro leg of Gyeongbu Line was designed as four-track rails to allow the passage of both the intercity and metropolitan trains. With the continued rise of the demand for metropolitan railways, however, it became necessary to expand the line's rail capacity. In July 1988, construction to upgrade the 11.7-km-long Seoul-Guro leg to six-track rails started, but its completion was pushed to 1995 due to the difficulty in building a rail bridge over Han River and the lack of fiscal support. After the upgrade, the rail capacity of the Seoul-Guro leg jumped two fold to 576 a day from 288.More than three million people had settled down in Incheon and Bucheon, cities located east of Seoul, pushing up the metropolitan traffic to and from Seoul. While the trains running on Gyeongin Line got increasingly crowded with passengers, the peak number of train operations allowed for the line was limited by the insufficient rail capacity. To ease the gridlock, the government started construction in 1991 to upgrade the 27-km-long Guro-Incheon section to four-track rails, with the Guro-Bupyeong leg completed first in 1999, followed by the opening of the entire track in 2005. Since the completion of the upgrade, local and express trains have been running on their respective tracks. Gyeongin Line is the only line in the country that has tracks dedicated to express trains.

<Figure 2-18> Local and express tracks of Gyeongin Line

Mainly intercity trains ran on Joongang Line, but a series of housing projects built in the northeastern part of the metropolitan area since the 1990s worsened the congestion in Guri-si and Namyangju-si. To ease the congestion, a project to upgrade Joongang Line to electrified double-track rails was commenced. In December 2005, trains started to run on the Cheongryangri-Deokso leg, followed by subsequent extension to Yongmun Station.

The government reviewed the feasibility of upgrading Gyeongui Line to electrified double-track rails in 1989 as part of the transportation initiatives following the development of Ilsan New Town. Only Ilsan Line, however, was eventually built. The project was delayed several times, but the construction eventually started in 1999. The construction was suspended once, however, as the residents of Ilsan requested that Gyeongui Line be buried underground. The construction restarted in 2005 after the residents' agreement to the overground railway, followed by the opening of the Munsan-DMC leg in 2009. The existing Gyeongui Line had connected Seoul and Munsan Station, but the line was redrawn to connect Yongsan and Munsan Station over the course of the upgrade. The line has yet to be connected to Yongsan Station.

Gyeongchun Line opened in 1939 as a single-track rail connecting Seoul and Chuncheon, the central city of Gangwondo. Owing to the continued urban expansion of Seoul, part of the line crossing the city was removed. With a series of housing projects built in the northeastern part of the metropolitan area, however, the line was upgraded to double-track rails in December 2010, roughly a year after the start of the construction in 1999, providing metropolitan rail services in the area. The Mangwoo-Maseok leg of the line is a metropolitan rail and was financed by the local government, whereas the Maseok-Chuncheon leg is a national railroad and was financed

entirely with fiscal support. ITX-Cheongchun trains, the country's first double-deck express trains, are running on the line, as well as the local trains that stop at every station. The ITX-Cheongchun trains stop only at the key stations, and the fares are charged according to the national railroad fare system.

<Figure 2-19> Double-deck express train running on Gyeongchun Line

3.2 Construction of New Metropolitan Lines

To promote the development of Ansan, a rising new industrial city in the southwestern part of the metropolitan area, and to improve the city's transit connection with Seoul, construction of the 20-km-long Geumjeong-Wongok section of Ansan Line started in February 1986 and was completed in October 1988. The project was entirely financed by Korea Water Resources Corporation - recently renamed "K Water." Ansan Line was directly connected with Gyeongbu Line at the time of its opening, but it was reconnected with Gwacheon Line in 1993. The line effectively satisfied the rapidly growing demand for transit in Ansan-si and its surrounding areas and has since been extended to Oido Station, located in Siheung-si.

After the plan for large-scale housing projects in Pyeongchon and Sanbon was confirmed in 1988, the construction of Gwacheon Line, a 15.7-km-long double-track metropolitan railway connecting Geumjeong and Sadang, started to improve the transit connection with Seoul from these areas. The Geumjeong-Indeokwon leg opened first in 1993, followed by the opening of the entire line. Gwacheon Line was originally designed to be compatible with Seoul Metro Line 4, but in terms of the train operation mode and electric current[3], it was quite different therefrom.

3) Gwacheon Line: Cruising to the left on a 25,000 V alternate current; Seoul Metro Line 4: Cruising to the right on a 1,500 V direct current

As the operators of both lines failed to come up with a compromise, an X-type crossing tunnel was built in the Namtaeryeong-Seonbawi section, where the two lines are linked, and train sets capable of running on both alternate and direct currents are running along the two lines. The trains momentarily disconnect the power whenever they pass the rail link here.

Ilsan Line was built to provide transit services to the residents of Ilsan and Goyang by connecting Seoul and Ilsan New Town. The line was built between 1991 and 1996. As Ilsan New Town and Gupabal Station, the terminal of Metro Line 3, were located at different latitudes, Ilsan Line had to detour along the Seosamneung and Seooreung areas via Muakjae, lowering its transportation efficiency and competitive edge. Its over 560 billion won construction cost was financed by Korea Land Corporation (renamed "Korea Land and Housing Corporation"), and rolling stocks were purchased by KORAIL, the operating body, with a budget of 43.4 billion won. As Ilsan Line was designed as an extension of Seoul Metro Line 3, trains run on a 1,500 V direct current while keeping to the right, the first time for KORAIL trains.

<Figure 2-20> KORAIL and Seoul Metro trains running on Ilsan Line

After the plan for the development of Bundang New Town was confirmed, Bundang Line, connecting Bundang and Wangshimni, was designed to improve the city's transit link with Seoul. The first-stage section of Bundang Line between Suseo and Ori (18.5 km) was built between 1990 and 1994. The commuters had to transfer to Seoul Metro Line 3 at Suseo Station, however, to go to the city center. The line was extended to Seolleung Station in 2003, making it much easier to access the city center by transferring to Metro Line 2. A further extension of the line to Wangshimni Station is currently under way. The line was also extended to Giheung, Yongin-si to handle the metropolitan traffic south of Bundang, and a further extension to Suwon is currently under way. Out of the nearly 733 billion won total construction cost, 682.7 billion won was financed by Korea Land Corporation, the competent body responsible for the development of

Bundang New Town.

Shin Bundang Line was constructed to improve the service level of the metropolitan railway in the Bundang area by directly connecting the Gangnam district in Seoul to Pangyo, a new town built in Seongnam-si, as well as complementing the weakness of the existing Bundang Line. The planned speed of Bundang Line is barely over 40 km/h, and the line turns a lot, lowering its competitive edge in terms of connecting the Bundang and Gangnam districts. Therefore, Shin Bundang Line was designed to have only six stops within the 18.5-km section between Gangnam and Jeongja Station, pushing up the line's planned speed to 62 km/h. As the line was financed through the BTO (build-transfer-operate) method, where private investors shoulder over 50% of the project cost, and as much of the fiscal support was also paid for by the new-town developer, the financial burden of the local government was quite low. Shin Bundang Line, built between 2005 and October 2011, has train sets consisting of six cars running on the track, which are autopiloted via CBTC (communication-based train control). To ensure safety, however, a safety staff qualified to drive the train is always aboard the train. A privately funded project to extend the line northward to Yongsan Station and southward to Suwon Station is currently under way.

<Figure 2-21> Unmanned train operation system of Shin Bundang Line

Meanwhile, the introduction of rapid railways along the key metropolitan transit axes, where trains can cruise with a speed over two times faster than that of the conventional metropolitan railway, has been suggested beginning in 2008. The rapid metropolitan railway is a new type of

metropolitan rail system designed to accommodate EMUs (electric multiple units), which are to cruise up to 180 km/h along the tracks built some 40 m below the surface, with the maximum speed allowance of 200 km/h and a station interval of 7 km. If introduced, the rapid metropolitan railway is expected to significantly reduce the travel time between Seoul and its key satellite cities.

Chapter 3.

Urban Railway Development Policies in South Korea

1. Governance of Urban Railway Development

1.1 Urban Railway Governance in the 1970s

The urban railway, called "underground railway" back in the 1970s, was classified as a private railway as the local government assumed the responsibility for its construction. To build a private railway according to the Law on Railroads, a license must be obtained from the Ministry of Transportation, and the construction and operation of the urban railway had to be done according to the other relevant ordinances and regulations, as specified in the Law on Railroads. On the other hand, the Law on Urban Planning classified the underground railway as a "high-speed railway"[4] making it mandatory to proceed with the administrative works pertinent to the construction according to the said law. Accordingly, the Urban Bureau of the Ministry of Construction approved the Seoul City Underground Railway Construction Plan submitted by the Seoul metropolitan government in March 1971, when it obtained the required number of votes from the Central Urban Planning Committee. The project had to obtain another license for electric railway operation from the Ministry of Commerce, as well as the approval of the Ministry of Construction to reclaim the "public water surface" for the car depot, and to install an in-car radio station.

4) Facilities, as stipulated in the Law on Urban Planning, are divided into railroad and high-speed railway, with the underground and elevated railways classified as high-speed railways. Railroads, however, were reclassified as regular, high-speed, and urban railways during the construction of Seoul-Busan High-Speed Railway, to prevent confusion in terminologies.

<Table 3-1> Regulatory process with regard to the construction of Seoul Metro Line 1

Category	Content	Governing Body	Date
Urban planning	Decision on the facility	Ministry of Construction	March 1971
	Approval of the working plan	"	May 1971
Private railroad	Operation license	Ministry of Transportation	September1971
	Approval of construction	"	December 1971
Electric railroad	Operation license	Ministry of Commerce	February 1972
Public water surface	Approval of reclamation	Ministry of Construction	January 1971
Communication duct	Construction agreement	Ministry of Communication	December 1971
In-car radio station	Approval of installation	Ministry of Construction	November 1973

The Ministry of Transportation enacted the Regulation on the Construction of Seoul Metro Line 1 in 1974 as well as the Rules on the Operation of Seoul City Subway in 1977, according to the Law on Railroads. During the construction of Seoul Metro Line 1 project, no technological standard was in place in the country with regard to subway construction. Accordingly, the project followed the rail track design standards enforced in Europe and Japan then, with the country's own subway construction regulations enacted later, by modifying and complimenting them.

Seoul City, as the competent authority responsible for the execution of the project, established Subway Construction Headquarters, staffed with 29 officials, in 1970, well before the groundbreaking of Seoul Metro Line 1, followed by the enactment of the Ordinance on Special Accounting for Seoul City Subway Construction in late 1970, providing a legitimate ground for financing the project. In June 1973, the role of Subway Construction Headquarters was reinforced when it was made to assume the “operation system” under its capacity on top of the “construction system.” In June 1974, near the completion of the construction, the Ordinance on the Seoul City Subway Operation was enacted based on the Law on Regional Public Corporations, stipulating the details regarding the management and operation of the subway. Based on the ordinance, the Rules on Special Accounting for Seoul City Subway Operation was enacted in August 1974. Seoul Metro Line 1 has been managed by Subway Sales Bureau since its inauguration.

1.2 Urban Railway Governance in the 1980s

To spur the building of underground railways and to thus ease the traffic congestion in the cities and their surrounding areas, the government enacted the Law to Promote the Construction of Underground Railways in 1979. The law concerned the underground railways built by the central and local governments, KORAIL, or other corporations. It stated that local governments should obtain approval from the Minister of Transportation before setting up an urban development plan involving the construction of an underground railway, and that the routes of underground railways should be designated by the Ministry of Transportation. In addition, the Ministry of Construction was required to report its decision regarding the urban development plan to the Ministry of Transportation. As a result, the regulatory procedure regarding the construction of urban railways, which was formerly under the control of the Ministry of Construction, was effectively handed over to the Ministry of Transportation.

The aforementioned law stated that if an underground railway project is granted approval based on the Law to Promote the Construction of Underground Railways, the project should be assumed to have been automatically granted approval for operation as well by the Law on the Appropriation of Land. The law also listed ways to finance the construction of underground railways as well as rules on issuing and buying underground railway bonds. It also stipulated that when needed, the central government can subsidize the project or lend money to the builders of an underground railway.

As indicated in its name, the Law to Promote the Construction of Underground Railways focused on the construction of underground railways. With the opening of Seoul Metro Line 1, 2, 3 and 4, however, the government shifted its focus to the operation of underground railways by enacting in 1986 the Law on the Construction and Operation of Underground Railways, which it hoped would enhance the operation efficiency of railways. The law stated that the construction of an underground railway by a local government should be preceded by the creation of a master plan on the construction and operation of the railway. According to the law, the operation and construction of an underground railway is supposed to be planned in advance and approved by the Ministry of Transportation.

When a local government plans to establish an underground railway corporation, it is required by the aforementioned law to discuss the plan in advance with the Ministry of Transportation. Further, according to the law, the transfer, merger, suspension, or closure of the operation of a corporation with a license to operate should also be approved by the Ministry of Transportation. It also states that the Ministry of Transportation can order the operators of an underground railway to modify their management plan, fare, and train operation schedule to improve the urban traffic flow. This rule was intended to ensure the stable provision of convenient transit services to the public by tightening the supervision of the operators of underground railways.

Underground railway bonds, previously "underground railway construction bonds," which were originally issued to finance the construction of underground railways, can also be issued to finance the operation of an underground railway.

1.3 Urban Railway Governance in the 1990s

In 1990, the Ministry of Transportation announced that it would build subways in the country's six major cities to solve the urban transportation problems therein, while recommending the construction of light rails to ease the congestion between the central city and the surrounding cities. Instead of enacting a separate law custom-made for every new urban railway project, the single consolidated regulatory system would henceforth oversee the country's urban railway projects. The Law on the Construction and Operation of Underground Railways was replaced by the Law on Urban Railways in 1990 to include light rails as well as the conventional underground railways.

The Law on Urban Railways redefined "urban railway" to include urban transit with dedicated tracks such as monorail, as well as railways including underground railways located in the vicinity of the urban transit network. To promote the construction of urban railways and to improve their management efficiency, the builders of urban railways were allowed to push for the commercial development of a "railway station sphere" within a given radius spreading from the station. The profits from the development would be used to finance the construction and operation of another urban railway. If an urban railway builder intends to use the

underground space of someone else's land to construct an urban railway, the legal grounds of the compensation for the underground space and for the expropriation of the land were clarified so that adequate compensation could be given depending on the value and depth of the land.

The Rules on the Construction of Urban Railways was established as the supporting ordinance to the Law on Urban Railways. Before, each city had its own regulatory provisions on the construction of an urban railway, with numerous duplicates strewn across similar laws, thereby complicating the construction process as each new set of rules had to be enacted every time a new urban railway was to be built. By consolidating all these regulations into a single unified law, the complication was resolved. The law stipulated only the minimum requirements, those in need of national standardization, such as safety standards, and left the other particulars of railway construction at the disposal of the mayor or governor who will oversee the urban transit network. Thus, the law still made room for the possibility of regional variations in the regulations while at the same time streamlining the regulatory process of urban railway construction.

The government advised that the third-sector development alternative be opted for to lighten the fiscal burden carried over from building the metropolitan subway network, where a local government and private investors can jointly build and operate a light railway. In 1994, the Law to Promote Private Investments in the Social Overhead Capital was enacted to systematically push for private investment in public projects. Backed by this policy, a few projects, including Busan-Gimhae Light Rail, had been designated as privately funded projects, but the project suffered from low interest before stumbling upon the Asian financial crisis. The government, however, kept tempering with the supporting policy to further stimulate private investment. The year 1999 saw the introduction of the minimum revenue guarantee scheme, in which the local government is required to compensate the private investors for the difference if the actual revenue falls below 90% of the projected amount, as stipulated in the working agreement. Since the introduction of the scheme, light rails have been built in Gimhae, Yongin, and Uijeongbu. As unexpected problems began to surface in the 2000s with regard to the MRG scheme, the MRG for the projects proposed by private investors was first rescinded in 2006, followed by the abolition of MRG in 2009 for projects that were privately funded

but were still initiated by government notice.

Busan-Gimhae Light Rail

Yongin Light Rail

<Figure 3-1> Examples of privately funded light rail

In 1997, the government enacted the Special Law on Metropolitan Transit Management to effectively tackle, with a wider perspective, the mounting traffic problems in the metropolitan area, which had been caused by the new satellite cities sprouting around the greater Seoul area. According to the law, the developers of large-scale housing projects were obliged to shoulder the cost of metropolitan transit revamp while the tax levied in this way was to be invested again in various metropolitan transit projects, including metropolitan railways. The central government usually assumed the management of metropolitan railway projects, and the share of the government's fiscal support for those projects was higher than that for urban railway projects. The metropolitan railways built by the central government are currently being managed by KORAIL.

1.4 Governance in the 2000s

In 1999, the government introduced the "preliminary feasibility study"[5] rule targeted at large-scale public investment projects to assess their policy initiative and economic feasibility as well as to suggest effective and realistic ways of executing the project. The rule is applied to projects that cost over 50 billion won in total investment and that receive over 30 billion won in fiscal support.

5) The main framework of the rule was established in 2006 with the enactment of the National Finance Law

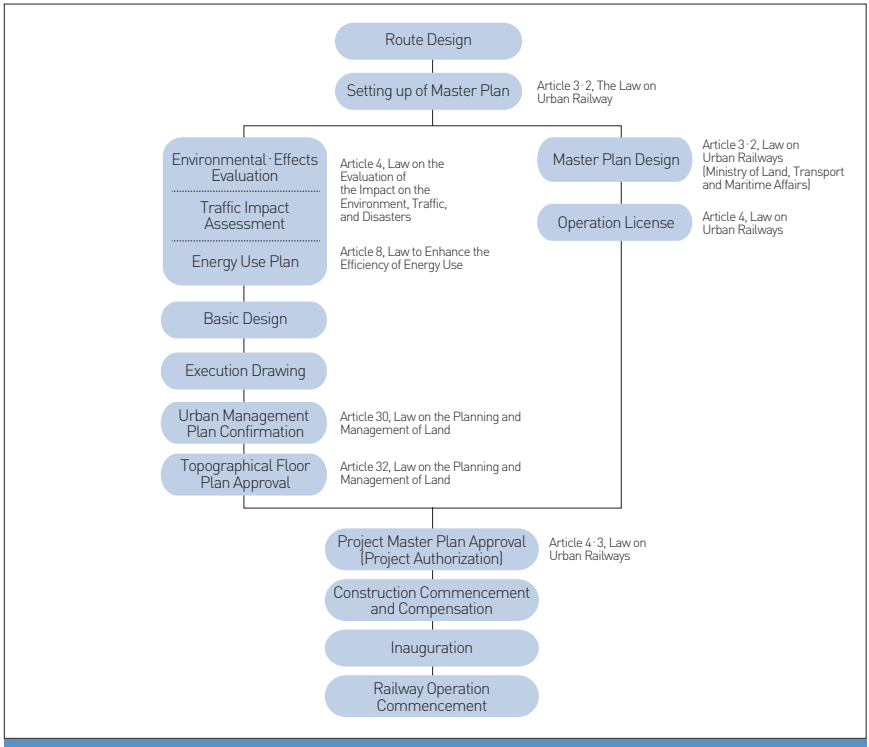
The preliminary feasibility study was earlier performed by the local government, but it tended to overestimate the demand and economic viability. To address this issue, the central government, particularly the Ministry of Strategy and Finance, assumed the responsibility in 1999 for a more objective evaluation of the projects and so that efficient fiscal support could be obtained from Seoul. Accordingly, the decision regarding whether an urban railway project should be pushed ahead with would also be made by the Ministry of Strategy and Finance.

Ministry of Land, Transport and Maritime Affairs approves the construction and operation of the master plan of an urban railway for those projects that passed the feasibility test. During the approval process, the ministry can request for the fine-tuning of the project across a broad range of issues, such as the design of the line, the railway system, and the construction cost. As approval is granted, however, without enough preliminary consultation, the central government can involve itself in the process only to a certain extent.

Urban railway projects were usually conducted by the offices of local governments and local public corporations. Seoul Metro Line 9 and Busan-Gimhae Light Rail, however, which opened in 2009 and 2011, respectively, were both built and operated by private investors, and since then, the construction and operation of urban railways by the private sector has gained momentum. Light rail projects led by private investors have constantly been pushed ahead with of late, mostly in Seoul.

The metropolitan railways are mostly national railways built by Korea Rail Network Authority and operated by KORAIL. New Bundang Line was built, however, and is being operated by a private enterprise as the project was funded privately tagged with a BTO (build, transfer, and operate) option.

Consequently, an urban rail project that would receive more than 30 billion won in fiscal support from the central government should pass the preliminary feasibility test before it can be pursued in earnest. Once the project is deemed feasible, the head of the concerned metropolitan government should draft a master plan for the proposed lines before the project can be approved by the Ministry of Land, Transport, and Maritime Affairs, and before an operating license can be granted.



<Figure 3-2> Flow of an urban railway project

2. Urban Railway Development Strategy of South Korea

2.1 Service Route Design Strategy

In the late 1960s, when Seoul's subway was still in the planning stage, the city's commuting radius was already growing wider with the development of the city's outskirts, while the demand for urban transit jumped, spurred by the population growth. The growth of automobiles also outpaced the growth of the population in the 1970s. The roads back then, however, spread out from the city's hub like the spokes of a wheel, worsening the traffic in the city center even more. To ease the congestion of some crowded roadways in the city center, the subway development in the 1970s focused on building lines that reached the urban outskirts after penetrating the city center. Accordingly, Seoul Metro Line 1 was built along the Seoul Station-

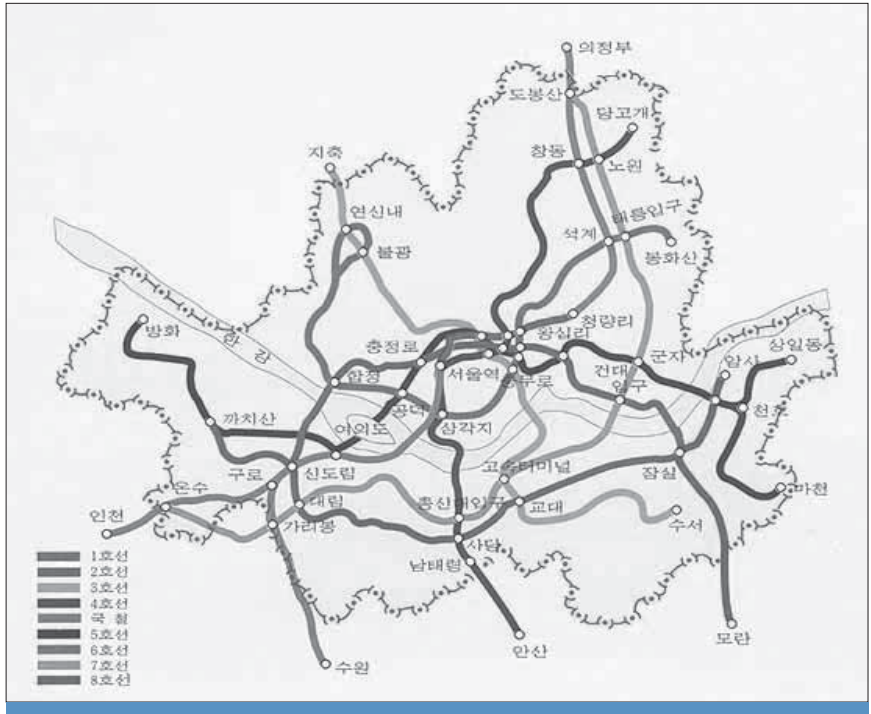
Cheongryangri transit axis, the most congested section in Seoul, which was again connected with the existing railways in the greater Seoul area after their revamp and electrification, helping the city cope with the ever-growing commuting radius of its residents. Among the first-phase lines, Seoul Metro Line 3 and 4 were designed to penetrate the city center in an attempt to boost the transportation efficiency of Seoul Metro Line 2. The same principle was applied to the route designs of Busan Metro Line 1 and 2 and Daegu Metro Line 1 and 2, as all the lines penetrated their respective city centers.

<Figure 3-3> Daegu Metro routes

The urban development strategy of the country's metropolitan cities was shifting from single- to multi-core development, which aims to develop multiple subcity centers around the city. In the process, urban railways were built in a way that effectively connected such subcity centers. Seoul, for instance, consisted of three cores: the old urban center, which was responsible for the key functions; the Yeongdeungpo district for business and finance; and the Yeongdong-Jamshil district for housing and residence. The centerpiece of this revamped scheme was Metro Line 2, a belt line that would connect Seoul's three urban cores. Among the railways that were built in the local metropolitan cities, Incheon Metro Line 1 was built along the north-south axis to effectively connect the new housing projects in Gyeyang-gu and Yeonsu-gu, as opposed to the existing east-west urban development axis. Daejeon Metro Line 1, however, was designed to connect the old and new city centers along

the east-west axis.

In the metropolitan areas, the expansion of the central city often triggered an explosion of housing projects in the surrounding cities. To handle the subsequent increase of the metropolitan traffic between the central and surrounding cities, the existing metro lines were extended. In the greater Seoul area, Seoul Metro Line 7 and 8 were extended to Gwangmyeong-si and Seongnam-si, respectively. Seoul Metro Line 7 is currently being extended again to Bucheon and Incheon. Meanwhile, Seoul Metro Line 3 and 4 were connected to Ilsan and Gwacheon Line, respectively, both metropolitan lines, boosting the urban development of Ilsan and Pyeongchon New Town. Among the railways in the local metropolitan cities, Busan Metro Line 2 was extended to Yangsan-si while Busan-Gimhae Light Rail was jointly built by the two cities to enhance their connection. In Daegu-si, Metro Line 1, which is currently in operation, is being extended to Gyeongsan-si.



<Figure 3-4> Seoul Metro lines and their connections with the surrounding cities

The urban railway network was continuously expanded in the city for a more

comprehensive service coverage. Seoul Metro Line 2, for instance, was built over a long distance to pass the areas that had been unserved by Seoul Metro Line 1. Despite the many turns along the line, the number of regions within the city that are served by the urban railway jumped dramatically. The same strategy was applied to the construction of metro lines in Busan and Daegu. Even today, the country's metropolitan cities keep working on new projects to expand their service coverage. As the areas that will be covered by the new lines, however, are relatively less populated and low in traffic, light rails are planned to be built for them.

2.2 Designing Systems Optimized for the Demand

The urban railway project demands massive investment, making it crucial to design the scale of each project in such a way as to optimize it for the demand. Especially in the case of subways, where the stations are built underground, the optimization of the station capacity according to the demand was even more critical as it cost a huge sum. For the urban railways built in Seoul, a city of 10 million people, it was recommended that lines good for running large, ten-car train sets be designed in the case of the first-phase lines. In the case of the second-phase lines, however, it was recommended that lines good for running mid-sized, six- to eight-car train sets be designed as the lines would pass through relatively less populated areas.

As the local metropolitan cities were less populated than Seoul, mid-sized, four- to eight-car train sets were employed for the cities' urban railways. Busan, a city of 3.6 million people, had eight-car train sets running on Metro Line 1, laid out along the city's central transit axis, but had four- to six-car train sets for the lines built afterwards. Daegu, a city of 2.5 million people, had six-car train sets running on all the city's lines, while Daejeon and Gwangju, each with about 1.5 million people, had four-car train sets running on their respective lines. Yongin, Gimhae, and Uijeongbu, each with less than one million people, have or plan to have light railways running in their respective cities.

The government laid out guidelines for urban railway construction so that local governments could consult with regard to the design of adequate urban railway systems. The guidelines includes the following specifications, according to the size of the population, the traffic demand, and the fiscal condition: cities with over one

million people can build heavy railways; large trains are recommended when a peak demand of 40,000 people in the most congested section is expected within ten years after the opening of the urban railway; mid-sized trains are recommended when a peak demand of 20,000 people is expected; cities with over half a million people can build light rails with a peak demand of 10,000 people in the most congested section within ten years after the railways' opening. These guidelines can be lowered, however, if a sufficient demand is expected, or if a connection with the existing lines is deemed necessary.

If all the train sets currently running on the country's urban rail tracks will be broken down according to the number of cars per train set, it will be found that the capacity of each train set has continuously gone down. This may not necessarily imply that the system and capacity of the current railways is most appropriate for the city's main transit axis, even though the data reflect the city's size and traffic demand.

<Table 3-2> Urban railway train set capacity by period

Start of Operation	City	Line(s)	Train Car Size	No. of Cars per Train	Remarks
1970s	Seoul	Line 1	Large	10	
1980s	Seoul	Line 2-4	Large	10	
	Busan	Line 1	Mid-sized	8	
1990s	Seoul	Line 5-7	Large	8	
		Line 8	Large	6	Connects Seongnam-si
	Busna	Line 2	Mid-sized	6	
	Daegu	Line 1	Mid-sized	6	
2000s	Seoul	Line 9	Mid-sized	4	
	Busan	Line 3	Mid-sized	4	
	Daegu	Line 2	Mid-sized	6	
	Incheon	Line 1	Mid-sized	8	
	Gwangju	Line 1	Mid-sized	4	
	Daejwon	Line 1	Mid-sized	4	
2010s	Busan	Line 4	Light rail	6	
		Busan-Gimhae	Light rail	2	Connects Gimhae-si

2.3 Financing the Projects

2.3.1 Foreign loans

The budget required for the construction of Seoul Metro Line 1 far exceeded what Seoul City could line up from its own coffers. The fiscal lineup possible from the central government fell short of the necessary amount as the country was preoccupied with investing in its economic development. For this reason, the government signed an official loan agreement with Japan's OECF (Overseas Economic Cooperation Fund) in the Korea-Japan Ministerial Meeting. The total loans offered by Japan was USD35 million, about 48% of the total budget, with USD20 million paid in with in-kind rolling stocks and other equipment, and the remaining USD15 million in cash.

The first-phase Seoul Metro lines in the 1980s, and Busan Metro Line 1, were financed with foreign loans, but their shares in the total project cost were lower than that of Seoul Metro Line 1. The urban railway projects in the 1990s, during which fiscal support from the central government had been stipulated, rarely relied on foreign loans. Even though it is the local government that oversees urban railway projects, its fiscal capability was clearly limited for it to push ahead with the project on its own terms, due to the project's massive budget. As the country was still a developing nation back then, the government's decision to finance the project by signing a loan agreement was a big boost for the urban railway project.

2.3.2 Issue of the urban railway bonds

Seoul City enacted the Ordinance on the First Seoul City Subway Bonds in 1973 to finance the construction of Seoul Metro Line 1. The share of the bonds was about 10% of the total project cost, but it was repaid in 1975, two years after the issue, with fiscal support from the government, effectively making it a de-facto fiscal support by the government. The share of the financing by bonds has since steadily risen as the issue of urban railway bonds was stipulated in the Law to Promote the Construction of Urban Railways and the Law on Urban Railways. In the construction of Seoul Metro Line 2, Daegu Metro Line 1, and Gwangju Metro Line 1, more than 30% of the project cost was financed by bonds. For the flawless issue of bonds, the Law on Urban Railways stipulates the compulsory purchase of the urban railway bonds when a person:

- is granted a license, permission, or approval by the central or local government;
- applies for registration of real estate or other assets with the central or local government;
- signs a subcontract agreement on construction with the central or local government; or
- signs a subcontract agreement on construction, services, or procurement with regard to the construction and operation of an urban railway.

2.3.3 Fiscal support from the central government

Beginning in the 1980s, the government subsidized or lent part of the project cost when it decided that fiscal support is necessary for the construction of an urban railway. With the enactment of the Law on Urban Railways, the share of fiscal support rose from 30% (subsidies: 15%; fiscal loans: 15%) in the early 1990s to 30% in 1996. It rose again to 50% in 1998 and to 60% in 2005. For the fiscal support granted to the urban railway projects conducted between 1990 and 2004, the government paid the difference between 60% of the project budget and the actual amount of fiscal support given in those years, so that the beneficiaries can use the amount to pay back the principal and interest of their debts.

<Table 3-3> Share of the state fiscal support in the urban rail projects by period

Region	1980s	Early 1990s	Mid-1990s	Late 1990s	2000s
Seoul	About 3%	15%	30%	40%	40%
Other local cities	About 15%	15%	30%	50%	60%

In 1993, the government enacted the Law on Special Accounting for Transportation Facilities and the Law on the Transportation Tax to secure a budget for stable fiscal support. The tax incomes that were transferred to the special accounting of the transportation facilities include the entire tax collected based on the Law on the Transportation Tax and the special consumption tax on the passenger cars imposed according to the Law on the Special Consumption Tax. An object tax created to secure a budget for the roadways, urban rails, and other social overhead capital, the transportation tax is imposed on gasoline, diesel oil, and other similar alternative fuels, which are the targets of the special consumption tax.

The government currently provides fiscal support only for projects adjudged economically feasible and whose basic plans are confirmed according to the Law on Urban Railways. According to the guidelines, the construction cost is paid in the same proportion to the total budget in the cases of both heavy and light railways, while up to 40% of the project cost is paid to Seoul City and 60% to the local governments. In principle, however, the operation cost is not paid. If a local government cannot afford to repay the debt that it incurred in the construction of the urban railway, it is stipulated that the government can suspend or reduce its fiscal support to a new or pending project. A local government's capability to repay its debt is decided by reviewing if it is paying back a 30-40% interest as well as the operating loss and construction cost from its own coffers.

Meanwhile, the government provides fiscal support of up to 75% of the project budget with regard to metropolitan railway projects for which the central government assumes responsibility, while the remaining 25% is paid by the local government.

2.3.4 Restitution of development gains

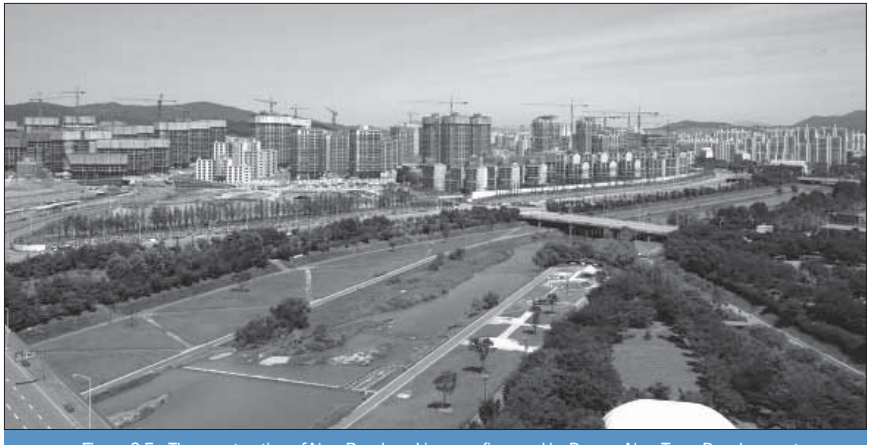
In 1989, President Roh Tae Woo ordered that ways of restituting development gains be sought by closely associating the construction of urban railways and public development. A housing or an urban development project is usually designed as a highly packed development to maximize the land use, resulting in the rise of traffic. In the metropolitan cities, the construction of a subway is inevitable because the roads are not good enough to meet the rising demand for transportation. Imposing a partial financial burden for subway construction on housing projects would jack up the prices of lots. Still the restitution of development gains was justified for the following reasons: (1) the development cost was relatively low as most of the new housing projects were taking place in the undeveloped greenbelt areas; and (2) the development created a new demand for mass transit service that was not there in the first place.

Accordingly, Seoul City, in the midst of planning the second-phase metro lines, decided to add a 178 billion won additional cost to the budget of five housing development projects in the city. The share of the subway construction cost in each housing project was 10% on average.

A similar technique was applied to the metropolitan railway project in the greater Seoul area. The building of new metropolitan railways was instrumental in connecting Seoul and the new satellite cities, such as Ansan, Sanbon, Ilsan, and Bundang, which were built in the 1980s. Consequently, the national enterprises responsible for the new-town development shouldered much of the construction cost.

In 1997, the government enacted the Special Law on Metropolitan Transit Management to effectively tackle, with a wider perspective, the mounting traffic problems in the metropolitan area, which had been caused by the new satellite cities sprouting around the greater Seoul area. According to the law, the developers of large-scale housing projects were obliged to shoulder the cost of metropolitan transit revamp, while the tax levied this way was invested again in various metropolitan transit projects including metropolitan railway.

The construction of Gyeongchun and Joongang Line was also financed by the burden charge for metropolitan transit, which was levied during the construction of housing projects along the line. The share of the burden charge in the construction of New Bundang Line, which was levied during the construction of Pangyo New Town, was also significant.



<Figure 3-5> The construction of New Bundang Line was financed by Pangyo New Town Development

2.3.5 Involvement of private capital

The government advised opting for the third-sector development alternative

to lighten the fiscal burden carried over from building the metropolitan subway network, where a local government and private investors can jointly build and operate a light railway. Further, to systematically push for private investment in public projects, the supporting regulations were also modified. Backed by this policy, a few light railway projects were pushed ahead with in Gimhae, Yongin, and Uijeongbu, with over 50% of the total project cost shouldered by private investors. As for the remaining cost, the central and local governments shared the burden according to the guideline applied for the projects financed by fiscal support.

For light railway projects funded privately and tagged with a BTO option, the private investors are required to pay up to 50% of the project cost, with up to 20% of the cost being a burden charge. In the case where the burden charge cannot be easily secured, the local governments have to shoulder the entire cost.

2.4 Localization of the Railway Technology

Although Japanese trains were imported for Seoul Metro Line 1, the government was determined to secure homegrown technologies to manufacture its own rolling stocks as it saw the looming explosion of the demand for train cars in the Seoul subways and other metropolitan rails. The government originally intended to take a leadership role in the development of the relevant technologies by establishing the Ten-Year Plan to Develop Subway Train Cars back in 1972. As some local companies, however, showed a strong willingness to develop the technologies with their own resources, the project eventually became a civilian endeavor. In response to a request by National Railroad Administration, a government agency, Daewoo Heavy Industry delivered three subway cars in 1976 for the first time in the country. The share of the homegrown technologies in the first South Korean subway trains was just over 28%, but with the technological advancement of local parts manufactures, most of the components had been localized by the time Seoul Metro Line 2 was built, except for the core technology. To further increase the share of the locally produced components of the train cars, it was stipulated, before the purchase of the third-round train cars for Seoul Metro Line 2, that the foreign-made components cannot be imported without the approval of the Ministry of Commerce and Industry.

In the purchase of train cars for Seoul Metro Line 3 and 4, the foreign manufacturer/supplier was requested to localize the tractor motors and motor generators, the two most critical electric components of train cars, up to a certain proportion. The proportion was set at 10% in the end. For the purchase of train cars for Seoul Metro Line 6, it was required that more than 50% local components be used. With the strategy of increasing the localization, it was possible to lower the dependence on the foreign technology firms while at the same time cutting the cost of buying and maintaining the train cars.

With the growing demand for the light rails in the 2000s, the government pushed ahead with the research and development of a variety of light rail technologies, such as the rubber-wheeled AGT, urban maglev, and wireless (catenary-free) tram, hoping that the light rail trains could be produced locally with the help of these homegrown technologies. Meanwhile, the construction of a test rail or the purchase of the locally produced trains was recommended to help commercialize those assembled trains. For instance, it was stipulated that the light rail trains assembled in the country should be considered alternatives when setting up a master plan for the urban rails.

Urban maglev

Rubber-wheeled AGT

<Figure 3-6> Light rail train systems developed in South Korea

2.5 Fare Policy

The fare system of urban railways consists of the distance scale rates system, in which fares are charged according to the trip miles; the unified rate system, in which a single fare is charged across the board; and the zoning system, in which all the lines are divided into a certain number of zones. Moreover, the fares are charged according to the number of zones a passenger would travel across.

Since the opening of Seoul Metro Line 1 in 1974, the subway fares had been charged according to the distance scale rates system until the introduction of the automatic fare collection (AFC) system in 1985. This was because the metropolitan rails also shared the track of Seoul Metro Line 1 even though it was barely over 8 km long.

With the completion of the first-phase metro lines, the number of subway stations jumped, complicating the fare system. To simplify the matter, the zoning system was introduced in Seoul whereas the base rate plus an additional fare for every 5 km was charged once outside the city limits. An unexpected problem was soon stumbled upon, however: the frequent changes in the fare system with the opening of each new line as well as the mounting complaints about the zoning system.

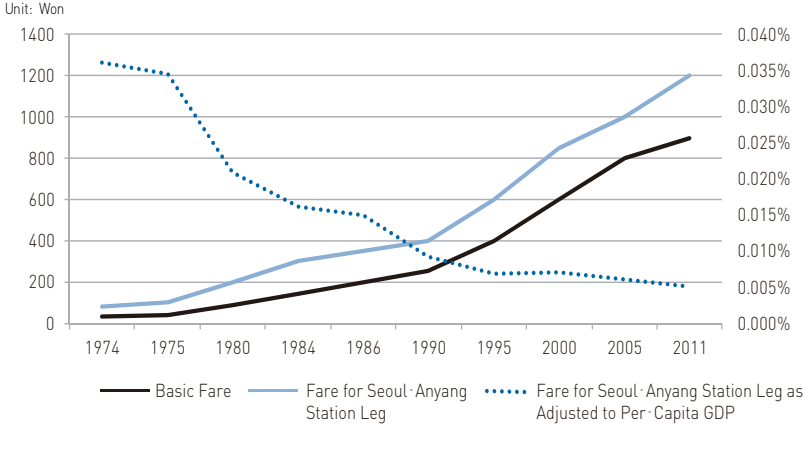
In 2004, the consolidated fare system for the urban mass transit was introduced in line with the reformation of the Seoul bus system, where the passengers can freely transfer between the subways and the buses without paying an additional fare. As of 2011, the base rate of Seoul Metro is 900 won when paid using a transportation card, within the base distance of a 10-km-long trip. If the trip goes beyond the base distance of 10 km, 100 won is charged for every 5 km covered thereafter. The passengers are allowed to transfer between the buses and the subways up to five times, for free. Meanwhile, other regional urban rails are applying the zoning or single fare system as their metro lines are relatively simple or there are no metropolitan rails.

In 1974, the basic fare of Seoul Metro Line 1 was 30 won for up to 8 km, and an additional 3 won per km is charged if the trip continues over to the metropolitan lines. Lower than the published fares were charged for the passengers who purchased a commutation ticket or who were traveling across Seoul Metro Line 1 and the metropolitan railways. The fare of Metro Line 1 had risen consistently to 90 won in 1980, three times higher than the fare at the opening, with an additional charge of 6.38 won per 6 km, about two times as high as the rate at the opening. In 1984, right before the introduction of the zoning system, the basic fare had reached 140 won, with an additional 10 won charged for every new km. As of 2011, the base rate of Seoul Metro is 900 won when paid using a transportation card, within the base distance of a 10-km-long trip. If the trip continues over the base distance of 10 km,

100 won is charged for every 5 km covered thereafter. The passengers, however, are allowed to transfer between the buses and the subways up to five times, for free. Meanwhile, passengers aged 65 or higher, disabled passengers, or persons of national merit can use Seoul Metro Line 1 free of charge.

The Law on Urban Rails stipulates that the metro operators should report the fare to the governing authority, and that such fare must be set within the limits imposed by the head of the metropolitan government. Still, the metro operators are required to set the fare reasonably after carefully weighing the fare with those of other mass transit means, with the preliminary notice on the fare change being a precondition. This is because the urban rails are the mass transit de rigueur for the public, which again justifies the governmental intervention in terms of the transportation welfare and price management.

In view of its role as a mass transit friendly to common people, the fare of the local urban railway was made to rise slower than the economic growth rate. When Seoul Metro Line 1 opened to the public in 1974, for instance, the fare for the 24-km leg between Seoul and An yang Station was 80 won. If adjusted according to the per-capita gross domestic product of USD554 and the exchange rate of 400 won per USD1 in 1974, the fare - 80 won for the 24-km leg between Seoul and Anyang Station - is just 0.036% of the per-capita domestic product of 220,000 won. Its share



<Figure 3-7> Share of the urban rail fare in the per-capita gross domestic product

had dropped to 0.021% in 1980, however, followed by a continued decrease to 0.009% in 1990, 0.007% in 2000, and 0.005% in 2011. Thanks to this intervention policy to maintain the urban railway as a mass transit friendly to common people, the share of the urban rail fare in the country's per-capita gross domestic product has steadily declined over the years.

3. The Governing Body and Its Role in the Urban Railway Development

3.1 The Central Government

One of the key roles of the central government was to approve and notify the public of the urban railway basic plan submitted by the local government. In the 1970s to 1980s, well before the enactment of the Law on Urban Railways, the government approved the basic plan on an independent line, but since the 1990s, it has approved the basic plan that contained at least a ten-year roadmap of the city's urban railway expansion plan to prevent the unbridled construction of urban railways. The basic plan, complete with the future route map, was intended to serve as a master plan for the city's urban railway network to be built over the next ten years. Accordingly, if an independent line is to be constructed, the line should also be included in the basic plan, which again required approval by the head of the metropolitan government.

The central government reviews the submitted basic plan for the urban railway development, including its routes, construction cost, and period, and the financing plan, including the share to be paid by the local government. It then notifies the public of the basic plan after (1) fine-tuning the required modifications with the relevant authorities; and (2) a review by the National Transportation Committee. The guideline for urban railway projects is divided into heavy and light railways, and the government recognizes the validity of a project only when it meets the requirements of the urban population, transit demand, and fiscal condition. To encourage the use of the urban railway and to enhance the convenience of the passengers, it stipulates that the basic plan should include the building of a link-up transit, the reduction of the transfer distance, and the installation of convenience facilities like escalators and elevators for the disabled.

The government issues an operating license to the parties that intend to construct and operate an urban railway. The potential licensees include local governments, local public enterprises, or corporations entrusted with the construction and operation of the urban railway by the central or local government. The central government then approves the management plan submitted by the operation licensee for the construction and operation of an urban railway, before publishing the notification. For a license to be issued, the following conditions must be met:

- the plan should be adequate for the city's transit demand;
- the applicant should be capable of executing the project; and
- the project should be economically feasible.

The central government has been supporting the construction and operation of urban railways by providing guidelines for their policy and technology. In the 1970s, it stipulated the rules on the construction and operation of each line, providing technical standards for the construction and operation of an urban railway. In the 1980s, the government enacted the regulation on the issue of urban railway bonds to promote the construction of urban railways, and stipulated the grounds for its provision of fiscal support for the projects. In the 1990s, the government enacted the regulation on the technologies required for the construction and operation of safe and convenient urban railways.

The central government has been financing the urban rail projects. Between the 1970s and 1990s, there was no specific guideline for the financing of urban rail projects, with the financing mostly consisting of fiscal support from the central government and loans dependent on the year's fiscal situation. The fiscal support for urban rail projects began to be settled, however, through the formulation of a clear guideline in 1991, to ensure the accountability for and organized management of the project. The shares in the fiscal support were 30% for the local metropolitan governments and 25% for Seoul, with both rising to 50 and 40%, respectively, in 1997 due to the poor fiscal condition of the local governments.

The government currently provides fiscal support only for those projects adjudged to be economically feasible and whose basic plans have been confirmed according to the Law on Urban Railways. According to the guidelines, up to 40% of the project cost shall be paid by the central government to Seoul City, and 60% to the local

governments. If a local government can not afford to repay the debt that it incurred for the construction of the urban railway, it is stipulated that the government shall suspend or reduce its fiscal support for a new or pending project. In principle, the operation cost shall not be paid, but it is stipulated that the central government can provide a part of the principal and interest that a local government is supposed to pay back to clear its debt. In fact, when the share of the fiscal support for the construction of an urban railway rose in 2005, the central government backdated the stipulation to provide fiscal support to key local metropolitan cities, so that they can pay back the principal and interest of the debt that they incurred for the construction of an urban railway.

The preliminary feasibility study was often performed by the local government, but the central government assumed the responsibility in 1999 for a more objective evaluation of the projects and so that efficient fiscal support can be obtained from Seoul. Consequently, an urban rail project that costs over 50 billion won and that receives more than 30 billion won in fiscal support from the central government should pass the preliminary feasibility test before it can be pursued in earnest. Except for the projects proposed by private investors, most of the urban railway projects since 2000 had to pass the preliminary feasibility study.

In the construction of Seoul Metro Line 1, the country had to rely on advanced Japanese technologies, such as rolling stocks and the signaling system. As a growing number of local governments wanted to build its own urban railway, however, the government sought to raise the share of the local parts in the key technologies. Since 2000, the government has been developing urban railway technologies according to the National Transportation Technology Development Plan stipulated in the Law on Transportation Efficiency. The list of technologies developed so far includes standardization of urban railways, technology development and enhancement of the urban railway system, and development of cost-efficient construction technologies. With the growing demand for light rails in and out of the country, the government carried out research and development on a variety of light rail technologies, such as the rubber-wheeled AGT, urban maglev, and wireless (catenary-free) tram. The homegrown urban railway technology has advanced markedly through research and development, resolving the issue of cost overruns and maintenance difficulty that had often dogged the urban railway projects conducted with the help of imported

technologies.

3.2 The Role of the Local Government

The competent authority in relation to urban railway projects is the local metropolitan government. As such, the head of a metropolitan government should draft a ten-year roadmap of its urban railway plan and should submit it to the responsible ministry. The local government should set up a basic plan on each line that it plans to lay down, and should obtain approval from the central government by drafting a working plan. The urban railway basic plan includes:

- the characteristics and current traffic of the urban transportation network, and a projection of the future transit demand;
- the economic feasibility of the urban railway project and the evaluation of other particulars;
- a rough route map including the name and total length of the planned line, the starting and terminal points, and the locations of the stations and of the car depot;
- the construction period and financing plan, including the share to be paid by the local government;
- a rough estimation of the construction cost and the mid- and long-term fund management plan;
- a road traffic management plan along the proposed line during the construction;
- the building of link-up infrastructure with other transportation systems; and
- the employment of the urban rail operating staff.

The metropolitan cities have operated their own urban railway planning team or urban railway construction headquarters staffed with local government officials. The urban railway planning team mainly carries out the task of establishing the basic plan, and as of this year (2012), it is in operation in Daejeon City. During the construction stage, the team is expanded and renamed ‘‘Urban Railway Construction Headquarters.’’ The headquarters is currently active in Daegu, Incheon, and Gwangju and is organized as an urban railway bureau in the urban infrastructure headquarters in Seoul City. Meanwhile, in Busan, Busan Transportation Corporation, a local public enterprise, is overseeing the construction and operation of the urban railway project. The Busan Metro Line 1 project started after the establishment of

Busan City Subway Construction Headquarters in 1981, but Busan Urban Transit Authority has assumed responsibility since 1988, after its incorporation as an umbrella institution of the central government according to the Law on Busan Transportation Corporation. In 2006, Busan Urban Transit Authority was changed to a local corporation controlled by Busan City.

As a competent authority responsible for the urban rail project, the local government assumes the responsibility for financing the project. On top of the fiscal support from Seoul, the local government can actively seek other means of financing, ranging from obtaining a fiscal line from the municipal account to issuing bonds and procuring bank loans.

3.3 The Role of Public Corporations

At present, the urban rail built with fiscal support from Seoul is usually being managed by a public enterprise controlled by the local government. While the local government usually consigns the management of the rail to a single public enterprise, Seoul has two: Seoul Metro for the first-phase lines and Seoul Metropolitan Rapid Transit Corporation for the second-phase lines. Busan Transportation Corporation oversees both the construction and operation of the project in Busan while Metropolitan Rapid Transit Corporation manages the project in Daegu, Gwangju, and Daejeon. In Incheon, it is managed by Incheon Transit Corporation, which oversees the city's mass transits in general. The ordinance of each local government with regard to the establishment of urban railway operating authorities stipulates that they carry out the following tasks:

- construction and operation of the city's urban railway;
- urban planning according to the construction and operation of the urban railway;
- construction, supply, and management of the administrative, commercial, residential, convenience, and public welfare facilities within the railway station sphere;
- housing and urban development projects in association with the urban railway;
- other derivative businesses of urban railway operation, including the construction and supervision of an urban railway operation system for domestic and overseas clients;
- construction and operation of other link-up transits with the urban railway, and

operation of a public bus service with no operational overlap with the existing bus operators; and

- management of the project entrusted by the central and local government, and other clients.

4. Evolution of the Administrative Body Governing the Urban Railways

4.1 Evolution of the Administrative Body of the Central Government

The Ministry of Construction started as the construction bureau of the Ministry of Home Affairs in November 1948. After a series of changes, it had been raised to the Ministry of Construction by June 1962. According to the Law on Urban Development[6] enacted in 1962, facility selection and working plans involving the construction and improvement of urban planning facilities or urban infrastructure should be approved of. As urban railway projects are key urban planning facilities, they need approval from the Ministry of Construction before they can be executed. Accordingly, the Ministry of Construction approved and notified the public of the facility selection and working plan of Seoul Metro Line 1, after the project was reviewed by the National Urban Planning Committee. Since the enactment in 1986 of the Law on the Construction and Operation of Underground Railways, however, the approval by the Ministry of Transportation has been assumed to have the same binding power with regard to the project's legality.

To start an urban railway project, the project initiator should obtain an operation license as well as approval of the working plan from the Ministry of Transportation, which had been in place since the founding of the Republic of Korea. The governing authority in the said ministry with regard to the Seoul Metro Line 1 project in the 1970s was the general transportation planning officer. With the enactment in 1979 of the Law to Promote the Construction of Underground Railways, the Urban Transportation Bureau, including the Underground Railway Section under its arm,

6) Enacted in 1962 to stipulate the particulars of the setting up and execution of urban planning, the law was abolished in February 2002 with the enactment of the Law on the Planning and Use of Land.

was established in the Ministry of Transportation. The Urban Transportation Bureau, however, was merged with the Ground Transportation Bureau in 1981 while the urban railway affairs were administered by the Urban Transportation Section. With the enactment in 1990 of the Law on Urban Railways, the Urban Transportation Bureau was revived, while the newly established urban subway section in the bureau oversaw the urban railway affairs. The urban subway section was renamed to the urban railway section in 1991. The Urban Transportation Bureau was renamed ''Ground Transportation Bureau'' in 1994, but the Urban Railway Section remained well into late 1994, when the Ministry of Construction and the Ministry of Transportation merged to become the Ministry of Construction and Transportation.

Following the amendment of the Law on Government Organizations in December 1994, the Ministry of Construction and Transportation was born when the two ministries were merged in an attempt to realize a small government as well as to establish an efficient connection between the investment and management of the social overhead capital. Urban railway affairs were still administered by the Urban Railway Section under the Ground Transportation Bureau, even after its supervising ministry was changed to the Ministry of Construction and Transportation.

In the 2000s, the Office of Metropolitan Transportation Policy was established when the metropolitan transit in the greater Seoul area emerged as a pressing issue. The Metropolitan Railway Section was established under the office to oversee the construction of metropolitan railways in association with the development of new towns in the greater Seoul area. The urban and metropolitan railway affairs were administered by the Urban Railway Team and Metropolitan Railway Team, respectively, which were installed under the Headquarters of Everyday Transportation, even after the ministry was reshuffled into a headquarters system in 2005.

In 2008, the Urban Railway Team and Metropolitan Railway Team were merged to become the Metropolitan Railway Section when the Ministry of Construction and Transportation and the Ministry of Marine and Fishery were merged to become the Ministry of Land, Transport, and Maritime Affairs. Accordingly, urban railway affairs are currently being administered by the Metropolitan Railway Section under the Office of Metropolitan Transportation Policy in the Ministry of Land, Transport,

and Maritime Affairs. The key tasks of the Metropolitan Railway Section include the establishment of laws, rules, and design requirements for metropolitan and urban railways, research and development on urban railway technologies, management of privately funded light railway projects, review and approval of urban railway plans, and management of metropolitan railway projects.

4.2 Evolution of the Administrative Body of the Local Governments

Seoul City established Subway Construction Headquarters in June 1960 and entrusted it with the construction of Metro Line 1. The office was renamed ‘‘Subway Headquarters’’ in 1974, and the Subway Sales Bureau was established to operate Metro Line 1. The office was dissolved when the construction of Seoul Metro Line 2 was completed. Seoul City established Seoul City Subway Corporation, a local public corporation, in September 1981, and entrusted it with the construction of Metro Line 3 and 4. Beginning in 1984, the corporation took over the operation of all the metro lines in Seoul. Renamed ‘‘Seoul Metro’’ in 2005, the corporation has subsidiaries besides the headquarters, including a customer service center, a railcar office, a train crew office, a train control center, a technical office, a rail equipment office, and a technology research center.

In November 1989, Seoul City launched Seoul City Subway Construction Headquarters and entrusted it with the construction of the second-phase metro lines. In March 1994, the city established Seoul Metropolitan Rapid Transit Corporation and entrusted it with the operation of the second-phase metro lines. Meanwhile, in 2008, Subway Construction Headquarters was merged with Construction Safety Headquarters to become Urban Infrastructure Headquarters while the Urban Railway Bureau in the headquarters takes care of the construction of urban railways, including the extension of Seoul Metro Line 9. The Urban Railway Bureau consists of the design, engineering, civil engineering, construction, and facility departments.

Busan City established Busan City Subway Construction Headquarters in 1980 to construct Metro Line 1. In 1988, the headquarters was renamed ‘‘Busan Urban Transit Authority’’ and came under the control of the central government after the enactment in 1987 of the Law on Busan Urban Transit Authority. Busan Urban Transit Authority administered the construction of Metro Line 2 and 3 in the 1990s,

and of Metro Line 4 in 2003, and operated Metro Line 1. In many other cities with their own metro lines, however, the local governments are managing and operating the subway. Spurred by this fact, there has been a consistent request since 1997 to transfer the task of Busan Urban Transit Authority to Busan City. The massive debt and loss of the authority, however, hindered the implementation of the plan for nearly nine years. In 2006, Busan Urban Transit Authority was changed to Busan Transportation Corporation, which was under the control of Busan City. The corporation operates Busan Metro Line 1 to 4 and conducts the construction of the city's urban railway.

Daegu City launched the Daegu City Subway Planning Team in 1989. The team was expanded into Subway Construction Headquarters in April 1991, which in 2007 was renamed ‘‘Daegu City Urban Railway Construction Headquarters.’’ It currently oversees the construction of Daegu Metro Line 3. The city established Daegu City Subway Corporation in 1995, which was renamed ‘‘Daegu Metropolitan Rapid Transit Corporation’’ in 2008. It operates Metro Line 1 and 2.

Incheon City launched the Subway Planning Team in 1991, which was expanded in April 1992 to Subway Construction Headquarters to start the construction of Metro Line 1 in 1993. The headquarters has consistently expanded until 1996, but it reduced its size after the design of Metro Line 2 and 3 was halted. It was renamed and expanded to ‘‘Urban Railway Construction Headquarters’’ in 2004 and currently oversees the construction of Metro Line 2. Incheon City established Incheon City Subway Corporation in 1998 and entrusted it with the operation of Metro Line 1, which was renamed ‘‘Incheon Metro’’ in 2009. In 2011, Incheon Transit Corporation was launched and was entrusted with the operation of the city's urban railway. Unlike Busan Transportation Corporation, the corporation manages the affairs of the mass transits in the city other than the urban railway.

Gwangju City established the Subway Planning Team in 1994 to construct Metro Line 1, and the team was renamed ‘‘Subway Construction Headquarters’’ in 1996. The headquarters was expanded after the start of the construction of Metro Line 1 in 1997 but was downsized beginning in 2000. In 2008, it was renamed ‘‘Urban Railway Construction Headquarters.’’ The city has no lines under construction for now but plans to build Metro Line 2. The city established the Operation Planning

Team in Subway Construction Headquarters on a limited basis. Further, Gwangju Metropolitan Transit Corporation, established in 2008, has since operated Metro Line 1.

Daejeon City established the Subway Planning Team in 1994 to construct Metro Line 1, and the team was renamed ‘‘Subway Construction Headquarters’’ in 1996. The headquarters was expanded after the start of the construction of Metro Line 1 in 1997 but was downsized after the opening of Metro Line 1 in 2007. At present, it is still a planning team that oversees the planning of Daejeon Metro Line 2. In 2004, the city established the Subway Corporation Planning Team in Subway Construction Headquarters on a limited basis. Further, Daejeon Metropolitan Transit Corporation, established in 2006, has since operated Metro Line 1.

5. Evolution of the Laws on Urban Railways

5.1 Law on Railroads

Enacted in 1962, the Law on Railroads was enforced on all the railways built and operated in the country. According to the law, the operators of private railways, including urban railways, had to obtain a license from the Ministry of Transportation. The fares of such railways were also required to be approved by the Ministry. The law mostly included stipulations with regard to the fares of and transport by railways and had limited stipulations on the details of urban railways. The law was abolished in 2005, during the reformation of the country's railway structure.

5.2 Law to Promote the Construction of Underground Railways

Enacted in 1979, the law was enacted to promote the construction of underground railways as stipulated in the Law on Railroads, thus improving the traffic in the cities and the surrounding areas. The law was enforced on underground railways built according to the Law on Railroads, or on those built by corporations entrusted with the construction and operation of underground railways commissioned by the local government with an operation license, or by KORAIL. The facility of an underground railway is decided as part of the urban planning, as stipulated in the

Law on Urban Planning, whereas the designation of the underground railway route was decided by the Ministry of Transportation.

The law stated that if an underground railway project is granted approval by the Law to Promote the Construction of Underground Railways, the project should be assumed to have been automatically granted approval as well for operation by the Law on the Appropriation of Land. The law also listed ways to finance the construction of underground railways as well as the rules on issuing and buying underground railway bonds. The law also stipulated that when needed, the central government can subsidize the project or lend money for the builders of an underground railway. As the law focused only on the construction of underground railways, it was changed to the Law on the Construction and Operation of Underground Railways in 1986, which included the operation of underground railways.

5.3 Law on the Construction and Operation of Underground Railways

With the opening of Seoul Metro Line 1, 2, 3 and 4, however, the government shifted its focus to the operation of underground railways by enacting in 1986 the Law on the Construction and Operation of Underground Railways, which it hoped would enhance the operation efficiency of underground railways. The law stated that if a local government aspires to build an underground railway, the construction of the railway should be preceded by the creation of a master plan on the construction and operation of the railway. The law also stated that the transfer, merger, suspension, or closure of the operation of railways should be approved by the Ministry of Transportation.

Regarding the financing of the project, underground railway bonds, which were originally issued to finance the construction of underground railways, could also be issued to finance the operation of underground railways. The name of the bonds was thus changed from ‘‘underground railway construction bonds’’ to ‘‘underground railway bonds.’’

The builder of an underground railway was allowed to entrust a corporation with the construction and operation of the railway after approval by the Ministry of

Transportation. It was also stipulated that the party entrusted with the construction and operation of the project shall be held accountable for such, and that the underground facility built by the party entrusted with the construction and operation of the project shall belong to the local government that commissioned the project. The law also stated that the Ministry of Transportation could order the operators of underground railways to modify their management plan, fare, and train operation schedule to improve the urban traffic flow.

5.4 Law on Urban Railways

By 1990, the Law on Urban Railways was enacted to include in the urban rail category a variety of rolling stocks, such as the light railway, and to simplify the administrative process of urban rail construction projects. By redefining the urban railway category, the law made it possible to push for diverse light railway projects. The law stated that the parties that wish to start an urban railway project should first obtain a license from the Ministry of Transportation and should also have the project's working plan approved by the ministry. If the licensee of the urban railway violated the licensing conditions, the Ministry of Transportation could repeal the license or could halt the operation of the railway.

To promote the construction of urban railways and to improve their management efficiency, the builders of urban railways were allowed to push for the commercial development of a ‘‘railway station sphere’’ within a given radius spreading from the station. The profits from the development would be used to finance the construction and operation of another urban railway. If an urban railway builder intends to use the underground space of someone else's land to construct an urban railway, the legal grounds of the compensation for the underground space and for the expropriation of the land were clarified so that adequate compensation could be given depending on the value and depth of the land.

The key contents stipulated in the law are:

- the formulation of a master plan for the urban railway;
- the designation of the urban rail lines and of the operation license;
- compensation for the underground space and for the expropriation of the land;
- relocation of the construction barriers and policy on resident relocation;

- limitations to the disposal of the state and publicly owned lands;
- financing of the construction and operation of the urban railway;
- consignment of the construction and operation of the urban railway;
- report on the fare and administrative order to improve the railway operation;
- coordinated operation;
- employment of the urban railway operating staff; and
- rail technologies, including the general standards, safety standards, performance test, and quality certification.

Meanwhile, a follow-up law was enacted to support the local governments with the technological terms of the construction and operation of the urban rails, as many urban rail projects had been initiated outside Seoul.

<Table 3-4> Rules and ordinances on the urban railway technologies

Law	Key Contents
Regulations on the Construction of Urban Railways	- Rules on the rail, platform, and other facilities - Special rules on the light rails
Regulations on the Operation of Urban Railways	- Rail quality assurance, rolling stocks and other facilities - Operation of the subway trains, and operation speed - Rules on train signaling
Regulations on the Safety Standards of Urban Railways	- Safety standards on the rail, installation and maintenance of the various equipment and facilities - Planning on the maintenance of the urban rails
Regulations on the Safety Standards of the Urban Rail Rolling Stocks	- Safety standards on the structure and equipment of the rolling stocks
Regulations on the Maintenance of the Urban Rail Rolling Stocks	- Rolling stocks quality verification - Urban rail supplies quality certification

Chapter 4.

Financing of the Project and Analysis of the Barriers

1. Financing of Seoul's Urban Railway Projects

1.1 Financing of the Construction of the First-Phase Metro Lines

1.1.1 Financing of the Seoul Metro Line 1 project

The budget required for the construction of Seoul Metro Line 1 was about 33 billion won as of 1974, far exceeding what Seoul City could line up from its own coffers, making it inevitable to rely on the fiscal support of the central government or foreign loans.

In the 5th Korea-Japan Ministerial Meeting held in August 1971, Seoul and Tokyo reached an agreement that Japan would provide USD35 million as loans for the Seoul Metro Line 1 project and another USD45 million for the metropolitan railway project. The South Korean government signed an official loan agreement with Japan's OECF (Overseas Economic Cooperation Fund) in April 1972. The total loan offered by Japan amounted to USD35 million (15.836 billion won), about 48% of the total budget, with USD20 million (9.36 billion won) to be paid with in-kind rolling stocks and other equipment, and the remaining USD15 million (6.476 billion won) to be paid in cash. The loan was payable in 15 years, with a five-year grace period, and the interest rate was 4.125% per year.

For the flawless financing of the project, Seoul City enacted in December 1972 the Ordinance on Special Accounting for Seoul City Subway Construction. The ordinance stated that the tax incomes consisted of taxes transferred from the general

account, fiscal support, and other incomes from the municipal for-profit enterprises.

<Table 4-1> Financing structure of the Seoul Metro Line 1 project

(unit: million won)

Article		Total	1971	1972	1973	1974
Total investment		33,011	1,468	6,066	13,242	12,235
Foreign funds (loan in kind)		9,360		789	2,684	5,887
Domestic funds	Municipal financing	13,375	468	5,230	5,230	6,076
	Issue of bonds		1,000	-1,000		
	Government bonds	3,500			3,500	
	Loans	6,476		3676	2,678	122
	Fiscal support	300			150	150
	Total	23,651	1,468	5,277	10,588	6,348

The city asked for a fiscal loan, however, as the project cost exceeded the initial estimate, coupled with a prospective difficulty in municipal financing. The city also reviewed a variety of potential income sources, including the tax imposed on automobiles, the issue of subway construction bonds targeted at the landlords along the metro line, and the tax imposed on the companies headquartered at the city center. In the end, the city enacted the Ordinance on the First Seoul City Subway Bonds in August 1973 to finance the construction cost. The amount of issued bonds was 3.5 billion won, but they were repaid with fiscal support in 1975, two years after the issue.

1.1.2 Financing of the Seoul Metro Line 2 project

As of 1984, a total of 877.1 billon won had been invested in the Seoul Metro Line 2 project. Japan International Cooperation Agency (JICA) offered loans, but the discussion never developed to a government-level fiscal loan agreement. The USD100 million foreign loan needed for the project was lined up from what the government had in its foreign loan account, while the domestic funds consisted of municipal financing, subway bonds, and fiscal support from the government.

About 252.3 billion won municipal financing was realized by transferring money from the general account, with an additional 278.9 billion won financed by issuing

the subway bonds. In addition, it was stipulated in the city's ordinance that whenever an automobile is registered, the owner had to buy subway bonds on the condition that they were payable in five years, with a grace period of five years and an annual interest rate of 6%. To import the equipment that was unavailable in the country, the city borrowed USD100 million (50 billion won) from the government's foreign loan account on the condition that it was payable in 15 years, with a grace period of five years and a LIBOR rate of 0.5% for the first installment and 1% for the second installment. The fiscal support from the government amounted to 116.9 billion won. Of this, 59.9 billion won consisted of subsidies from the government, and the rest was loaned from the National Investment Fund, without interest.

1.1.3 Financing of the Seoul Metro Line 3 and 4 projects

Seoul Metro Line 3 and 4 were originally supposed to be financed by private funds. According to a financing schedule written in 1979, private investors were to shoulder the entire cost of the projects (409.4 billion won), with 51% (209.4 billion won) to be self-financed and the remaining 49% (200 billion won) to be loaned from the National Investment Fund. The subsequent inflation and the rise of the construction cost, however, made it impossible to involve private investors in the project. The subway company was dissolved, and Seoul Subway Corporation was established to push ahead with the construction of Seoul Metro Line 3 and 4 as public projects.

In 1981, when Seoul Subway Corporation was established, the construction cost of Seoul Metro Line 3 and 4 had ballooned to 985.1 billion won, more than double the initial budget. The total project cost amounted to 1.4825 trillion won as of 1985. Of this, the portion of self-financing was about 20% of the total budget (289.2 billion won), with much of it consisting of municipal financing (269.2 billion won) and the remaining 5 billion won to be lined up from the fiscal coffers. The borrowed funds amounted to 80% (1.1932 trillion won) of the total budget, consisting of bonds (396.6 billion won), foreign loans (314.9 billion won), fiscal loans through the National Investment Fund (296.7 billion won), and other bank loans (185 billion won).

1.1.4 Consolidated financing result of the first-phase Seoul Metro lines

The total project cost of the first-phase metro lines will add up to 2.3926 trillion won without counting the inflation rate. The self-financing amounted to barely 27%

of the project cost, leaving the city sitting on mountains of debt: 1.7602 trillion won. The less-than-expected operating incomes from the first-phase metro lines added even more pressure to the repayment of the debt. Accordingly, Seoul City had to spend 10% of the city's total tax incomes for repaying the principal and interest of the debt since 1986.

As of 2011, the share of the fiscal support for the Seoul subway projects funded with public investment amounts to 40% of the total project budget. The share was just 2.7%, however, or 64.9 billion won, for the first-phase Seoul Metro lines. It is concluded, therefore, that the first-phase Seoul Metro lines project relied too heavily on the borrowed funds, without sufficient fiscal support from the central government.

<Table 4-2> Financing structure of the first-phase Seoul Metro lines

(unit: billion won)

Article		Total	Line 1	Line 2	Line 3/4
Total investment		2,392.6	33	877.1	1,482.5
Self-financing	Subtotal 1	632.4	14.9	328.2	289.3
	Municipal financing	536.4	14.9	252.3	269.2
	State subsidies	64.9		59.9	5
	Others	31.1		16	15.1
Borrowed funds	Subtotal 2	1,760.2	18.1	548.9	1,193.2
	Fiscal fund	314	2.3	15	297.6
	Bank loans	368.6		183.6	185
	Loans	386.3	15.8	55.6	314.9
	Foreign loans	15.8		15.8	
	Government bonds	675.5		278.9	396.6

1.2 Financing of the Second-Phase Seoul Metro lines

Seoul City relied on borrowed funds for more than 70% of the financing of the first-phase Seoul Metro project. This, coupled with its operating loss from the completed metro lines, made it difficult for the city to finance the second-phase Seoul Metro project. Although the government changed the tobacco consumption tax to a local tax, it decided not to provide fiscal support for the project. As the total financing secured this way was barely over 25 billion won annually, the city intended

to downsize the project scale.

The government, however, decided to provide the city with an additional 20 billion won upon the request of some politicians, to extend Metro Line 5 from Yeongdeungpo to Yoido. It also decided to finance the construction of the Seongnam section of Metro Line 8 by giving fiscal support to Gyeonggi-do instead of Seoul.

Furthermore, an about one trillion won accumulated surplus was found after the annual settlement of accounts in 1989. Spurred by this turn of events, the government established a comprehensive traffic management plan to resolve the congestion in the greater Seoul area and in the local metropolitan cities, as well as various policies to support the local governments. In the process, the government decided to allocate 400 billion won for the construction of subways and roads in the metropolitan cities while suggesting that it would finance up to 30% of the country's total subway construction cost, estimated at 12 trillion won, by selectively distributing the money to the local governments beginning in 1991.

Following the aforementioned decisions, Seoul City came up with a financing plan in which the Seongnam section of Metro Line 8 was to be entirely financed by the government while the remaining Seoul section was to be financed up to 30% by the government, with the payment to be made upon the commencement of the second-phase Seoul Metro project. The cost of this project, however, had ballooned nearly twofold, from 4.187 trillion won in 1990, when the project was planned, to 9.429 trillion won by late 1996. The cost overrun was blamed on varied reasons, such as inflation, the increase of the purchased rolling stocks, the extension of the planned lines, the growing number of stations, the rising land price, the changing of the engineering method used, and the relocation of the buried stuff. As a result, the share of the fiscal support dropped from the initial 33.9% to 21%.

The share of the total self-financing by the city grew to 50% in the end as the budget transferred from the general account jumped while the burden charge and development gains from the housing project was newly counted in the city's project account. As a result, the share of the borrowed funds dropped significantly compared to that in the first-phase Seoul Metro project.

<Table 4-3> Financing structure of the second-phase Seoul Metro lines

(unit: billion won)

Category		Initial Budget	As of Late 1996
Total		4,187	9,429
Fiscal support	Subtotal	1,420	2,335.7
	Fiscal support	1,420	1,981.7
	Fiscal loans		244
	Special governmental loans		110
Self-financing	Subtotal	1,373.1	5,032.6
	General account	1,266.1	3,951.5
	Burden charge of housing evelopment		238
	Development gains		405.1
	Budget of subway corporation	107	155
	Other incomes		283
Borrowed funds	Subtotal	1,393.9	2,060.7
	Special governmental loans	200	40
	Urban railway bonds	298.9	1,323.4
	Foreign bond issue	895	697.3

1.3 Financing of the Third-Phase Seoul Metro lines

In the financing plan that Seoul City laid out in the early 1990s, the city intended to finance the third-phase metro project by lining up 30% from the municipal coffers, 20% from loans, and the remaining 50% from the fiscal support from the central government. The prospect of fiscal support from the central government turned murky, however, in the wake of the Asian financial crisis in the late 1990s. This, coupled with the decreasing tax income of Seoul City as well as the reduction of the sales of subway bonds, made the delay of the project inevitable.

The combined debt of Seoul Metro and Seoul Metropolitan Rapid Transit Corporation had ballooned from 2.1 trillion won in 1990 to 4.8 trillion won by 1997. The debt was too large compared to the equity capital, and the repayment of the principal and interest was way larger than what was earned. The debt kept growing due to the lack of effort by the corporations to improve the financial management. Accordingly, it was suggested that they had to take some drastic measures to

improve the debt management, such as dividing the debt into an operating debt and a construction debt, with a separate action to be taken on each by Seoul City, while increasing the fare gradually to the realistic level. Consequently, Seoul City sought to attract private investors to the Seoul Metro Line 9 project, and in November 2000, it notified the public of the basic plan for a privately funded urban infrastructure project.

The project was financed through the BTO method, where Seoul Metro Line 9 was partly financed by the private investors in the construction of the first-phase tracks and stations. The operator was endowed with a right to run the line for 30 years after the line's opening.

The project budget of Metro Line 9 was 2.399 trillion won, with 899.5 billion won invested for the construction of the first-phase tracks and stations, and 94.8 billion won invested for the acquisition of rolling stocks as of 2003. Of this amount, a total of 479.5 billion won was funded by private investors. The share of each financing source was as follows: 40% for fiscal support, 40% for the municipal account, and 20% for private funds. Meanwhile, the private investors consisted of investors in the construction (51%) and investors in financing (49%), with the equity of Hyundai-Rotem, the rolling-stock manufacturer, being 25%, the highest.

2. Financing of the Local Urban Railway Projects

2.1 Financing of Busan Urban Railway

The total project cost of Busan Metro Line 1 was 975.1 billion won. Of this, the borrowed funds amounted to 73% (712.5 billion won), while foreign loans amounted to 27.9% (271.7 billion won). Financing from the city's own coffers was just 10.6% of the project cost, while the fiscal support amounted to 16.3%.

As the share of fiscal support in Busan Metro Line 1 was just 16.3%, the city has to shoulder a massive fiscal burden. The government established Busan Urban Transit Authority to resolve this quandary, and entrusted the authority with the construction and operation of the Busan Metro lines. For this reason, the authority took leadership

in financing the construction of Busan Metro Line 2. As the third-stage section of Metro Line 2 was constructed as part of the urban development project in Yangsan-si, Korea Land Corporation financed the entire project cost.

<Table 4-4> Financing structure of Busan Metro Line 1

(unit: billion won)

Financing Type		Cost	Remarks
Total		975.1 (100%)	
Subtotal		159.2 (16.3%)	
Fiscal support		103.4 (10.6%)	Transferred from the general account
Borrowed funds	Total	712.5 (73.1%)	
	Fiscal loans	118.2 (12.1%)	Korea Development Bank
	National bonds	95.9 (9.8%)	Subway bonds (compounded interest: 6%)
	Foreign loans	271.7 (27.9%)	Loans in kind, foreign private loans
	Others	226.7 (23.3%)	Floated bonds, foreign exchange borrowed in the country

A total of 1.7394 trillion won was invested in the construction of Busan Metro Line 3. Of this, the share of fiscal support was 53% (923.2 billion won) whereas 47% (816.2 billion won) was financed by Busan City, with 328.9 billion won financed with loans. A total of 1.2616 trillion won was invested in Busan Metro Line 4, which opened to the public in 2011, while the share of fiscal support was 60% and that of the local government was 40%.

<Table 4-5> Financing structure of Busan Metro Line 2

(unit: billion won)

Financing Type		First Stage	Second Stage	Third Stage
Total		1,367.1	1,126.4	361.5
Fiscal support		491	518.2	-
Borrowed funds	Total	336.3	554.8	-
	General account	316.3	378.2	-
	Loans	20	176.6	-
Borrowed from Busan Urban Transit Authority		539.8	94	-
Others (Korea Land Corporation)		-	-	361.5

Busan-Gimhae Light Railway, a privately funded project, cost 774.2 billion won based on the 2000 fixed price. Among them, the private investors shouldered 62.3% (482 billion won) while the remaining 292.3 billion won was equally divided and financed by the central and local governments, respectively. The project cost was 1.3123 trillion won as of the 2011 adjusted price, with 62.4% financed by the private investors, as earlier envisioned. The share of fiscal support was 15.1%, however, lower than that of the local government (21.5%).

<Table 4-6> Financing structure of Busan-Gimhae Light Railway

(unit: billion won)

Financing Type	Total Project Cost	Private Funds	Fiscal Support	Local Funds	Others
As of the 2000 fixed price (planned amount)	1,367.1	1,126.4	1,126.4	1,126.4	361.5
As of the 2011 adjusted price (actual amount)	491	518.2	518.2	518.2	-

2.2 Financing of the Urban Railway Projects in Other Cities

A total of 1.4597 trillion won was invested in the Daegu Metro Line 1 project. The share of fiscal support was 26.3%, that of the municipal funds was 20%, and the borrowed funds amounted to 53.7% (783.4 billion won). Among the loans, 457.3 billion won was financed by the issue of bonds whereas 155 billion won was financed by the fiscal loans. A total of 2.333 trillion won was invested in the Daegu Metro Line 2 project. The share of fiscal support was 48.5%, that of the municipal funds was 24.5%, and that of the loans was 27%. Among the loans, 251.6 billion won was financed from the Public Capital Management Fund[7], bigger than the 233.9 billion won financed through the issue of bonds.

The Incheon Metro Line 1 project cost 1.69 trillion won. The share of fiscal support was 35.1% (593.6 billion won), that of the municipal funds was 29.1% (491.9 billion won), and that of the loans was 35.8% (604.5 billion won). Meanwhile, the construction of the Songdo extension of Metro Line 1 cost 680.5 billion won. Of

7) A public capital management fund established by the government to secure and provide the funds needed for public purposes, such as for fiscal loans, and to effectively manage the issue and repayment of bonds.

this, the share of fiscal support was 67.5% (408.3 billion won). The share was that high because the project was executed in close association with the development of Songdo International City. A total of 204.6 billion won was financed by municipal funds whereas the share of borrowed funds, including the issue of subway bonds, was roughly 10% (67.6 billion won).

The Gwangju Metro Line 1 project cost 2.647 trillion won. The share of fiscal support was 50.1% (1.3266 trillion won) and that of the municipal funds was 9.6% (252.8 billion won). As the share of loans was 40.3% (1.675 trillion won), the city had to bear a significantly high capital expenditure.

Daejeon City initially planned to finance the city's urban railway project with fiscal support, bonds, and other sources, including the gains from the railway station sphere development and foreign loans. Right after the start of the construction of Metro Line 1, however, the city's financing endeavor stumbled upon the Asian financial crisis and less-than-expected local tax incomes. While 50% of the total cost had to be financed with municipal funds, this was difficult to realize. The issue of bonds was not easy either. To tackle the financial gridlock and to complete the project on time, the city instead adopted a BLT-(build, lease, and transfer)-type private leasing arrangement, where the project developer constructs the facility by raising funds and leases it to Daejeon City for a certain period.

The amounts of the fiscal support provided to the urban railway projects in Daegu, Incheon, Gwangju, and Daejeon are different despite the fact that all of them started in the 1990s because the guidelines for fiscal support varied over time. In the early 1990s, the share of fiscal support was about 30% (subsidies, 15%; fiscal loans, 15%), but it was changed to 30% subsidies in 1996. It was changed again to 50% subsidies in 1998 and to 60% subsidies in 2005. For the fiscal support granted to the urban railway projects conducted between 1990 and 2004, the government paid the difference between 60% of the project budget and the actual amount of fiscal support given back in those years so that the beneficiaries can use the amount to pay back the principal and interest of the debt.

<Table 4-7> Financing structure of the urban railway projects in other cities

(unit: million won)

Financing Type		Daegu		Incheon	Gwangju	Daejeon
		Metro Line 1	Metro Line 2	Metro Line 1	Metro Line 1	Metro Line 1
Total		1,459.7	2,333	1,690	2,647	1,884.9
Fiscal support		383.6	1,132.7	593.6	1,326.6	948
Municipal funds	Total	292.7	570.8	491.9	252.8	178.4
	Transferred from the general account	272.9	513.3	399.5		
	Other incomes	19.8	57.5	92.4		
Borrowed funds	Total	783.4	629.5	604.5	1,067.5	758.5
	Fiscal loans	155	251.6	149	192.2	75.6
	Subway bonds	457.3	233.9	343.1	777.3	370.6
	Bank loans	50	110	-	8	297.3
	Others	121.1	285.6	112.4	90	15

3. Overcoming the Barriers

3.1 Lack of Experience in Urban Railway Construction

As the construction of an urban railway is an integrated technology project that involves such varied sectors as civil engineering, construction, electricity, signaling, communications, and rolling stocks, specialized knowledge on each area is essential. For a country that lacks experience in the design and construction of urban railways, it is not an easy task. As the subways were mostly built underground, the precise construction was crucial as mistakes are irrevocable once made.

During the construction of Seoul Metro Line 1, the engineers sometimes met tricky zones riddled with complicated technological challenges as they had to dig deep along the city center packed with buildings and road traffic. An exaction and a cover-up had to be done in a phased manner to protect the buildings and cultural assets along the roads, to ensure safety when digging across the streams and rivers and to ease the roadway congestion. To keep the key urban functions working, the construction had to be executed without interfering with the utility pipes and various

cables buried underneath.

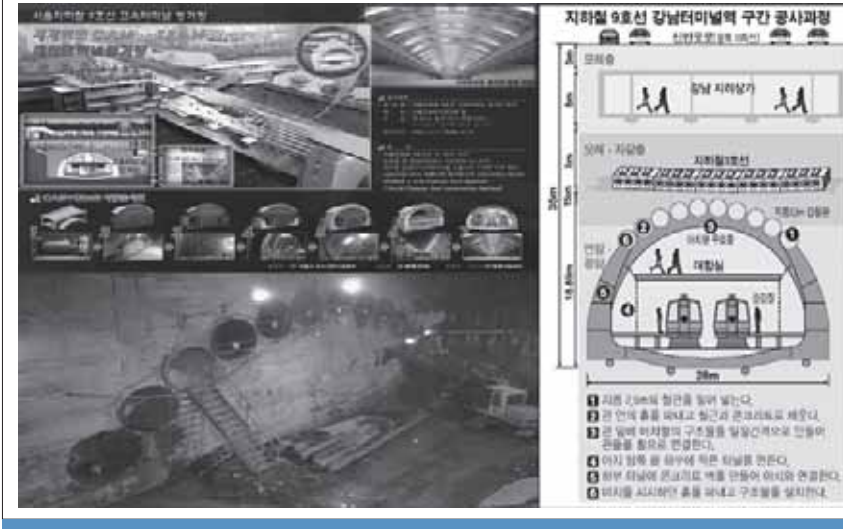
The Japanese research team originally considered sending its own team of engineers to Seoul for the construction of Seoul Metro Line 1 if the South Korean staff had no adequate technological prowess to construct the subway themselves. In the end, however, much of the construction and engineering, except for the high-tech areas like rolling stocks and signaling, was carried out by the South Korean engineers armed with their own technology, with the role of the Japanese limited to the supervision of the project. The same specifications employed in laying down the conventional catenary wires were used, and in the process, the engineers who formerly worked at National Railroad Administration were invited to do the task. Meanwhile, the subway superstructure was designed by relying on the knowledge about railways, roads, and structural engineering. Even though the trains and operating equipment were imported, all the other construction supplies were procured domestically. From the planning to the design stage, the entire construction and engineering was carried out using domestic equipment, saving a massive amount of foreign currency while at the same time increasing the use of the local heavy construction equipment.

During the earthwork of the construction, the engineers met some challenging sections, but they went ahead with these and successfully completed the construction by employing some cutting-edge technologies or homegrown engineering know-how. Some key engineering examples are as follows:

- The construction in the city center section of Seoul Metro Line 3 and 4, for instance, was particularly challenging as many buildings were cramped in a narrow space and as various utility pipes, cables, and other equipment were buried underground. Furthermore, the excavation-from-the-surface method was not applicable as the construction workers had to dig under Seoul Metro Line 1 and 2. NATM, an advanced tunnel boring technique at the time, was employed to address the problem.
- In the case of Busan Metro 1, the engineers had to dig under the reclaimed ground located under the seawater, making it necessary to introduce the ‘‘slurry wall method’’ during the excavation for the first time in the country.
- The tunnels of Gwangju Metro Line 1 had to pass below the underground malls and packed buildings in the city center. To prevent cave-in or cracks, a shield

tunnel boring machine armed with a 7.38-m-radius shield, the largest in the South Korean construction history, was used.

- The Yeoui Naru-Mapo Station leg of Metro Line 5 was designed to pass under Han River by boring a tunnel, but the section was riddled with underground water and a fragmental zone of faults. For all the challenges, the tunnel was built anyway after six years of relentless construction, all with local technologies.
- The engineers of Seoul Metro Line 9 had to overcome various hurdles along the line with their own technology, especially in Express Bus Terminal Station, where the Gangnam underground shopping arcade built just 15 cm above the construction site 25 years ago, as well as the existing Metro Line 3, posed some difficult engineering challenges as the cramped space soaked with underground water had to be dug into. They completed the construction anyway by applying a special engineering technique that combined TRcM and CAM for the first time in the world.



<Figure 4-1> Engineering techniques employed in the construction of Seoul Metro Line 9 Express Bus Terminal Station

3.2 Delay in the Schedule Due to Civil Complaints

The construction of a subway took five to seven years, setting off a barrage of civil complaints. In the early stage of the construction, the complaints were generally on the issue of private interests, such as the request for an extension or change of

the lines and stations, or the demand that the construction method be changed to tunneling from excavation from above the surface. During the full-scale construction stage, however, the complaints spanned a variety of issues, such as the safety measures, the environmental precautions against the noise, the quake and dust, and the compensation for the deteriorating traffic flow, the cracks in the building, or the damage to the businesses. There was also opposition to the expropriation of land or condominium leasehold. In the completion stage, the complaints mainly involved downright opposition to the construction of vents or a demand that the location of the vents be changed, that additional exits be created or that the planned exits be relocated, or that certain convenient facilities be installed.

A closer look at the data would show that most of the complaints were simple ones posed mostly by individuals. If they concerned the route and location of a station, however, as well as various facilities, such as exits and vents, the complaints persisted, often leading to a formal petition or a courtroom fight.

The construction of Seoul Metro Line 2 saw about 8,000 civil complaints, for instance, but the number tapers down to 5,400 if the repeat complaints are counted out. The key complaints were mostly about worries over the potential deterioration of the quality of life during and after the construction, and damage to the privately owned property, as the subway had to go under the apartment complexes and residential areas, or the elevated rail tracks sometimes passed near the residential blocks. Meanwhile, the excavation often set off a leakage of underground water, leading to complaints and requests for the repair of the damaged buildings or for compensation for the dried underground waters. There were also plenty of complaints about inadequate safety precautions and environmental damage as well as those for or against the construction of urban railway facilities.

The local government sought to make its constituents understand the issues by publicizing the legitimate selection process of metro lines and the positive impact of the metro project on the local economy. With regard to the request for a change of line, the local government persuaded its constituents against it by pointing to its technical impracticality or to its potentially detrimental impact on the efficiency of the finished lines.

Regarding the safety and environmental issues that worried the residents, the contractors minimized the construction vibration by using a machine drilling technique or compartmentalized detonation while improving the safety using precision measurements. Moreover, to minimize the vibration during the train operation, extra-long rail tracks were laid down together with vibration-absorbing sleeper pads and soundproof walls.

In 1992, the legal ground of the compensation for the right of underground usage was secured. The acquisition of the land was in principle negotiated through a compensation scheme, but if the landlord rejected the offer, the construction went ahead after an arbitrated expropriation of the land. Thanks to these efforts, 57% of the complaints posed during the construction of the second-phase metro lines were accepted while 34% of them were resolved through negotiations and persuasion.

3.3 Accidents Due to Negligence During the Construction

The early stage of the construction of the first-phase metro lines saw not a few safety accidents. A total of 133 workers were killed on the construction sites, especially within two to three years after the groundbreaking, with the cause of the deaths varying from electric shock and falling rocks to landslides. The falling rocks and landslide, representing of the more serious accidents, were caused by the inadequate safety precautions or the lack of preliminary reinforcement during the excavation of the earth or the blasting of rocks. Besides causing human and material damages, it also delayed the construction schedule and added to the cost of the project. The second-phase Seoul Metro construction saw similar types of accidents. In the case of Seoul Metro Line 5, for instance, a total of 55 workers were killed during the seven-year construction, 35 of them within three to four years, with the cause of death varying from falls, falling rocks and debris, and accidents involving the construction equipment.

After a series of accidents, the contractors took the responsibility for the safety management. The newly reinforced safety management team intensified the safety precautions, and the construction went ahead with the ‘‘safety first’’ mindset. The girders supporting the utility pipes and cables were extensively reinforced while the detonation process was standardized and the block-type excavation technique was

employed to ensure flawless construction. The technicians and onsite workers were educated about safety precautions and took tests, strengthening their safety mindset.

In the meantime, a tragic fire set off in the train car by an arsonist killed 192 passengers and injured 148 in Deagu Metro Line 1, highlighting the absence of a safety management system in the country's urban railways and the insufficient safety standards of the train cars. Following the disaster, the government issued an order for the interior materials of urban and metropolitan railcars to non-flammables, and tightened the safety standards of facilities, train cars, and the operation of urban railways, markedly reducing the number of safety accidents in the operation of the urban railways.

3.4 Electric System Incompatible with the Metropolitan Railway

While Seoul Metro Line 1 was being constructed, debates raged on the choice of electric system. As the trains running on the metropolitan railways were powered by a 25,000 V alternate current, it was recommended that the same voltage be chosen if subway cars were to also run on those tracks. The 1,500 V direct current, however, is known to be optimal for the railcars' running tracks inside the city. Railway officials could not agree on the best system, but in the end the 1,500 V direct current system prevailed. Accordingly, the railcars running along the metropolitan railways via Seoul Metro Line 1 had to be changed to be compatible with both the alternate and direct current, while the trains had to rely on the inertial momentum when running on the dead section installed on both ends of Seoul and Cheongryangri Station, where Metro Line 1 and the metropolitan rail are linked.

Seoul Metro Line 3 and 4 also faced the same problem. Gwacheon Line was originally designed to be compatible with Seoul Metro Line 4, but in terms of the train operation mode and electric current, it was quite different from Metro Line 4. As the operators of both lines failed to come up with a compromise, an X-type crossing tunnel was built in the Namtaeryeong-Seonbawi section, where the two lines are linked, while train-sets compatible to both alternate and direct current are running along the two lines. Ilsan Line was built, however, with a 1,500 V direct current system in the first place, eliminating the hurdle in linking it directly with Seoul Metro Line 3.

So as not to repeat the mistake of having invested excessively in railcars that can run on both alternate and direct currents, the second-phase lines were designed from the outset without any consideration for a potential connection with the metropolitan railways. The different architecture of both systems led to an incompatibility between the rail cars running on the metropolitan railways and those running on the second-phase Seoul Metro lines. To link the two separate railway systems, the construction of costly extension line is necessary.

3.5 Other Barriers

As the superstructure of the subways is made mainly of reinforced concrete, the construction is impossible without the adequate supply of rebar and ready-mixed concrete. About a couple of years after the start of the construction of Seoul Metro Line 1 in 1971, the price of rebar jumped due to the shortage of scrap iron in 1972 and the subsequent oil shock in 1973. Whenever there was a price hike, the construction was suspended due to the shortage of rebar. The government intervened to resolve the gridlock, persuading the suppliers via Public Procurement Servic1e to provide the rebar first and to be paid the bills later, according to the price guideline negotiated through government arbitration. Thanks to this extraordinary measure, the construction could go ahead without a break.

Meanwhile, to protect the cultural assets from the vibration caused by the construction and operation of urban railways, some special engineering techniques that do not generate vibrations were used for the construction near Namdaemun and Dongdaemun. As the station was built near Dongdaemun, an extraordinary precaution was required to protect the valuable cultural asset. Non-vibration explosives were used for the construction while protective devices were installed to block or reduce the vibration from the detonation. Moreover, vibration-proof facilities were installed in the stations to prevent vibration during the railway operation, and vibration-proof walls were built outside the stations. During the construction, the displacement of the constructed structures and the earth pressure and underground water level were constantly gauged and monitored.

Chapter 5.

Results of the Urban Railway Development and Implications for the Future Projects

1. Construction of a World-Class Urban Railway Infrastructure

1.1 Urban Railways in Operation

South Korea has constantly built urban railways since the 1970s to resolve the problems facing the urban mass transits resulting from the country's rapid industrialization and urbanization. Thanks to the efforts of the government, 19 metro lines totaling 571.6 km are currently under operation all over the country as of late 2011. Environment-friendly and energy-efficient, the urban railway is still attracting people's attention. The country has kept expanding its urban railway network by introducing adequate railway systems that can achieve maximum operation efficiency.

Seoul, a city with 10 million people, has nine metro lines in operation, adding up to 316.9 km. Seoul Metro and Seoul Metropolitan Rapid Transit Corporation, two local corporations controlled by the city, operate Metro Line 1-4 and Metro Line 5-8, respectively. The railcars running on these lines are mid-sized trains. Seoul Metro Line 9, which was opened to the public in 2009, was funded by private investors with regard to the construction of stations and acquisition of rolling stocks. Currently being run by a private operator, mid-sized trains are running on the line, which are narrower and shorter than the prevalent large trains. Meanwhile, the construction of a 10.3-km extension of Seoul Metro Line 7 to Bucheon and Incheon is under way, along with the light railway project between Wooui and Shinseol.

Busan, a city with 3.57 million people, has four lines in operation, adding up to 107.8 km. All the lines were financed by fiscal support and are being operated by Busan Transportation Corporation, an umbrella local corporation of the city. Mid-

<Table 5-1> South Korean urban railways in operation as of late 2011

City	Operator	Line	Total Length (km)	No. of Stations	Route	Type of Rolling Stocks
Total		19	571.6	554	-	-
Seoul: 9 lines	Seoul Metro	Line 1	7.8	10	Seoul Station-Cheongryangri Station	Large train
		Line 2	60.2	50	Seongsu-Seongsu	〃
		Line 3	38.2	34	Jichuk-Ogeum	〃
		Line 4	31.7	26	Danggogae-Namtaeryeong	〃
	Seoul Metropolitan Rapid Transit Corp.	Line 5	52.3	51	Banghwa-Sangil, Macheon	〃
		Line 6	35.1	38	Eungam-Bonghwasan	〃
		Line 7	46.9	42	Jangam-Onsu	〃
		Line 8	17.7	17	Amsa-Moran	〃
	Seoul Metro Line 9	Line 9	27.0	25	Gaehwa-Shinnonhyeon	Mid-sized train
	Subtotal		316.9	293		
Busan: 5 lines	Busan Transportation Corporation	Line 1	32.5	34	Nopodong-Shingpyeong	Mid-sized train
		Line 2	45.2	43	Jangsan-Yangsan	〃
		Line 3	18.1	17	Daejeo-Suyeong	〃
		Line 4	12.0	14	Minam-Anpyeong	Rubber-wheeled AGT
	Busan-Gimhae Light Rail Transit Co., Ltd.	Busan-Gimhae Light Rail	22.6	21	Sasang-Samgye	Steel-wheeled AGT
	Subtotal		130.4	129		
Daegu: 2 lines	Daegu Metropolitan Transit Corporation	Line 1	25.9	30	Daegok-Anshim	Mid-sized train
		Line 2	28.0	26	Munyang-Sawol	〃
	Subtotal		53.9	56		
Incheon	Incheon Transit Corporation	Line 1	29.4	29	Gyeyang-Songdo International Business District	Mid-sized train
Gwangju	Gwangju Metropolitan Transit Corporation	Line 1	20.5	20	Nokdong-Pyeongdong	〃
Daejeon	Daejeon Metropolitan Transit Corporation	Line 1	20.5	22	Panam-Banseok	〃

sized trains are running on Metro Line 1 to 3 whereas the locally developed rubber-wheeled AGT (auto-guided transit) trains are running on the track of Metro Line 4, which opened in 2011. On the other hand, the 23.9-km-long Busan-Gimhae light railway was constructed with funding from private investors. Opened in 2011, the steel-wheeled AGT trains are running on the track.

Daegu, a city with 2.51 million people, has two lines in operation, adding up to 53.9 km. Both lines were built financed by fiscal support, and is being run by Daegu Metropolitan Transit Corporation, an umbrella corporation of the city. Mid-sized trains are running on the track while Daegu Metro Line 3 (23.9 km), currently under construction, will have a type of monorail track.

Incheon, a city with 2.75 million people, has one line (29.4 km) and was built financed by fiscal support. Mid-sized trains are running on the track. Incheon Metro Line 2, currently under construction, will have steel-wheeled ATG trains running on a 29.3-km track. Gwangju, a city with 1.45 million people, and Deajeon, a city with 1.5 million people, have a 20.5-km line, respectively, and were built financed by fiscal support. The two lines are being run by Gwangju Metropolitan Transit Corporation and Daejeon Metropolitan Corporation, respectively. Mid-sized trains are running on the two lines.

1.2 Metropolitan Railways in Operation

The Special Law on Metropolitan Transportation Management defines the metropolitan railway as a railway that deals with the daily traffic of more than two metropolitan cities or a railway that links them together. The metropolitan railway is also defined based on its capability: a transport mode that can get a person to the center of a central city in one hour, at the scheduled speed of 50 km/h and within a 50-km radius. The metropolitan railways being operated by KORAIL in the greater Seoul area, however, are also included in the category on top of those stipulated by the law.

8) The greater Seoul area encompasses Seoul-si, Incheon-si and Gyeonggi-do, with a combined population of 24.86 million as of 2010.

Twelve metropolitan lines totaling 554.2 km are currently in operation in the greater Seoul area.[8] Among them, ten lines totaling 478.9 km are being run by KORAIL, and Incheon International Airport Railway (58 km) is being run by KORAIL Airport Railroad Co., Ltd. New Bundang Line, which was constructed and funded by private investors, has been run by a private operator since its opening in 2011.

A variety of signaling systems are in place for the operation of the metropolitan railways. For the four-track electric metropolitan railways converted from the conventional rails, the ATS (automatic train stop) system was installed along the track to stop the trains in an emergency. Besides ATS, the ATP (automatic train protection) system was installed in Gyeongbu and Gyeongchun Line to protect the trains. Ilsan and Gwacheon Line, however, which are linked with the Seoul

<Table 5-2> Metropolitan railways in operation as of late 2011

Line	Operator	Total Length (km)	No. of Stations	Route	Signaling System
Total		554.2	215		
Gyeongbu (Janghang) Line	KORAIL	122.9	45	Seoul-Cheonan (Shinchang)	ATP
Gyeongin Line		27.0	20	Guro-Incheon	ATS
Gyeongwon Line		42.9	24	Soyosan-Cheongryangri (underground station)	〃
Joongang Line		71.2	24	Yongsan-Yongmun	〃
Ansan Line		26.0	13	Oido-Geumjeong	〃
Gwancheon Line		14.4	8	Namtaeryeong-Geumjeong	ATC
Bundang Line		27.7	20	Seolleung-Bojeong	〃
Ilsan Line		19.2	10	Jichuk-Daehwa	〃
Gyeongui Line		46.3	18	Seoul-DMC-Munsan	ATS
Gyeongchun Line		81.3	18	Sangbong-Chuncheon	ATP
Airport Railway	KORAIL Airport Railroad Co., Ltd.	58.0	9	Seoul Station-Incheon Int'l Airport	ATO
New Bundang Line	Neotrans Co., Ltd.	17.3	6	Gangnam-Jeongja	CBTC

Metro lines, were further upgraded with the installation of the ATC (automatic train control) system, while the airport railway was equipped with the ATO (automatic train operation) system, which enables the trains to operate automatically. The CBTC (communication-based train control) system was introduced to New Bundang Line, which opened in 2011. The system allows the control center to remotely operate the trains, eliminating the need for locomotive engineers.

2. Establishment of the Urban-railway-centered Transportation

2.1 Urban Railways in Operation

2.1.1 Seoul Metro lines in operation

The first-phase Seoul Metro lines, operated by Seoul Metro, have ten-car train sets running on the track at 2.5- to 3-min intervals during the peak hours, supplying the largest transportation capacity in the country.

Metro Line 2 transports over two million passengers a day along the 60-km-long track, the largest number of passengers carried by a single line. Metro Line 1, the first urban railway in the country, has only a 7.8-km-long track but still transports 57,000 daily passengers per km, the largest in the country, because the line is directly linked with the metropolitan railways. Metro Line 3 and 4 are connected with Ilsan and Gwacheon Line, respectively, transporting over 20,000 daily passengers per km.

The second-phase Seoul Metro lines, operated by Seoul Metropolitan Rapid Transit Corporation, have six- to eight-car train sets running on the track at 2.5- to 6-min intervals during the peak hours. The number of daily passengers per km being carried by each line is between 13,000 and 18,000, smaller than that of the first-phase Seoul Metro lines. The reason that the number is smaller compared to the total length is that the lines detour frequently and are not linked with the metropolitan railways.

Metro Line 9, a privately funded line, has four-car train sets running on the track at 5-min intervals during the peak hours. Unlike the other lines, Metro Line 9 operates

<Table 5-3> Seoul Metro lines in operation as of late 2010

Category		Total	Seoul Metro				Seoul Metropolitan Rapid Transit Corporation				Seoul Metro Line 9
			Line 1	Line 2	Line 3	Line 4	Line 5	Line 6	Line 7	Line 8	Line 9
Route		9 Lines	Seoul Station - Cheongryangri	Seongsu - Seongsu	Jichuk - Ogeum	Danggogae - Namtaeryeong	Banghwa - Sangildong Macheon	Eungam - Bonghwasan	Jangam - Onsu	Amsan - Moran	Gaehwa - Shin-nonhyeon
Distance (㎞)		316.9	7.8	60.2	38.2	31.7	52.3	35.1	46.9	17.7	Local: 27.0 Express: 23.4
No. of stations		293	10	50	34	26	51	38	42	17	25
Trip hours (min)		-	16	87	67.5	53	84~88	70	87	31.5	Local: 52 Express: 30
No. of cars		3,611	160	834	490	470	608	328	499	126	96
Trains per day		424 (4-10)	16 (10)	88 (4-10)	49 (10)	47 (10)	76 (8)	41 (8)	62 (8)	21 (6)	24 (4)
Dispatch interval (min)	Off-peak	-	4.0	6.0	6.5	5.5	6.0	8.0	6.0	8.0	Local: 10.0 Express: 20.0
	Peak	-	3.0	2.5	3.0	2.5	2.5-3.0	4.0-5.0	2.5-4.0	4.5-6.0	Local: 6.7 Express: 20.0
Scheduled speed (㎞/h)		-	29.3	33.6	34.0	35.8	32.3	30.1	32.3	33.7	Local: 31.2 Express: 46.8
Daily passengers (1000/day)		6,703	450	2,005	755	832	812	487	865	231	266
Annual passengers (million)	Transported	2,447	164	732	275	304	296	178	316	84	97
	On-board	1,769	108	554	199	227	212	121	227	58	63
	Inflow	678	57	178	76	76	85	56	89	27	34

both express and local trains. The local trains run at the scheduled speed of 31 km/h, the same speed as with the other lines, but the express trains, which stop only at the selected stations using a siding track, run at the scheduled speed of 46 km/h.

2.1.2 Urban railway in operation in the local metropolitan cities

Among the local metro lines, eight-car train sets are running only in Busan Metro Line 1 (operated by Busan Transportation Corporation) and Incheon Metro Line 1 (operated by Incheon Metro). The four-to six-car train sets are running on other local metro lines. The trains run at 4-to 7-min intervals, supplying a relatively smaller transportation capacity.

The daily number of passengers per km is 7,800 in the Busan metro lines, 7,500

in the Incheon metro lines, 5,800 in the Daegu metro lines, and 5,000 in both the Gwangju and Daejeon metro lines. The number is smaller in these cities than in Seoul because the traffic congestion in such cities is not as serious as that in Seoul, where the urban railway network has yet to be completed.

2.1.3 Metropolitan Railways in Operation in the Greater Seoul Area

Among the metropolitan railways being operated by KORAIL, ten-car train sets are running on the track of Gyeongbu, Gyeonin, and Gyeongwon Line, which serve numerous passengers, as well as Gwacheon, Ansan, and Ilsan Line, which are linked with the Seoul Metro lines. Gyeongchun Line has eight-car train sets running on the track because the line's total length and dispatch interval are relatively long. On the contrary, Bundang Line has six-car train sets running on the track at 4-min intervals during the peak hours. Gyeongui and Joongang Line both have four-car train sets running on the track because the demand is low.

Gyeongin Line has four-track rails capable of operating both express and local trains on the dedicated track at the same time. Thanks to this design capacity, over

<Table 5-4> Urban railways in operation in the local metropolitan cities as of late 2010

Category		Busan Transportation Corporation				Daegu Metropolitan Transit Corporation			Incheon Metro	Gwangju Metropolitan Transit Corporation	Daejeon Metropolitan Transit Corporation
		Total	Line 1	Line 2	Line 3	Total	Line 1	Line 2			
Route		3 Lines	Shin-pyeong - Nopo	Jangsan - Yangsan	Suyeong - Daejeo	2 Lines	Daegok - Anshim	Munyang - Sawol	Gyeyang - Int'l Business District	Nokdong - Pyeong-dong	Panam - Banseok
Distance (㎞)		95.8	32.5	45.2	18.1	53.9	25.9	28.0	29.4	20.5	20.5
No. of stations		94	34	43	17	56	30	26	29	20	22
Trip hours (min)		-	62	84	34	-	50.5	49	54	38	40
No. of cars		776	360	336	80	384	204	180	272	92	84
Trains per day		121 (4-8)	45 (8)	56 (6)	20 (4)	64 (6)	34 (6)	30 (6)	34 (8)	23 (4)	21 (4)
Dispatch interval (min)	Off-peak	-	6.0	6.5	7.0	-	7.0	7.0	8.5-10.0	10.0	10.0
	Peak	-	4.0-4.5	4.5	5.0-5.5	-	5.0	5.0	4.5-6.0	5.0-7.0	5.0-6.0
Scheduled speed (㎞/h)		-	31.5	32.3	31.9	-	30.8	34.3	32.6	34	30.8
Daily passengers (1000/day)		753	413	265	75	316	171	145	220	48	97
Annual passengers (million)	Transported	275	151	97	27	115	62	53	80	17	35
	On-board	275	151	97	27	115	62	53	61	17	35
	Inflow	-	-	-	-	-	-	-	19	-	-

Note: Excluding Busan Metro Line 4 and Busan-Gimhae Light Railway

200 express trains per day can run both ways. Gyeongbu Line, the line that boasts the largest capacity, can operate express trains by using siding tracks laid down on the surface section, but it has only 30 express trains running on the track both ways due to its limited capacity. As Gwacheon, Bundang, and Ilsan Line have most of their tracks buried underground and are not equipped with any siding track, express trains cannot run on these lines.

<Table 5-5> Metropolitan railways in operation as of late 2010

Category		Total	Gyeongbu Line	Gyeongin Line	Gyeongwon Line	Joongang Line	Ansan Line	Gwacheon Line	Bundang Line	Ilsan Line	Gyeongui Line	Gyeongui Line	Airport Railway
Route		-	Seoul - Cheon-an	Guro - Incheon	Soyosan - Cheong-ryangri (under-ground)	Yong-san - Yong-mun	Oido - Geum-jeong	Geum-jeong - Nam-taeryeong	Jichuk - Daehwa	Seoul - Munsan	Sangbong - Chun-cheon	Sangbong - Chun-cheon	Seoul - Incheon Int'l Airport
Distance (㎞)		536.9	122.9	27.0	42.9	71.2	26.0	14.4	27.7	19.2	46.3	81.3	58.0
No. of stations		209	45 (6)	20	24	24	13	8	20	10	18	18	9
Trip hours (min)			140	46.5	66	89	35.5	22.5	46	27.5	59.5	79	53.0
No. of cars		2,414	550	480	200	168	300		168	160	112	120	156
Trains per day (standard)		277	58 (10)	48 (10)	20 (10)	21 (4, 8)	30 (10)		28 (6)	16 (10)	15 (4, 8)	15 (8)	26 (6)
Dispatch interval (min)	Off-peak		7.1	5.2	5.3	14.6	8.7	9.2	7.0	8.6	14.6	30.0	6.0
	Peak		6.0	2.7	4.0	8.6	6.0	5.5	4.1	6.0	12.0	10.0	6.0
Total operation		2,735	441	507	31	176	277		340	270	152	137	422
Scheduled speed (㎞/h)			Local: 49.7; Express: 55.0	Local: 34.8; Express: 51.9	39.9	48.0	43.9	38.4	36.1	41.9	46.7	61.7	65.7
No. of passengers	Year(million)	958.9	269.9	201.4	159.0	29.7	56.7	52.7	110, 3	49.0	19.4	0.6	10.0
	Daily average (1000)	2,677.5	739	552	436	82	155	144	302	134	53	53	27.5

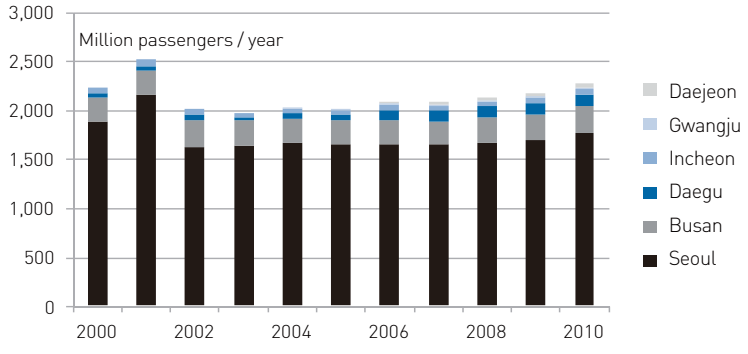
Note: Excluding New Bundang Line

2.2 Current Use of Urban Railways

Since the opening of Seoul Metro Line 1 in 1974, the annual number of subway passengers passed the 2 billion mark in 1999, when the construction of the second-phase Seoul Metro lines was completed. Helped by the opening of the local metro lines in the 2000s[9], the number of subway passengers grew consistently to 2.273 billion in 2010. The share of the urban railway passengers in Seoul accounts for nearly 80% of the total transit passengers in the city.

9) The transfer passengers between Seoul Metro and the Seoul Metropolitan Rapid Transit lines were doubly counted in 2001.

As Seoul has a well-developed network of urban and metropolitan railways, the proportion of railway passengers in the city is quite high - about 35.2% as of 2009, the highest in the country. Including the share of the public bus, the mass transit accounts for 63% of the total urban transportation, as is the case in many metropolitan cities in advanced countries.



<Figure 5-1> South Korean urban railway passengers by year

The share of the urban railways in the mass transit, however, is 12% in Busan, 8% in Daegu, and 6% in Incheon, with a significantly low share found in Gwangju and Daejeon[10]. The share varies greatly by city because each city has a varying degree of urban railway infrastructure constructed so far. Seoul, for instance, has nine urban and 11 metropolitan railways in operation, but Daejeon and Gwangju have only one each. Accordingly, the continued construction of urban railways is necessary to raise the passenger share.

The share of the urban railways in the mass transit, however, is 12% in Busan, 8% in Daegu, and 6% in Incheon, with a significantly low share found in Gwangju and Daejeon Gwangju-si and Daejeon-si each has the 1st stage of the city's metro line 1 up and running as of 2012.

10) Gwangju-si and Daejeon-si each has the 1st stage of the city's metro line 1 up and running as of 2012.

<Table 5-6> Passenger share of urban transportation in Seoul by transit type

Year	Total	Subway	Bus	Taxi	Car	Others
2003	100 (%)	35.6	25.6	7.1	26.4	5.3
	29.38 million/day	1,046	752	209	775	156
2004	100 (%)	35.8	26.2	6.6	26.4	5.0
	30.34 million/day	1,086	795	200	801	152
2005	100 (%)	35.9	26.8	6.2	26.3	4.8
	31 million /day	1,079	853	202	815	152
2006	100 (%)	34.7	27.6	6.3	26.3	5.1
	31.2 million/day	1,086	861	197	821	159
2007	100 (%)	34.9	27.6	6.2	26.3	5.0
	31.51 million/day	1,100	870	195	829	158
2008	100 (%)	35.0	27.8	6.2	26.0	5.0
	31.71 million/day	1,110	882	197	824	159
2009	100 (%)	35.2	27.8	6.2	25.9	4.9
	31.95 million/day	1,125	888	198	828	157

Source: Homepage of Seoul City Urban Infrastructure HQ

The share varies greatly by city because each city has a varying degree of urban railway infrastructure constructed so far. Seoul, for instance, has nine urban and 11 metropolitan railways in operation, but Daejeon and Gwangju have only one each. Accordingly, the continued construction of urban railways is necessary to raise the passenger share.

<Table 5-7> Passenger share of urban transportation by transit type in the local metropolitan cities

(unit: 1000 /day)

City	Category	Cars	Taxi	Bus	Rail	Total
Busan	Traffic	2,103	903	2,046	667	3,492
	Share	37%	16%	36%	12%	100%
Daegu	Traffic	1,800	460	944	288	3,417
	Share	52%	13%	27%	8%	100%
Incheon	Traffic	1,494	405	1,301	217	1,887
	Share	44%	12%	38%	6%	100%
Gwangju	Traffic	1,016	289	553	30	2,343
	Share	54%	15%	29%	2%	100%
Daejeon	Traffic	1,311	329	668	35	159
	Share	56%	14%	28%	1%	100%

Source: KTDB

2.3 Creation of Social Welfare

The construction and operation of urban railways in the urban transit network shifted the road traffic to rails, easing the congestion. The consequent speeding up of the road traffic shaved off the driving hours of automobiles on the road, thus cutting the vehicle operating cost. The biggest benefit earned from the construction of urban railways, the reduction of travel hours, accounts for over 60% of all the benefits. A category of driving performance, the ‘‘vehicle operation cost’’ is closely associated with the road, traffic, and geographic conditions, and with the road shape. Generally speaking, the faster the vehicle runs on the given road, the more fuel-efficient it becomes. Accordingly, the construction of urban railways leads to road traffic reduction, which accelerates the speed of automobiles, eventually lowering the vehicle operation cost.

The proliferation of automobiles consistently increased the number of traffic accidents, which are triggered by a combination of factors: traffic facility, driver, vehicle, and environment. Traffic accidents may cause human and material damage, with the human damage including the cost of lost productivity as well as the medical, post-accident administrative, and pain and psychological costs. As the construction of urban railways reduced the road traffic as well as the subsequent traffic accidents, it is creating the benefit of reduced traffic accidents.

The passengers of the conventional railway service had to spend a considerable time transferring to multiple transits while traveling to the railway station. The urban railways, however, remarkably reduced the access time to the final destinations. As there is no congestion on the rail, unlike automobiles, railways are excellent in terms of punctuality. Further, they can play a key role as an alternative transit to the roadway during the cold spell in winter or the thunderstorm in summer.

Other indirect benefits include reduction of the environmental cost, regional development, market expansion, and industrial restructuring. Among these, reduction of the environmental cost has been increasingly highlighted of late as the urban railways effectively reduced the amount of air contaminants per trip mile by reducing the accumulated mileage of automobiles, thus increasing their average cruising speed. The railways are playing a key role in creating social benefits,

especially because they have comparative advantages over other transits in dealing with such global issue as the energy crisis and environmental concerns.[11)]

3. Acquisition of the Advanced Urban Railway Technology Comparable to Those of the Developed Countries

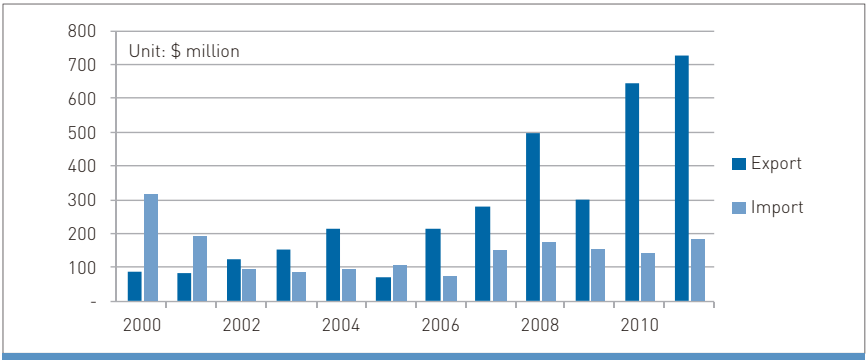
Ever since the first subway train was produced in the country in 1976, the government has pushed for the advancement of homegrown technologies through the localization. Starting with the urban railway standardization project in 1995, the government has also consistently pushed for research and development on urban railway technologies. In the 2000s, the government strove to develop a variety of urban railway systems, primarily to meet the local demand for urban railways and also to develop them as exports. Some of the technologies that the government targeted to develop were advanced urban railway system technologies, the rubber-wheeled light railway technology and commercialization, urban maglev commercialization, and the wireless (catenary-free) low-floor tram.

With the involvement of private funds in the urban and metropolitan railways, a user-friendly urban rail system was realized, and in the process, world-class homegrown design, construction, and information/communication technologies were extensively applied. In Metro Line 9, a subway system was installed to allow the operation of the first express trains in the country, realizing an urban railway system faster than passenger cars. In the case of New Bundang Line, passenger mobility and convenience were improved by designing customer-oriented stations based on advanced information technology, and by introducing an unmanned train operation system.

As a result of the continued efforts by private companies to localize the rail technologies and to commercialize them in the construction and operation of urban railway projects, the country's rail technology has advanced to a level that would qualify it to compete with those of other developed countries, while at the same

11) The energy consumption of a car for transporting one person over a distance of 1 km is five times bigger than that of the rail, while the emission of air contaminants by a car and a bus is estimated to be 200-300 times bigger than that by the rail.

time increasing the exports of the local rail products. The growth of the country's rail product exports in 2005, for instance, outpaced the growth of the country's rail product imports, turning the country into a net exporter of rail products. In the end, the urban railway development policy can be said to have contributed greatly to the advancement of the relevant technologies and to the growth of the country's technology industry.



<Figure 5-2> Export and import of rail products in South Korea

4. Lessons and Implications for the Future Projects

4.1 Important Role of the Central Government

The cases found in and out of the country show that urban rail projects are usually executed by the local governments because the metro rail operates within the city limits. The construction cost of the metro is immense, however, making the role of the central government all the more important, especially in the case of the developing countries. As in the case of the Seoul Metro Line 1 project, where the fiscal situation was not good, the central government can support the project by providing foreign loans amounting to up to 50% of the project cost, or by helping the local government repay the debt that it incurred for the project by issuing subway bonds. In other words, when obtaining direct assistance is difficult, the government can help the local government by devising an indirect apparatus. The country has grown to become a fully developed country, but the government still supports up to 60% of the project cost.

Accordingly, the role of the central government in pushing for urban railway projects is even more critical now than when it was still a developing country. State-level fiscal support is particularly important in the financing of the projects. Due to the limited fiscal resources, however, the government is advised to assume responsibility in acquiring foreign loans or in attracting foreign investments. The government can also streamline the relevant laws and regulations so that the local governments can easily issue bonds for the construction and operation of an urban railway, or it can take care of the process directly to a certain degree.

Setting exceedingly favorable preconditions for foreign or private investors to promote their investment in urban rail projects can backfire, however, as was seen in the case of the light rail projects executed with the involvement of private investors. Especially, applying extremely favorable regulations to the private operator in an attempt to encourage private investment can create serious problems during the operation. Accordingly, urban rail projects involving a third-party fund should be preceded by an extensive feasibility study and the streamlining of the relevant laws and regulations to guarantee their efficient management.

The local case in which the extension of the urban rails or the construction of new metropolitan rails went ahead in line with the development of housing lots merits further study. As the construction of the transit infrastructure was crucial to the success of the housing lot development, the developers were willing to shoulder the financial burden on behalf of the future beneficiaries - the landlords or homeowners in the target area. By so doing, the central and local governments could reduce their respective fiscal burdens dramatically. When such policies are implemented, however, they should also be examined in line with the housing and urban development policy on top of the transportation policy.

4.2 Efforts to Achieve Technological Independence

Urban rail projects are a showcase of high technologies as they involve not just construction and engineering skills but various other industries. The early urban railways in the country were built by emulating the foreign technologies in almost all areas. The Japanese research team originally considered sending its own team of engineers to Seoul for the construction of Seoul Metro Line 1 if the South Korean

staff had no adequate technological prowess to construct the subway themselves. In the end, however, much of the construction and engineering, except for the high-tech areas such as the rolling stocks and signaling, was carried out by the South Korean engineers, armed with their own technologies, with the role of the Japanese limited to the supervision of the project.

The successful completion of the Seoul Metro Line 1 project contributed to advancing the country's civil engineering techniques, but it also gave the country much confidence. In the Seoul Metro Line 2 project, the country's engineers worked day and night at the construction site to learn the advanced foreign technologies and to fine-tune them so they would meet the local conditions, thus establishing an urban railway technology best optimized for the geological features of Seoul's and the country's environments. The subsequent projects in Seoul and in the other local metropolitan cities, coupled with the railway technology development project, gave the country's engineers an opportunity to hone their engineering skills. The country now has capabilities comparable to those of advanced countries, and even goes out to the global market based on the technology it had accumulated.

If a country plans to push for urban rail projects, it will need to seek self-reliance with regard to the technologies to be used, to reduce the construction and operation costs. Some of the early light railway projects in South Korea triggered a heated debate about the project cost because the foreign system to be installed was imported. The operator experienced difficulty even in the operation stage because it had to rely on a foreign company for a certain period in the operation and maintenance of the system. It would thus be better for countries with limited technological prowess to pursue foreign-technology transfer or to train and educate their own engineers.

4.3 Construction of a Competitive Urban Railway System

Before the construction of an urban railway, the responsible parties should come up with a master plan that can address the needs of the target customers. With the rapid proliferation of automobiles and the growing competition between the roadway and the rail, it is now a prerequisite to prop up the demand for urban railways. Many local cities in the country built their own urban rails, but they are bleeding red ink now due to the less-than-expected passenger turnout.

This is happening because the large-scale development planned earlier was not implemented, and because their urban railways were not designed to be excellent in terms of speed and the passengers' access to the stations. Except for the extremely congested regions, simply transporting massive numbers of passengers is not good enough to guarantee its competitiveness. For instance, in the metropolitan areas, where the commute is long, express trains are required to shorten the travel time, but the lack of siding tracks enabled only a limited operation of such trains. Only after the opening of Seoul Metro Line 9 in 2009 did Seoul see the operation of express trains. The passengers' preference for the express train has been shown to be very high.

Accordingly, a country that is planning to build an urban railway should carefully come up with a plan to build a railway that is competitive as well as compatible to the city's characteristics. In the process, the design of the urban railway should encompass the comprehensive aspects of transportation, such as the linkup transits, management of the traffic demand, and the rail technologies, to maximize the impact of the project.

4.4 Role as a People-friendly Transportation

The country's urban railway operators are losing money because their operating income is less than their operating loss. Not only the urban railways in the local metropolitan cities with limited demands but also those in Seoul are recording an operating loss every year, despite the abundant demand. This is because of the policy that controls the urban railway fare as a people-friendly transportation. The fare of the country's urban railways is kept at about 30-50% of the fares in the advanced countries, quite low even after a correction according to the country's per-capita GNP. As the country has a consolidated fare system with buses, the actual fare per trip mile is even lower than those in the advanced countries. Accordingly, it is unlikely that one can earn profits under the current fare system. Furthermore, seniors older than 65, the disabled, and men of national merit are allowed to ride the train free of charge, lowering the profit even more.

It is hard to find an example of an urban railway operator that has realized profitability even in a foreign country though. In most countries, urban railways are

intended to boost the people's welfare in terms of transportation, and to thus create social benefits, rather than to make money. Accordingly, the developing countries are advised to build and operate urban railways as a people-friendly public transportation mode. Excessive loans and operating loss during the railway operation, however, can seriously hamper the project's financial integrity. In the end, adequate regulations and ordinances should be legislated[12] so that a precise estimate of the demand based on the target fare could be made, and so that the design of the matching system can be implemented.

4.5 Conclusion

One of the biggest problems facing the metropolitan cities the world over is traffic congestion. Everybody knows that the construction of urban railways is an excellent solution, with their punctuality, safety, and pollution-free operation. A developing country in the past, South Korea understood, during its economic development, that investment in transit infrastructure is as important as investment in industry. To achieve economic growth, it agreed that it is critical to improve the city's link with its surrounding areas, as well as to reduce the time required to commute between them. In retrospect, the construction of urban railways to fundamentally resolve the worsening traffic congestion in the city due to urbanization and industrialization was a very wise decision. South Korea's urban railways are considered the key social overhead capital supporting the country's socioeconomic development.

With the environmental and energy issues looming large as pressing global concerns, the importance of and interest in railways, including urban railways, are rising fast. The developing countries that aspire to achieve economic prosperity will have to consider building a transit infrastructure such as urban railways to resolve their traffic issues and to realize their potential for economic growth. South Korea is a rare example of a country that has advanced not just its economy but its urban railways to the level of those in the advanced counties. The experience of South Korea in the development of urban railways may turn out to be an excellent model to emulate for many developing countries.

12) In the country, KOTI or Korea Transport Institute is responsible for constructing a national traffic database that can help establish an efficient transportation master plan.

Part - Ⅱ

[2011 Modularization of Korea's Development Experience]

Construction of High Speed Rail in Korea

Government Publications Registration Number 11-1051000-000214-01
ISBN 978-89-93695-72-4 94320
ISBN 978-89-93695-27-4 (SET 40)

Contents

Contents

Contents _ List of Tables

Contents

Contents _ List of Figures

Summary

In the 1980s, transportation facilities such as roads and railroads were already crowded due to the rapid industrialization in the country. The investment in roads alone resulted in limitations in coping with traffic congestion. It was expected that, despite the construction of new expressways or the expansion of existing ones, the soaring number of automobiles would increase corridors with traffic congestions. Thus, a necessity was raised to introduce a new transport mode between Seoul and Busan, and a feasibility study results indicated that it would be appropriate to construct exclusive high-speed passenger railway line along the Gyeongbu corridor. For three years, from 1989 to 1991, a technical survey for the Gyeonbu high-speed rail project was conducted by some governmental research institutes and domestic rail technology-related engineering companies. Based on the results of the technical survey, the construction of Gyeongbu high speed railway line started in June 1992.

In the early stages of the KTX project, rail technology levels in Korea were very low. Despite lack of understanding of and experience in high-speed rail technologies, the country went ahead with the project with inadequately prepared design documents or specifications. Also, the type of cars was determined very late, which required overall complementation of the design and caused much confusion and many trial-and-error efforts. Also, due to the economic crisis in the latter half of the 1990s, the original plan to construct high-speed railway line by 2004 was changed to be wholly constructed by 2010 with partial operation of high-speed train from 2004.

High-speed rail projects require highly advanced technologies, are large-scale, and are highly likely to go through technical difficulties and trials and errors and to face

various difficulties such as NGO complaints in the process. During the high-speed rail project, construction work was stopped many times, which delayed the project, due to various civil complaints in the process of purchasing land and obtaining approval and controversies over the safety of the tunnels passing through areas adjacent to abandoned mines. Notably, the Gyeongju line had to be changed due to environmental civil complaints over the Mt. Cheonseong segment and to conserve heritage sites. The Daejeon and Daegu lines, which pass downtown areas, caused conflicts with relevant groups and municipalities. The central government and the Korea High-speed Rail Construction Authority had the patience and wisdom to persuade and negotiate with stakeholders, however, which helped them overcome these problems.

Despite many such difficulties and trials and errors, the project helped enhance Korea's rail technology level as well as the design and construction technology and the country's profile. Based on such a positive assessment of the KTX, Korea is now making efforts in the construction of new KTX lines as well as the speed upgrade of existing railway lines from the maximum speed of 150 km/h to 230-250 km/h.

To successfully implement large-scale projects such as high-speed rail, it is important to improve the impulsion system with the strong backing of the government. South Korea established an exclusive public agency (the Korea High-speed Rail Construction Authority) to implement the project from the beginning, and the related ministry established a special committee for this purpose (the SOC Infrastructure Construction Impulsion Committee). Another factor for the successful operation of KTX is the accumulated operation knowhow of Korea's national rail operator, Korea railroad. Korea railroad is the only agent that runs the national railway network in Korea with over 100 years of railway operation experience, and even before the introduction of KTX, it has experience in the train operation of 90 million train-km.

For the successful implementation of high-speed rail project, it is also necessary to improve the safety and quality standard. During the construction of high-speed railway line in Korea, huge distrust and suspicion toward the safety and quality of the project almost stopped the project. As a measure to reduce the suspicion and distrust on the safety and quality, it is worth considering having internationally

renowned organizations participate in the construction project as Korean government adopted.

It is inevitable for developing countries to introduce advanced high-speed rail technologies from foreign countries. In this case, it is highly recommended to set up technology transfer strategies to ultimately secure such technologies. They can thus use the secured technologies in constructing and operating additional high-speed rails and in entering overseas rail markets. In introducing foreign high-speed rail technologies, it is recommended for them to consider the technologies' marketability and development possibilities. Also during the introduction of high-speed rolling stocks from foreign countries, they can benchmark the Korean case in which rolling stock cost was reduced and better terms in technical transfer and financial procurement were achieved through the competition among bidding countries.

To increase high-speed rail demand, it is essential to develop an efficient transfer system between modes, such as buses, passenger cars, subways, and etc. It is recommended to develop a transfer system simultaneously with the opening of a high-speed railway line to increase the travel demand and the profitability. Also, high-speed rail stations, if constructed far away from downtown areas, will lower accessibility and weaken competitiveness. Thus, construction of the stations in downtown areas should be positively considered.

Although there have been many complaints and difficulties in KTX construction in Korea, these obstacles were wisely overcome, and now the KTX project is recognized as one of the most successful government-run projects. Even though there are some problems raised in terms of the deficits of Korea Rail Network Authority, the KTX project is evaluated to produce many positive effects, such as the drastic enhancement of Korea's railway technology, the improvement of the country's large-scale project management ability, consensus on the necessity of quality management, the acquisition of KTX operation techniques, the establishment of the eco-friendly national transportation system, the promotion of local economy, and improvement of the national image. Also, the Korea's experience in the construction of high-speed rails and enhanced rail technologies should provide it with an engine with which to enter the rapidly expanding global rail market.

Chapter 1.
Background

1. Proposal of High Speed Rail as a New Transportation Means

1.1 Necessity of Drastic Transportation Measures

To support the five-year national economic plan formulated in the 1960s, South Korea pushed to implement policies that bolster transportation capabilities centering on expressways. Thus, road infrastructures such as Gyeongbu and Gyeongin Expressway were constructed, increasing the number of expressways and national roads constructed. Less investment was made, however, in the construction of railroads.

Of the transportation investments made since 1970, road construction topped 50% while railroad construction (except for the extension of railroads to and from harbors and industrial complexes)[1] remained nil. Only double tracks for key railroad lines, electrification of railroads, and alignment improvement of some sections have been conducted. As a result, 92.7% of the passenger transportation was performed by the Gyeongbu Expressway while only 7% of the passenger transportation was performed by railways.

In the 1980s, transportation facilities such as surface roads and railroads were

1) As of 1975, the length of the national railway was 3,144 km.

already crowded due to the rapid industrialization in the country. The expanded investment in roads alone resulted in limitations in transportation infrastructure. It was expected that, despite the construction of new expressways or the expansion of existing ones, the soaring number of automobiles would increase zones with traffic difficulties. As of 1982, the key trunk line Gyeongbu Expressway, which was the country's great artery for social and economic activities and the key inland transportation route, serviced 65.8% of the country's population, and 73.7% of the country's GDP was concentrated along its route. Gyeongbu Expressway carried 66% of the total passengers in the country, and 70% of the total cargoes. Moreover, the average demand of passengers and cargoes was expected to increase by 5.3 and 4.7%, respectively, adding to the country's logistics difficulty. The introduction of new transportation facilities was therefore required.

1.2 Recommendation by Domestic and Overseas Research Institutes to Construct a High Speed Rail

An official discussion on the construction of high-speed rail began in the early 1970s. When the country discussed borrowings from IBRD in 1973, a survey group from SNCF and JARTS researched on measures in 1974, at the request of the bank, to cope with the Seoul-Busan transportation problems.

At that time, South Korea was just finishing the industrial-railway and metropolitan electric-railway projects, and the examiners in both countries who participated in these projects estimated that the existing Gyeongbu railway would have been saturated by the 1980s. They thus proposed the construction of a high speed rail.

About the same time, a group of professors assigned to evaluate the South Korean government's policies proposed a project similar to the one by the French and Japanese survey groups, as a measure to increase the long-term transportation capacity of the Gyeongbu railway.capita GDP, which again testifies to the close relationship between the country's building of the urban railway infrastructure and its economic growth.

1.3 Recommendation of Constructing a High Speed Rail to Improve the Gyeongbu Transportation System

It was after KAIST (Korea Advanced Institute of Science and Technology) came up with an independent-research report on “Heavy Freight Transportation System and Transportation Investment Optimization Plan” and proposed the construction of a new railway that the serious discussion of the construction of a high speed rail began. For three years (November, 1978-July, 1981), KAIST conducted a study on the development of a model for estimating the future national transportation demand, assessing the existing transportation facilities, comparing and reviewing plans for increasing transportation capacities, and creating a comprehensive national transportation system. The research report estimated that between 1985 and 1989, the Gyeongbu transportation line, the existing transportation system between Seoul and Busan, would reach a level of transportation difficulty. In particular, it predicted that in the railways, over half of the Gyeongbu transportation line would reach its capacity limit by 1989.

Based on such analysis results, KAIST proposed two alternatives: (1) to increase the transportation capacity of the Gyeongbu transportation line by creating a new double-track electric railway (New Gyeongbu Line) between Seoul and Busan; and (2) to create a high speed passenger railway to improve the efficiency of New Gyeongbu Line.

Based on the research results, the discussion of the necessity of constructing Gyeongbu High speed railcontinued in the 1980s at a more concrete level, and finally, in February 1979, the President ordered the establishment of a long-term transportation measure in relation to the high speed rail, at his new-year inspection tour of the Ministry of Transportation. As such, a full-scale survey on a high speed rail began.

Keenly aware of the necessity of a high speed rail, the South Korean government stipulated the high speed rail plan of establishing a 160-km-long corridor between Seoul and Daejeon in the Fifth Five-Year Economic and Social Development Plan (1982-1986) drafted in June 1981. Later, in the final review of the Fifth Five-Year Economic Development Plan in 1983, the South Korean government changed its

plan and decided to conduct a feasibility study on the construction of a high speed rail on the whole corridor between Seoul and Busan within the period of the Five-Year Economic Development Plan.

2. Selection of the High Speed Rail as the Optimal Alternative

2.1 Conducting a Feasibility Study

The Ministry of Transportation conducted the "Review on the Necessity of a Long-Term Transportation Investment on Seoul-Busan Line, and Feasibility Study on Seoul-Busan High-Speed Rail" in two stages, from March 1983 to November 1984.

The first-stage feasibility study (February-August 1983) resulted in the proposal of the construction of a Seoul-Busan high speed passenger rail between 1991 and 1997, considering the future transportation demand, by revising the existing Gyeongbu Line. Based on the necessity of the construction of a Seoul-Busan high speed rail, an economic, financial, and technical survey on the high speed rail plan was conducted as part of the second-stage feasibility study (January-November 1984). The study showed that the transportation demand in Gyeongbu Line would continue to increase and that by the second half of the 1990s, much of the line would experience severe congestion. To expand the transportation capacity of Gyeongbu Line, three alternatives were proposed. The first alternative was to focus on the great expansion of the expressways and the phased supplementation of the existing Gyeongbu railway; the second alternative was to aim at competing the railway and expressway by creating a high speed rail and expanding the required section on the expressway between Seoul and Busan; and the third alternative was to concentrate on railways by creating a high speed rail between Seoul and Busan, promoting the policy of increasing the use of the high speed rail, and minimizing the investment on roads.

A careful review of the three alternatives showed that the third alternative, the railway plan, was better than the second alternative, the expressway-railway plan, considering South Korea's transportation circumstances (As of 1997, the internal rate of return (IRR) for the high speed rail plan was 16.8-18.5% whereas that for the expressway-railway plan was 16.8%, supporting the superiority of the railway

plan). As a result of the feasibility survey, it was proposed that the construction of Gyeongbu High Speed Rail start in 1992 and be completed in 1997.

2.2 Determining the Technical-Survey Policies

After the feasibility survey, the need for constructing a high speed rail quickly expanded and was reflected onto the Fifth Five-Year Economic and Social Development Plan (1982- 1986). Thus, the construction of Gyeongbu High Speed Rail was to be started within that period. The soaring demand for the establishment of social-overhead-capital infrastructure in preparation for the 1988 Seoul Olympics, however, led to the conclusion that it would be realistically impossible to secure funding then for the construction of a high speed rail. Consequently, the project was postponed.

It was when the new president who won in the 1987 election made a public pledge to have a high speed rail constructed that the issue of the construction of a high speed rail re-emerged. After the new president took office, the construction of a high speed rail was stipulated in the Sixth Five-Year Economic and Social Development Plan (1987-1991). Accordingly, a technical survey on the construction project was to be conducted, leading to a full-scale presentation of the project.

There has never been any objection to the need for a high speed rail, but transportationrelated scholars, in particular, led various discussions then on the timing of the construction, and on the technical issues surrounding the project. Below is a summary of the key debates.

First, there were those who believed that it was premature to construct a high speed rail. At that time, some scholars argued that the speed of the existing trains, led by diesel locomotives, could be increased by up to 200 km only by changing the sections that were expected to become congested into a double-track line, and by renovating the line and track of the existing Gyeongbu Line. The key point of this argument was that the mid- and longterm demand could be covered and the transportation time could be reduced even without promoting the high speed rail, which would require additional lines. Indeed, even those who subscribed to such argument agreed that there was a need to construct a high speed rail, but they argued

that it would be more reasonable, considering investment priorities, to first invest in the public transportation system in large cities that were rapidly expanding at that time, using the available funding, rather than to construct a high speed rail, and to expand the arterial roads among regions to cope with the then-upcoming automobile era.

However, in case of the railway, it was analyzed that the Suwon-Daejeon section (125.3 km) had already reached its capacity limit, and even after the increase of the railway expansion after the electrification of the existing lines, the railway would reach its capacity limit by 2000 to 2003. It was determined that while the high speed rail was more expensive to construct compared to the four-lane expressway or a traditional double-line railway, it offered superior transportation efficiency, and therefore, the high speed rail would be constructed.

The second is the issue related to the vehicle type, a technical issue that was debated the most. Some scholars argued that rather than the wheel loader that could be immediately introduced, a magnetic-levitation train, the next-generation type, should be introduced. This debate led to the argument that pending the commercialization of the magnetic-levitation train, which was still being experimented on at that time, the construction of a high speed rail would have to be postponed. Considering the rate of progress of the development of railway technologies, the wheel loader method, which is not only slower than the magneticlevitation type but also produces much noise and dust, unlike the magnetic-levitation type, would soon be replaced by the latter, and if that happens, the investment made on the wheel loader type would be in vain. Therefore, as the construction of the magnetic-levitation railway was expected to be commercialized within two to three years, or by ten years at the longest, the construction of a high speed rail would have to be postponed accordingly to maximize the efficiency of the investment.

At that time, however, the magnetic-levitation type was being developed only by Japan and Germany, and there were some who were pessimistic about the possibility of its shortterm commercialization. Further, the economic performance and transportation capacity of the magnetic-levitation type vis-à-vis those of the wheel loader type had not been confirmed. Moreover, others argued that with regard

to the future safety issues of the system, even if the magnetic-levitation type was to be commercialized, the wheel loader type would still be more appropriate. With this, the debate ended.

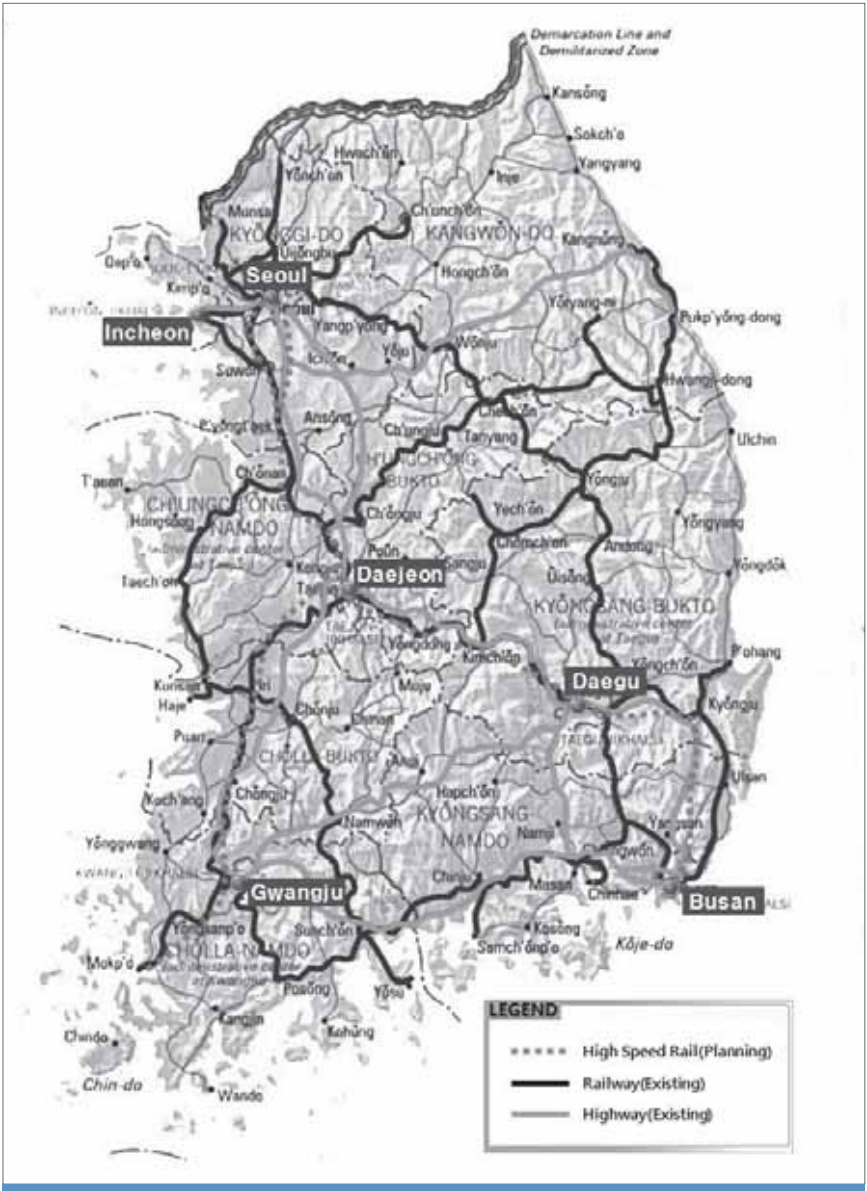
Third, some scholars argued that regardless of the timing or technical aspect of the project, constructing a high speed rail on the Gyeongbu corridor would aggravate the already-concentrated population and industry on the Gyeongbu Corridor. Furthermore, the reduction of the transportation time due to the introduction of a high speed rail would worsen the concentration on the Seoul Metropolitan Area. Such argument was made even more strongly by those who supported balanced regional development based on the case of Japan, to which a high speed rail had been introduced.

Those who supported the construction of a high speed rail, however, argued that if the already-saturated Gyeongbu Corridor suffered from the severer congestions, it would devastate the national economy, or that the development of railway station spheres in the regions where the station of Gyeongbu High speed rail were to be built would lead to balanced development in the regional economy.

Fourth, just before the December 1992 presidential election, the construction of Gyeongbu High Speed Rail was considered a public pledge. Thus, some argued that the fact that the project was being pushed forward although it was not really urgent, or that the construction was to be carried out when the detail design had not been completed and the locations of the underground or on-the-ground stations had not been determined, showed that the project was merely being used for political purposes.

Despite such criticisms, the construction of Gyeongbu High Speed Rail was strongly promoted by the government. For three years, from 1989 to 1991, a technical survey was conducted in relation to the project. Many public and private sectors participated, including concerned national-policy research institutes and South Korean railway-technology-related engineering companies; this technical survey reviewed all the technical conditions related to the construction and operation of a high speed rail, such as the alignment planning, engineering structure, railway tracks, vehicle type, vehicle dynamics, train operation, power transmission and

transformation, electric-railway line, signal and communication, and environmental impact, and completed the basic and detail design of the high speed rail. Based on the results of the technical survey, the construction of Gyeongbu High Speed Rail started in June 1992.



<Figure 1-1> Highway and Railway Network(1988)

Chapter 2.

Estabishment of the Project Plan and the Implementation System

1. Establishment of the Project Plan

1.1 Execution of the Technical Survey

1.1.1 Overview

On July 15, 1989, two months after the decision was made to include the technical-survey policy for the construction of Gyeongbu High Speed Rail in the Sixth Five-Year Economic and Social Development Plan, the technical survey was started. Performed for three years, until February 1991, the technical survey aimed at studying all the technical aspects of the construction of a high speed rail between Seoul and Busan. The introduction of a high speed rail requires a plan divided into three phases: the basic planning and designing phase, the vehicle system selection and acquisition phase, and the detail design phase for the construction. The technical survey focused on the first phase.

As shown in <Table 2-1>, six companies from 12 areas participated in the technical survey, and the survey examined all matters related to each area. The main contents of the survey included analysis of the transportation demand and economic feasibility, route selection and review of the station location selection alternatives, review of the performance and technical aspects of foreign high speed rails, preparation of a bid proposal (draft) for vehicle type selection, investment and operation plans for the high speed rail, and the basic design in each area, such as civil engineering, electricity, signal, etc.

<Table 2-1> Technical-Survey Service Related Agencies by Area

Area	Service Agency	Remarks
Overseeing the technical services	Korea Transport Institute	31.0 (24.9%)
Overseeing the technical areas	Louis Berger Group	U.S. company
Route planning	Yooshin Engineering Corp., KRETA	U.S. company
Structure	KRETA	U.S. company
Slope	KRETA	U.S. company
Station, architecture	Yooshin Engineering Corp., KRETA	U.S. company
Vehicle structure	Hyundai Precision&Industries Corp.	U.S. company
Vehicle dynamics	Daewoo Engineering&Construction	U.S. company
Vehicle operation	Yooshin Engineering Corp.	U.S. company
Power transmission/ transformation, electric vehicle line	KRETA	U.S. company
Signaling, communication	Yooshin Engineering Corp.	U.S. company

Source: Korea Rail Network Authority (2011)

1.1.2 Hosting an International Symposium on the High Speed Rail

Keeping in pace with the implementation of the construction of Gyeongbu High Speed Rail, The Korea Transport Institute, the entity that oversaw the technical-survey services, hosted the one-week “International Symposium on High Speed Rail” from October 16 to 22, 1989. This symposium aimed at establishing national understanding of and a national consensus on the high speed rail project, which was to be accompanied by largescale investments. It saw the convergence of comprehensive opinions on the technical developments in transportation, industries, and other fields, focusing on the high speed rail project, and collected basic data on selecting the system. Including some 100 foreign specialists in 11 countries, such as France, Japan, and Germany, 630 specialists participated in the symposium. These specialists presented various ideas and opinions on the technical methods involved in the high speed rail, on various issues following the technology transfer, and on policies and operation models, practical-operation experiences, and the magneticlevitation railway. As such, the symposium produced considerable outcomes in terms of collecting references for creating specifications, establishing contacts with high speed rail specialists in each country, analyzing the characteristics (especially the strengths and weaknesses) of each country’s high speed rail system, and forming a national consensus on the high speed rail project.

1.1.3 Basic Direction of the Construction Standard

The design criteria of the high speed rail was set in a way that would make it suit South Korea's topology, by considering the design criteria of the UIC and foreign high speed rail systems, as follows:

- A railway on which diesel locomotives can run by considering the connection with the existing railway;
- A railway that will allow direct operation with the South-North Koreas and the Eurasian railway through China in the future;
- A railway that will allow future speed improvement by considering the global trend of the high speed rail technological development; and
- A railway on which the vehicles from Japan, France, and Germany can be run.

These codes were proposed as the conditions for selecting the vehicle type so that whichever country was chosen to supply the vehicles could take comfort from these codes and would produce vehicles that would be appropriate for South Korea, thus guaranteeing connectivity between the vehicles and railways.

1.1.4 Basic Direction of the Vehicle Codes

The maximum speed of the vehicle on Gyeongbu High Speed Rail was set at 300 km/h because it was determined that this speed was most economical and efficient if there were two to four stations in the 409 km zone between Seoul and Busan. Moreover, the plan was to operate localized vehicles after the technology transfer of one of the three vehicles that had already been developed. The maximum speed of the high speed rail systems that were already in operation was 300 km/h.

Considering the energy consumption, maintenance and repair, and passengers' comfort level while ensuring that the vehicles run at their maximum speed and safely, the high speed rail system followed the construction codes that ensured the construction of a railway system appropriate for the design speed of 300 km/h.

Based on the technological-development trend in the world and the current technological level, high speed vehicles from Japan, France, or Germany, which allow South Korean companies to receive technology transfer by phase, were

chosen to improve the South Korean railway vehicle industry, particularly making its technical level reach the global level, and to eventually enable the manufacture of these vehicles in South Korea. Moreover, the vehicle to be chosen should allow few or no issues when connected to the existing railway, and should be suitable for a large amount of transport at a high speed in South Korea, where the land is limited and the population density is very high.

1.1.5 Project Implementation Direction

To cope with the difficulties in maintaining the interface of a high speed rail system, some officials in the National Railroad Association proposed a total system that combines the technologies in all areas while others proposed that these be categorized into core and infrastructure technologies.

Finally, accepting the opinion that the construction could be executed using domestic technologies, civil engineering, tracking, and architecture were to be executed using South Korean technologies while foreign technologies would be introduced as core technologies, such as high speed vehicles, train control, electric-vehicle lines, and train wireless communication, which have yet to be developed in South Korea. Through technology transfer and domestic production, however, it is expected that these technologies will be acquired in the future.

1.1.6 Technical-Survey Results

The results of the technical survey showed that the total transportation increase rate from 1988 to 2028 is expected to be 3.4% for passengers and 2.7% for freight, and that the railway between Suwon and Daejeon would reach the limit of its transportation capacity by 1991. It was also determined that Gyeongbu Expressway was already not performing to its full capacity due to chronic congestion.

When the discount rate was set at 13%, the analysis of the economic performance of the high speed rail project showed good results: 1.55 benefit/cost ratio, 19.4% IRR, and KRW 2.28 trillion net present value. Even at an 18% discount rate, the project is still deemed to be economically sound, with a 1.09 benefit/cost ratio and a KRW 290 billion net present value.

The cost-benefit analysis showed that an annual surplus would result within seven years after the start of the system's operation, and while the maximum accumulated debt in 2001 was to reach KRW 3.9 trillion, this could be adequately paid through the fare revenues during the system's operation.

1.1.7 Selecting the Route

The criteria for route selection were the maximum speed of the train, the location of the station, the environmental conditions, the natural conditions, the level of construction difficulty, the maintenance and repair control, the alignment conditions, and the economic performance.

For the route alternative analysis, a total of 108 alternatives were constructed by combining 12 route alternatives, three station alternatives, and three maximum-speed alternatives. Among these alternatives, 33 alternatives were selected and were broadly evaluated based on (i) convenience (saving time or vehicle/train operation costs); and (ii) cost (construction cost, high speed rail facility maintenance and repair cost, energy cost, labor cost, etc.). The results showed that at 300 km/h, the maximum speed, the efficiency was better when the number of intermediate stations was smaller (four or less), resulting in the following eight potential route plans:

- Seoul–Daejeon–Daegu–Busan (Jungbu Route, two intermediate stations)
- Seoul–Cheonan–Daejeon–Daegu–Busan (Jungbu Route, three intermediate stations)
- Seoul–Daejeon–Daegu–Ulsan–Busan (Dongbu Route, three intermediate stations)
- Seoul–Cheonan–Daejeon–Daegu–Miryang–Busan (Jungbu Route, four intermediate stations)
- Seoul–Cheonan–Daejeon–Daegu–Ulsan–Busan (Dongbu Route, four intermediate stations)
- Seoul–Cheonan–Daejeon–Gimcheon–Daegu–Busan (Jungbu Route, four intermediate stations)
- Seoul–Cheonan–Daejeon–Daegu–Gyeongju–Busan (Dongbu Route, four intermediate stations)
- Seoul–Cheonan–Daejeon–Daegu–Gyeongju–Busan (in tandem with the Donghaenambu Route Double-Track Project)

Two issues were debated on while selecting the route: (1) whether to straighten

the route and minimize the intermediate stations or to maximize the transportation demand and add intermediate stations while lengthening the route; and (2) whether to add Miryang Station [alternative (iv)] or Gyeongju Station [alternative (vii)] if an additional station was to be created.

Considering the scope of the high speed rail construction beneficiary regions and the issues related to the construction technologies resulting from the economic-feasibility analysis, alternative (viii) (Seoul-Cheonan-Daejeon-Daegu-Gyeongju-Busan) was selected in the technical survey in 1990.

1.2 Initial Project Plan

1.2.1 Project Plan

Based on the technical survey conducted beginning in 1989, the basic plan was established, and on June 15, 1990, based on the resolution of the third High Speed Rail&New International Airport Construction Promotion Committee, the basic plan and route of the Gyeongbu High Speed Rail Project were determined and announced, as shown below.

- Route extension: Seoul-Busan, 409 km (tunnels: 42%)
- Maximum design speed: 350 km/h
- Running hours: 90 minutes for the direct operation (101 minutes while stopping at two stations)
- Project term: 1992-1998
- Cost: KRW 5.8462 trillion (KRW 1.2144 trillion for vehicle purchase, as of 1989)
- Usage demand: 218,000 passengers/day
- Financial stability: Annual surplus three years after the opening; accumulated surplus ten years after the opening
- Route: Seoul-Cheonan-Daejeon-Daegu-Gyeongju-Busan (Four Intermediate Stations)

1.2.2 Determination of the Basic Route

For the selection of the route in the basic project plan, the eight potential route plans established in the technical survey were reviewed, and two alternatives-alternatives (i) and (viii)-were short-listed. Alternative (i), which had two intermediate stations (Daejeon and Daegu), offered the straight route. While its

running time was shorter, its tunnel extension was longer due to the topology, and compared to the size of the investment, the beneficiary regions were limited. Alternative (viii), which had four intermediate stations, including the Gyeongju and Cheonan stations, offered good financial stability due to its improvement of the high speed rail usage rate as it includes Gyeongju, a major cultural-heritage and tourist attraction, and Ulsan and Pohang, two key industrial areas, as well as Choenan, which has a huge transportation demand. It meant, however, that the route would be slightly diverted. Finally, alternative (viii) was selected as it could increase the high speed rail usage rate.

<Table 2-2> Comparison of Two Short-Listed Route Alternatives in the Basic Plan

Review \ Alternative		Alternative (i)	Alternative (viii)
		Seoul-Daejeon-Daegu-Busan	Seoul-Cheonan-Daejeon-Daegu-Gyeongju-Busan
Topology	Distance	387 km	409 km (changed to 412 km)
	Tunnel	48%	42%
Running time		Direct: 1 hour 26 minutes (two stops: 1 hour 37 minutes)	Direct: 1 hour 30 minutes (two stops: 1 hour 41 minutes)
Transport demand		192,000 passengers/day	218,000 passengers/day
Cost		KRW 4.4267 trillion	KRW 4.6318 trillion
Financial stability		Annual surplus: after five years Accumulated surplus: after 13 years	Annual surplus: after three years Accumulated surplus: after ten years
Characteristics		Shortest-distance route Limited beneficiary regions considering the investment size	Will accommodate the Cheonan and Gyeongju tourists Will improve the usage rate Needs to divert a bit

Source: Korea Rail Network Authority (2011)
Note: Additional KRW1.2144 trillion for vehicle purchase

1.2.3 Station Locations

In the process of determining the stations, the locations were a delicate issue, where the local governments' and residents' interests showed sharp conflicts. Some local governments or residents did not want the route to include their region due to the noise or environmental pollution that may be caused by the high speed rail and the damage to various resources, including cultural assets, that may be caused by the construction of the station and the route. Most of them, however, admitted that establishing a station in their region would promote the development of their local

economy. Some key issues that were debated when the locations of the stations were being selected were the formation of strong bases for creating and developing new cities, convenience in the use of the system in the city (Seoul), the underground stations and their construction cost (Daejeon and Daegu), and the effect of the construction on the region's cultural assets (Gyeongju).

1.2.4 Design Criteria

One important task in constructing the country's first high speed rail was the creation of design criteria. For this, the government referred to the design criteria of the UIC and other countries and sought the help of foreign and South Korean specialists and technical teams.It is noteworthy that in setting the goal of cultivating technical competency through the project, the project selected a core-method code, which meant that the government chose to introduce only the core technologies from the advanced countries and to promote the use of the South Korean technologies for the other aspects of the project, instead of the totalmethod code, based on which all the required technologies would come from the advanced countries and South Korea would only manage the project.

1.3 Revisions of the Project Plan

Since the determination of the basic plan in 1990, the Gyeongbu High Speed Rail Project has gone through two major revisions. The main reasons for the revisions were as follows: (1) after the construction of the test zone, it was determined that the cost would increase considerably if the original route plan would be followed; (2) there were consistent local complaints regarding the basic plan; and (3) the unit price increased due to the construction delay. Besides such big changes, other minor design changes caused by local complaints and changes in construction technologies continued throughout the term.

1.3.1 First Revision of the Project Plan (June 1993)

The initial cost of the project was KRW 5.8462 trillion, based on the constant market price from 1989 to the early 1990s. This cost calculation, however, was based on the method of adding extra cost by a fixed rate to the existing railway

construction cost due to the limited data available on the high speed rail construction, and therefore, it was somewhat unreasonable from the beginning to consider this cost accurate.

For example, in the 1990s, the sub-base course construction was estimated to be 1.4-1.5 times the unit cost of the existing line while the tracking was estimated to be the same as that of the pole railing for the existing railway. Also, the average unit price of Shinkansen in Japan, TGV in France, or ICE in Germany was applied to the cost of the signal communication facilities. Therefore, more accurate cost estimation had to be done when the actual construction had progressed to a certain point. It was after 1993, when the Cheonan-Daejeon Test Zone (57.2 km) was completed, that the actual and realistic estimation of the construction cost became possible.

a. Necessity of revising the plan

The construction cost of the high speed rail project, confirmed by the detail design and actual construction of the sub-base course construction, tracking, and signal communication facilities, was considerably higher than the originally estimated cost. Additionally, the marked increase of the construction cost, including the labor and material costs, from the time when the basic plan was drafted became a key reason for the drastic increase of the overall cost. To resolve the two issues regarding the basic plan (the error in the estimation and the market price increase), the first revision of the plan was carried out.

The problem did not end there. Besides simple errors in the estimation, the revision of the plan itself was inevitable. The total route length increased from 409 km by over 13 km due to the diverting route to Osong Station (4.9 km), the diverting route due to the protection of cultural assets in Gyeongju (7.1 km), and the diverting route due to the city plan in Yangsan Zone (1.3 km), all of which were not considered in the initial plan.

As such, considering the overall changes that were made to compensate for the errors in the estimation, the reflection of the market price increase, and the extension of the route, the total cost was re-estimated to be KRW 12.1743 trillion, over twice the original cost estimated, if the original construction term was to be maintained so that the project would be completed in 1998. In the revised cost, 81.8% of the

increase was from the changes that were made to compensate for the errors in the estimation and the reflection of the market price increase while 18.2% was from the increase in the investment cost due to the increase in the capacity. Accordingly, as the revision was being made, further revisions were made on some zones, and reasonable adjustment of the construction term and confirmation of the station locations were done to maximize the cost savings.

b. Key revised contents

The focus of the revision was the plan to cut down the investment cost. First, it was planned that the underground facilities be constructed on the ground, and maximum use of the existing facilities was planned. Accordingly, a revision was made in the underground zone plan between Seoul and Gwangmyeong Station and between Seoul and Susaek Station. The issue of the railway capacity due to the revision (Seoul-Siheung, 17 km) was to be resolved by reducing the services in the existing railway (Saemaeul and Mugunghwa) and freight trains. To handle the trains at Seoul Station, the central station for the project, the starting and ending trains were to be also allotted to Gyeongmyeong Station, located in the outskirt of the Seoul Metropolitan Area, and to cope with the limitation of the railway capacity between Seoul and Susaek Station (8 km), the adjustment of the block section was considered (reducing the block section from 800-1,300 to 500 m). Besides Seoul, the original underground-section plan in Daejeon and Daegu was converted into a ground-level plan, and by postponing the construction plan of the vehicle maintenance depot, the total investment cost was reduced from KRW 12.1743 trillion to KRW 10.74 trillion. To alleviate the annual investment load, which increased along with the increase of the total project cost, the construction term was extended for three more years, and therefore, it was planned that the project be completed by 2001. Cheonan-Daejeon Test section, however, was to be completed by 1997, and Seoul-Daejeon Zone, by the end of 1999, so that as of 2000, the high speed rail could be commercially operated. In the revision, every effort was made to follow the original objectives of the plan.

1.3.2 Second Project Revision (July 1998)

a. Necessity of the revision

After the first revision of the plan in 1993, further revision of the cost and term was

inevitable due to the underground construction in Daejeon and Daegu, the changes in the plan due to local complaints (e.g., the changes in the Gyeongju route), the market price increase, and the changes in the design. Accordingly, the government proposed a draft on the revision of the basic plan in November 1997. While the talks between the concerned organizations were in progress, some drastic changes occurred in the project implementation environment, such as the 1997 foreign-exchange crisis and the establishment of a new government in 1998, which led to the full revision of the project.

In April 1998, after the establishment of a new government, a joint-force task team consisting of the Ministry of Construction and Transportation, KTX, and Korea National Railroad was formed to review the cost and the project. Also, an assessment advisory committee consisting of 24 specialists in economics, journalism, transportation, and civil engineering, among others, conducted an in-depth analysis of the project, and after the feasibility assessment and advisory meetings, the Social-Overhead-Capital Construction Implementation Committee revised the basic plan on July 31, 1998, considering the dire economic conditions then.

b. Key revised contents

The key contents of the second revision maintained the framework of the original plan in consideration of the consistency of the government's policies and the transportation issues regarding Gyeongbu Line, while aiming to adjust the cost and the completion time by dividing the whole section into sections in the first and second phases in consideration of the then dire economic conditions. Accordingly, the original completion date for the whole section, 2000, was revised so that the first-phase project would complete the new high speed railway between Seoul and Daegu and transform the existing railway between Daegu and Busan as well as the downtown section in Daejeon and Daegu and the section between the two cities: into an electrical railway and would complete the project by April 2004. The second-phase project would create a new high speed rail between Daegu and Busan, transform the downtown of Daejeon and Daegu into an underground railway, use the existing railway between Seoul and Gwangmyeong Station, and create a diverting route in the Sangni Tunnel section, which had been controversial as the original plan was to go through a closed coal mine. As such, the project should have been completed by 2010.

Converting the original plan into a two-phase plan was strongly based on the dire condition of the government's budgets, which made it impossible to concentrate government investment on the project in 2000, as stipulated in the original plan.

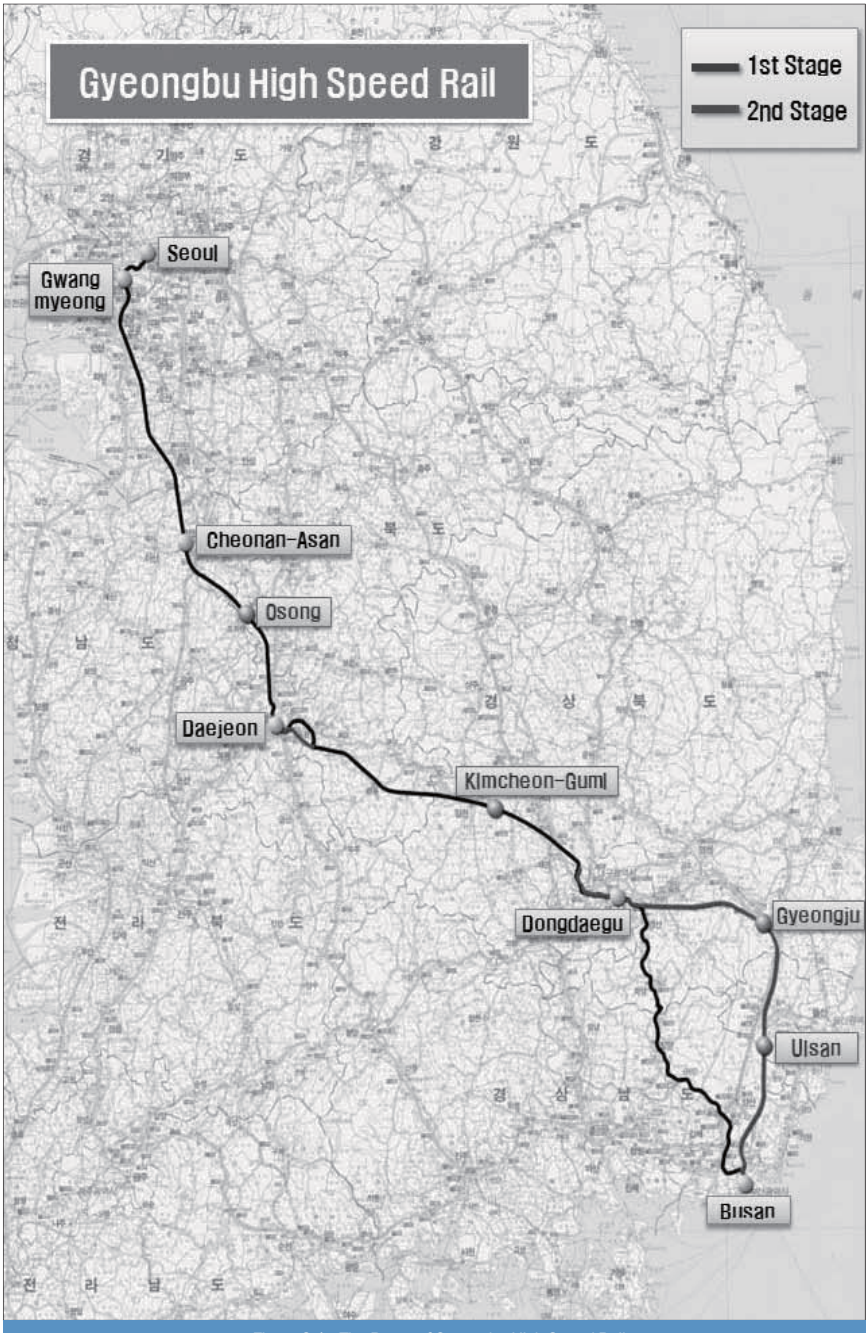
Another reason for the revision was that the estimated total cost doubled from KRW10.74 trillion, the cost estimated in the first revision (June 1993), to KRW18.4358 trillion in 1998, combining the costs of the first-and second-phase projects. Due to the huge increase in the cost, even if the investment would be made as planned in the yearly investment plan, the project would never be completed by 2000, as projected. Also considered was the dire economic condition at the time, which made additional financial investment impossible. Thus, within the scope that the budget allowed, the Seoul-Daegu section was to be completed and operated in the first phase by 2004, and the completion of the project was to be postponed to 2010.

As the project plan was changed into a two-phase plan, some of the civil complaints were resolved. Particularly, the underground route in Daejeon and Daegu was pushed to the second-phase project while the original plan was maintained, whereas the Gyeongju route was determined to be the final alternative, which was the Hwacheonri section. Also, for the Sangni section, the route that diverts from the unstable ground region due to the mining was determined and completed in the first-phase project. The Seoul Station-Gwangmyeong Station section, however, would use the existing route, as confirmed in the first revision.

<Table 2-3> Comparison of the Revisions of the Basic Project Plan

Category	Basic Plan Established (June 14, 1990)	First Revision (June 14, 1993)	Second Revision (July 31, 1998)	
			First Phase	Second Phase
Route	Seoul- Cheonan-Daejeon- Daegu-Gyeongju- Busan	Seoul-Cheonan-Daejeon-Daegu-Gyeongju-Busan	Seoul-Cheonan-Daejeon-Daegu-Busan	Seoul-Cheonan-Daejeon-Daegu-Gyeongju-Busan
Distance	409 km	430.7 km	409.8 km	412 km
Term	Aug. 1991-Aug. 1998	June 1992-May 2002	June 1992-April 2004	May 2004-Oct. 2010
Cost	KRW 5.8426 trillion	KRW 10.74 trillion	KRW 12.7377 trillion	KRW 5.6891 trillion
Stations	Seoul, Cheonan, Daejeon, Daegu, Gyeongju, Busan	Seoul, Gwangmueong, Cheonan, Daejeon, Daegu, Gyeongju, Busan	· Gwangmyeong, Cheonan, Daejeon, Daegu, Busan · Seoul Station: · Using the existing· Seoul Station · and the expansion · of Yongsan Station	Gwangmyeong, Cheonan, Daejeon, Daegu, Gyeongju, Busan
Running time (Seoul-Busan)	101 minutes	124 minutes	160 minutes	116 minutes
Vehicle arrangement	46	46	46 (foreign: 12; domestic: 34)	46
Budget plan	-	· Government funding: 45% · Other funding: 55%	· Government funding: 45% · Other funding: 55%	-
Major revisions	-	· Renovating and using the existing ground- level Seoul, Daejeon, and Daegu Station · Using the existing Gyeongbu Line between Seoul and Anyang · Creating a new station for Gwangmyeong	· Electrifying and using the existing line for the sections of Daegu and Daejeon as well as the Daegu-Busan section · Using the existing railway between Seoul and Gwangmyeong	· Constructing a new railway between Daegu and Busan · Constructing Gyeongju Station · Constructing an underground railway that will pass through Daejeon and Daegu downtowns

Source: Korea Rail Network Authority (2011)



<Figure 2-1> The Route of Gyeongbu High Speed Rail

2. Revision of the Implementation System

2.1 Implementation Organizations

The most representative implementation organizations for the Gyeongbu High Speed Rail Project are the Ministry of Construction and Transportation's High Speed Rail Construction Planning Team, the High Speed Rail Construction Headquarters at Korean National Railroad, Korea High Speed Rail Construction Authority, and Social-Overhead-Capital Construction Implementation Committee.

The Ministry of Construction and Transportation's High Speed Rail Construction Planning Team oversaw the establishment, revisions, and management of the pertinent law, the establishment (revision) and announcement of the basic plan, determining and planning other key policies related to the high speed rail project, approving of the project execution plan, managing the High Speed Rail Construction Review Committee, carrying out other supporting functions for Korea High Speed Rail Construction Authority, guiding and supervising Korea High Speed Rail Construction Authority, and mediating and adjusting the tasks between Korean National Railroad and Korea High Speed Rail Construction Authority.

The High Speed Rail Construction Headquarters at Korean National Railroad was commissioned by Korea High Speed Rail Construction Authority to conduct the repair and electrification of the existing railway and facilities in the project.

Korea High Speed Rail Construction Authority not only conducted the execution of the project but also performed the role of the project owner by establishing the execution plan and supplying funding.

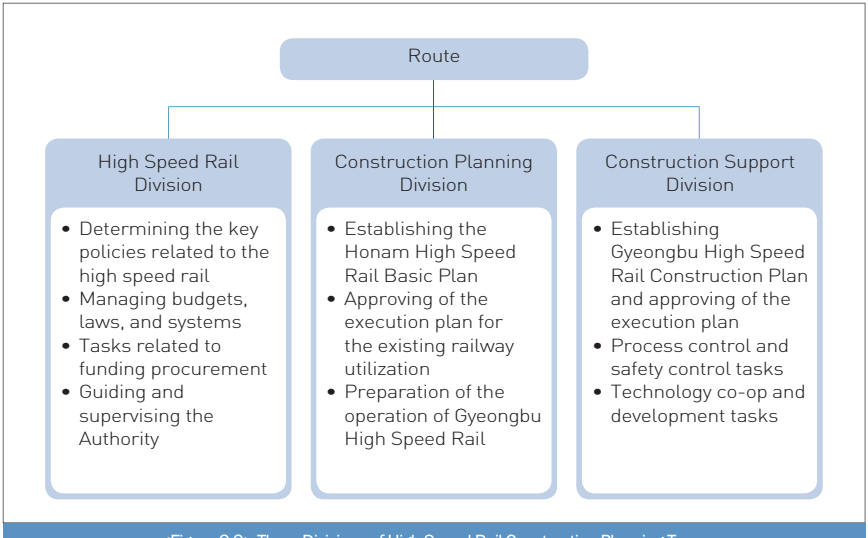
The Social-Overhead-Capital Construction Implementation Committee reviewed and mediated the key policies (basic plan, fund supply, etc.) in relation to the construction of the high speed rail, and oversaw the task cooperation among the concerned departments, organizations, and local governments.

2.1.1 High Speed Rail Construction Planning Team (Ministry of Construction and Transportation)

- History
  - April 30, 1994: The High Speed Rail Division (temporary organization) was established (8 people)
  - May 1, 1996: Reorganized into High Speed Rail Propulsion Team (9 people)
  - June 29, 1996: Reorganized into High Speed Rail Department (official organization) (12 people)
  - November 23, 1996: The High Speed Rail Construction Planning Team was established (22 people in two divisions)
  - September 3, 1997: The Construction Planning Division of the Ministry of Construction and Transportation's High Speed Rail Construction Planning Team was expanded (29 people in three divisions)

- Tasks and functions
  - Establishing and adjusting the high speed rail plan and policies
  - Establishing and adjusting the investment and funding supply for the project
  - Guiding and supervising High Speed Rail Construction Authority

- Organization and personnel (three divisions)



<Figure 2-2> Three Divisions of High Speed Rail Construction Planning Team

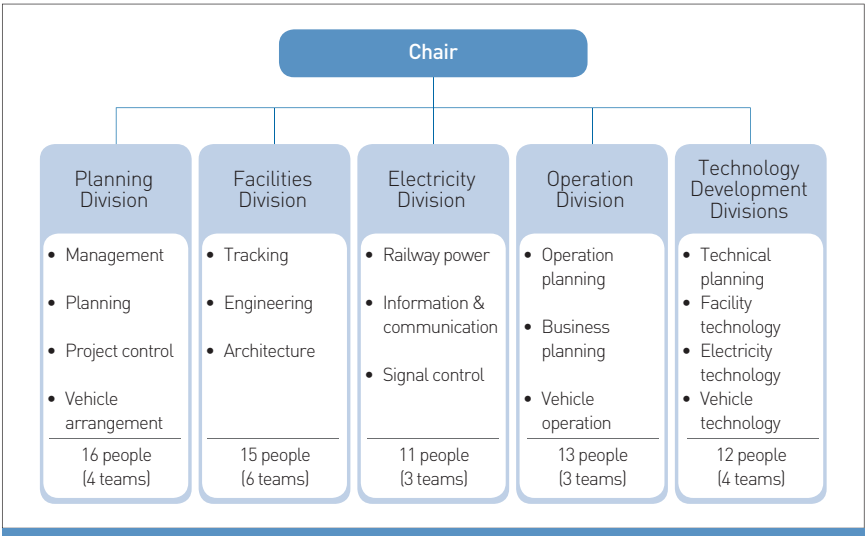
2.1.2 High Speed Rail Headquarters (Korean National Railroad)[2)]

- History
  - December 1989: The High Speed Rail Construction Task Force (High Speed Rail Planning Team) was established.
  - December 1994: The High Speed Rail Operation Preparation Team was established.
  - July 1996: The Technology Promotion Management Team was reorganized into the High Speed Rail Management Team.
  - July 1997: The High Speed Rail Training Division was established within Korean National Railroad Officials Training Center.
  - August 1998: The High Speed Rail Management Team was renamed High Speed Rail Project Management Team; the High Speed Rail Operation Management Team was established.
  - July 1999: The High Speed Rail Headquarters was established (one chair, 76 people in five divisions, and 20 teams).
  - January 2000: The High Speed Rail Construction Project Office was established within the Headquarters (one chair, 118 people in six divisions, and 22 teams).

- Tasks and functions
  - Systematic execution of the budget and process control for railway system maintenance and repair tasks (including the electrification of the existing railway) in the High Speed Rail Construction Project
  - Formulating design, construction, and maintenance/repair plans in the facilities and electricity areas related to the project
  - Preparing for the operation of the high speed rail
  - Systematic promotion of the railway technology development

- Organization and personnel
  - High Speed Rail Headquarters (68 people in five divisions, and 17 teams)

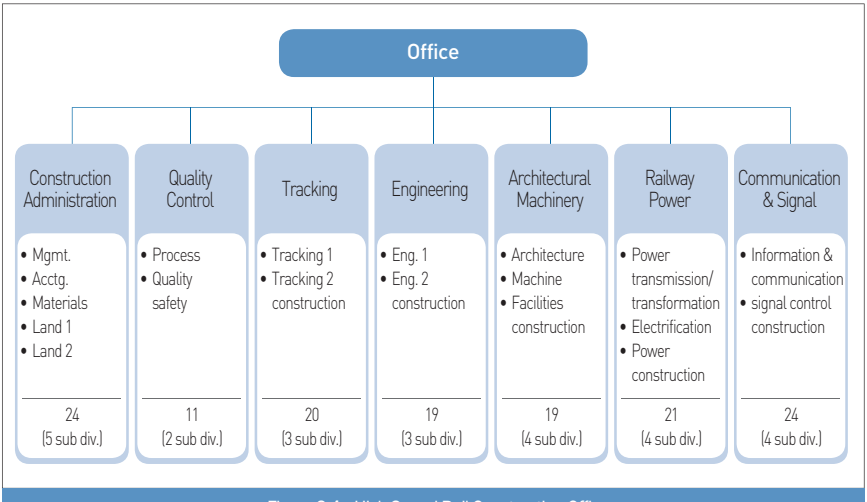
2) Having supervised the construction and operation of the railway system, the Headquarters was divided into Korean National Railroad Facilities Authority, which oversees the railroad facilities, and Korean National Railroad, which manages the operation, according to the National Railroad Industry Restructuring Plan (2004).



<Figure 2-3> High Speed Rail Headquarters

※ Not including the regular personnel at the branch offices and the dispatched vehicle management team (T/F)

- High Speed Rail Construction Office (one chair, 182 people in seven divisions, and 25 subdivisions)

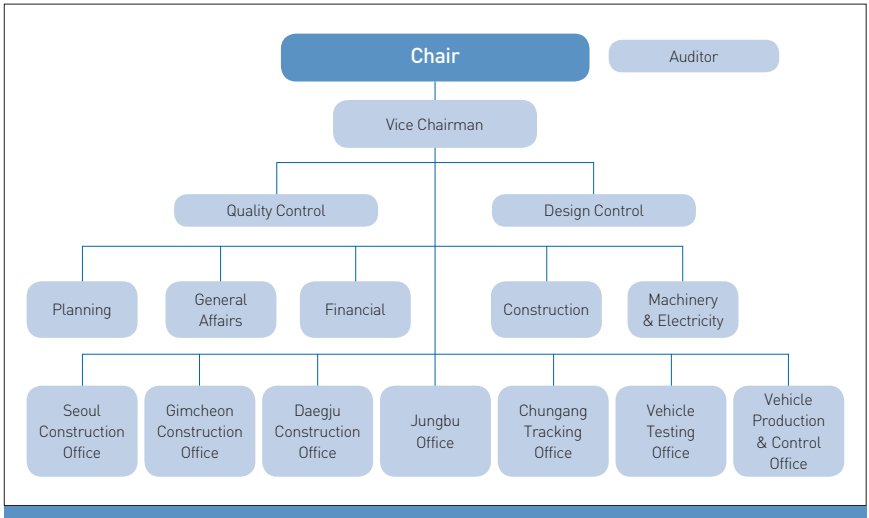


<Figure 2-4> High Speed Rail Construction Office

2.1.3 Korean High Speed Rail Construction Authority

- History
  - July 1989: The High speed rail&New International Airport Construction Implementation Committee & Task Committee were established.
  - Implementation Committee: 17 members, excluding the Minister of Economic Planning Board (Chair)
  - Task Committee: 22 members, excluding the Vice Minister of Transportation (Chair)
  - December 1989: The Task Force Team was established (54 KORAIL employees).
  - February 1991: The High Speed Rail Project Planning Team was established (140 people).
  - December 1991: Korea High Speed Rail Construction Authority Act (Act No. 4456) was enacted.
  - March 1992: Korea High Speed Rail Authority was established (seven headquarters, 379 people).

- Tasks and functions
  - Constructing the high speed rail



<Figure 2-5> Organization and Personnel of Korean High Speed Rail Construction Authority

- Carrying out the high speed rail station spheres and neighboring-zone development project
- R&D and survey of high speed rail technologies

• Organization and personnel (5 headquarters, 2 divisions, 7 offices, 776 people)

2.1.4 Social-Overhead-Capital Construction Implementation Committee

• Establishment Grounds
  - Provision on the High-speed Electric Rail and New International Airport Construction Impulsion Committee (Presidential Decree No. 12762 enacted on July 24, 1989)
  - Amendment of the Provision on the SOC Infrastructure Impulsion Committee (Presidential Decree No. 15173 partially amended on November 23, 1996)

• Goal
  - Reviewing and adjusting the basic plan and key policies on the construction of high speed rails, new international airports, and new harbors

• Functions
  - Issues related to the establishment of the construction basic plan for high speed rails, new airports, and harbors
  - Issues related to the key policies related to the construction of high speed rails, new airports, and harbors as well as construction funding procurement
  - Issues related to interdepartmental cooperation with regard to the construction of high speed rails, new airports, and harbors

• Organization (30 people, including the chairman and vice chairman)
  - Chairman: Minister of Planning and Budgeting
  - Vice chairman: Minister of Construction and Transportation, Minister of Maritime Affairs and Fisheries
  - Members: Ministers of Public Administration and Security, National Defense, Agriculture and Forestry, Commerce, Industry and Energy, Information and Communication, Environment, Science and Technology, and Office for Government Policy Coordination; Presidential-Secretariat Economic-Division

secretary; Director of Forest Services; Director of Korean National Railroad; Seoul Metropolitan City Mayor; mayors of metropolitan cities; governors; Chairman of Korean High Speed Rail Construction Authority; Chairman of Incheon International Airport; and others related to the issues to be reviewed and appointed by the chairman

* Task Force Committee (30 people, including the chairman and vice chairman)

- Chairman: Vice Ministers of Construction and Transportation, Maritime Affairs, and Fisheries
- Vice chairman: Director of the Conveyance Policies Office at the Ministry of Construction and Transportation, Director of Planning and Management at the Ministry of Maritime Affairs and Fisheries
- Members: Ministers of Strategy and Finance, Public Administration and Security, National Defense, Culture and Tourism, Agriculture and Forestry, Commerce, Industry and Energy, Information and Communication, Environment, and Science and Technology; Office of Planning and Budgeting; Office of Government Policy Coordination; Office of Forest Services; Korean National Railroad; Presidential Secretariat; directors of Seoul City and the other concerned cities and provinces; National Railroad Authority; Vice Chairman of Incheon International Airport; and those appointed by the chairman

2.2 Relevant Laws

2.2.1 Provision on the High-speed Electric Rail and New International Airport Construction Impulsion Committee

The provision on the High-speed Rail and New International Airport Construction Impulsion Committee was enacted in 1989 to deliberate on and coordinate the basic plan and important policies for the construction of the high-speed rail and new international airport. This Act defines the committee's functions and composition, its working committee composition, and other necessary matters concerning its operation (in November 1996, the provision name was changed to "Provision on the SOC Infrastructure Construction Impulsion Committee.").

2.2.2 The Korea High-speed Rail Construction Authority Act

The Korea High-speed Rail Construction Authority Act was enacted in 1991

to establish the Authority so as to efficiently construct the high-speed rail with a view to expanding the rail transportation networks, in a bid to enhance public transportation convenience and to help promote national economic development. This Act defines the Authority's business scope, officer composition/qualifications, financing methods, collection of service fees, and other overall matters related to the operations of the Authority.

2.2.3 The High-speed Rail Construction Promotion Act

The High-speed Rail Construction Promotion Act was enacted in 1996 to define matters necessary for the early construction of the high-speed rail so as to efficiently implement the high-speed rail construction project. This Act defines the term of the high-speed rail, the formulation of the basic plan for the high-speed rail construction, implementers of the high-speed rail construction project and supervision thereof, designation of the prearranged areas for the project, and other matters concerning the construction of the high-speed rail.

<Table 2-4> Laws Pertaining to the High Speed Rail

Relevant laws	Purpose	Outline	Date of enactment
Provision on the Highspeed Electric Rail and New International Airport Construction Impulsion Committee	To deliberate on and coordinate the basic plan and important policies for the construction of the high-speed electric rail and new international airport	Define the committee's function, composition, and working committee composition, and other matters necessary for the operation of the committee	July 24, 1989
Korea Highspeed Rail Construction Authority Act	To establish the Korea High-speed Rail Construction Authority so as to efficiently construct the highspeed rail with a view to expanding Korea's rail networks	Define the business scope, officer composition and qualifications, financing methods, collection of service fees, and other overall matters necessary for the operation of the Authority	December 27, 1991
High-speed Rail Construction Promotion Act	To define matters necessary for the early construction of the high-speed rail so as to efficiently implement the highspeed rail construction project	Define the basic plan and the execution plan for the high-speed rail construction, the project implementers, supervision of the project, the Act's correlation with other laws, designation of the prearranged areas for the rail, and other matters concerning the construction of the highspeed rail	December 31, 1996

Note: See the Appendix for the full text.

Chapter 3.

Key Project Issues

1. Design Criteria and Detail Design

1.1 Establishment of the Design Criteria and Basic Design

The Gyeongbu High Speed Rail Project was a good opportunity to notch up South Korea's construction technology in terms of both the size and content of the construction. Therefore, the South Korean government propelled the project by focusing on the independence of the country's high speed rail technology and the production of railway technicians. Accordingly, from the planning phase, the government made sure that South Korean technical experts would lead the project, but foreign technical teams were encouraged to handle the technology areas that South Korea was lacking in to ensure the technical stability and reliability of the high speed rail. South Korean technologies were also used in the civilengineering, tracking, and architectural issues so that in the future, South Korea would be able to construct a high speed rail system using its own technology.

The detailed design for the sub-base course construction was performed by specialists from 14 South Korean technical-service companies, and in the designing process, academic scholars and specialists joined the force so that the design would conform to the design criteria of UIC and foreign high speed rail systems.

The dynamic safety review of the extensions, structures, and forms of the sub-base facilities and structures, such as the bridges and tunnels, designed by South Korean specialists was commissioned to and performed by renowned foreign specialists.

After the first-phase design and the second-phase dynamic safety review, a comprehensive safety review of the technical connectivity between the core equipment (e.g., the TGV vehicles in France, the actual vehicle to be introduced) and the sub-base course facilities was performed by a special technical team of SYSTRA (formerly SOFRERAIL), a high speed rail company affiliated with SNCF in France.

1.1.1 Establishment of the Design Criteria

Some 300 South Korean and foreign specialists joined forces to create the design criteria for the Gyeongbu High Speed Rail System that are suitable for South Korea's topology, using the design criteria of UIC and foreign high speed rail systems.

Considering the connecting operation between South Korea and its neighboring countries (China, North Korea, Russia, etc.), the UIC code, the standard load applied worldwide, was set as the design load.

a. Establishment of the construction code

The High Speed Rail Construction Code on Railway and Structures for the Construction of a High Speed Rail was established on December 28, 1991 in relation to the track gage, curve and slope, construction limitations, distance between the centers of the tracks, formation level, and track. The code was first used in the detail design and test railway sections.

b. Creating the standard specifications

With KSCE as the main contractor, 134 specialists participated in creating eight standard specifications, including the steel bridge and composite bridge design standard specifications, for the high speed rail system for 10 months, from November 13, 1990 to September 12, 1991. Shown below are the high speed rail design criteria of other countries at that time.

<Table 3-1> Design Criteria for the Foreign High Speed Rail Systems

Category	South Korea: KTX	Japan: Shinkansen	France: TGV	Germany: ICE	Spain: AVE
Max. speed	300 km/h	260 km/h	320 km/h	300 km/h	250 km/h
Min. radius of curve	7,000 (400 m)	4,000 m	6,000 m	7,000 m	4,000 m
Max. grade	25‰	15‰	25‰	12.5‰	12.5‰
Width of formation level	14.0 m	11.6 m	13.6 m	13.7 m	13.3 m
Distance between the centers of tracks	5.0 m	4.3 m	4.5 m	4.7 m	4.3 m
Section area of the tunnel	107 m^2 (75m^2)	60 m^2	100 m^2	82 m^2	74 m^2
Design load	HL load (UIC load)	NP load	UIC load	UIC load	UIC load

Source: Korea Rail Network Authority (2011)

1.1.2 Basic Design

Through the preliminary measurement of the optimal alternative and the reviewed alternatives, the total sizes of the facilities for engineering, bridges, stations, tracks, buildings, electricity, vehicle depots, and other sites were roughly determined, and the total project cost and term were calculated.

1.2 Detail Design

The detail design of the sub-base facilities for Gyeongbu High Speed Rail was performed from June 1991 to August 1998 by dividing the Seoul-Busan section into 14 construction sections based on the results of the technical survey (Korea Transport Institute) and the standard specifications (KSCE). The Cheonan-Daejeon section (57.2 km) was selected as the test line, and to ensure that the construction would begin in 1992, the detail design of the fourth and fifth construction sections was performed first. The detail design of the power facilities was performed by dividing the facilities into six sections for the power transmission/transformation facilities, two sections for the electric railways, three sections for the electric-power distribution facilities, and one section for the remote-control facility.

In the detail design process, as much advice as can be gathered from specialists in various fields, and foreign technical information, was utilized. As for the key structures

such as bridges and tunnels, international specialists and technicians from the country that would supply the trains participated in the review of the technologies and the selection of new technologies.

2. Introduction of the Project Management System

2.1 Background

As the Gyeongbu High Speed Rail Project was a compound project that would entail a large investment cost, a scientific and systematic management technique was required for the effective implementation of the project. Also, the fact that the locations of the project were distributed all over the country and that the project would be executed through technical cooperation with France and required the control and management of various state-of-theart technologies, a large number of staffs, various materials, equipment, and data made the introduction of a reasonable project management system even more urgent. At that time, however, there was no specialist or organization that had the capacity or experience of managing a large project like the High Speed Rail Project. Thus, all the specialists agreed that the introduction of a foreign-project management technique was absolutely necessary.

Although some project management systems were introduced to some projects in the early 1970s in South Korea, they were mostly in the infant stage. In the 1980s, a South Korean technical team carried out a nuclear-power-plant construction project under a project management system. A foreign company was the main contractor, however, while the South Korean company participated only in some areas, thus acquiring some process control and cost management techniques under the project management system.

After the 1990s, computers became widely distributed in South Korea, and there was an increase in the number of large-scale projects, such as nuclear-power-plant construction projects. Accordingly, the people's recognition of the need for project management rapidly increased. Since then, the South Korean companies already led technological development and utilization and received technical advice from foreign companies only in the areas where the South Koreans' technical know-how

was lacking. As such, South Korea began to accumulate technologies on project management systems.

Accordingly, on September 26, 1992, the selection guideline for the project management service company was determined, and on November 23, 1992, a proposal request was sent to seven foreign service companies, including Bechtel. After the receipt of proposals from three companies (Bechtel, Louise Berger, and Parsons Brinkerhoff), on December 19, 1992, the proposal made by Bechtel was selected, and a contract was concluded. The contract with Bechtel started as one for simple advisory service and expanded to project management services in 1997.

2.2 Bechtel's Project Management Services (1993-2001)

- Bechtel's role
  - ○ Establishing the infrastructure required for executing an international-grade large project
    - Negotiations for core system contract and international loan contract, etc.
  - ○ Theoretical and practical support according to the introduction of a project management method
    - Developing various procedures, systems, the basic-process chart, and the management guideline process charts
  - ○ Proposing the direction of and alternatives to key decisions through various advising activities on construction, supervision, and quality control
  - ○ Support on various coping methods and capacities under an international contract
    - Creating international contracts, RFPs, RFP evaluation, and measures for various claims, etc.
  - ○ Acquiring an international credit standing for Gyeongbu High Speed Rail of Korean High Speed Rail Construction Authority
    - Contributing to the convenience in attracting funds from foreign financial markets, and to the reduction of the financial costs

- Outcomes of the services

1) PMAS (Project Management Advisory Service) (April 1993-September 1997)[3)]
   - ○ Established the project management system by introducing a systematic

process and cost management system

- ○ Reduced the budget by establishing an effective strategy when negotiating for a core system contract
  - Initial price suggested by France: about USD 4 billion→final contract: USD 2.14 billion (saved USD 1.86 billion)
  - Established an effective exchange risk avoidance management system (saved about KRW 4.3 billion)
- ○ Led to a reasonable contract with foreign companies on the train wireless system and construction supervision
  - Price suggested by Motorola: about USD 98 million→final contract: USD 83.5 million (saved about USD 14.5 million)
- ○ Design and quality control
  - Reduced the term by introducing new methods (PSM method and waterproofing systems)

2) PMS (Project Management Service) (December 1997 – January 2001)[4]

- ○ A total of 62 ideas on method changes were proposed when the basic plan was revised in July 1998, and 53 ideas were reflected onto the revision, which reduced the cost by about KRW 160 billion.

A. Core contract claim negotiations on the compensations due to the change in the vehicle supply schedule

- ○ France requested for USD 193 million→negotiated at USD 57.9 million (saved USD135.1 million)

B. Established a comprehensive project management system by developing project management procedures and expanding the electronic system

C. Offered training programs for project management techniques and technical documents

- ○ 2,187 employees received 62 training programs; 176 technical documents, including standard waterproofing codes and structural calculations

D. Contributed to the acquisition of ISO 9001 and KSA 9001 certifications (May 2000)

3) It was a simple advisory contract without concrete responsibilities, and at the owner's behest, Bechtel supported the owner's decision-making process by offering its opinions, advice, and suggestions.

4) A contract under which Bechtel was to perform the services either in cooperation with or on behalf of the owner, and was to take responsibility for the outcomes

<Table 3-2> Conditions of the PMS Contract

Category	Phase 1	Phase 2	Phase 3		Phase 4
			Original	Revision (May 24,1999)	
Type	PMAS		PMS		
Term	1993.04.16-1995.04.15	1995.04.16-1997.09.30	1997.12.01-1999.11.30		1999.12.01-2001.11.30
Amount	$20.35M	$34.92M	$82M	$41.6M	$57.63M
Executed amount	$12.71M	$21.32M	-	$36.77M	-
Labor	Max. 20	Max. 36	37-120	Max. 87	Max. 85
Methods	Review at the behest of High Speed Rail Authority Offering advice Supporting the decision-making process		Creating an integrated organization with the Authority Managing the co-op projects Participating in the decision-making process		

Source: MLTM (2010)

2.3 Establishing an Independent Project Management System (2002-2005)

After completing the project management contract with Bechtel, the Authority established the system for producing specialists by having a specialist service provider train its project management staff with theories and electronic education to enable them to perform independent project management tasks. After January 2004, a new organization (Korean National Railroad Facilities Authority) that integrated the construction area of the high speed rail system and the existing railway system was established, which created a need for various project management methods for projects in various sizes and formats. In 2004, the project management system was revised, and in 2005, the comprehensive project management system was completed.

3. Vehicle Type Selection and Contract Conclusion

3.1 Overview

One of the core tasks of the Gyeongbu High Speed Rail Project was the selection of the vehicle type and technology transfer. The task for selecting the vehicle type began

by sending the RFP to three countries - Japan, France, and Germany - on August 26, 1991.

3.1.1 RFP

a. Objective and basic direction

The objective of the RFP was to receive reliable proposals on the technology, technology transfer, funding, and price for the construction of the Gyeongbu High Speed Rail System, and to select among the proposals the best vehicle type.

The scope of the RFP included vehicles with a maximum speed of 300 km/h, and electric car lines and ATCs that required state-of-the-art technologies. The target countries were France, Germany, and Japan, which owned high speed rail technologies. Each system proposal was reviewed, and the best proposal was selected based on compatibility, transport capacity, high-speed capability, stability, technology transfer, and localization.

Further, the RFP requested that each proposal stipulate the best foreign-funding-supply conditions that would facilitate the procurement of the funding required for the acquisition of vehicles and core equipment, and it was determined that the vehicle type would be finalized through the negotiation process after reviewing the proposals.

(1) Procedure

The first draft of the RFP was created based on the results of the technical survey and the basic design, as requested by KORAIL and performed by Korea Transport Institute, among others (July 1989-February 1990).

The International High Speed Rail Symposium was held in Seoul on October 16-22, 1989 and about 100 foreign specialists and 531 South Korean specialists. Referring to the technical trends determined in the symposium, Korea Transport Institute, Yooshin Engineering Corp., KRETA, Hyundai Precision&Industries Corp., Daewoo Engineering&Construction, and Louise Berger (USA), among others, created and reviewed the RFP.

The creation of the RFP for vehicle introduction, however, underwent various trial-anderror periods until it was completed and sent out, due to the lack of technical information on the high speed rail system.

(2) Evaluation standard and method for the proposals

Out of the total score of 30,000, the evaluation standard divided each proposal into four areas (cost, technology, technology development, and sales), each of which was given a total score of 7,500. The four areas were subdivided into 300 subcategories, and to ensure the objectivity and fairness of the evaluation, an evaluation team consisted of 50 reviewers in three teams of specialists in High Speed Rail Construction Authority, as well as South Korean and foreign specialists, was established.

The evaluation method assessed the proposals by comparing their characteristics based on an inclusive scoring system. In particular, the method used both a qualitative assessment method that evaluated the technical performance and characteristics subjectively, and a quantitative method that, based on the proposed price, analyzed and evaluated the economic performance of each proposal by considering the financial condition, foreignexchange rate, market price increase rate, etc.

(3) Evaluation participant organizations

- Korea High Speed Rail Construction Authority
- Five South Korean organizations: Korea Transport Institute, KIMM, KERI, Korea Ratings, and Shin & Kim
- Foreign organization: International Overseas Bechtel, Inc.

(4) Evaluation items by area

- Finance (8 items): Credit rating, total loan, amount of interest, redemption period, warranty period, capitalization of construction interest, exchange risk hedge, other special conditions
- Rolling stock (60 items): Vehicle system, noise & vibration, vehicle structure, amenities, seats, operating-room facilities, air-conditioning system, truck & comfort, brake device, current collector, propelling device, controlling device, services & others
- Catenary (11 items): Dynamic performance, electric characteristics, reliability, safety characteristics, installation condition, installation services, training plan, testing & test-driving plan, parts/tools/other equipment, maintenance & repair plan/services, basic & detailed designs
- ATC (15 items): Headway, speed control phase, interface to the train,

reliability, usability, maintenance & repair, safety, installation condition & services, training plan, testing & test-driving plan, operation&maintenance/ repair guidelines, parts/ tools/equipment, maintenance/repair plan & services, basic design & supervision

- Connecting devices (IXL; 10 items): Electric-train devices, ground-signaling device, reliability, maintenance & reparability, safety, basic design & supervision, installation condition & services, training plan, testing & test-driving plan, parts/tools/equipment, maintenance/repair plan & services
- CTC (8 items): Auxiliary devices to the computer, resistance force to defects, software, central-control-room & display device, installation labor, training plan, testing & test-driving plan, parts/tools/equipment, maintenance/repair plan & services
- QA/QC (18 items): Quality control plan, organization, design control, guidelines, procedures & drawings, operation-storing-loading & control, materials & equipment control, special-process control, investigation, test control, testing, inspection & states, quality program records
- Technology transfer (33 items): Full-scope license, foreign-market sales rights, system engineering, conditions, vehicles, electric-car line, signal facilities design, automatic-train-control device, train concentration control device, connecting device, signal facilities, testing & test driving, signal facility installation services
- Localization (28 items): Vehicles, electric-car line, testing & test driving, installation of signal facilities, automatic-vehicle-control device, central-concentration control device, connecting device
- General & special conditions (48 items):
  - General conditions: General responsibilities (dispute mediation, etc.), design & manufacturing (guaranteeing the patents, etc.), installation & maintenance/repair (contractor's installation services, etc.), contractor responsibility (contract & defect warranty, etc.)
  - Special conditions: Compensation for deferment, insurance conditions, joint surety of the contractor
- Project experiences (three items): Project execution capacity, experience in high speed rail construction, funding sources
- Scheduling (60 items): Contract scheduling, project objectives scheduling, scheduling-related data submission, production scheduling, detailed

scheduling, 90-day scheduling, six-week scheduling, schedule adjustment, schedule meeting, progress reports, project management plan, administrative/ mediation/technical/industrial/quality/purchase/operation management

3.1.2 First-Phase Proposal Evaluation

a. Evaluation process and overall opinions

Following the government's high speed rail project policies, High Speed Rail Construction Authority sent out the RFP to three countries - France, Germany, and Japan, which own high speed rail technologies - on August 26, 1991, and received the initial proposals on March 31, 1992 from three consortiums: GEC-Alsthom (France), Siemens AG Transport Group (Germany), and Mitsubishi (Japan). Despite the difference in the method and characteristics, the vehicle systems proposed by the three consortiums were determined to be suitable for the Gyeongbu High Speed Rail System in terms of technology and performance. Most of the contents of the proposals, however, such as the price, technology transfer and localization conditions, and scheduling, did not meet South Korea's expectations, and South Korea requested the first supplement proposal (April 28, 1992), notifying that if the supplements do not meet its expectations, the priority of negotiation would not be determined, and the bid will be opened to other companies.

The supplementary proposals showed that while Alsthom in France was somewhat superior to the other companies in terms of financial conditions, technological development, control plan, and qualifications, Siemens in Germany was superior in terms of economic performance and overall technological aspects. While Mitsubishi in Japan was considered superior in terms of price conditions and scheduling, its proposal did not meet South Korea's expectations. Therefore, South Korea changed its policy to generate intense competition among the companies, and to drastically improve the level of the proposals.

Having submitted a report on such circumstances to the Social-Overhead-Capital Construction Implementation Committee, the Authority proposed the holding of simultaneous and multiple-party negotiations with the three countries as a measure. After the approval, the Authority officially notified the three companies of the initiation of simultaneous, multiple-party negotiations with them, the negotiation organization of

South Korea, and the schedule on June 10, 1992.

b. Negotiation and evaluation results

The evaluation of the initial and supplementary proposals showed not only that the proposed content by area was well below South Korea's expectations but also that the proposing companies kept one another in check while maintaining their own stance. To cope with such circumstance and to drastically improve the level of the proposals so as to conclude the contract with a better price and better conditions, South Korea changed its strategy into simultaneous and multiple-party negotiations, which could lead to intense competition among the three companies.

As such, South Korea set the optimal negotiation goal and detailed negotiation plans by area, and the Authority held negotiations with South Korean and foreign specialists by area. Moreover, to ensure an efficient negotiation process, the Authority first underwent training sessions from KEPCO, which acquired extensive experience in international negotiations during the nuclear-plant construction projects, and from the Bechtel staff, who were international negotiation and contract specialists.

The vehicle negotiation was conducted by phase and area. The topics in the firstphase negotiation included the financial conditions, the technical aspects related to the performances of various equipment, state-of-the-art technology transfer and localization, contract conditions, and other sales area. The topics in the second-phase negotiation, on the other hand, focused on relating all the conditions to the price, with the primary objective of reducing the price.

(1) First-phase negotiation targets:

- Financial conditions: Stable procurement of project funding through a long-term loan with low interest by setting the target values on the overall loan conditions, such as the total amount of loans and interest rate, as well as the deferred term related to the export finance and commercial loan
- Technical areas: Leading to the construction of a low-maintenance/repair cost system that offers the best performance, and selecting the vehicles and amenities that are suitable for South Korea's circumstances
- Technology development: Ensuring the transfer of all the technologies, including and especially the state-of-the-art core technologies, to South

Korea, to enable the construction of localized high speed trains therein, and minimizing the technology transfer cost related to the transfer process; ensuring that 44 vehicle groups, excluding the two sample vehicle groups, would be assembled in South Korea so that South Korean companies could participate as actively and intensively as possible in the vehicle manufacturing process

- Sales: Setting the target values on various responsibilities and obligations related to the project in such a way that the results would be beneficial to South Korea, and planning the scheduling so that each process proposed by South Korea would not pose any problem or give rise to any issue

(2) Second-phase negotiation targets (price):

- Setting the target price for all expenses related to the project, and encouraging each company that submits a proposal to competitively approach the target price; minimizing the factors contributing to future cost increases, such as market price increases

3.1.3 Second-Phase Proposal Evaluation

Through the first-phase negotiation by area with the three companies from June 16 to September 30, 1992, their technical level could be compared and verified, based on which South Korea requested the firm price by setting the work scope.

On September 30, 1992, the revised proposals from the three companies were received, and the second-phase proposal evaluation was carried out on October 10-29. The evaluation team, consisting of a total of 53 reviewers - 29 from the Authority evaluation team, 21 from Bechtel, and three from Shin & Kim - evaluated the proposals based on the same method as in the first-phase evaluation, which was to score the proposals by area and to sum up the scores.

While the three companies proposed a firm price, it was very high based on the adjustment of the work scope and the foreign-exchange rates. They also continued to avoid technology transfer, and the numbers of assemblies in South Korea were below what had been originally requested. Particularly in terms of core-technology transfer, while they granted the right to manufacture and sell vehicles, the target sales

regions were restricted or required advance approval -all of which did not meet the expectations of South Korea at all. Even with regard to South Korean localization, they proposed a plan based on their own production price rather than one based on which the localization could be calculated, resulting in an extremely low reliability of the proposals.

a. Evaluation results

For the evaluation results for each area (i.e., cost, technology, technology development, and sales), out of 30,000, Alsthom in France scored 20,030; Siemens in Germany 19,983; and Mitsubishi in Japan 19,151. All the scores were about 63% of the total score.

b. Second-phase negotiation

Based on the price proposed by Mitsubishi, South Korea wanted to encourage Alsthom and Siemens to reduce their prices, and to compare and evaluate the further-reduced price proposals, but due to the unstable political circumstances at that time (presidential election, etc.), the negotiation became stagnant, and each company sat on the table with less enthusiasm.

Thus, the South Korean government changed its negotiation tactics to make them more realistic and concrete. First, it collected and analyzed the information on the actual transaction price of foreign high speed rail vehicles so as to estimate the price appropriate for Gyeongbu High Speed Rail, and in the negotiation, it focused on the difference between the estimated and proposed prices. Second, by comparing the proposed prices and the proposed supply amounts, it encouraged the reduction of the unit prices and the amounts of supply of the parts that were excessively overestimated (training cost, provisional parts, translation and interpretation services charges, and other labor fees). Third, it urged the three companies to participate in the negotiation of those parts that had not been agreed upon with greater enthusiasm (guaranteeing the system performance, core-technology transfer, localization, etc.), and explained the conditions by comparing them to those of the other companies so as to instigate a sense of competition among them. Finally, recognizing that the three companies were predicting the level of the proposal among themselves and attempted to adjust their proposal just below those of the two other companies and within the smallest scope so as to have the upper hand in the negotiation, the South Korean government advocated

a strong policy against such tactic, announcing that it would exclude the company whose level of proposal is the lowest among the three companies, so as to urge them to participate in the negotiation with greater enthusiasm.

3.1.4 Third-Phase Proposal Evaluation

Having received the third proposals on December 10, 1992, the South Korean government evaluated the proposals on December 16. The evaluation team consisted of 51 reviewers -20 from the Authority's evaluation team, 19 from Bechtel, and 12 from specialist organizations and law firms -and the evaluation method was the same as that in the secondphase evaluation.

The third-phase evaluation and negotiation focused on the price. To encourage drastic price reduction from the three companies, the negotiation team adjusted the scope of some work and alleviated the overall conditions to the level of the custom of international trade, but the three companies could not meet the target price of the negotiation team.

Nevertheless, the three companies sufficiently understood the request of the negotiation team and reviewed their first price revision and considerably lowered it.

As for technology transfer and localization, the three companies conducted practical negotiations with a South Korean company to accommodate the requests made by the negotiation team, and calculated and presented the localization price based on the estimates proposed by the South Korean company. As for the basic contract, general contracts, and some parts related to technology transfer, the negotiation team made some progress: it succeeded in concluding complete technology transfer and proposed a plan to establish a joint-investment company for the production of parts that require high-level technology.

The price proposed by all three companies, however, exceeded the target price (USD 2.7 billion). While the price proposed by Mitsubishi was within the target price based on a simple comparison, if the standardization cost, financial and operational costs, and the costs of other economic performances were to be considered, it would have been higher than the price proposed by Alsthom. Furthermore, all the three companies

excluded the core technology from the technology transfer.

Furthermore, the number of key assembly groups in South Korea was between 28 and 30, and the participation rate of South Korean companies was low (between 29.1 and 35.7%). Moreover, the technology transfer contracts concluded with South Korean companies were inadequate, and the proposals on the contract conditions and scheduling were not satisfactory. All these made the negotiation team feel that the request for additional proposal revisions was inevitable.

3.1.5 Fourth-Phase Proposal Evaluation

The fourth-phase proposals were requested on December 23, 1992, received on January 11, 1993, and evaluated and negotiated on January 12-30, 1993. All the three companies proposed prices that were between 10.4 and 26.9% lower than the prices in the second-phase proposals, and between 1.9 and 11.1% lower than the prices in the third-phase proposals, at USD 2.5 billion (Mitsubishi), USD 2.7 billion (Alsthom), and USD 2.94 billion (Siemens), getting closer to the negotiation team's target price.

The three companies, however, were still reluctant about the technology transfer of core technologies, and as for the localization proposal, the number of assembly groups in South Korea was merely around 31, and the participation ratio of the South Korean companies to the total proposed amount of the price remained at around 38%. Meanwhile, it was determined that the financial burden of South Korea needed to be minimized, and accordingly, another revision was requested to maximize the competition in the lesssatisfactory areas and to encourage the submission of better proposals that would be more in keeping with the national interest.

3.1.6 Fifth-Phase Proposal Evaluation

As a consequence of the first to fourth proposal evaluations, some progress was made in the price and core technology. The overall conditions, however, did not meet the negotiation team's expectations. As such, the fifth-phase proposals were requested on February 3, 1993, were received on February 22, and were evaluated and negotiated on March 4-31, 1993.

The fifth-phase proposal evaluation focused on improving the less-satisfactory

conditions in finance, localization, and technology, and on reducing the proposed price. In the review of the revised proposals, it was determined that the terms of repayment, such as the interest rate or contracted charges, were much improved, although there were some differences among the companies. In terms of technology transfer, the proposals extended the scope of free technical training and support as well as offered detailed technological-development plans. Some or all of the items excluded from technology transfer were removed, and the number of assemblies in South Korea or the localization ratio was also greatly increased.

3.1.7 Sixth-Phase Proposal Evaluation (Final Evaluation)

After reviewing the investment cost and construction process of the Gyeongbu High Speed Rail Construction Project on June 14, 1993, the South Korean government decided to revise some parts of the basic plan, such as the production process, vehicle supply schedule, and project scope.

To acquire better conditions and technologies, the final evaluation was conducted by a vehicle negotiation team consisting of specialists from the Authority and in various fields. The South Korean negotiation team consisted of 57 members (the Authority, Shin&Kim, Korea Development Bank, Foreign Exchange Bank, and Bechtel) while the French negotiation team consisted of 70 members.

After the contract negotiations for vehicle introduction and core technology that lasted for about eight months, the negotiation team announced the results on April 18, 1994. Below are the results of the negotiations for key issues, such as technology transfer and localization, as well as for technological issues, including warranty, thorough test drive, improvement of passenger facilities, and comfort of use.

- Price: USD 2.1016 billion (an about 43% reduction from the highest proposed price)
- Unprecedented technology transfer and localization of over 50% of the production cost
- Securing the right to supervise High Speed Rail Construction Authority in all technology transfer and localization processes
- If the localization failed to meet the goal, 20% of the rest of the amount will be paid as penalty.

- Reduction of the technology transfer fees: Free prepaid technical fees; sales technical fees reduced from 2.5 to 2%
- Securing the manufacturer's production, testing, sales, and world market advancement rights (except for the European and North American markets, on which further negotiation is required)
- Guaranteeing the Authority's right to use the already-developed technologies and ownership of the new technologies developed during the project
- Guaranteeing the performance for two years after the acquisition, and a five-year warranty after the contract for unpredictable defects
- Individual and joint responsibilities among consortium-participating companies over all the tasks performed
- Drastic improvement of various other contract conditions, operation experiences, and scheduling

3.1.8 Concluding the Contract

a. Negotiations for the contract

- Technical issues:
  - Quality control: Based on ISO 9000, achieving the target quality of the related companies under the responsibility of the contract
  - Data and drawings control: Conforming to the new design and revised contract conditions
  - Running speed: Running speed of a normal-functioning train – 300 km/h; brake safety speed – 330 km/h
  - Training: Testing, test driving, operation, and inspection training
- Offered by the contractor:
  - Vehicle arrangement: 20 vehicles for one group (two power trains + two power passenger vehicles + 16 general passenger vehicles)
  - Noise level of passenger vehicles: below 66-75 dBA
  - Environmental noise: Less than Lmax. 93 dBA (measured at 25m from the noise source)
  - Air conditioner
  - Passenger information: 16-inch video monitors installed
  - Public phone: Six phones per group
  - Operational software: Offering operational codes; offering the source codes for

the software required for entering the variables

- ○ Exterior design: Electronic calculation and wind tunnel test
- ○ Offering design software

- Technology transfer and localization
  - ○ Offering the full-scope license: Offered to all the three South Korean companies in charge of manufacturing the vehicles
  - ○ Sales regions: World market (further negotiations for EC and North America)
  - ○ Calculation code for the localization rate: Domestic price to the total production price (excluding buy-backs)
  - ○ Approval of the technology transfer contract: Concluding the technology transfer contract among the companies over the vehicle parts, which takes effect after the approval by the Authority
  - ○ Next-generation R&D technologies: Participating in the co-research on France's next-generation high speed rail technology (350 km/h), aerodynamic technology while the vehicle is at a stop, and ten other research topics
  - ○ Technology transfer among the companies: Executed according to the technology transfer contract by the transfer company
  - ○ Intellectual copyrights:
    - · Contractor's ownership of the already-developed intellectual properties: Authority's non-exclusive right to use the intellectual properties for the high speed rail project and within South Korea
    - · Ownership of the intellectual properties after the contract: Authority owns the patents, and the contractor owns the non-exclusive right to use the intellectual properties
  - ○ Guaranteeing the execution of the project
- Guaranteeing the execution of the contract
  - ○ 10% of the total amount of the contract
  - ○ Warranty over defects
    - E. Deposit: 5% of the total amount of the contract
    - F. Warranty period: 24 months after the acquisition, or 12 months after FSC (fullsystem commissioning), whichever comes later
  - ○ Repayment of deferment
    - G. Rate: 0.05% of the item; 0.1% per day after FSC
    - H. Max. amount: 5% of the total amount of the contract
- Scheduling

○ The vehicle delivery schedule should conform to the total project plan or construction plan.

○ South Korean and foreign delivery level: CFR or FOB price

b. Concluding the contract on the introduction of vehicles and core system

On June 14, 1994, about two months after the announcement of the negotiation results, the contract on the introduction of vehicles and core system was concluded. The price and supply scope in the contract sealed between the owner, High Speed Rail Construction Authority, and the supplier, Korea TGV Consortium, are shown below.

(1) Price

- Total amount of the contract: USD 2.1016 billion (about USD 1.682 trillion)
- Foreign tasks: FFr 6.009542 billion
- Domestic tasks: USD 1.069843 billion

(2) Supply scope

- Design of 46 groups of rolling stock (basic, detailed, and production designs), manufacturing, delivery of the completed vehicles, testing and preparation for the operation
- Design (basic and production designs) of the catenary, manufacturing, material supply, supervision of the installation and detailed design, testing and preparation for the operation
- Technical data, training and technical support for the technology transfer of the French company, the contractor, and over 50% of the localization of the equipment production price
- Training, testing and test driving, creating operation and maintenance/repair guidelines, supplying the provision parts and maintenance/repair tools, establishing and executing the maintenance/repair plan (for two years), offering various services, etc.

(3) Key contract conditions

- Mediating disputes: Based on the mediation regulations of Korea Commercial Arbitration Board, both parties appoint one arbiter each, and the third-party arbiter is appointed by Korea Commercial Arbitration Board.
- Task outcomes: The Authority owns the copyrights.

- Inspection and testing: The Authority reserves the right to review, request proof for, attend to, and reject the tasks or delivered goods if these do not conform to the contract provisions.
- Right to audit: The Authority owns the rights for claims and cost reimbursement, and reserves the right to investigate if the target localization has been achieved.
- Interface management: The interface management responsibilities shall be shared by the contractor and the concerned companies, and shall include the related tasks.
- Intellectual copyrights: Securing the Authority's right to use the already-developed intellectual properties as well as the right to own the intellectual properties developed during the project
- Contractor's liability for reparation: Within 10% of the total contract amount against the direct damages or claims that may arise during the project
- Right to cancel tasks: The Authority reserves the right to stop some or all of the related tasks.

c. Sealing the contract on the introduction of public loans

Another important task of the Authority was to supply a large amount of the fund for acquiring vehicles and core equipment through a long-term and low-interest loan. It was partly because of France's extensive financial offer that the Authority selected France (TGV) as its "prioritized negotiating partner." To initiate the loan based on such a financial offer, the South Korean government established the 1994 Public-Loan Introduction Plan, with the South Korean government as the loaner, and acquired the National Assembly's approval for such on December 16, 1993.

Even after the approval by the National Assembly, the South Korean government was not satisfied with France's final, sixth-phase proposal. Thus, for additional improvement of the financial conditions, it entered into a financial negotiation with Indosuez Bank for five months, from January 1994. After agreeing on the loan term sheet, the two parties signed the contract on May 27, 1994. Later, on August 12, the loan contract was sealed between 25 loan bank associations, including Indosuez Bank, and the former Ministry of Finance, which represented the South Korean government. As the outcome of the two-yearand-a-half-long negotiations, this contract allowed a total of USD2.337 billion worth of loans for introducing vehicles and core equipment by way of the export credits guaranteed by COFACE and the export-tied loan, which

was connected to the export credits, as one package. This allowed the South Korean government to acquire stable, long-term, lowinterest funding in terms of interest rates and loan terms, which played the decisive role in establishing the infrastructure of the Gyeongbu High speed railConstruction Project.

<Progress>

- August 26, 1991: The RFP was sent out to France, Japan, and Germany.
  - ○ The South Korean government would be the loaner and guarantee the payment of part of or the whole proposed loan amount.
  - ○ The loan would be used to cover 100% of the vehicles and core equipment costs and the other domestic costs.
- July-August, 1993: Ministry of Finance's opinions on the Authority's foreign-loan plan
  - ○ The foreign loans, out of the loans for the vehicles and core equipment costs would be obtained as public loans, but a plan was required to minimize the contract charges.
  - ○ The localization cost was a kind of cash loan, and since after August 1986, foreign loans have been restricted under the foreign-investment policy. To obtain foreign-currency domestic loans, it was necessary to provide various plans for the use of the loan.

<Table 3-3> Key Loan Conditions Agreed upon by the National Assembly

Category	Export Finance	Tied Loan
Amount	USD 1,915 million	USD 825 million
Interest rate	CIRR	Libor + 0.75 (average)
Terms	18 years (including 8 years deferment)	15 years (including 8 years deferment)

Source: Korea Rail Network Authority (2011)

- August 20, 1993: Final finance proposal by Alsthom, France, which was selected as the prioritized negotiation partner
- September 10, 1993: During the meeting with the Vice Prime Minister and the Ministers of Finance and of Transportation after the meeting with the Minister of the Economy, it was determined, as a policy, to proceed with obtaining public loans also to cover the localization costs.
- September 24, 1993: Submitted a public-loan application to the Ministry of Finance

- ○ Loaner: South Korean government
- ○ Project owner: Korean High speed railConstruction Authority
- ○ Estimated loan amount: USD 2.74 billion
- ○ Projected loanees: International loaning team, including Indosuez Bank in France

- December 16, 193: The original motion on the introduction of public loans was passed at the National Assembly's 165th general meeting, with the conditions below.
  - ○ The government would stipulate the early-repayment and cancellation rights on the loan contract, and report every three years to the National Assembly if early repayment and cancellation would be necessary, which the National Assembly may review.
- August 12, 1994: The public-loan contract was concluded.
  - ○ Loaner: Minister of Finance
  - ○ Loanees: 25 South Korean and foreign financial institutes, including Indosuez Bank (seven South Korean and 18 foreign institutes)
  - ○ Loan amount: USD 2.337 billion (USD 1.617 billion exports finance; USD 722 million tied finance)
- August 26, 1994: The public-loan subcontract was sealed between the Ministry of Finance and the Chairman of the Authority, based on Article 26 of the Foreign Investment Act.

<Table 3-4> Final loan Conditions

Category	Export Finance	Tied
Contrast amount	USD 1.617 billion	USD 720 million
Interest rate	6.25% confirmed based on CIRR	Libor + 0.57%
Terms	10-year redemption by installment (8 years deferment)	7-year redemption by installment (8 years deferment)
Charges	Management charges: 0.4% Contract charges: 0.28% per year	Management charges: 0.7% Contract charges: 0.3% per year
Capitalization	Interest and insurance premium	Interest
Usage	Foreign-equipment purchases, exports insurance premium, interest and market price increase during the construction	Advance, South Korean equipment purchases, interest during the construction

Note: Based on the vehicle contract results on June 14, 1994, the loan amount was reduced from that agreed upon by the National Assembly.
Source: Korea Rail Network Authority (2011)

d. Concluding the train wireless communication system supply contract

It was originally planned that the train wireless communication system would be established by the exclusive proposal together with the core system, and all three countries proposed the wireless communication system that was in use in their own country. This equipment, however, was old and in the analog format, and the proposed amount was too high. Thus, the negotiation team asked for the proposal of a frequency-sharing method based on digital technology, but no proposal was satisfactory. Thus, the train wireless communication system was separated from the core system and was ordered independently. After the call for project proposals in the newspapers in 10 countries, including the U.S., U.K., and Germany, seven companies from the U.S., France, Germany, and Switzerland showed interest in participating in the project.

As of May 1994, the deadline for the proposals, only two companies in the U.S. submitted proposals, which were reviewed by a committee consisting of scholars and researchers in South Korea and abroad. As a result, Motorola was chosen as the prioritized negotiation partner, and after negotiations with the company, the negotiation team concluded a contract with it on April 22, 1995, at about USD 83.4 million, which was 38.5~53.8% lower than the amount indicated in the high speed rail proposals. The performance of the resulting system was superior to, and its functions were more diverse than, those in the previously proposed systems. As such, the negotiation team was able to integrate wireless communication systems in all areas of the high speed rail system, resulting in efficient operations.

<Basic Conditions of the Train Wireless System>

- Efficient support of the centralized control system for all trains
- Securing the communication zone in over 98% of all the system zones
- Securing sufficient data and voice communication capacities between land and trains
- Securing the reliability through the establishment of a no-barrier system by doubling the principal equipment and parts
- Zero-disturbance system insusceptible to electromagnetic waves caused by highvoltage lines around the railway
- The central command center can perform surveillance and control functions of the land and train systems
- Allowing emergency calls, general calls, and group and individual calls, and

allowing the setting of calling priorities
- Allowing handover at a high speed (over 300 km/h)

4. Technology Transfer and Localization

The agreement between both parties on the technology transfer and localization through the six-phase negotiation, and the resulting contract, were smoothly executed in the construction of Gyeongbu High Speed Rail and the vehicle production process. As a result, before April 2004, when the first stage of Gyeongbu High Speed Rail opened, all the agreements were realized as planned.

4.1 Vehicle Production

According to the contract, the initial 12 groups of vehicles out of the total of 46 groups would be produced in France and assembled in South Korea while the rest of the 34 groups would be produced and assembled in South Korea. The initial 12 groups of vehicles were produced in 10 factories in France, Belgium, and the U.K. from 1995, and were brought to South Korea from 1998, and after the assembly, vehicle tests, and test drives, they were introduced to Korean National Railroad Authority for two years, from 1999.

Rotem, Inc., the largest South Korean railway vehicle producer, began producing the vehicles that were planned to be produced in South Korea, manufacturing and assembling the locomotives, passenger and locomotive-passenger vehicles, and joint rings. These vehicles were produced in phases beginning in 2001, for two years, and were gradually brought into Korean National Railroad Authority by 2003.

4.2 Technology Transfer

The technology transfer related to vehicles concerned all the parts and auxiliaries required for the production of vehicles, electric-car lines, and train control, and the agreement was for the contractor to offer technical data consisting of a total of 29 items as well as 350,000 technical documents, and to train and provide support for 2,000 technicians. Such technology transfer contract subsequently proceeded without

any problem, and the letter of the agreement in all the items that confirmed the official completion of the technology transfer between the company that offered the technology and each company that was to receive the technology transfer was submitted to the South Korean government on December 29, 2003.

<Table 3-5> Progress of the Technology Transfer

Category	Plan	Outcome	Ratio (%)
Technical data	352,145 sheets of technical data	353,370 sheets of technical data	100.3
Technical training	1,120 people	1,194 people	106.6
Technical support	892 people	1,027 people	115.1

Source: Ministry of Construction and Transportation, KICTEP (2007)

4.3 Progress of the Vehicles and Parts Localization

The localization of the vehicle-related parts was divided into vehicle production and assembly, electric-car lines, and train control. In the first phase of the localization, two groups of sample vehicles manufactured by Alsthom in France were brought to South Korea and were reassembled and subjected to a factory test drive, employing the services of the technical personnel trained in France, through which the South Korean technicians could acquire group assembling and testing skills. This was completed in 2001.

In the second-phase localization, ten groups of vehicles produced in France were brought to South Korea, and using the acquired assembling and testing techniques in the first-phase localization and with technical support from Alsthom, the locomotive and locomotivepassenger vehicles were connected, and vehicles and trucks were assembled, groupassembled, and tested at the factory by 2001.

In the third-phase localization, parts were produced, and after passing the performance inspection through individual tests, such parts were manufactured and installed on the vehicles that were also manufactured in South Korea. In this phase, KTX No. 13, the first vehicle produced in South Korea, was completed in 2002, and in 2003, KTX No. 46, the final group of South-Korean-made vehicles, was completed, signaling the completion of the localization of the vehicles. As such, five years after the production of two sample train sets, South Korea achieved a 93.8% localization ratio.

The localization of electric-car lines was also divided into two phases. The first phase involved the localization of parts like clips and stress cones that were required for the Cheonan-Daejeon zone, the test zone, by 1999, and the second phase involved the completion of the localization of the electric-car lines, clips, and stress cones that were to be used in the zones other than the test zone by 2001. The localization of train control also proceeded in two phases. The first phase involved the completion of the localization of ATC devices (railway line facilities, detectors, etc.), IXL devices (relays, frames, power devices, input/output devices, etc.) that were to be used in the test zone by 2000. The second phase involved the completion of the localization of ACT devices (top parts of the vehicles, interiors, railway line facilities), CTC devices (command console, computers, LAN facilities, software), and IXL devices (electronic-connection devices, display panels, railway line converters, software) that were to be used in the zones other than the test zone.

The actual localization ratio of the vehicles, electric-car lines, and train control devices through technology transfer according to the localization contract was 55.4% at the end of November 2003, exceeding the target ratio in the contract (50%).

<Table 3-6> Localization Outcomes of the Vehicles and Parts

Category		Localization Scope
Vehicles (~10/2003)	1st Phase (two sample train sets)	Reassembling, testing, and test driving of two sample train sets (KTX 1, 2) in South Korea
	2nd Phase (10 train sets)	Assembling, testing, and test driving of train sets (KTX 3-12), and manufacturing joint rings in South Korea
	3rd Phase (34 train sets)	Reassembling, testing, and test driving of 34 train sets (KTX 13-46) in South Korea
Electric-car line (12/1996-12/2001)	1st Phase (sample line section)	Localization of primary and secondary parts, small steel parts
	2nd Phase (sections except the test section)	Localization of all parts (excluding the items that offer no economic value)
Train control device (03/1995-10/2003)	1st Phase (testing section)	Introducing foreign materials; some parts are assembled in South Korea
	2nd Phase (Gwangmyeong-Daegu)	Manufacturing basic parts; assembling and testing key parts

Source: Ministry of Construction and Transportation, KICTEP (2007)

5. Development of the High Speed Rail Technology

5.1 G7 High Speed Rail Technology Development Project

5.1.1 Overview

The High Speed Rail Technology Development Project, one of the Pioneering Technology Development Projects (G7) promoted by the Ministry of Science & Technology, was participated in by various government departments, including the Ministry of Construction and Transportation as the center and the Ministry of Commerce, Industry, and Energy and the Ministry of Science and Technology as its partners, and led by Korean Railroad Research Institute, the project was participated in by 4,934 researchers from 129 organizations (82 companies, 18 research institutes, and 29 universities) from December 1996 to October 2002. The final goal of the project was "to develop the Korean High Speed Rail System with the maximum operational speed of 350 km/h and while securing core technologies." A total of KRW 210.1 billion (KRW 105.2 billion from the government and KRW 104.9 billion from the private sectors) was invested in the project.

The project was largely divided into two parts. The first part promoted the project through analysis and design while the second part promoted it through manufacturing, testing, and results evaluation.

<Table 3-7> Milestones of the Korean High Speed Rail Technology Development Project

1st Phase (12/1996-10/1999)	- Determining the next-generation South Korean system specifications and detailed design - Manufacturing the sample vehicle and developing the first sample of the signal device - Developing an original design technology and producing technical personnel - Developing a railway line structures design technology
2nd Phase (11/1999-10/2002)	- Developing an independent 350 km/h testing evaluation technology and creating and test driving the sample vehicle - Acquiring the original design technology and independent system engineering technology - Developing an independent railway line structure design technology

Source: Ministry of Construction and Transportation, KICTEP (2007)

The High Speed Rail Technology Development Project concentrated on overcoming the technical issues due to the increase in the vehicle operation speed compared to

KTX, on the existing high speed rail system, and on acquiring an exclusive technology.

- Improving the pulling force and reducing the vehicle air resistance
  - ○ Developing a large-capacity main power converter, induction motor, and transformer
  - ○ Applying the air-resistance-reducing structure to the lower part of the vehicle
  - ○ Developing lightweight vehicles (the main body and devices)
  - ○ Minimizing the air resistance of the front part of the vehicle
- Driving safety
  - ○ Analysis of the vehicle fatigue strength
  - ○ Developing a lightweight body and revision of the vehicle frame structure
  - ○ Characteristics analysis and development of a suspension device for high-speed operation
- Braking system
  - ○ Additional development of an eddy current braking device
  - ○ Developing and implementing wheel and ventilation discs
- Collector and signal devices
  - ○ Developing the vehicle/line interface and dynamic characteristics analysis, and a collecting device
  - ○ Developing new line system design and materials according to the speed improvement

<Table 3-8> Core Technologies of the Korean High Speed Rail System

Category	Korean High Speed Rail System (G7 Project)	KTX	Remark
Max. operation speed	350 km/h	300 km/h	
Front	South Korean	TGV	Aerodynamic design
Body	Aluminum	Mild steel	Material technology
Pulling motor	Induction motor	Synchronous motor	
Main power converter (power device)	IGCT	GTO	
Pressure control system	Pressurization system	Ventilation openings	
Braking system	Friction, regeneration, eddy current	Friction and regeneration	

Source: Ministry of Construction and Transportation, KICTEP (2007)

○ Establishing a compatible signal system (developing automatic train control, concentrated train control, and an electronic-tied device)

- Environmental measures
  - ○ Developing various devices and technologies for reducing noise (vehicle body and truck, etc.)
  - ○ Developing an absorptive technology for improving the tracking performance (fixing tools, dust proofing materials, slab tracking, etc.)
  - ○ Developing a technology for tunnel and bridge characteristics analysis and measures
  - ○ Establishing an electromagnetic-effect analysis and impact assessment system

5.1.2 Outcomes of the G7 Project

Through the G7 Project, a high speed rail system with the highest speed of 350 km/h was manufactured using South Korea's domestic technology. The following is a summary of the project's key outcomes.

<Table 3-9> Key Outcomes of the G7 Project

Category	Research Contents
System engineering	- Establishing system engineering management and technical systems - Performing comprehensive control and test driving/inspection/ assessment based on the testing and assessment plan - Completing system performance assessment and performance assessment technology - Reviewing the performance of the comprehensive test-driving system, and establishing the measurement system - Developing a sample signal control product, and integrated testing - Developing an integrated signal control system simulator and an electric/ electronic environmental assessment and measurement system - Developing a railway line structure performance improvement technology and a test-driving performance assessment technology - Reviewing the performance and safety of railway line structures based on test driving
Vehicle system and parts	- Establishing a vehicle system engineering technology system - Establishing a vehicle system and parts assessment plan, setting the assessment standards, and confirming the specifications - Developing and assessing the sample vehicle system and parts - Completing and manufacturing the detailed design of the vehicle system and electronic components - Optimized design of the vehicle system, and completing the sample vehicle production - Establishing a plan for the integrated vehicle electrical-system test, revising and diagnostic control plan - Carrying out a performance test of the sample vehicle - Supporting the integrated test driving and testing/assessment

Source: Ministry of Construction and Transportation, KICTEP (2007)

5.2 High Speed Rail System Technology Development Project

5.2.1 Overview

The High Speed Rail System Technology Development Project was conducted in tandem with the G7 Project, whose goal was to establish a stable, reliable, and safe system from the Korean High Speed Rail System developed in the G7 Project. The term of the project was planned to be five years, from December 2002 to October 2007, and the total budget for the project was KRW 45.7 billion (KRW 35.3 billion from the South Korean government and KRW 10.4 billion from the private sector).

Below are the key research topics for the project:

- Stable and practical technology development by acquiring the reliability of the Korean High Speed Rail System
- Technological development of an integrated passenger-freight transportation system
- Establishing a high speed rail system that meets both the safety and performance standards
- Developing South Korea's own multiple-propulsion system technology

For the effective promotion of the research, the project was divided into two parts: (1) reliability and safety system development, and (2) system stabilization.

5.2.2 Progress of the project

The project was led by the Ministry of Construction and Transportation, and research institutes, including Korea Railroad Research Institute as the main research body, were selected based on eight objectives. The project started in December 2002 and went on for five years, and the two objectives -development of a high speed rail performance standard and safety system, and development of a high speed rail vehicle development system -were completed in the fourth year while the rest of the six objectives were pursued until the fifth year.

The maximum speed of the high speed rail system developed by the G7 Project was 350 km/h, which was faster than 300 km/h of the existing KTX, and the new high speed rail system started to operate in March 2010.

<Table 3-10> Key Research Topics by Objective

Category	Key Research Topics
Integrating and overseeing the high speed rail technology development	- Controlling and overseeing the high speed rail technology project - Overseeing the procurement of maintenance/repair parts - Controlling and adjusting the subcategory task schedules
Development of the technology for improving the reliability and operational efficiency of the high speed rail system	- Acquiring a reliability assessment technology - Establishing a comprehensive measurement system - Integrating and commercializing development S/W - Technical survey of the high speed rail integrated transport system - Integrated transport system design, implementation and feasibility analysis - Developing an operational-efficiency infrastructure technology
Development of the high speed rail performance standard and safety system technology	- Analysis of cases in foreign countries on the high speed rail performance standard and safety system - Producing a draft on the performance standard and safety control system - Reviewing the technical aspects of the draft, and collecting opinions on it - Establishing the South Korean high speed rail performance standard - Establishing the South Korean high speed rail system safety control system - Legislating the performance/safety standards
Development of structure technology of the high speed rail vehicle system	- Analyzing the sample vehicle parts performance test, and establishing measures - Technical support for the test driving of the vehicle system - Establishing the vehicle system development structure - Establishing the quality control of the vehicle system
Development of stability technology of the high speed rail vehicle system	- Stabilization test for vehicle system stabilization - Vehicle system maintenance/repair - Revised design for practicality - Practical system development and performance assessment - Establishing a vehicle system maintenance/repair system
Development of control system stabilization technology of the high speed rail system	- ATC/CTC/IXL stabilization and reliability test - Producing and analyzing train-control-related hazards - Analyzing the safety requirements and plan - Establishing a safety inspection system - Related H/W and S/W development - Life cycle stability analysis
Development of the high speed rail track structure stabilization technology	- Development of a track structure safety improvement technology - Study on the commercialization of the developed products, including high-speed turnout - Development of a parts reliability tracking technology
Development of a South Korean multiple-propulsion system technology	- Analysis and confirmation of the multiple-propulsion system application plan - Selection of the multiple-propulsion system capacity and characteristics analysis - Characteristics analysis and test assessment of the multiplepropulsion system - Test driving and assessment of the developed system

Source: Ministry of Construction and Transportation, KICTEP (2007)

A high speed rail system with the maximum speed of 430 km/h (HEMU-400X) is currently being developed. As the operation stability test was successfully completed in October 2011, it is projected that the developed system would go through performance and stability assessment via test driving in 2012.

6. Selection of the Construction Companies and Construction of the Test Railway Section

6.1 Selection of the Construction Companies

For the bidding method for selecting a contractor for the Gyeongbu High speed rail Project, pre-qualification (PQ) was chosen so that only qualified companies could participate in the bidding. In addition, the open-competition principle was used for those who were selected via PQ, and considering various conditions, one construction zone was set to be around 10 km to promote clear construction and to accumulate technical experience.

6.1.1 Bidding Process

To have a healthy and excellent contractor who would use advanced construction equipment and highly skilled personnel to complete the project within the given term, and who would conduct international-level quality control and process control, the PQ system was used as a bidding process for all the bidding participants. While allowing a jointventure contract to extend the bidding opportunity to small and middle-sized companies, and for technology accumulation, measures were also implemented in the bidding process to prevent poor construction due to a joint-venture contract by only small and middle-sized companies.

6.1.2 Improvement of the Bidding Process

The second project plan revision in September 1997 strengthened the qualifications of the contractors and limited the number of joint-venture contractors. Specifically, the revision plan allowed the participation of companies that had little experience in bridge and tunnel construction and that had few contract limits, and allowed up to five

companies to submit a joint-venture contract, which might lead to poor construction (35 companies in 16 construction zones). Thus, the revised plan raised the contract amount limit to KRW 400 billion from KRW 35 billion. Further, the number of companies in a joint-venture contract was adjusted from five to three companies, and priority was given to companies that had acquired ISO quality certification.

6.2 Commencement of the Test Railway Section

In March 1992, Korean High Speed Rail Construction Authority, which was to lead the project, was established, and the practical procedure for the commencement of the project began. On June 30, 1992, the groundbreaking ceremony on the test railway section [the first four construction zones (39.6 km) among the seven test railway sections] was held.

A test section was constructed because the high speed rail system had trains running over 300 km/h, and because the system was a state-of-the-art technology that was to be implemented in South Korea for the first time. Therefore, it was necessary for the project to go through sufficient performance and safety tests before the commencement of the construction in all the sections. The Cheonan-Daejeon section was selected as the test section because this region had various topological characteristics, such as tunnels, bridges, and earthworks, which were required for the test. Moreover, while the region was relatively close to Seoul, there were no large cities nearby; as such, it would be less affected by the noise and vibration generated in the test operation.

7. Preparation for the Opening and Operation of the High Speed Rail System

7.1 Completion of the First-Phase Construction Project, and Execution of a Commercial Test Run

7.1.1 Completion of the First-Phase Construction Project

Since after the target process was completed in 2001 and 2002, in the first half of 2003, the construction of all facilities, including the sub-base course, tracks, and power facilities, was completed, and from May, the high speed vehicle was placed

in the Gyeongmyeong-Cheonan zone for the performance of a facility performance test. Moreover, the substation at Busan Vehicle Depot, the final substance in the first-phase zone, successfully started receiving electricity on October 1, 2003, and all the seven substances that were to offer power to high speed vehicles, and the supporting facilities, were ready for operation. Thus, the power supply preparation for the 409.8-km-long first-phase section was completed.

Meanwhile, Seoul Station started its operation on November 28, 2003 to prepare for the official opening in April 2004, and the construction of Cheonan-Asan Station was finalized at the end of 2003 and was completed towards the end of March 2004, after continuous performance testing and supplementary construction of passenger facilities. Towards the end of April of the same year, Gwangmyeong Station was also completed. The revision of Busan, Daejeon, and Dongdaegu Stations was completed towards the end of September 2003.

The final KTX No. 46 was shipped out on November 28, 2003, and since October 17 of the same year, an integrated test drive in cooperation with KORAIL had been conducted between Seoul and Busan.

7.1.2 Completion of the Test Drive, and Execution of a Commercial Test Drive

After their acquisition, the high speed rail vehicles were subjected to an integrated test to confirm the comprehensive performance of the system. The integrated test was performed to verify various performance issues of each system (e.g., vehicle, track, power, signal, communication, CTC) while the test vehicle was running on the railway where it was to operate, to discover and address any potential problem in advance.

The integrated test, targeting all the railway sections, was performed in tandem with the train operation time and energy consumption. The Gwangmyeong-Bukdaejeon section (135.6 km), including the test railway section, underwent the running test at 300 km/h from July 18 to August 14, 2003, and the test drive was extended to the Daejeon-Daegu section from October to November 7 in the same year.

The test drive on the Daejeon-Daegu zone measured the truck vibration acceleration of the KTX vehicle, the derailing rate of the electric railway line, the performance of

the power supply system, and the wireless communication system while increasing the speed in six stages, from 60 to 300 km/h. The running test at 300 km/h on November 7, 2003 satisfied all the standard values and was completed.

After completing the running test between Daejeon and Daegu, the KTX test drive that had been performed only between Seoul and Daejeon was extended to Seoul and Daegu until the end of 2003. From January 2003 until the official start of the service, a commercial test drive was performed, which assumed normal business operations, with the staff onboard.

7.2 Preparation for the Official Start of the Service

7.2.1 Organization of the Preparation for the Integrated Operation

As the high speed rail should be differentiated from the then-existing railway operation system as it is operated by a state-of-the-art system and requires higher service quality, the South Korean government established the "Integrated Operation Preparatory Plan" in December 2001 for the preparation for the official opening of the service, and for the subsequent operations. The preparatory plan was divided into seven propulsion fields, each of which was assigned to the Ministry of Construction and Transportation, KORAIL, and Korean High Speed Rail Construction Authority.

As of the end of January 2002, an integrated operation organization began operating as a manager had been assigned for each operation preparation field, to regularly check the status of the preparation. In August of the same year, the High speed rail Operation Preparatory Task Force Team (team leader, a secretary, one administrative officer, two sixgrade officers, two dispatched staff members from KORAIL, and one dispatched staff from the Authority) was expanded and reorganized for the preparation for the operation.

<Table 3-11> Key Issues of the Integrated-Operation Preparatory Plan

Category	Unit Task
Operation organization and personnel training	- Construction of the operational organization - Personnel training and control
Operation system and business strategy	- Reorganization of the operation system and regulations - Establishment of an integrated train operation plan - Establishment of an integrated information system - Establishment of safety and security measures - Establishment of a tied-transport system - Securing the operation facilities and operating amenities - Establishing marketing strategies - Developing auxiliary-profit projects - Strengthening the international cooperation
Test driving	- Test drive of individual systems - Integrated test operation - Organization of the test operation and control agency
Maintenance/ repair	- Maintenance/repair of high speed trains - Maintenance/repair of infrastructure facilities
Transfer and acquisition	- Data control and transfer - Transfer/acquisition of assets and debts
Preparation for the official start of the service	- Final checkup before officially starting the service - Notice of confirmation of the official service start date - Formulating the opening-ceremony plan

Source: Korea Rail Network Authority (2011)

7.2.2 Concluding a Business Agreement between the Authority and KORAIL

In June 2003, in the process of preparing for the start of the operation of the High Speed Rail System, the Railroad Industry Structure Reform Management Act was established, which effectively separated the construction and operation subjects. The Authority and KORAIL thus concluded a business agreement in September of the same year for the opening and operation of the High Speed Rail System. The basic issues of the agreement were the spot acquisition before the legal transfer and acquisition of the operational assets, the transfer of the right to use the High Speed Rail System facilities and assets, and the support of the Authority by dispatching technical personnel to KORAIL in preparation for the opening of the service.

7.2.3 Preparation for the Operation by Area

a. Operating staff training and management

To recruit talented workers who could operate the state-of-the-art high speed rail system, and to produce elite operation specialists trained through systematic educational programs, an operating-staff training program was developed.

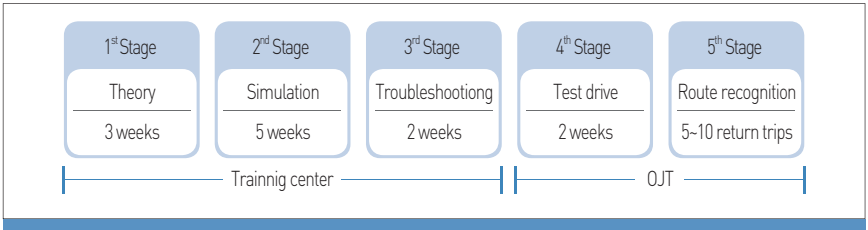
Based on Article 18 of the Korean High Speed Rail Construction Authority Act, a high speed rail operation organization was established in KORAIL. Among the total of 3,039 operational workers (estimation by KORAIL as of December 2000), 2,259 workers completed the theory and simulation training program by the end of December 2002, and 80 high speed train engineers and 84 high speed rail maintenance/repair engineers received OJT.

Since after the conclusion of the core training contract in June 1994, particularly since 1996, the Authority had offered domestic and overseas training programs to the operation, central command, and other related staff, and the planned 320 staff members completed the training. Since August 2002, the Authority had conducted OJT for KORAIL's train engineers, CTC operational staff, and train attendants, completing the practical training for 4,044 workers by August 2003.

b. Producing high speed train engineers

The high speed train engineers were selected among KORAIL's train engineers with at least five years' experience, based on the aptitudes and health conditions. The selected engineers were trained by 20 training staff who had received dispatch training in France.

The high speed train engineer training program was systematically designed to consist of theories, practical training, and test driving, and it took at least five months for it to produce one train engineer. Specifically, the training program consists of three stages, with theory training in the first stage, simulation-based training in the second



<Figure 3-1> The Five Stage of the High Speed Train Engineer Training Program

Existing route recognition : 13 return trips by zone (137 hours)/per engineer (October-November 2003)
High speed rail route recognition : 4 return trips by zone (50 hours)/per engineer (October 2003-March 2004)

stage, and troubleshooting training in the third stage, all of which were given at the training center. Later, in the fourth and fifth stages of the program, the trainee engineers were subjected to test driving and route recognition training, respectively.

During the theory training, the trainee engineers learned various operation regulations and theories related to the high speed train operation, and during the simulation-based training, they underwent simulated-driving tests on a simulator vehicle that offered operation conditions almost the same as those of the actual vehicle. Later, through the test driving of the actual vehicle, the trainee engineers received static-and dynamic-troubleshooting training and finally completed the high speed rail route recognition and simulation training.

c. Test drive, maintenance/repair, and transfer/acquisition

To cope with any potential issue during the actual operation of the system, test driving and various facility inspections were performed, and various systems were established by March 2004.

As for the test drive, the Authority conducted and completed a performance and design verification test on the individual systems (high speed trains, electric railway lines, power, signal, etc.) in the test section from December 2002. In March 2003, the vehicle acquisition test was conducted, and it was completed by the end of January 2004. The test drive on the connectivity between the high speed train wheels and the railroad in the existing railway section was successfully completed (January-June 2002), and in March 2003, when the existing railway renovation project had been completed, the full-scale test was conducted.

Further, in October 2003, an integrated test was conducted, where the dynamic connectivity between the individual systems and the high speed trains was inspected and revised. The test was completed at the end of January 2004.

7.2.4 Supporting Tasks for the Preparation for the Official Start of the Service

a. Establishment of a joint regular inspection system among the concerned organizations

As the first-phase Gyeongbu High Speed Rail Construction Project progressed as planned, the official start of the service was set to April 2004. Thus, the Ministry

of Construction and Transportation, the Authority, and KORAIL established a joint regular inspection system. Targeting the wide-scale promotion of the safe operation and high-quality passenger services of the high speed rail system, the three organizations held a joint inspection meeting to inspect the progress of the project and test drive plans, and discussed the related key issues and various alternatives of each organization.

The Authority made an early transfer of the high speed rail assets and the maintenance/ repair tasks of the facilities in new railway zones to KORAIL, and dispatched its special task force to KORAIL to support the official start of the system operation, which helped in the successful opening of the high speed rail system.

For the final inspection before the official start of the service, the Ministry of Construction and Transportation organized the Opening Task Force in May 2003, and the Authority also established the Opening Preparatory Team for thorough post-event management through the systematic integration and adjustment of the opening-related preparatory tasks. In June of the same year, KORAIL organized and used the Integrated High Speed Rail Operation Preparatory Center for checking potential issues, making final adjustments, and providing measures.

b. Installation and operation of the Opening Preparation Status Room

In August 2003, to promote the successful start of the service, the Authority monitored the status of KORAIL's opening preparations and provided the necessary measures to address the various problems that were discovered through the field checkups and inspections by installing and operating the Opening Preparation Status Room.

7.2.5 Establishment and Execution of Safety Measures in Prearation for the Opening

a. Comprehensive facilities inspection by foreign specialists

(1) Goal

The High Speed Rail Construction Project consisted of a complex system in which various technologies in sub-base courses, tracks, power, communication, signal,

vehicles, etc., are integrated. During the construction, various entities in design, inspection, and construction promoted systematic quality control activities that met the ISO 9001 standards, ensuring good quality through preventive training and inspection activities. In addition, the continuous test driving in the test zone between Cheonan and Daejeon enabled sufficient inspections of the performance of the high speed rail facilities and vehicles.

To increase the South Korean people's trust, however, in the preparation for the opening of the first-phase business section, the South Korean government came up with a comprehensive inspection plan, to be executed by a foreign inspection specialist organization. After the conclusion of a contract with SYSTRA (France) for this purpose, a three-month comprehensive inspection was conducted from September 23 to the end of December 2003.

Consisting of nine members, including specialists in each related area and special UIC members, the inspection team conducted a comprehensive inspection of the performance and safety of the facilities (earthwork, tracks, electric railway lines, control, and communication) and the vehicles, using the same inspection method that was implemented for France's high speed rail system.

(2) Inspection results

The results of the inspection showed that the quality of the sub-base course, track, and other facilities was good. Not only were they constructed based on the exact guidelines regarding the design, construction, test, and test drive stages; their quality was comparable to that of any European high speed rail system that was already in operation. Moreover, the system facilities, such as the power, signal, and communication, were excellent in terms of the production and purchase processes, and the field construction status was considered appropriate. After taking a KTX train ride, the team concluded that the train was very stable dynamically, and that there is likely to be no problem that could affect the system's commercial operation starting in April 2004. The team, however, presented a total of 21 recommendations, 16 improvement measures to be made before the official opening of the service, and five required for the future maintenance and management. The Authority completed all the recommended measures by March 26, 2004, before the opening.

b. Safety checkup

The first-phase Gyeongbu High Speed Rail section that opened in April 2004 is 409.8 km long, and about 19% of the zone consists of tunnels (52 tunnels, 76.4 km). There are three tunnels (26.4 km) that are over 5 km long: Iljik Tunnel (10.3 km) from Gwangmyeong to Asan in Gyeonggi; Hwashin Tunnel (6.3 km) in Yeongdong, Chungbuk; and Hwangak Tunnel (9.9 km) between Yeongdong, Chungbuk and Kimcheom, Gyeongbuk. Moreover, five out of the total of six stations are on the ground while Gwangmyeong Station is on the semi-basement.

The railway construction for KTX and high speed trains was designed and executed based on France's standards, and their safety was achieved through thorough vehicle tests and test drives. Before the first-phase opening of the system, however, the South Korean government established safety measures by area, and conducted safety checkups with the current vehicles, particularly on the structures and safety facilities, to ensure complete stability.

(1) Fire drill with the current vehicles by independent specialists

The passenger interior materials in all KTX vehicles are of A1 grade, the highest quality material grade under France's industrial code (NFF-16101), and have been designed with nonflammable and nontoxic materials to prevent fire. Each item was tested by an official fire-testing agency, and after the testing and confirmation, was used in the production.

In particular, the South Korean government conducted a fire test on KTX vehicles on March 11, 2003, with KORAIL, Rotem, and EUKORAIL officials attending. At the fire test, an about-900ºC flame thrower was used to set on fire the passenger floor materials, walls, ceilings, curtains, and seats, to measure the self-extinguishability and the degree of smoke creation. The results showed that all the materials were self-extinguishable and created little smoke, thus posing no threat of fire. Another actual fire test was conducted outside Goyang Vehicle Depot, which proved the excellent fireproof quality and self-extinguishability of KTX materials. Furthermore, various fire detection and alarm equipment were installed in the vehicles to address any potential threat.

(2) Station fireproof measures

All the fireproof facilities in the stations were designed and constructed based on the firefighting plan and facility standards set by a special firefighting agency. Gwangmyeong Station, however, installed on the semi-basement, may pose a fire threat. To remove all threatening elements, the South Korean government had a special service agency review an evacuation plan in the event of a fire by commissioning "Firefighting Research," and took precautionary measures for unexpected fires by inspecting the flow of smoke in the event that a fire breaks out, via computer simulation.

(3) Tunnel firefighting measures

For the firefighting facilities in the tunnels, emergency lights, exit lights, evacuation passages (1.7 m wide), and handrails were installed in all the tunnels to facilitate the passengers' evacuation. To enable communication via cell phones in emergency cases, antenna cables and wireless phones were installed. Evacuation passages were also installed in the long tunnels (over 5 km).

In addition, for the easy passage of emergency and firefighting vehicles in case of fire, each tunnel was equipped with an access road and a vehicle return road, and for fire direction in KTX vehicles, vehicle axle temperature detectors were installed outside the railway.

(4) Sub-base structures safety inspection

To ensure the safety of the high speed rail, a comprehensive safety inspection of the constructed structures was conducted by WJE (USA) between June 1992 and April 26, 1996. The results showed that 39 structures required partial reconstruction; 109 structures required minor repairs for small cracks, etc.; around 200 structures required surface finishing improvement; and the other 583 structures required no repair. Overall, WJE found no structural-safety issue.

In addition, the South Korean government commissioned Korea Infrastructure Safety Corporation to conduct regular safety inspections for the structures constructed between April 27, 1996 and April 30, 1998, and Korea Infrastructure Safety Corporation and seven other organizations to conduct regular safety inspections for the structures constructed between May 1, 1998 and April 30, 1999. These regular

inspections revealed no structural cracks or leakage, and that over all, all the structures were safe and appropriately constructed based on the design specifications.

The sub-base structures had been built in sequence since 1999 and in compliance with Article 6 of the Special Act on Facilities Safety Management, defect inspection and thorough checkup were conducted every six months to verify the safety conditions of the structures. In particular, the Authority headquarters and KCQR, which were registered as safety inspection agencies, and two other agencies, conducted thorough checkup and defect inspection of the structures in the prioritized zone (Seoul-Daegu) in preparation for the official start of the service. The results revealed no structural issues, but minor recommendations were made, such as the repair of small cracks and surface finishing, which were undertaken based on the repair specifications.

(5) Tracking test and inspection to ensure high-quality service

As the tracking construction in the first-phase Seoul-Daegu zone proceeded as planned, a tracking inspection test in tandem with a 300 km/h acceleration test for the KTX vehicle was conducted in the already-completed zones. This test used the ultrasound detection car that examined in detail the condition of the rail, and the self-propelled track inspection car that accurately measured the precision of the tracking slopes in millimeters. Under warranty and by the supervision of the French technical team, which oversaw the supervision of the said zone, the inspection was conducted error-free.

The results of the track inspection test on the first-constructed test zone, which was conducted by international track specialists from five countries, including France, in May 1999, showed that the Gyeongbu High Speed Rail track satisfied the precision level and performance required for a high speed rail system.

In November 1999, just before the service opening of the test zone, an inspection was performed on the performance, safety, and connectivity of the track, the electric railway lines, and the train control facilities, as well as on the vehicles between Cheonan and Daejeon, the 34.4 km zone. The results showed that the Gyeongbu High speed rail track had world-class quality.

The safety and quality of the Gyeongbu High Speed Rail structures were confirmed through various inspections, from the design stage, and in the construction stage,

experienced foreign consulting companies such as DEC in Germany and SYSTRA and INGEROP in France participated in the process as inspectors, and oversaw the construction process to acquire the highest possible quality, which bolstered the construction technology in South Korea.

Also during the construction, safety inspection was conducted by an official agency every year, and all small defects that were discovered were immediately addressed. Moreover, after the construction, thorough checkup and defect inspection were conducted every six months to reconfirm the safety condition of the structures.

Considering that the track construction was the first and largest mechanized construction that was ever attempted in South Korea, the construction went through technical reviews by foreign technical teams from the design to the construction and final-inspection stages, to acquire the highest possible quality. As a result, Gyeongbu High Speed Rail acquired a level of safety and quality that would allow it to compete with the best railway systems in the world.

8. Financial Procurement

8.1 Financial-Procurement Plan

The budget finalized on July 31, 1998, was KRW 12.7377 trillion, based on the firstphase project plan (1992-2004). To procure the budget, the South Korean government and the Authority established the financial-procurement principle while concluding the first revised plan in 1993. According to such principle, the South Korean government would provide 45% of the total budget while the Authority would

<Table 3-12> Gyeongbu High Speed Rail Budget Plans

(Unit: KRW 100 million as per the basic plan)

Category	Total	Government			Authority			
		Subtotal	Investment	Loan	Subtotal	Foreign loan	Bonds, etc.	Private financing
Total	202,939	93,998	79,025	14,973	108,941	30,750	75,568	2,623
1st Phase	127,377	57,320	44,582	12,738	70,057	30,750	36,684	2,623
2nd Phase	75,562	36,678	34,443	2,235	38,884	-	38,884	-

Source: MLTM (2010)

provide the rest (55%). The financial support was divided into the investment by the Authority and the financial-loan projects while the self-procurement consisted of issuing bonds, foreign loans, and private financing.

The budget finalized in the second-phase project plan (2002-2014) was KRW 7.9454 trillion, and as of 2007, considering the practical railway management, the government's financial support and the Authority's self-procurement ratios were adjusted to 50 and 50%, respectively.

8.2 Financial-Procurement Performance

8.2.1 Government's Financial Support

The government's financial support was about KRW 620 billion per year from 1992 to 1999, and since after 2000, about 40% of the yearly financial support was offered as a financial loan through the Transportation Project Special Accounting. As a result, since after 2000, the financial investment was reduced to KRW 370 billion per year whereas the financial loans increased to about KRW 250 billion per year. This shows that while the government's financial support was around KRW 620 billion per year, about the same as that before 1999, the responsibility of the Authority increased as the government used the loan method rather than investing on the project, partly due to the financial difficulties that the government was experiencing after the onset of the foreign-exchange crisis. As a result, the government's investment represented 30% of the total budget while the financial loan represented 15%.

8.2.2 Issuing Bonds

Among the self-procured financing by the Authority, the owner of the construction project, issuing bonds took the largest share of the financing plan (29%). The bond issuance maintained the objective of the original plan, which was active financing through the publicfunding management fund and the bonding market for the shortage. As a result, the original bonding issuance plan at KRW 3.6648 trillion successfully supplied KRW 3.8097 trillion through the acquisition of the public-funding management fund, and the rest of the KRW 2.9 trillion through the bonding market, as of April 2004. A larger amount of bonds than as planned was issued because the Authority had to supplement the shortages in foreign loans and private funding, and

also because the Authority had to renew the fund due to the redemption of the five-year matured bond.

8.2.3 Foreign Loans

Representing as much as 24% of the total budget, the foreign loans introduced USD 2.364 billion in 1994 from 25 international loan consortiums, including Calyon (formerly Indosuez) Bank in France, as public loans by the South Korean government. Of such amount, USD 2.11745 billion was used by the Authority for purchasing vehicles and core equipment, as a type of sub-loan.

In the 2000s, the international interest rate decreased, and the initial loan conditions (interest rate: 6.25%) were worse than the conditions for new bonds or foreign-currency loans. Thus, the Authority stopped the withdrawal of the exports finance on July 25, 2003 and introduced foreign funds through foreign-currency loans (USD 45 million) and foreign bonds (USD 140 million) as part of the Authority's effort to reduce the repayment after the start of the railway service by procuring the funding with better conditions.

<Table 3-13> Conditions for Public-Loan Introduction

Category	Exports Finance	Tied Finance
Contract amount	USD 1,617 million	USD 720 million
Interest rate	6.255% based on CIRR	Libor+0.57%
Term	10-year installment, with 8 years deferment	7-year installment, with 8 years deferment
Charges	Management charges: 0.4% Contract charges: 0.28% yearly	Management charges: 0.7% Contract charges: 0.3% yearly
Capitalization	Interest and insurance premium	Interest
Usage	Foreign-equipment purchase, exports insurance premium, interest and market price increase during the construction	Prepayment, purchase of South Korean equipment, interest, etc. during the construction

Source: Ministry of Construction and Transportation, KICTEP (2007)

8.2.4 Private Funding

Due to the postponement of the station construction after the opening of the first-

phase section in 2004, or the revision of the original plan, where the existing stations were decided to be used, it was difficult to promote private-funding projects whose main target was constructing new stations. In the case of Gwangmyeong Station, the only newly constructed station, as it was built in the development restriction zone, the subsequent private funding was restricted. In relation to the development of Daegu Station in the second-phase project, private-funding projects are being promoted, and it is expected that other types of private funding will be possible for the other stations, through the development projects of railway station spheres.

<Table 3-14> Funding Procurement Plans and Outcomes of Gyeongbu High Speed Railway (Phase 1)

(unit: KRW 1 billion)

Category	Total Budget	1992-1999	2000	2001	2002	2003	2004
· National budget	5,732	2,634	790	833	737	608	394
-Investment	4,458	2,634	590	601	457	151	232
-Financial loan	1,274	-	200	232	280	457	162
· Self-procurement	7,006	2,609	1,001	1,457	1,085	646	607
Total	12,738	5,243	1,791	2,290	1,822	1,253	1,000

Source: Ministry of Construction and Transportation, KICTEP (2007)

8.3 Future Repayment Plan and Measures

Based on the KORAIL structural reform after the start of the railway service, the construction and operation of the national railway system were separated (2004-2005), and the repayment of the funding procured for the construction of the high speed rail was separated into the railway operation and facilities, each of which is being repaid under the responsibility of KORAIL and the Authority. Among the debts related to the high speed rail, those related to the operation, including the vehicles (about KRW 4.3 trillion as of 2004), were transferred to KORAIL, which repays them through its operational income, whereas the facilities debts, including the railway, etc. (about KRW 6.8 trillion as of 2004), are being repaid by the Authority, which receives the facility usage fees from KORAIL. Thirty-one percent of the high speed rail income is applied to the fees for the use of the high speed rail that KORAIL, the railway operator, pays the Authority, the facility manager. In 2010, however, the railway usage income of the Authority was KRW 210.6 billion, less than half of the interest in the same year (KRW 462.7 billion), making it impossible for it even to repay the interest.

Chapter 4.

Difficulties in the Process of Executing the Project

1. Key Factors in the Poor Performance of the Project

1.1 Excessive Civil Complaints and Regional Self-centeredness

While the construction of the test section (Cheonan-Daejeon) began on June 30, 1992, some presidential candidates made a public pledge to stop the project completely amid the heated presidential election in December 1993, and in the middle of the turnover of power, some argued that the construction should be transferred to the next government. Moreover, many problems began to emerge due to the insufficient preliminary surveys, lack of experience in high speed rail projects, and lack of technical know-how and means. As a result, the Gyeongbu High Speed Rail Project was on the verge of being completely dismantled. The mass media questioned South Korea's poor infrastructure construction conditions in relation to the collapse of Seongsu Bridge in 1994 and that of Sampoong Department Store in 1995, and also strongly questioned the safety of Gyeongbu High Speed Rail, whose full-scale construction had just begun. Every day, the mass media reported on the feasibility and even possible dismantlement of the project.

Meanwhile, the construction progressed little, and the impact of the collapse of large-scale structures increased the nation's sense of insecurity against various structures. The progress of the construction was even further delayed as the structural safety became more important than the progress of the construction and the continuous revisions of the construction plan. In particular, even the Jangjae-ri site, where the groundbreaking ceremony was to be held, was not purchased, and

the ceremony was held at a leased site. As such, land purchase and the subsequent compensation issues were not progressing as smoothly as planned. Furthermore, the residents of the areas neighboring the construction zones continued to raise civil complaints, and the worsening regional self-centeredness stopped almost the whole construction.

In fact, an official of a service company at the construction site admitted that it took them almost a year to finish even just the groundwork of a government-owned river. The difficulties in relation to land purchases and civil complaints were evidenced by the long sighs of the then Authority's staff who was in charge of the construction.

Later, the land compensation issues were somewhat resolved, and the construction resumed. As Alsthom in France, however, was selected as the supplier of the vehicle system, the construction had to be stopped in the process of reviewing the technical connectivity between the vehicle characteristics and the sub-base course and safety, and in the process of revising the design. This could be considered a trial-and-error process borne by the inexperience of the South Korean government in the high speed rail project. In other words, although the design and construction of the structures should be preceded by the selection of the high speed rail vehicle system, the design and some construction actually started before a decision was made regarding the vehicle system to be adopted, consequently resulting in the project's inefficiency as the whole design needed to be revised.

In addition, the lack of geological and topological surveys on the regions where the trains would pass, the insufficient discussions among the concerned organizations in relation to cultural assets, the civil actions of the residents in relation to the railway station sphere development and land compensations, and the continuous civil complaints of and demands by the local governments and residents for the power transmission lines and transformer facilities to be moved as these might hinder the local development and lower the land price all effectively led the construction project towards a dead end.

The cultural-assets issue that emerged when the South Korean government started the construction of Osong Tracking Depot without an excavation survey on the

cultural sites to be affected by the construction became a national debate, particularly in relation to the Gyeongju route. That is, the Ministry of Transportation and Construction argued that the original route should be followed due to the tremendous expenses that would be incurred on account of the construction delay caused by doing otherwise, and due to the additional funding required by the construction of a different route. Further contributing to the construction inefficiency was the Ministry of Culture&Tourism's argument that the route should never pass Gyeongju so that the cultural assets in Shilla's old capital would be preserved. The debate became even more intense when Federico Mayor, then Director-General of UNESCO, in his visit to South Korea, said that it would be difficult for Gyeongju to be designated as a world heritage site if the high speed rail would pass through the city.

The debate on the Gyeongju route, whose construction had started, as regards culturalassets protection later developed into a very complicated situation as those who were involved in the debate argued even more vigorously in defense of their respective stance. Further, the voice of each local government added to the regional self-centeredness, and the debate on the Gyeongju route made many people worry about the possibility that the other regions that had been confirmed to be made part of the railway system as well, as routes, would also enter into the debate.

Besides, according to the media in 1996, there were more than ten major civil complaints that could affect the process and term of the construction: those regarding the location of Seoul Central Station; the installation of Gwangmyeong Station; the early installation of Osong Station; the underground work for the Kimcheon-passing route; the underground work for the Yangsan-gun-passing route; the underground work near Beomeosa; the installation of Bujeon Station, Busan Vehicle Depot, and Seoul Vehicle Depot; and the request that the station names be changed.

Such civil complaints and controversies took a turn when the South Korean government proposed solutions for them and announced that it would prove the safety of the construction through a safety inspection by an independent agency, and if problems were discovered, the concerned structures would be rebuilt.

Subsequently, WJE, a U.S. safety inspection agency, conducted a safety inspection of the 92 structures built between June 1992 and April 1996. While this inspection

demonstrated the determination of the Authority, the owner of the project, to eliminate not only poor construction but also the makeshift construction custom, the Authority's public pledge not to repeat the trial-and-error process in the continuance of the project when the inspection was announced to the public led the South Korean people to consider the Authority a hotbed of poor construction. Consequently, the Authority came to face even more difficulties.

1.2 Route Change

1.2.1 Change in the Gyeongju route

Since after the South Korean government announced in June 1992 that it selected the route that passes through the downtown of Gyeongju and would build Gyeongju Station on the northern field 5 km south from the downtown, objections to this decision by the cultural, religious, and academic fields had been expressed due to the belief that it would directly and indirectly damage not only the cultural relics and sites in Gyeongju but also the landscape of Mt. Namsan in Gyeongju.

At that time, the Ministry of Construction and Transportation and the Authority proposed a plan to change the station from the northern field to Ijori (10 km south from the downtown) in October 1995, and another plan not to develop the railway station after the joint survey in the same year, to protect the cultural assets and landscape in Gyeongju.

The Ministry of Culture and Tourism, however, and the religious and academic professionals, opposed the aforementioned plans due to the insufficient measures therein to protect the region's cultural assets, arguing in favor of the original route as the construction inefficiency and investment cost would damage the landscape and cultural atmosphere of the 1,000-year-old capital and would risk damaging the cultural assets therein. This made the gap between the two parties even wider.

Thus, the Ministry of Construction and Transportation proposed alternatives that included extending the underground section to 8.4 km (from 3.5 km) as a revision of the Hyeongsan River route, and moving the station from the downtown of Gyeongju to Ijori, 10 km south from the downtown, but failed to reach an agreement on such matters.

Towards the end of April 1996, the Office of the Prime Minister led a joint field survey with the Ministry of Construction and Transportation and Ministry of Culture and Tourism, participated in by the staff of both departments and by independent cultural-assets, urbanplanning, and transportation reviewers who had been recommended by the opposing party.

The basic stance of the government on the Gyeongju route was to minimize the damage that it would cause to the atmosphere and to the cultural assets that might be buried therein, and to proceed with the project without any more hitches, and at the same time, to consider the transportation convenience of the residents in Gyeongju, Ulsan, and Pohang in selecting the location of the route and the station.

Based on the government's principle, the joint survey team completed a joint report, based on which the Prime Minister led a series of meetings with the Minister of Economy, Culture and Tourism, and with the Minister of Construction and Transportation, leading to an agreement.

Based on what was agreed upon, the government determined and announced a new Gyeongju route in January 1997. The changed route was determined based on the consideration that it would minimize the damage to the cultural assets in Gyeongju, and would have technical and economic feasibility. Further, it was decided that the location of the station would be placed within the administrative section of Gyeongju City.

1.2.2 Route Change of Sangni Tunnel Section

The construction of Sangni Tunnel Section started on May 8, 1995, but a survey on the nationwide unused or abandoned mines through the National Assembly inspection of the government offices revealed a web-like empty space in the upper/lower parts and at the side of the tunnel, which is 25 m long and has a 50 m 3 capacity. Consequently, the issue of the safety of the high speed railwas raised. This space was an abandoned mine shaft from the mining work in Sambo Mine, which produced zinc for 40 years, since 1956. At that time, 298 m of the 2.1 km Sangni Tunnel had already been dug.

To establish a fundamental measure for ensuring Sangni Tunnel's safety, the South Korean government commissioned Professor Kirschke and his team in Germany to conduct a preliminary safety assessment. As a result, the team recommended a reinforcement plan of some sections through the visual observation of the floor plan of the abandoned mine and ore. Later, in November 1996, Korea Resources Corporation commissioned a ground safety assessment and international services.

After a series of assessments, on October 19, 1996, the Authority's board of directors decided to change the route, and after the feasibility survey for the selection of a new Sangni Tunnel route, the Authority commissioned Korea Transport Institute to conduct the work. The detoured route was determined on March 14, 1997.

1.2.3 Change in the Method of Passing the Downtown of Daejeon and Daegu

In June 1991, to minimize the running time of the high speed rail, a plan to construct an underground route for Daejeon and Daegu downtown sections proposed based on the results of the technical survey. The main objective of such plan was to overcome the reduction in speed (120 km/h) due to the severe slopes (1 site R = 100 m; 13 sites R = 600 m), the difficulty in creating an interchange due to the existing roads (20 sites in Daejeon and 17 sites in Daegu), the damage to the urban landscape, environmental issues like noise or vibration, and excessive obstacles in residential areas.

To reduce the investment cost, however, in June 1993, the underground plan was changed into the on-the-ground plan after the Social- Overhead-Capital Construction Implementation Committee agreed to do so. The total amount saved by the revision was KRW 403.3 billion, which is consisted of KRW 225.3 billion (from KRW 646.2 billion to KRW 420.9 billion) in Daejeon and KRW 208.2 billion (from KRW 945.3 billion to KRW 737.1 billion) in Daegu.

Besides the economic reasons, the on-the-ground construction would offer easy benefits such as construction, a reduced construction term, easy connectivity and transfer to the existing railway, disaster prevention, environmental maintenance, lower facilities and maintenance/repair costs, and easy recovery in case of accidents.

The continuous civil complaints from the residents and local governments regarding the environmental damages (e.g., noise, vibration), however, as well as the worsening division of the downtown, resulted in the decision to revert the construction back to underground work in April 1995. Later, in 2001, due to the question raised by the local government with regard to the underground passage, the construction was finalized as on-the-ground work in August 2006. As such, the continuous revisions of the Daejeon and Daegu downtown section construction could not be completed in 2004, the target first-phase opening of Gyeongbu High Speed Rail. The latter is thus expected to be completed in 2014.

1.2.4 Change in the Bridge Type

The detailed design standard of the high speed rail was created by South Korean specialists from July 1987 to February 1991, by referring to the public-design data of the high speed rails in France, Germany, and Japan. Later, in June 1991, the design was commissioned to 14 South Korean specialist companies, which designed the upper structure of the bridges based on PC box.

Four test zones started to be constructed in June 1992, but due to the first project revision in June 1993, which was reviewed and agreed to by the Social-Overhead-Capital Construction Implementation Committee based on the socioeconomic situation in the country then, the bridge structure was changed from PC box to PC beam as part of the plan to effect maximum cost savings (first format change). Later, in August 1993, after the selection of Alsthom in France as the prioritized negotiation partner, the dynamic behavior of the bridges was reviewed for the inspection of the bridges' safety at high-speed operation. Although the results showed that there were no issues in deflection or vibration, it was recommended that the stiffness of the structures in the Rahmen and PC beam bridges be reinforced to reduce the vehicle's vibration and to promote the passengers' comfort. Accordingly, considering the long-term stability improvement and maintenance/repair aspects of the structures, the bridge type was reverted back to the continuous PC box structure from PC beam in August 1995 (second format change).

As such, the Gyeongbu High Speed Rail Project went through various technical conflicts because of the minimal experience of the South Korean technical team in

designing high speed rail systems and because the design was started before selecting the vehicle format. The bridge type was finally changed to PC box considering long-term stability and convenience of maintenance and repair.

1.2.5 Environmental Civil Complaints Concerning Mt. Cheonseong

Environmental civil complaints concerning Mt. Cheonseong, which Gyeongbu High speed rail passes through, were raised in 2001 by Monk Jiyul, who requested that the construction be completely stopped. In November 2004, the Busan High Court dismissed the injunction filed by Monk Jiyul on the construction on the following ground: "The probability of environmental encroachment of the tunnel construction on the high mountains and swamp areas is considerably low, and the tremendous interest of the public cannot be disregarded on account of the environmental-encroachment disadvantage that has considerably low probability."

Monk Jiyul protested against the court's decision and appealed the case to the Supreme Court. He also went on a hunger strike, discrediting the review by the specialists appointed by the Ministry of Environment and the High Court's decision.

The Authority agreed to the conduct of a joint environmental-impact survey in February 2005, upon the request of Monk Jiyul, to end the distrust of the tunnel construction in relation to environmental issues, and to save lives. As such, the construction was stopped for three months, during the survey period (August 30-November 29, 2005).

The joint survey was conducted by a joint survey team consisting of 14 specialists from each party in five areas (underground water, geophysical prospecting, geological structure, rock mechanics, and ecosystem), and the results were announced to the media on February 28, 2006 and were submitted to the Supreme Court, where the appeal was pending litigation, on March 14, 2006.

As for the appeal for the issuance of an injunction to the Authority for the stoppage of the construction, the Supreme Court determined on June 2, 2006 that "there is no basis for the encroachment of environmental interest raised by environmental organizations and others," which effectively ended the five-year-long

conflict between the government and environmental organizations concerning Mt. Cheonseong. The litigation, however, resulted in an increase in the construction cost and in a delay in the construction term.

<Progress>

- 2001.11.13: Gyeongbu High Speed Rail route plan review was requested.
- 2003.03.07: The President ordered the review of the route.
- 2003.10.15: Monk Jiyul requested for an injunction to stop the construction (the socalled “Korean Salamander Lawsuit”).
- 2003.11.27: Sub-base course construction began on Mt. Cheonseong (Yeonhyo Tunnel).
- 2004.04.08: The injunction request was dismissed in the first trial; the decision was appealed to the High Court (2004.04.16).
- 2004.08.09: The Yeonhyo Tunnel excavation was started.
- 2004.08.26-2004.11.29: The Mt. Cheonseong construction was stopped (three months).

□ Monk Jiyul went on a hunger strike for 58 days; the construction was stopped as per the agreement between the Authority and Monk Jiyul, pending the completion of the Busan High Court proceedings.

- 2004.11.29: The Busan High Court dismissed the appeal; the construction resumed.
- 2004.12.06: The decision was appealed to the Supreme Court.
- 2005.02.03: The Authority and Monk Jiyul agreed to conduct a joint environmental-impact survey.
- 2005.08.30-2005.11.29: The survey was conducted. (The tunnel construction was stopped for three months.)
- 2006.02.28: The survey results were announced.

□ While the survey team agreed that there would be specific environmental impacts on four areas (underground water, geography, rock mechanics, and geophysics), there were differences in the detailed contents of the survey results. The survey team showed different opinions about the ecosystem.

- 2006.03.14: The survey report was submitted to the Supreme Court.
- 2006.06.02: The Supreme Court dismissed the appeal.

2. Overcoming the Difficulties

2.1 Conducting Safety Inspections and Establishing Measures to Prevent Poor Construction

2.1.1 WJE's Safety Inspection

A series of large-scale disasters, such as the collapse of Seongsu Bridge and of Sampoong Department Store in 1994 and 1995, respectively, led the South Korean people to develop an extreme distrust of the South Korean construction industry. In such a situation, a question was raised concerning the safety of the Gyeongbu High Speed Rail Project, a large national project. Furthermore, the continuous revisions of the bridge designs, and the consequent reconstruction and structural reinforcement, required the inspection of the structures and the verification of their safety by specialist organizations.

Having realized that the South Korean people's trust in the construction project urgently needed to be regained, the Authority decided to conduct a safety inspection of the structures that had been built between June 1992 (the start of the construction) and April 26, 1996. At that point, the overall progress of the construction project was 8.3%, and that of the test zone between Cheonan and Daejeon was about 60%. As such, the Authority sent a safety inspection request to Bechtel in the U.S., SYSTRA in France, DEC in Germany, and WJE and FKC in the U.S. Among them, four companies submitted a proposal, and after a thorough review of the proposals by the selection committee consisting of specialists in various fields, WJE, which had extensive experience in safety inspections (about 4,000 cases) and in repair and reinforcement work worldwide, was chosen as the best company to conduct the inspection.

a. Target structures for the safety inspection

☐ One construction section between Seoul and Cheonan (2-1 construction zone) built between June 1992 and April 26, 1996, and the whole test line section between Cheonan and Daejeon

- ○ Total length: 61 km; 1,012 sites
- ○ Bridges: 32.5 km (37 bridges)
- ○ Tunnels: 14.7 km (15 tunnels)

- ○ Earthworks and culverts : 13.8 km (72 earthworks, 18 culverts)

☐ Contractor: WJE (Wiss, Janney, Elstner Associates, Inc., USA)

☐ Terms and cost:

- ○ First inspection: 08/01/1996-01/31/1997 (six months); USD 2,828,535
- ○ Second inspection: 08/01/1997-01/31/1998 (six months); USD 1,070,000)

b. Results

The results showed 200 sites for field revisions, 190 sites for repair, 39 sites for partial reconstruction, and 583 sites for no repair. The field revision (200 sites) and repair (190 sites) posed no structural safety issues as they involved minor defects that might have been caused by the carelessness in the construction, such as in the surface finishing, small cracks due to drying shrinkage, pockmarks, and inappropriateness of construction joints used. As a measure for the partial reconstruction (39 sites), the bridge bearing in rail format in 35 sites was exchanged in the future maintenance and repair, and for the bridge slab in the rest of the four sites, patching repair was requested.

2.1.2 Establishing Poor-Construction Preventive Measures

The reasons for poor construction and delay in the schedule of Gyeongbu High Speed Railway Project were, first, the lack of preparation in design documents and specifications, and second, the lack of understanding in safety and accuracy due to the nonexistence experience in high speed railway construction. Also several incidents of the stoppage of the construction forced the project to focus mostly on meeting the construction deadlines, and consequently, quality of the construction was neglected. This resulted in a series of long-lasting side effects, such as the mass media's hastily written articles that scandalized problems, and apathetic social atmosphere, the nation's indifference of and misunderstanding in safety.

But the project overcame such difficulties through the safety inspection conducted by WJE, and could learn from the experience that the construction of a high speed railway would require comprehensive quality and construction management. The recommendations by WJE as a result of the safety inspection it conducted showed that most of the issues resulted from the poor management of the construction. The various defects and problems that had been identified were thoroughly reviewed and addressed

so that no identical issues would appear in the future. Moreover, the quality control and field inspection tasks were strengthened to ensure the safety of the construction, and the Safety Control Promotion Plan was established to ensure better safety based on the provision of technical support for and the reinforced supervision of the construction.

2.2 Design Verification and Supplementation

After WJE's safety inspection, the safety issues of structures due to the South Korean construction industry's custom of "build first, repair later" or the careless management of construction projects emerged. This became an opportunity to change such practices and to reform the industry to raise its competency level to that in advanced countries.

To regain the people's trust in the safety of the country's structures, and to obtain technical connectivity between the TGV vehicle system and the core system, the Authority commissioned SYSTRA, an affiliate company of SNCF, to conduct a full-scale design inspection of the sub-base course, track, and structures of Gyeongbu High Speed Rail. The design review by SYSTRA, which had extensive experience in high speed rail design and construction projects, was conducted into two phases (first phase: 09/1994-05/1995; second phase: 05/1996-08/1998). In the first phase, the contractor reviewed the sub-base design standard and test line zone design, and in the second phase, it conducted a detailed review of the areas that were not looked into in the first phase, and created a design drawing for the PC box bridge standardization. The Authority had a SYSTRA technician stay in South Korea during the review, who undertook the task cooperation and technology transfer.

Thanks to the design review, the construction project acquired external reliability and ensured the structural safety of the sub-base structures, and the implementation of the detailed top structure design in the standard format could improve the constructability and could reduce the construction cost by about 5%. Furthermore, the South Korean technical team acquired advanced high speed rail construction know-how and accumulated related advanced technologies as South Korean technologies, which became the driving force for performing high speed rail projects not only in South Korea but also in other countries.

2.3 Execution of a Complete-responsibility-based Management System

For safe operation at the maximum speed of 300 km/h, Gyeongbu High Speed Rail should be thoroughly constructed, with the highest quality, safety, and process control, but with the lack of experience in such projects and the fact that the vehicle type had not been decided, the Authority conducted the design based on the UIC standard, and ordered the construction. As a result, the lack of quality consciousness of the contractor, and the low management level in South Korea, in the initial project implementation period, among others, resulted in poor construction.

Accordingly, to fundamentally resolve the problem of poor construction, the Authority initially commissioned SYSTRA to review and revise the design, and then implemented the contractor-named construction project system to develop quality consciousness on the part of the contractor.

In addition, the Authority implemented the complete responsibility-based management system in all the construction zones, and hired specialists from foreign supervision companies, such as DEC in Germany and INGEROP in France, to conduct verification and inspection tasks with the South Korean supervision team, and to address the technical shortage. The complete responsibility-based management system is the system where a supervision specialist company (1) verifies if a construction project with a total cost of over KRW 5 billion or with a total floor area of over 10,000 m^2 conforms to its design and related documents; (2) offers technical guidance; and (3) plays the role of a quality control, construction, and safety control supervisor.

2.4 Establishing the High Speed Rail Quality Control System

To ensure the perfect construction and high quality of the high speed rail, the contractor, the supervising team, and the Authority maintained separate quality control organizations, and to systematically perform self-inspections, tests, and reviews to prevent the emergence of quality-related issues, they established a quality control system. The contractor acquired the testing lab and quality control organization appropriate for the quality control system so that during the construction, it would assume responsibility for the project through voluntary quality control activities. The Authority exercised joint supervision with DEC or INGEROP, which had experience

in high speed rail projects and contributed to the acquisition of high quality by supplementing the South Korean supervision team's supervision techniques. In particular, the issues by phase that should be verified were recognized and divided into attending and inspection points, and were thoroughly controlled. The partially completed structures were also verified through tests and inspections.

Based on the main quality control system, any issue pointed out to the contractor was divided according to their level of seriousness, and QDNs or NCRs were issued so that the contractor could take the necessary measures. The Authority (the headquarters, the construction testing center, and the office), on the other hand, regularly conducted inspection tests on the quality of the materials and on the construction condition at the sites, to maintain thorough and strict quality control.

Furthermore, the quality control staffs of Bechtel, who had extensive experience in the management of large-scale projects, were dispatched to the headquarters and construction sites and performed quality supervision activities to ensure the highest quality. Finally, the self-established quality control department of the contractor conducted inspections of and tests on (first-phase inspection) the tasks performed by the construction division based on the IPT, and submitted the results of such inspections and tests to the Authority. The supervising team, for its part, verified and inspected (second-phase inspection) by process phase if the contractor conducted the quality inspection tasks based on the inspection plan.

Even the structures built with such systematic quality control system were subjected to safety inspection by an independent safety inspection agency, which thoroughly verified the safety conditions of all the structures to prevent poor construction and to reconfirm the quality of the project.

2.5 Public Promotion of the High Speed Railway System

In order to resolve the issues related in the construction process of Gyeongbu High Speed Railway and the nation's concern over the poor construction, it was necessary to conduct a series of public promotion that could have the publiuc understand that the construction was being performed safely and establish the public's understanding and trust for the project in relation to various economic, social and cultural effect of

the construction on the country that were to be expected after the completion as a new transportation means in the 21st century. In particular, for a large national project like Gyeongbu High Speed Railway Project, the public understanding and cooperation are more important than anything else, and to draw the public support by informing people of its benefits was essential in promoting the project. As a result, various public promotion activities were proactively conducted.

The project conducted indirect public promotion activities using mass media between 1992 and 1996, which were limited in offering general information of the current status of the project and the introduction of the construction sites. After 1997, the validity, necessity or effectiveness of the construction was neglected and the public opinions of the mass media and people on the project were largely negative. For the Corporation, this period was important to conduct public promotion strategies to correct such negative views. Accordingly, the project executed direct and proactive public promotion activities led by its PR team between 1997 and 1998.

Since after 1999, the project conducted public promotion activities that presented a longterm and ambitious vision to make the nation feel safe and expect for the future high speed railway system. Around the test-drive between Cheonan and Daejeon section in December 1999, the project conducted a series of direct and experiential events through the mass media, publication of PR materials, and test-drive events. Such events that proposed the vision targeted the competitive marketing against various other types of transportation means that would emerge along with the completion of the project.

Chapter 5.

Evaluation and Implications

1. Evaluation

1.1 Major Achievements

1.1.1 Enhancement of Rail Technology Competitiveness and Preparation of the Export

One of the major achievements of the high-speed rail project was to build up Korea's technological experience in applying foreign technologies locally and overcoming the corresponding challenges. This experience helped advance Korea's local rail technology. In the first stage of the project, the country depended on foreign technology, but the second stage (April 2004-November 2011) was carried out by the local technical team, thus upgrading Korea's rail technology to the world-class level. The localization of Korea's high-speed rail technology helped reduce the budget for the project, created jobs, and enabled local construction firms and architectural designers to participate in the construction of the highspeed rail of Taiwan, among other overseas projects.

By securing high-speed rail technologies, Korea has drastically improved its overall architectural design capabilities in conventional rails, subways, light rail, and other means of public transportation. This is expected to improve technologies in related fields. Aerodynamic technologies can be used to design the bodies of high-speed vehicles such as aircraft, cars, and guided missiles. Car body sealing and pressure wave prevention technologies, which are designed to prevent passengers from suffering from ringing in the ears, are being used to design aircraft, submarines,

etc. Computer control and self examination technologies are being used in the industrial equipment automation, industrial robot, and demand-based semiconductor industries. Total treatment technology using computers promotes the development of the software and information industries. Largecapacity power transformation and gate control technologies are being used for home electronic products, industrial power transformation, robots, etc. Lightweight and highstrength new material technologies are expected to be used in the development of lightweight automobiles and other materials.

1.1.2 Improvement of Project Management Capabilities

The High-speed Rail Construction Authority introduced and applied its project management skills to systematically and efficiently manage the large-scale high-speed rail project. In the early stages of the project, with the help of Bechtel of the U.S., the local technical team managed the project. After the project management agreement expired, however, the Authority educated its employees on how to manage the project by themselves, fostered experts, and built up the Authority's managerial capabilities.

In the second stage, the Authority developed a 3-D project management system dubbed "GPMS," which combined sophisticated information and GIS technologies. The Authority patented GPMS locally, and thereby upgraded its project management skills and earned project management orders for China's rail projects, which enabled it to advance into global markets.

In the supervision field, the Authority executed a total responsible supervision system across the entire process of high-speed rail production. Experts from a foreign supervisory firm were commissioned for the project, and the local supervisory team coordinated with the foreign experts, which enabled the Authority to enhance its supervisory capabilities.

1.1.3 Raising Awareness of Construction Work Quality Management

Various defects due to poor construction management were detected in the safety inspection of the high-speed rail project, which led to stronger quality management

and field inspection. A quality management system was developed to systematically perform self-inspection and examination as well as tests to proactively prevent quality problems. To secure the safety of the construction works, measures for safe management were devised. As such, the high-speed rail construction project improved relevant practices of the local construction industry and advanced the domestic supervisory and oversight system. Currently, the Authority's construction quality management is cited as the best of its kind.

1.1.4 Securing of High-speed Rail Operation Technologies

The high-speed rail is a culmination of cutting-edge sciences and technologies, and its service is an innovative product that calls for a change in the management mindset. Thus, all the processes for the preparation and operation of the high-speed rail drastically advanced rail operation technologies.

Working manuals for new fields were drawn up, and for the smooth operation of the high-speed rail, four-step assessment criteria and other scientific maintenance and repair skills were introduced. A proactive repair system based on data analysis and prior detection of lowered performance was developed. Also, the localization of the operating equipment helped reduce maintenance costs; cut labor costs with the management system automation; and improved customer management skills. These are also among the effects of the highspeed rail construction.

1.1.5 Changes in the National Transportation System and Social and Economic Effect

a. Changes in the national transportation system

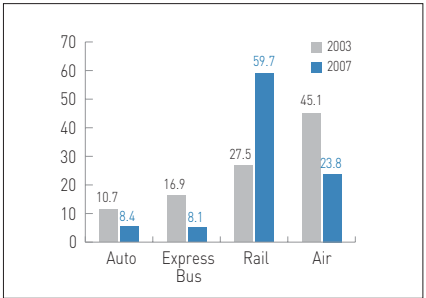
High Speed Rails have higher energy efficiency and are more cost-effective than private cars, aircraft, and other means of transportation, and also help reduce travel time and costs. There was a drastic change in transportation ratios among cities that had high speed railway stations. Rail passengers have increased, and passengers of private cars, express buses, and aircraft have decreased. There was also a notable change in air travel demand. In the case of the Seoul-to-Daegu segment, the high-speed rail reduced air travel demand, which led to the closure of such air travel route in 2007.

<Table 5-1> Mode Share between Vehicles after the Opening of the High Speed Rail

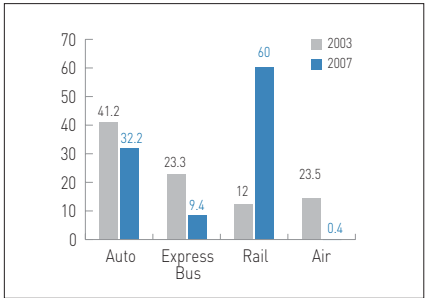
(unit: %)

Description	Seoul-Busan (424 km)		Seoul-Daegu (293 km)	
	2003	2008	2003	2008
Auto	14.0	5.4	41.1	32.0
Express Bus	7.6	7.5	13.7	6.3
Rail	29.3	63.3	26.5	61.7
Air	49.1	23.8	18.7	0.0
Total	100	100	100	100

Source: KORAIL Research Institute (2009)



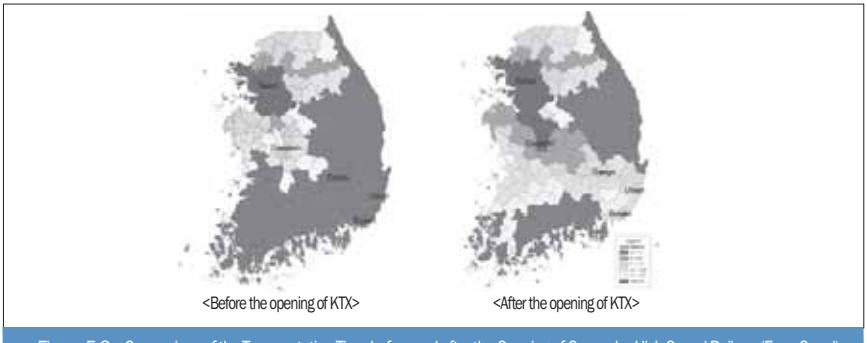
<Figure 5-1> Mode Share in the Seoul-Busan Corridor



<Figure 5-2> Mode Share in the Seoul-Daegu Corridor

The opening of the high speed railway reduced the transportation time amongst major cities down to two hours (Seoul-Busan: from 4 hours and 30 minutes to 2 hours and 18 minutes). In the future, it is expected that the establishment of a KTX high speed railway network that connects all regions in the country within one hour will remove the gap between Seoul and local regions by integrating the country into one zone.

b. Social and economic effect



<Figure 5-3> Comparison of the Transportation Time before and after the Opening of Gyeongbu High Speed Railway (From Seoul)

The change in the carriage ratios between vehicles led to economic and environmental benefits such as lower petroleum energy consumption, CO_2 emissions, and environmental pollutant discharge. KORAIL (2009) forecasted the effects of the operation of the highspeed rail as an energy cost reduction of KRW 297.4 billion and an environmental cost reduction of KRW 118.3 billion in 2008.

<Table 5-2> Reduction in Energy and Environmental Costs due to the Gyeongbu High Speed Rail

(unit: KRW)

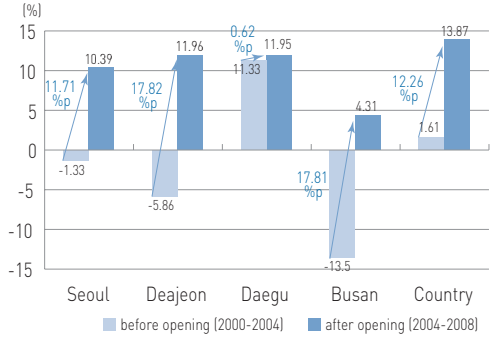
Region	2004	2005	2006	2007	2008	Total
Reduced energy costs	1,900	2,883	2,947	2,974	2,974	13,678
Reduced environmental costs	789	1,178	1,195	1,183	1,183	5,529

High-speed rail stations are the so-called KTX economic zones where people, capital, and technology gather, prompting them to emerge as regional transportation and business hubs. Thanks to the opening of KTX, both physical and psychological distance to local cities has decreased, and consequently, there is a growing tendency in considering local cities as places for hosting international summits, conventions, and seminars.

<Table 5-3> International Conventions Held in Cities that have a KTX Station

Region	2003	2004	2005	2006	2007	2008	Average annual increase ratio
Seoul	158	164	155	191	171	193	4%
Busan	19	27	49	82	78	143	50%
Daegu	8	13	11	15	20	16	15%
Daejeon	14	10	7	18	18	53	31%

The tourism industries in these cities have also been positively affected by KTX. The sales from tourist accommodation facilities in Busan and Daejeon have greatly improved after the opening of KTX, showing that the influx of tourists in these cities has been active. While it may be unreasonable to explain such a result only from the effect of KTX, it is expected that the improvement of the city image due to the increasing number of international conventions held and the reduction of the transportation time will increase the demand on leisure and tourism activities in the local regions, thus, activating the local economy.



<Figure 5-4> Changes in the Ratio of the Sales from Tourist Accommodation Facilities before and after the Opening of KTX

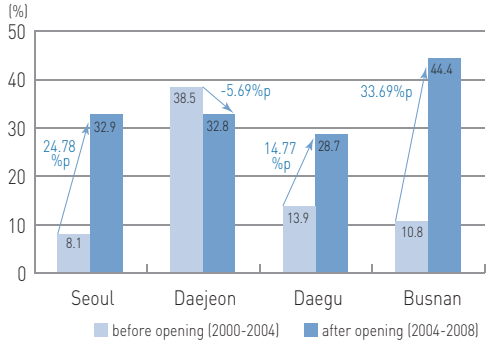
On the other hand, the concentration phenomenon toward Seoul that local cities had been worrying about before the opening of KTX was shown to be unclear. In the medical industry, the opening of KTX affected people's movement toward Seoul for the use of medical services. However, the transportation from Seoul to KTX cities was larger than that from KTX cities to Seoul.

<Table 5-4> Trends in the Number of Days of Using Medical Facilities in Other Regions

Category	2003	2004	2005	2006	2007	2008	2009
Seoul → 4 Cities	895	953	1,037	1,273	2,643	3,556	3,785
4 Cities → Seoul	1,236	1,315	1,452	1,656	2,067	2,361	2,536

Note: The 4 cities are Busan, Daegu, Daejeon and Ulsan.

The wholesale and retail sales increase ratio also showed little difference among KTX cities. The sales in Seoul increased by 24.78% while those in Daegu and Busan increased by 14.77% and 33.69%, respectively. While those in Daejeon decrased by a small margin, the increase ratio is still very high, and the much-worried phenomenon of the concentration toward Seoul is not observed so far. Still some local cities argue that the opening of KTX fortified the concentration to Seoul and weakened the competitiveness of local cities. In fact, when they first opened the high speed railway system, Japan also experienced the concentration to Tokyo in the beginning of the opening.



<Figure 5-5> Changes in the Wholesale and Retail Sales Increase Ratios before and after the Opening of KTX

1.2 Downsides

1.2.1 Lower demand than expected

The high-speed rail demand, as of 2010, was 112,000 passengers a day, which is half of the expected 226,000 passengers a day under the second revised plan (1998). One of the reasons for this lower demand is that while the revised basic plan forecasted the Seoulto-Busan travel time as 116 minutes (2-station stoppage), the current running time is 145 minutes. In the future it is expected that once the downtown section high speed railway construction in Daejeon and Daegu is completed, the travel time will be close to the original goal. Also, basic data for demand estimation were not adequately accumulated, which made it impossible to accurately forecast the demand.

<Table 5-5> Travel Demand for the High Speed Rail

(unit: 1,000 people/day)

Description	2004	2005	2006	2007	2008	2009	2010
Demand forecast	149	159	171	183	196	211	226
Actual demand	54	88	99	101	102	101	112

Moreover, a considerable number of rail passengers are transferring to the high-speed rail, whereas new passengers represent 40% of the total number of high-speed rail passengers.

<Table 5-6> Travel Demand for the High Speed Rail and the Conventional Rail

(unit: 1,000 people/day)

Description	2002	2003	2004	2005	2006	2007	2008	2009	2010
KTX	-	-	49	80	90	92	93	92	99
Conventional rail	172	165	138	116	111	108	112	109	116
Total	172	165	188	196	201	200	205	201	215

Such a lack in demand for KTX affects the transportation profits. KTX maintains a profitable operation and expects to further increase its operating revenues whereas the conventional rail losses drastically increased from before the commencement of KTX, due to which KORAIL has been posting a deficit of over KRW 500 billion in the passenger category each year, and the overall passenger profits show a deficit of KRW 200 to 300 billion. If the KTX demand had increased to the originally estimated level, the profitability of KORAIL's passenger operation must have hugely been improved.

<Table 5-7> KORAIL's Passenger Carriage Revenues

(unit: KRW 100 million)

Description	2002	2003	2004	2005	2006	2007	2008	2009	2010
KTX	-	-	-2,169	1,394	2,336	2,555	2,836	2,495	3,202
Conventional rail	-400	-1,365	-2,610	-4,472	-4,636	-5,452	-6,194	-5,642	-5,245
Total	-400	-1,365	-4,779	-3,078	-2,300	-2,897	-3,358	-3,147	-2,043

Note: Excluding the multi-regional electric rail and logistics revenues
Source: KORAIL (each year)

However, the KTX fares in Korea is very low compared to that in Japan, France or Germany, and it is difficult to raise the fares. Considering the low fares flexibility of KTX demand, it is expected that the increase in the fares will promote its profitability.

KORAIL makes much effort to resolve such deficit issues, such as creating efficient management and improving profitability, and thus, after 2008, the deficit is on the decrease. But to reduce a large amount of deficits, it is necessary to make the management more efficient and create new transportation demand. KTX demand is a key factor in the profitability of KORAIL, the operating body, and the return of

KORAIL Network Authority's investment. Therefore, it is necessary to promote the project based on more careful demand estimation when conducting the high speed rail project.

<Table 5-8> Comparison of Each Country's Railway Fares

Category	Zone	Vehicle	Fare	Distance	Simple comparison		Comparison by PPP		
					Fare per km (Won)	Fare level *Korea = 100	PPP index per GNI	Fare weight per GNI	Fare level *Korea = 100
Korea	Seoul-Busan	KTX	51,200 Won	409 km	125	100	$28,120 (31,803 K Won)	0.39%	100
Japan	Tokyo-New Osaka	Shinkansen	¥14,050 (171,691 won)	553 km	311	248	$35,200 (31,803 K won)	0.78%	198
France	Paris-Lyon	TGV	¢70.0 (106,990 won)	429 km	249	199	$34,400 (38,906 K Won)	0.64%	163
Germany	Frankfurt-Munich	ICE	¢91.0 (139,087 won)	400 km	348	277	$35,940 (40,648 K won)	0.86%	218
China	Guangzhou-Wuhan	Wuguang	490 yuan (81,193 won)	1,068 km	76	61	$6,020 (6,808 K won)	1.12%	283

Note: As of March 30, 2010 (However, the fare in China is based on the second-level seat at the time of the opening of the high speed rail in December 2009.)

1.2.2 Increased construction debts

The Korea Rail Network Authority (Korea Network) depends on rail ussage fees collected from KORAIL for its revenues. Its rail usage fees account for 31% of its operating profits, and its 2010 rail usage fees for KTX amounted to KRW 210 billion. Its rail usage fees for four years, from their 2004 commencement to 2010, amounted to KRW 1.24 trillion, of which Korea Network used KRW 446.50 billion, excluding the maintenance cost of KRW 793.4 billion paid to KORAIL, to repay its debt of KRW 446.5 billion. The rail usage fees that it used to repay its debts is just 19% of the interest on the KTX construction cost. In other words, the rail usage fees that Korea Network charges to KORAIL do not even pay the interest of the funding that it procured for the construction of KORAIL. The accumulated debt of Korea Network consists of the internal procurement cost for the construction and the

interest and amounts to 12.707 trillion won as of 2010. Since the accumulated debt continues to increase, the financial condition of Korea Network will be worsened if the operating income from KTX does not increase.

The main reason for the increase of the Korea Network's debt is that the rail usage fees that it receives from KORAIL is low. It is believed that this is due to that the KTX demand is lower than the estimated demand, and that the rail usage fees are set too low to 31% of the KORAIL operating income. Another reason is the low fee level of KTX. Although such low fees may worsen the financial condition of Korea Network and KORAIL, it may, on the other hand, be a positive thing for the users who can receive quality services at a low fee. Also, it is determined that the deficit issues of Korea Network are a peculiar situation of Korea, not a general issue for all the other countries. In other words, the increase in the rail usage fee will be able to improve the yearly accumulated deficits.

In a bid to improve its financial structure, Korea Network is striving to reduce its construction project costs, to develop rail station spheres, and to generate revenues through supplementary businesses. And it is asking KORAIL to increase the rail usage fees, which currently does not even pay the interest.

<Table 5-9> Korea Network's Accumulated KTX Debts

(unit: KRW 100 million)

Description	2004	2005	2006	2007	2008	2009	2010	Total
Rail usage fees (A)	1,056	1,598	1,821	2,006	2,004	1,808	2,106	12,399
Maintenance costs (B)	1,178	1,712	1,630	802	889	781	942	7,934
Debt repayment (C= A-B)	-122	-114	191	1,204	1,115	1,027	1,164	4,465
Interest cost (D)	2,003	2,764	3,084	3,555	3,305	4,111	4,627	23,449
Deficit (D-C)	2,125	2,878	2,893	2,351	2,190	3,084	3,463	18,984
Accumulated debt[5]	56,446	62,899	69,530	80,908	94,245	107,338	127,070	-

Source: Korea Rail Network Authority

5) Debts for financing the KTX construction costs and the interest cost deficit

1.2.3 Accessibility Problems in Some Stations and Untimely Setup of Transfer Systems

KTX stations in some cities were constructed far away from downtown areas to conserve heritage sites and due to opposition to train passage through downtown areas. Such accessibility problems led KTX to lose in competition with other means of transportation, thus inconveniencing KTX passengers and reducing demand and profitability.

The reason for such phenomena is because Korea Network focused mainly on the construction of KTX and showed less interest in connecting transportation means. As such, the scope of the connecting transportation network construction, the responsible party, the standard for the connecting network, and the distribution of the investment were not clearly presented. The Ministry of Land recognized the inefficient transportation facility investment, which results in the lack of the connecting network among key nodes, such as railway stations, harbors, national industrial complexes, and tourist complexes, and causes disservice zones, and to improve the situation, proposed a basic plan on establishing a connecting transportation system and renovates the overall connecting transportation system. Particularly, it promotes the complex transfer centers that link various public transportation means, such as KTX stations, conventional rail stations, subway, buses and light-rails, and is making effort in establishing KTX stations as the hub of local economic development, such as urban development and industrial promotion projects centered on KTX stations.

2. Implications

The Gyeongbu KTX construction project began in June 1992 and entered the first stage of its operation on April 1, 2004. The second stage began on November 1, 2010, and the full operation will be launched in 2014. This project is the largest state project so far, accomplishing remarkable technical achievements in the rail history of South Korea.

In the early stages of the KTX project, local technical foundations, particularly rail

technology levels, were very low. Despite lack of understanding of and experience in high-speed rail technologies, the country went ahead with the project with inadequately prepared design documents or specifications. Also, the type of cars was determined very late, which required overall complementation of the design and caused much confusion and many trial-and-error efforts. On the other hand, due to the foreign currency crisis in the latter half of the 1990s, the original plan to install new tracks for KTX across all the sections was changed in the first and second stages. These trial-and-error moves enabled the country to accumulate new technologies and knowhow, and to be equipped with advanced rail construction capabilities.

The construction work was stopped many times, which delayed the project, due to various civil complaints in the process of purchasing land and obtaining approval and controversies over the safety of the tunnels passing through areas adjacent to abandoned mines. Notably, the Gyeongju line had to be changed due to environmental complaints over the Mt. Cheonseong segment and to conserve heritage sites. The Daejeon and Daegu lines, which pass downtown areas, caused conflicts with relevant groups and municipalities. The central government and the Korea High-speed Rail Construction Authority had the patience and wisdom to persuade and negotiate with stakeholders, however, which helped them overcome these problems.

Despite many such difficulties and trials and errors, the project helped enhance Korea's rail technology level as well as the design and construction technology throughout the industry and the country's profile. Also, the country's experience in the construction of high-speed rails and enhanced rail technologies should provide it with an engine with which to enter the rapidly expanding global rail market.

Based on South Korea's experience in the construction of high-speed rails, some tips to developing countries on the implementation of high-speed rail construction projects are proposed, as follows.

High-speed rail projects require highly advanced technologies, are large-scale, and are highly likely to meet with technical difficulties and trials and errors and to face various difficulties such as NGO complaints in the process. To be successful,

it is important to improve the impulsion system with the strong backing of the government. South Korea established an exclusive public agency (the Korea High-speed Rail Construction Authority) to implement the project from the beginning, and the related ministry established a special committee for this purpose (the SOC Infrastructure Construction Impulsion Committee). Also one of the reasons for the successful operation of KTX is Korea Network's accumulated operation knowhow. Korea Network is the only agency that runs the national railway system in Korea with over 100 years of railway operation experience, and even before the introduction of KTX, it has experience in business extension of 3,000 km as well as the operation railway system of 90 million train-km. These organizations and government-wide efforts enabled Korea to successfully complete the large-scale project. Nonetheless, the country met with many difficulties in the process, which delayed the project. It is necessary to establish a dedicated organization and government-wide measures as well as to improve the safety and quality issues during the construction of KTX. Because the huge distrust and suspicion toward the safety and quality of the project during the construction almost stopped the project. As a plan to reduce the suspicion and distrust on the safety and quality, it is necessary to consider having internationally renowned organizations participate in the construction project.

It is inevitable for developing countries to introduce advanced high-speed rail technologies from foreign countries. It is strongly recommended to ultimately secure such technologies under a technology transfer strategy. They can thus use the secured technologies in constructing and operating additional high-speed rails and in entering overseas rail markets. In introducing foreign technologies for high-speed rail systems as well as cars and to benefit from technology transfer, they must consider the technologies' marketability and development possibilities. Also during the introduction of a foreign vehicle system, it is necessary to benchmark the cases in which vehicle cost was reduced through the competition among bidding countries and negotiations led to better terms in technical transfer and financial procurement.

In the case of South Korea, the high-speed rail construction costs were financed by the central government and the government-controlled Korea Network, which helped ease the financial difficulty. Developing countries may have difficulty financing the project, however, and may opt to choose a private-capital-backed project. The

private-capitalbacked project requires a prudent decision on the minimum revenue guarantee. Under MRG, the government will compensate for lower-than-planned operating revenues; but given the uncertainty of demand forecasts, it is necessary to take careful consideration in introducing the MRG system. In the case of South Korea, the central government pays a huge amount of compensation to private operators under the MRG system in a number of projects on light-rails and toll roads.

For South Korea, the construction of the high-speed rail was financed by the central government, but the operating losses of the Korea Network are increasing each year. Such debts due to the high speed railway construction should be eventually borne by the central government, and this point should be heeded. In other words, developing countries should base their high-speed rail projects on well-founded plans hinged on accurate demand, selection of operation segments, and the feasibility of the project, to reduce government risk. The benefits of high-speed rail construction projects may offer huge socioeconomic benefits vis-à-vis costs, but may not guarantee profitability. On the other hand, a private-capitalbacked project will entail many difficulties in purchasing land and compensating for them, and in coping with various civil complaints. To activate private-capital-backed projects, the government should address various complaints of various NGOs and municipalities in addition to purchasing land and compensating for them.

To increase high-speed rail demand, it is essential to develop systems for easy passenger transfer to other means of transportation (buses, taxis, and subways). South Korea was focused more on the construction of a high-speed rail than on the development of transfer systems. Thus, some high-speed rail stations are experiencing low demand. Developing countries must develop transfer systems simultaneously with their opening of a high-speed rail to increase the high-speed rail demand and the improvement of profitability. Also, highspeed rail stations, if constructed far away from downtown areas, will lower accessibility and weaken competitiveness. Thus, construction of the stations in downtown areas should be positively considered.

Although there have been many complaints and difficulties in KTX construction in Korea, these obstacles were wisely overcome, and now the KTX project is recognized one of the most successful government-run projects. There are some

problems raised in terms of the debuts of Korea Network. However, the KTX project affects positively in Korea, such as the drastic enhancement of Korea's railway technology, the improvement of the country's large-scale project management as well as consensus on quality management, the acquisition of KTX operation techniques, the establishment of the eco-friendly national transportation system, the promotion of local economy, and improvement of the national image. Based on such a positive assessment of KTX, Korea is now making effort in the construction of new KTX lines as well as the renovation of existing lines into expressways (150 km/h→230-250 km/h).

References

Ministry of Construction and Transportation, High-speed Rail Work Data, 2001.

Ministry of Construction and Transportation, KICTEP, Integration and Oversight of Development of High-speed Rail Technology, 2007.

HIRA Institute of Health Insurance Policy, Data on Payment to Medical Insurance for Company Employee and Self-Employed Subscribers to Healthcare Insurance, 2010.

MLTM, High-speed Rail Work Manual, 2010.

KOTI, Basic Scheme of KTX Economy Specialization Development, 2010.

KOTI, Survey and Analysis of KTX Use Status and Its Influence on Regional Economy, 2010.

KORAIL, Business Reports, each year.

KORAIL, Railway Management Status, 2010.

KORAIL Research Institute, Research on Five Years of KTX Operation Results, 2009.

KORAIL, Korea Rail Network Authority, Statistical Yearbook of Railroad, each year.

Korea Rail Network Authority, History of Construction of Gyeongbu High-speed Rail(Ⅱ), 2011.

Korea Rail Network Authority, One Hundred Years of History of Korea's Railway Construction, 2005.

Appendix

Appendix 1. The High-speed Rail and Its Plan

1) Overview of the Gyeongbu High-speed Rail Operations

<Table A-1> Operations Overview (as of 2011)

Category	Description
Commencement date	• 1st stage (Seoul-Daegu): April 2004 (Downtown areas in Daeju and Dajeon, and electrification of the existing Daegu-Busan segment) • 2nd stage (Daegu-Busan): November 2010 (Construction of new tracks between Daegu and Busan, and use of the existing rails in the downtown areas in Daejeon and Daegu) • Full operation (downtown areas in Daejieon and Daegu): scheduled for 2014
Length	• Seoul-Busan: 423.8 km - New high-speed rail tracks: 346.4 km (as of 2011) - Existing tracks: 77.4 km (Seoul-Siheung, and downtown area segments in Daejeon and Daegu)
Frequency	• 59 frequencies during weekdays, and 77 frequencies during weekends
Max. speed	• 300 km/h
Stations	• Seoul, Gwangmyeong, Cheonan and Asan, Osong, Daejeon, Gimcheon (Gumi), Dongdaegu, Singyeongju, Ulsan, and Busan
Running time (Seoul-Busan)	• Non-stop: 2 hours and 13 minutes • Stopping at 5 stations: 2 hours and 42 minutes

<Table A-2> Fares (as of 2011)

(unit: KRW)

Description			Seoul-Daejeon (159.8 km)	Seoul-Daegu (293.1 km)	Seoul-Busan (423.8 km)
Weekdays (Mon.-Thu.)	Special room	Adults	30,000	53,800	72,500
		Children	19,300	34,600	46,600
		Elderly	23,600	42,300	57,000
	Regular room	Adults	21,400	38,400	51,800
		Children	10,700	19,200	25,900
		Elderly	15,000	26,900	36,300
	Seat unavailability / free seat	Adults	20,300	36,500	49,200
		Children	10,100	18,200	24,600
		Elderly	14,200	25,500	34,400
Weekends (Fri.–Sun.)	Special room	Adults	32,100	57,500	77,700
		Children	20,600	36,900	49,900
		Elderly	25,200	45,200	55,500
	Regular room	Adults	22,900	41,100	55,500
		Children	11,400	20,500	27,700
		Elderly	16,000	28,800	38,800
	Seat unavailability / free seat	Adults	21,800	39,000	52,700
		Children	10,900	19,500	26,300
		Elderly	15,300	27,300	36,900

Source: Korea Rail Network Authority

<Table A-3> Travel Demand

(unit: 1,000 people/day)

Description	2004	2005	2006	2007	2008	2009	2010
KTX carriage demands	19,791	32,104	36,017	36,709	37,417	36,823	40,765

2) Plan for the High-speed Rail Construction

A. Honam High-speed Rail

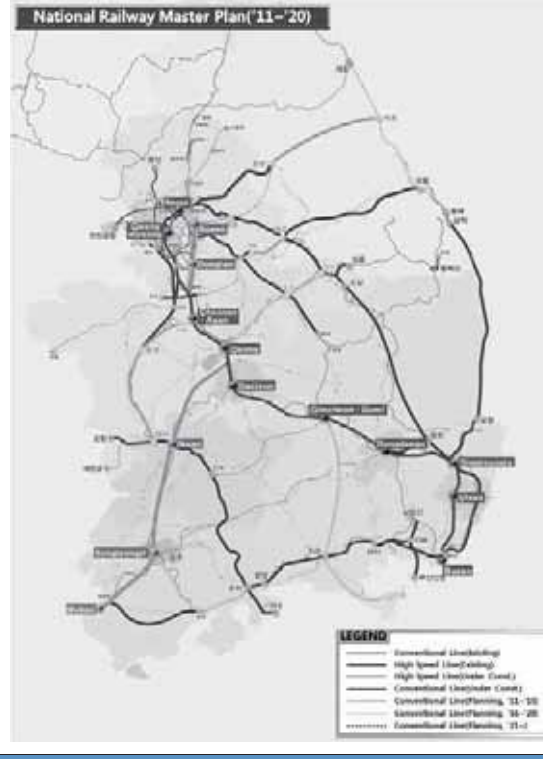
- ○ Projected segment: Osong-Mokpo (231 km)
- ○ Project period: 2006-2017
  - 1st stage: Osong-Gwangju (Songjeong-ri; 182.3 km, scheduled for completion in 2014)
  - 2nd stage: Gwangju (Songjeong-ri-Mokpo: 48.7 km, scheduled for completion in 2017)
- ○ Project cost: Total of KRW 11.272 trillion (including a car cost of KRW 753.5 billion)
- ○ Stations for stoppage: Osong, Gongju, Iksan, Jeongeup, Gwangju, and Mokpo
- ○ Project history
  - Apr.-Oct. 1990: Feasibility study of the Honam high-speed rail (KORAIL)
  - Sep. 1994-Dec. 1997: Survey to devise a basic plan for the Honam high-speed rail (KORAIL)
  - May 2001-Nov. 2003: Commissioning of the survey and research to devise a basic plan for the Honam high-speed rail (Ministry of Construction and Transportation)
  - Apr. 2006: Commissioning of the complementation of the survey and research to devise the basic plan for the Honam high-speed rail (Ministry of Land, Transport, and Maritime Affairs)
  - Nov. 2006: Basic design of the Honam high-speed rail construction project
  - Nov. 2008: Completion of the basic design of the Honam high-speed rail roadbed, and commencement of the execution design
  - Apr. 2009: Approval of the execution plan for the Honam high-speed rail
  - Apr. 2009: Issuance of notice on a change in the basic plan for the Honam highspeed rail
  - Aug. 2009: Approval of the first change in the execution plan for the Honam highspeed rail project
  - May-Dec. 2009: Start of construction of 19 roadbed segments in the Osong-Gwangju (Songjeong-ri) route

B. Seoul Metropolitan (Suseo-Pyeongtaek) High-speed Rail

- ○ Project purpose

- Even after the opening of the Gyeongbu KTX line, the Seoul-Siheung segment (17 km) of the Gyeongbu Line is being used jointly in the high-speed rail, regular rail, freight trains, and Seoul metropolitan subways, due to which it has reached its capacity limitations. Measures are needed to address the corresponding bottlenecks.
- Also, the starting and ending stations in the Seoul metropolitan area should be distributed to Suseo Station, so as to diversify the rail operation patterns. To create 5 million potential passengers in Gangnam and Gangdong in Seoul as well as in southeastern Gyeonggi, the Suseo-Pyeongtaek high-speed rail project is being constructed.

○ Projected segment: Suseo~Pyeongtaek (60 km)
○ Project period: 2011-2014
○ Project cost: KRW 3,723.1 billion



<Figure A-1> National Railway Master Plan (2011~2020)

Appendix 2. Progress of the High Speed Rail Project

1) Key Process History

Year	Project History
06/14/1990	• Basic plan confirmed - Four stations to be completed: Absorbing the transportation demand in the Ulsan·Pohang region and Cheonan, close to the capital region; Gyeongju and Cheonan Station would increase the high speed rail usage rate.
06/10/1992	• Detailed plan confirmed - Main line - Service line at the vehicle depot
06/14/1993	• First revision of the plan - Realistic project cost, term extension, and cost savings
04/25/1995	• Daejeon-Daegu downtown zone plan revised - Hindering urban development due to noise, vibration, and city division into two (on-the-ground (93)-underground work)
06/05/1996	• Selecting a new route (68 km) in Gyeongju - Minimizing the damage to cultural assets; considering technical and economic feasibility; Gyeongju Station shall be built within the city limits
02/25/1997	Route change of the Sangni Tunnel zone, in which an abandoned mine was discovered
07/31/1998	• Second revision of the plan - To minimize the initial investment cost, the plan was conducted in the first and second phases; early opening of the services in Busan by converting the existing line into an electrified line
11/07/2003	• Additional policy on intermediate stations - At the Ministers' meeting on the economy, Osong, Kimcheon, Gumi, and Ulsan were added as intermediate stations for expanding the beneficiary regions
08/23/2006	• Third revision of the plan - Three more regions (Oseong, Kimcheon-Gumi, Ulsan) were added as intermediate stations; the Daejeon-Daegu downtown route was changed to onthe-ground work; reflecting the vehicle repair facilities, etc.
10/26/2007	• Fourth revision of the plan - In preparation for the future Bujeon intermediate station, the minimal infrastructure facilities cost was reflected on the total cost.
06/24/2009	• Fifth revision of the plan - The Daejeon-Daegu downtown route construction term was changed (12/2010→ 12/2014)

2) Detailed Progress History

Year	Project History
12/1973-06/1974	• The construction of a new railway system in Gyeongbu was proposed (International Bank IBRD) - Survey team: SNCF survey team, Japan Foreign Railway Technical Cooperation Team
11/1978-06/1981	• The construction of a new railway system in Gyeongbu was proposed. - Services: KAIST (led by the Ministry of Transportation)
06/1981	• Reflecting Seoul-Daejeon (160 km) on the high speed rail plan (1986-1989) - Fifth Five-Year Economic and Social Development Plan (1982-1986)
03/1983	• Revised to determine the construction after the feasibility survey of Gyeongbu High Speed Rail - Fifth Five-Year Economic and Social Development Plan revised
03/1983-11/1984	• Seoul-Busan long-term transportation investment and high speed rail construction feasibility survey - Results: By early 1990, the railway and expressway in Gyeongbu would have reached their capacity limits, and the acquisition of a new transportation facility should focus on a railway-based plan, which offers better economic value.
05/08/1989	• Determining the Seoul-Busan high speed rail construction policy (about 380 km) - Operation speed over 200 km/h; term: 08/1991-08/1998 (seven years); cost: KRW3.5 trillion (national budget)
07/1989-02/1991	• Technical survey (KORAIL)
10/16/1989-10/22/1989	• International High Speed Rail Symposium (Seoul) - Participated in by 631 specialists (100 from 10 foreign countries, including Japan, France, Germany, and USA)
06/14/1990	• Project plan and route determined - Route: Seoul-Cheonan-Daejeon-Daegu-Gyeongju-Busan; four intermediate stations (Cheonan, Daejeon, Daegu, Gyeongju)
03/1991-04/1992	• Aerial photograph measurement of the optimal route (width on both sides: 200 m)
06/03/1991	• Sub-base course detail design service for Seoul-Busan began
08/26/1991	• The RFP for vehicle format selection was sent out to Japan, France, and Germany (deadline: 01/31/92).
06/10/1992	• The detailed route was determined. - 04/30/1992: Reflecting the issues discussed at the seventh Implementation Committee meeting
06/30/1992	• The construction of the test line (Cheonan-Daejeon) began. The sub-base course was constructed using South Korean technology. To meet the completion goal (1998), the construction was started before the vehicle format was determined

Year	Project History
06/14/1993	• The High Speed Rail Construction Plan was revised. - Cost: KRW 5.8462 trillion (1998) to KRW 10.74 trillion (1993) - Term: 1992-1998 to 2001 (Seoul-Daejeon: 1999) - Financing: 45% from financing support; 55% self-procurement * The project was revised. - Daejeon and Daegu Downtown section construction were changed to the ground level; the suspension of the bridges was changed to PC beam - The Anyang-Seoul-Susaek underground route was revised to use the existing line.
08/20/1993	• The prioritized negotiation partner for the vehicles was selected (Alsthom in France).
06/15/1994	• The vehicle introduction contract was concluded. - Owner: the Authority; supplier: Korea TGV Consortium - Contract amount: About USD 2.1 billion (initial proposal: about USD 3.7 billion)
08/12/1994	• A contract on the introduction of a public loan amounting to USD 2.3037 billion was concluded. - Loan line: 25 financial institutes (South Korea: 7; foreign: 18)
04/25/1995	• The Daejeon-Daegu section revised into an underground route. - Considering the noise, vibration, and environmental impact of the vehicle operation as well as the division of the city, the residents requested that it be changed into an underground route.
06/05/1996	• A new route that would pass through Gyeongju (68 km) was determined. - Electrified line of the existing Gyeongbu railway between Daegu-Busan; the normal high speed rail operation in the whole Seoul-Busan zone by 2002
08/01/1996	• Structural-safety inspection was conducted by WJE (USA). - Structures built between 06/1992 and 04/25/1996 (USD 2.83 million; about KRW 2.4 billion)
02/24/1997	• Reflecting Seoul-Daejeon (160 km) on the high speed rail plan (1986-1989) - Fifth Five-Year Economic and Social Development Plan (1982-1986)
02/24/1997	• A change was made in the Sangni Tunnel route, which was to pass through an abandoned mine.
04/14/1997	• The results of WJE's safety inspection were announced.
09/08/1997	• The project revision draft was announced, and a public hearing on it was held.
11/14/1997	• The project revision draft was discussed with 24 concerned organizations. (The implementation of the revised project plan was postponed due to the worsening economic conditions then, such as the foreign-exchange crisis.) * Project plan review results: - Cost: KRW 10.74 trillion to KRW 17.5028 trillion - Term: 02/2005 to 11/2005 - Economic performance: B/C 1.55 to 1.22 - Financial health: Surplus seven years after the opening → 11 years after the opening; debt repayment: 17 years after the opening → 29 years after the opening

Year	Project History
04/03/1998	• The policy of reviewing the project plan was determined. - A joint-review team, private economic-performance analysis team, and evaluation advisory committee consisting of specialists in various fields were organized for the review of the project plan.
07/08/1998	• The revised project plan draft was discussed with 24 concerned organizations.
07/31/1998	• Project plan revision was decided. - Cost: KRW 10.73 trillion → KRW 18.4358 trillion (first phase: KRW 12.7377 trillion) - Project method: Two-phase process - Term: 06/1992-05/2002 to 04/2004 (second phase: by 2010)
07/18/1999	• Official name of the High Speed Rail - KTX: "Korea Train Express"
11/22/1999	• The KTX noise limit was determined (in agreement with the Ministry of Environment). - Noise measurement: Leq (equivalent sound level); test line: 65-70 dB; other sections: 63-68 dB; 15 years after the opening: 60-65 dB
12/16/1999	• Test drive of Gyeongbu High Speed Rail (L = 34.4 km) - speed: 200 km/h
11/13/2000	• The test line section (57.2 km) was completed; test drive at 300 km/h
11/27/2000	• The second-phase project started early with the approval of the President (2004→ 2002).
12/01/2001- 09/31/2003	• Review service on the plan for the Daejeon and Daegu downtown route
06/18/2002	• Second-phase section: Three sub-base course sections began construction.
07/18/2003	• An underground route for Daegu was proposed.
11/07/2003	• The construction of additional intermediate stations was decided at the Ministers' Meeting for the Economy - Osong, Kimcheon-Gumi, Ulsan; part of the installation cost was to be paid by the concerned local governments
11/14/2003	• The government's policy on the construction of additional intermediate stations was announced.
12/31/2003	• The first phase of the Gyeongbu High Speed Rail Project was completed.
04/01/2004	• The first-phase section of the project was opened for services.
05/12/2004	• On-the-ground construction for the Daejeon downtown route was proposed.
04/2004 – 12/2004	• Services for the establishment of the Gyeongbu High speed rail Intermediate Stations Basic Plan

Year	Project History
11/16/2004	• On-the-ground construction of the Daejeon downtown route was proposed again. - An on-the-ground route that uses the existing railway, with the renovation of the railway as a precondition
03/16/2005 – 05/2005	• Discussion on the second-phase project revision
12/12/2005	• The draft of the plan for the revision of the second-phase project was submitted to the Social-Overhead-Capital Construction Implementation Committee.
07/21/2006	• The written decision of the Social-Overhead-Capital Construction Implementation Committee on the second-phase project was requested.
07/21/2006-08/14/2006	• The written decision of the Social-Overhead-Capital Construction Implementation Committee on the second-phase project was submitted to the minister and chairman.
08/23/2006	• Written decision of the Social-Overhead-Capital Construction Implementation Committee on the second-phase project: - Cost: KRW 5.6981 trillion to KRW 7.19 trillion (national budget: 35-50%) - Term: 2004-2010 to 2002-2010 - Daejeon-Daegu downtown route (underground to on-the-ground level) - Intermediate stations: Daejeon, Dongdaegu, Gyeongju, Osong, Kimcheon•Gumi, Ulsan
10/26/2007	• Written decision of the Social-Overhead-Capital Construction Implementation Committee on the second-phase project - Cost: KRW 7.19 trillion to KRW 7.2136 trillion (national budget: 50%) - Revision: Reflecting the minimal infrastructure facilities cost for the future installation of the Bujeon intermediate station on the total cost
06/18/2009	• Written decision of the Social-Overhead-Capital Construction Implementation Committee on the second-phase project - Cost: KRW 7.2136 trillion to KRW 7.5562 trillion (national budget: 50%) - Revision: Extension of the Daejeon-Daegu downtown route construction term (12/2010-12/2014)
11/20/2009	• Adjustment of the total cost that reflects the new installation cost for a connecting line between Gyeongbu High Speed Rail and Donghae Nambu Railway - Total cost: KRW 7.5562 trillion to KRW 7.9454 trillion - Cost for the installation of the new connecting railway: KRW 173.5 billion; reflecting the detail design result: KRW 215.7 billion

Appendix 3. Relevant Laws

1. Regulation on the High-speed Rail and New International Airport Construction Committee

(Enforced on July 24, 1989) (Presidential Decree No. 12762 enacted on July 24, 1989)

Article 1 (Purpose).

Under this regulation, the High-speed Rail and New International Airport Construction Committee ("the committee") shall be established to deliberate on and coordinate the basic plans and major policies for the construction of a high-speed rail and a new international airport in Korea.

Article 2 (Function).

The committee shall deliberate on and coordinate the following matters.

1. Matters concerning the formulation of a basic plan for the construction of the highspeed rail and the new international airport.
2. Matters concerning major policies for the construction of the high-speed rail and the new international airport.
3. Matters concerning the introduction of technologies necessary for the construction of the high-speed rail and the new international airport, and concerning the development of relevant domestic technologies.
4. Matters concerning the financing of the construction of the high-speed rail and the new international airport.
5. Matters concerning inter-ministerial cooperation in the construction of the highspeed rail and the new international airport.
6. Matters that the Chairperson will propose as part of the agenda regarding the construction of the high-speed rail and the new international airport.

Article 3 (Composition).

1. The committee shall consist of up to 25 persons, including one Chairperson and one Vice-chairperson.
2. The Chairperson shall be the Minister of Economic Planning of Korea, and the Vicechairperson shall be the Minister of Transportation.
3. The members shall be the Minister of Home Affairs, the Minister of Finance, the Minister of National Defense, the Minister of Agriculture and Fisheries,

the Minister of Commerce, the Minister of Energy and Resources, the Minister of Construction, the Minister of Communications, the Minister of Science and Technology, the Seoul Mayor, the Forest Service Commissioner, the Minister of Environment, the Korea Rail President, the Economic Secretary of the President, and the Administrative Coordination Office Head, as well as personnel with ample knowledge and experience in relevant areas who shall be appointed by the Chairperson.

Article 4 (Duties of the Chairperson and the Vice-chairperson).

1. The Chairperson shall represent the committee and supervise its affairs.
2. The Vice-chairperson shall assist the Chairperson, and shall act as the Chairperson when the Chairperson is incapacitated.

Article 5 (Meetings).

1. As deemed necessary, the Chairperson shall convene meetings of the committee, and shall preside over such meetings.
2. The committee meeting shall start with the attendance of the majority, and shall make resolutions with the concurrence of the majority of the attendees.

Article 6 (Hearing of Opinions).

As deemed necessary, the committee may hear the opinions of relevant public officials and experts in deliberating on and coordinating the matters stipulated in Article 2.

Article 7 (Moderator).

1. The committee shall appoint one moderator to handle its administrative affairs.
2. The moderator shall be appointed by the Minister of Transport from among the officials of the Ministry of Transport.

Article 8 (Working Committee).

1. The committee shall establish a working committee to conduct a working review of its deliberation and coordination matters, as well as of its assigned matters.
2. The working committee shall consist of fewer than 30 members including one Chairperson and two Vice Chairpersons.
3. The working committee Chairperson shall be the Vice-minister of Transportation, and the Vice-chairpersons shall be the Head of the Planning and Coordination

Office under the control of the Ministry of Transport and the Vice-president of the Rail Service.

4. The working committee shall consist of relevant bureau directors from the Ministry of Economic Planning, Ministry of Home Affairs, Ministry of Finance, Ministry of National Defense, Ministry of Agriculture and Fisheries, Ministry of Commerce, Ministry of Energy and Resources, Ministry of Construction, Ministry of Transportation, Ministry of Communications, Ministry of Science and Technology, Seoul City, Forest Service, Ministry of Environment, and Korea Rail, as well as of second- and third-grade officials in charge of transportation at the Presidential Secretariat (including second- or third-grade special officials), second- and third-grade reviewers in charge of transportation at the Administrative Coordination Office, researchers from relevant research institutions, and experts in relevant fields as appointed by the Chairperson.
5. Matters concerning the working committee, such as its operation, and the establishment of subcommittees shall be determined by the Chairperson of the committee through a resolution by the committee.
6. Articles 4-6 shall apply to the working committee, with modifications as deemed necessary.

Article 9 (Operation of Working Members and Dispatch of Relevant Officials).

1. To support the work of the committee, as deemed necessary, its working members shall hold office at the Ministry of Transport and Korea Rail.
2. As deemed necessary to the conduct of the work of the working members of the committee, the Minister of Transport and the president of Korea Rail may request the dispatch of officials from relevant administrative agencies, and of officials and employees from relevant corporations or research institutions, to the working group.

Article 10 (Minutes).

The committee and the working committee shall keep minutes of their meetings.

Article 11 (Allowances, etc.).

Allowances and trip expenses may be paid to non-public-officials in the committee and the working committee, and to relevant specialists and working group members in these committees, within the budget scope.

Article 12 (Detailed Operational Rules).

As deemed necessary, matters outside this Decree shall be decided on by the Chairperson through a resolution by the committee.

2. The Korea High-speed Rail Construction Authority Act

(Enforced on March 1, 1992) (Act No. 4456 enacted on December 27, 1991)

Article 1 (Purpose).

This Act establishes the Korea High-speed Rail Construction Authority ("the Authority") to efficiently construct the high-speed rail with a view to the expansion of rail transportation networks, in a bid to improve transportation convenience and to help promote a healthy national economic development.

Article 2 (Definition).

A high-speed rail under this Act is a rail wherein a train can run at over 200 kph on its major segments, and that the Minister of Transportation designates as such along with a public notice.

Article 3 (Corporate Entity). The Authority shall be a corporation.

Article 4 (Establishment).

1. The Authority shall be established with an establishment registration in its main office location.
2. The establishment registration details under Section 1 shall be described as follows:
   1.1. Purpose;
   1.2. Name;
   1.3. Main office, branches, and sub-branches;
   1.4. Names and addresses of officers; and
   1.5. Method of public announcement.
3. Regarding the Authority registration, except for its establishment registration, the provision on foundation and corporation registration under the Civil Act shall apply with modifications as deemed necessary.

Article 5 (Office).

1. The main office of the Authority shall be defined in its Articles of Association.
2. As deemed necessary, the Authority may establish branches or sub-branches according to its Articles of Association.

Article 6 (Articles of Association).

1. The Articles of Association of the Authority shall stipulate the following details:
   1.1. Purpose;
   1.2. Name;
   1.3. Location of the main office;
   1.4. Matters concerning works and their execution;
   1.5. Matters concerning assets and accounting;
   1.6. Matters concerning officers and employees;
   1.7. Matters concerning the board of directors;
   1.8. Matters concerning the amendment of its Articles of Association; and
   1.9. Matters concerning public announcements.
2. In amending its Articles of Association, the Authority shall obtain prior approval from the Minister of Transportation.

Article 7 (Projects).

The Authority shall perform the following projects to achieve the purpose stipulated in Article 1:

1. Construction of the high-speed rail;
2. Construction of the high-speed rails of foreign countries;
3. Research, development, and survey of high-speed rail technologies;
4. Projects to develop high-speed rail station spheres and the areas surrounding the high-speed rail;
5. Projects annexed to Paragraphs 1 to 4; and
6. Projects commissioned by the government.

Article 8 (Officers).

1. The Authority shall have the following officers: 10 directors (including one president and two executive vice-presidents) and one auditor.
2. Upon the recommendation of the Minister of Transportation, the president shall be appointed and dismissed by the President of Korea.

3. The auditor shall be appointed and dismissed by the Minister of Transportation.
4. The executive vice-presidents and directors shall be appointed and dismissed by the president of the Authority subject to the approval of the Minister of Transportation.
5. The term of the /president, executive vice-presidents, and directors shall be three years, and the term of the auditor shall be two years.

Article 9 (Limitation of the Representative Rights of the President).
With regard to matters wherein the interest of the Authority and that of the president conflict with each other, the president shall not represent the Authority, and instead, the auditor shall represent the Authority.

Article 10 (Appointment of a Proxy).
The president may, according to the Articles of Association of the Authority, appoint a proxy from among the employees of the Authority, who will have the authority to engage in trials and other matters of the Authority.

Article 11 (Duties of Officers).
1. The president shall represent the Authority and supervise the works of the Authority.
2. The executive vice-president shall assist the president, and one of them shall be the/ acting president according to the Articles of Association when the president is incapacitated.
3. The president shall divide the works of the Authority according to its Articles of Association, and if the president and the executive vice-presidents are all incapacitated, an officer shall be an the acting president according to the priority stipulated in the Articles of Association of the Authority.
4. The auditor shall audit the works and accounts of the Authority.

Article 12 (Reasons for Disqualification of Officers).
The personnel described below shall not be eligible to become officers of the Authority:
1. A person who is not a South Korean national;
2. A person who is not reinstated after declared incompetent, quasi-incompetent, or bankrupt;

3. A person who is sentenced to imprisonment or higher punishment, and whose sentence ended less than two years ago or whose sentence was lifted less than two years ago; and
4. A person who is disqualified or whose qualifications are suspended according to laws or the court's decision.

Article 13 (Limitation of Multiple Jobs of Officers and Employees).
The officers and employees of the Authority shall not engage in businesses for profit other than their jobs. Officers shall not engage in other jobs without the approval of the Minister of Transportation, and employees shall not engage in other jobs without the approval of the president of the Authority.

Article 14 (Board of Directors).
1. The Authority shall establish a board of directors to resolve important matters of the Authority.
2. The board shall consist of the president, executive vice-presidents, and directors.
3. The president shall convene board meetings and shall be the chairperson of the board.
4. The board shall decide on matters by approval of the majority in meetings attended by the majority of all the members.
5. The auditor may attend board meetings and state his/her opinions thereat.

Article 15 (Appointment and Dismissal of Employees).
The employees of the Authority shall be appointed and dismissed by the president of the Authority according to its Articles of Association.

Article 16 (Free Lending of State-owned Properties etc.).
1. As deemed necessary for the efficient performance of the projects of the Authority under Article 7, the government may, notwithstanding the State-owned Property Act, lend state-owned properties to the Authority for free, or allow it to use and benefit from them.
2. The Authority may, notwithstanding the provision on the state-owned properties, construct buildings or permanent facilities in the sate-owned properties that are lent to it for its use and benefit under Section 1.
3. Necessary matters concerning conditions and procedures for the approval of

lending or the use and benefit under Section 1 shall be defined by Presidential Decree.

Article 17 (Sublease of State-owned Properties etc.).

1. As deemed necessary for the efficient construction of the high-speed rail, the Authority may sublease the state-owned properties that are lent to it for its use and benefit under Article 16.
2. In subleasing the properties under Section 1, the Authority shall obtain prior approval from the Minister of Transportation. This shall likewise apply to a revision thereof.
3. In approving the sublease under Section 2, the Minister of Transportation shall have prior consultation with the head of the central administrative agency that lends the relevant state-owned property or that allows it to be used by the Authority for the Authority's benefit.
4. Article 16, Sections 2 and 3 shall apply to the subleased state-owned properties under Section 1, with modifications as deemed necessary.

Article 18 (Succession to the High-speed Rail etc.).

1. The Korea Rail Corporation, established according to the Korea Rail Corporation Act, ("Korea Rail Corporation"), shall, according to the Korea Rail Corporation Act, take over the rights to properties and facilities and the operation thereof that are acquired in connection with the high-speed rail constructed under Article 7, and with the projects for the development of the high-speed rail station spheres and the areas surrounding the high-speed rail ("the assets"), as well as to debts related to the relevant assets ("the debts") when all the projects end. Assets not directly needed for the works of the Korea Rail Corporation shall be owned, however, by the state according to the Presidential Decree.
2. When the Authority intends to transfer the assets and debts under Section 1 to the Korea Rail Corporation, it shall prepare transfer-related documents and obtain approval thereof from the Minister of Transportation.
3. The time for the Korea Rail Corporation to take over the assets and debts under Section 1, as well as the method of evaluation thereof, the evaluation base date, etc., shall be determined by Presidential Decree.

Article 19 (Financing etc.).

1. The operation and projects of the Authority shall be financed as follows:
   1.1. Through investment by the government or other parties;
   1.2. Through funds raised from the issuance of high-speed rail construction bonds;
   1.3. Through proceeds from the operation of assets;
   1.4. Through borrowings (including foreign borrowings and materials); and
   1.5. Through other revenues.
2. Necessary matters concerning the provision, management, and use of the government's investment fund under Section 1, Paragraph 1 shall be determined by Presidential Decree.

Article 20 (Projects on the Development of a Railway Station Sphere etc.).

1. In performing projects to develop the high-speed rail station spheres and the areas surrounding the high-speed rail, as deemed necessary for promoting the construction of the high-speed rail, the Authority may perform housing development projects according to the Housing Land Development Promotion Act. In this case, in applying the Housing Land Development Promotion Act, the Authority shall be regarded as included in the category of implementers of housing land development projects under Article 7 of the same Act.
2. The scope of the rail station spheres and their surrounding areas under Section 1 shall be determined by Presidential Decree.

Article 21 (Collection of Service Fees etc.).

1. The Authority may collect service or use fees from those who use the facilities that it manages.
2. Necessary matters concerning the collection targets, the collected amount, and the collection procedure with regard to the collected service or use fees under Section 1 shall be determined by the Transportation Ministry Decree.

Article 22 (Investments etc.).

1. As deemed necessary for the efficient performance of its projects, the Authority may make monetary or material investments in projects under each Paragraph of Article 7.
2. Necessary matters concerning monetary or material investments under Section 1

shall be determined by the Presidential Act.

Article 23 (Purchase of Land etc.).

1. To achieve the purpose stipulated in Section 1, the Authority may purchase or sell necessary lands or fixtures on the relevant land.
2. As deemed necessary for the performance of the projects under Article 7, the Authority may expropriate or use the land, properties, or rights under Article 2 of the Land Expropriation Act.
3. The Land Expropriation Act shall apply to the expropriation or use of lands under Section 2.

Article 24 (Borrowing of Funds etc.).

1. As deemed necessary for the performance of the projects under Article 7, the Authority may, with the approval of the Minister of Transportation, borrow funds (including foreign funds and the introduction of foreign materials). This shall likewise apply herein.
2. In approving the borrowings under Section 1, the Minister of Transportation shall have prior consultation with the head of the relevant central administrative agency.

Article 25 (Issuance of Bonds for the High-speed Rail Construction etc.).

1. To finance the projects under Article 7, the Authority may issue high-speed rail construction bonds ("the bonds").
2. In issuing the bonds under Section 1, the Authority shall obtain approval thereof from the Minister of Transportation. In this case, the Minister of Transportation shall have prior consultation with the head of the relevant central administrative agency.
3. The government may guarantee the repayment of the principal of the bonds issued by the Authority.
4. The government may help in the payment of some of the costs incurred for the Authority to pay for the interest on its issued bonds.
5. The extinctive prescription of the bonds shall be completed in 5 years for the principal, and in 2 years for the interest, from the repayment date.
6. Other necessary matters concerning the issuance of bonds shall be determined by Presidential Decree.

Article 26 (Approval of the Project Plan etc.).

The Authority shall prepare the business plan and budget plan for each fiscal year according to the Presidential Decree, and obtain approval thereof from the Minister of Transportation. This shall likewise apply to revisions thereof.

Article 27 (Submission of the Settlement Statement).

The Authority shall prepare a statement of settlement of revenues and expenditures in each fiscal year, have it examined by certified public accountants, and submit it to the Minister of Transportation by the end of February of the next fiscal year.

Article 28 (Fiscal Year).

The fiscal year of the Authority shall be the same as that of the government.

Article 29 (Disposition of Surplus).

The Authority shall dispose of the surplus shown in its settlement statement for each fiscal year, if any, with the following priorities:

1. Covering of the deficit carried over from the previous term;
2. Facility reserve fund defined by the Presidential Decree; and
3. Payment to the state coffers.

Article 30 (Request for Provision of Data).

As deemed necessary for its works, the Authority may request relevant administrative agencies, or other institutions and organizations related to the high-speed rail, to provide necessary data.

Article 31 (Accounting Provision of the Authority etc.).

The Authority shall determine matters concerning its organization, accounting, human resource affairs, and remuneration, and obtain approval thereof from the Minister of Transportation. This shall likewise apply to revisions thereof.

Article 32 (Guidance and Supervision).

1. As deemed necessary for the guidance and supervision of the Authority, the Minister of Transportation may require the Authority to report its works, accounting, and properties, or may order his/her officials to inspect the Authority's books, files, facilities, and other properties.

2. If the report or inspection under Section 1 reveals illegality or improprieties, the Minister of Transportation may issue a corrective action order to the Authority.
3. The officials who will perform the inspection under Section 1 shall carry a certificate representing their authority and show it to the relevant personnel.

Article 33 (Confidentiality).
The Authority's officers or employees or personnel, and those engaged in the design, construction, improvement, or repair of the high-speed rail facilities under agreements with the Authority or who are employed for such works shall not leak confidential business information that they may come to know.

Article 34 (Ban on the Use of Similar Names).
Entities that are not the Authority by this Act shall not use the name Korea High-speed Construction Authority or similar names.

Article 35 (Application of Other Laws with Modifications as Deemed Necessary).
Except as stipulated in this Act, the provision on foundations and corporations under the Civil Act shall apply to the Authority, with modifications as deemed necessary.

Article 36 (Legal Function as Public Officials with Regard to the Application of Punishment).
When applying Articles 129-132 of the Criminal Act, the Authority's officers and employees shall be regarded as public officials.

Article 37 (Punishment).
Violators of Article 33 shall be penalized with up to two years imprisonment or with a fine of up to KRW 2 million.

Article 38 (Fines).
Violators of Article 34 shall be fined up to KRW 2 million.

3. High-speed Rail Construction Promotion Act

(Enforced on April 1, 1997) (Act No. 5250 enacted on December 31, 1996)

Article 1 (Purpose).

This Act defines necessary matters concerning the early construction of a high-speed rail in Korea, so as to efficiently implement the high-speed construction project with a view to coping with the rapidly increasing traffic demand and boosting Korea's economic development.

Article 2 (Definition).

The terms of this Act shall be defined as follows.

1. "High-speed rail" refers to a rail wherein a train can travel on major legs at over 200 kph, and that the Minister of Construction and Transportation has designated as such, along with a public notification thereof.
2. "High-speed rail facility" refers to each of the following facilities:
   - 2.1. Tracks of the high-speed rail (including facilities annexed to the tracks) and station facilities (including the transfer facilities stipulated in Article 2, Section 3 of the Urban Traffic Improvement Promotion Act, which shall likewise apply hereunder);
   - 2.2. Car maintenance depots, track repair bases, and car detention facilities designed to repair and maintain cars and tracks of the high-speed rail;
   - 2.3. In the high-speed rail, transformers, power transmission lines, and other power facilities, as well as rail communication facilities and train control facilities;
   - 2.4. Facilities needed to link the operation of the high-speed rail to that of other rails;
   - 2.5. Facilities to develop, test, and research on high-speed rail technologies; and
   - 2.6. Facilities to construct, maintain, and repair the high-speed rail, as designated by the Presidential Decree.
3. "High-speed rail construction project" refers to the following projects:
   - 3.1. Construction projects for facilities under Paragraph 2;
   - 3.2. Residential facilities and convenience infrastructure construction projects for those who will lose their residential areas due to construction projects under Paragraph 2; and
   - 3.3. Construction projects for public facilities, military facilities, or communal

buildings (excluding high-speed rail facilities) that shall be installed under Article 16, Section 1.

Article 3 (Formulation of a Basic Plan for the High-speed Rail Construction).

1. As deemed necessary for the construction of the high-speed rail, the Minister of Construction and Transportation shall formulate the basic plan for the high-speed rail construction ("the basic plan") according to the Presidential Decree.
2. In devising the basic plan under Section 1, the Minister of Construction and Transportation shall have prior consultation with relevant mayors or provincial governors ("mayors and governors") and with the heads of relevant central government agencies, and shall have the plan reviewed by the High-speed Rail Construction Impulsion Committee as designated by the Presidential Decree ("the impulsion committee").
3. The Minister of Construction and Transportation shall notify the public of the basic plan devised under Section 1 according to the Presidential Decree, and shall send the plan to the mayors and governors for public disclosure thereof over a period of more than 20 days.
4. The basic plan shall include the following matters:
   4.1. Regarding the prearranged area for the construction of the high-speed rail, its characteristics, traffic situation, and forecasts of traffic demand;
   4.2. Evaluation of the economics, feasibility, and other aspects of the high-speed rail construction;
   4.3. Sketchy route maps;
   4.4. Construction period and financing measures;
   4.5. Approximate construction costs and mid- and long-term fund operation plans;
   4.6. Building of transportation systems linked to other means of transportation;
   4.7. Countermeasures against earthquakes;
   4.8. Plan for securing and fostering high-speed rail operations manpower; and
   4.9. Other matters deemed necessary by the Minister of Construction and Transportation.
5. Sections 2 and 3 shall apply--with modifications as deemed necessary--to revisions of the basic plan devised according to Section 4. This shall exclude the revision of light matters stipulated in the Presidential Decree.

Article 4 (Implementer of the High-speed Construction Project).

1. The high-speed rail construction project shall be performed by the Korea High-speed Rail Construction Authority established according to the state or the Korea Highspeed Rail Construction Authority Act. If, however, the construction of the highspeed rail shall be performed under the Private Capital Attraction Promotion Act Concerning SOC Infrastructure, the person designated in the Act shall implement the project.
2. As deemed necessary for the efficient implementation of the high-speed rail construction project, the Minister of Transportation and Construction may allow an administrative agency, a government-invested institution, etc., other than the persons designated in Section 1, to perform part of the project according to the Presidential Decree.

Article 5 (Designation of Prearranged Areas, etc.).

1. In implementing the high-speed rail construction project, the Minister of Construction and Transportation may designate prearranged areas for the high-speed rail construction ("prearranged areas") or change the designated prearranged areas.
2. In designating or changing the prearranged areas under Section 1, the Minister of Construction and Transportation shall have prior consultation with the relevant mayors and governors and the heads of relevant central administrative agencies, and shall have the corresponding results reviewed by the impulsion committee.
3. The Minister of Construction and Transportation shall notify the public of the designated or changed prearranged areas under Section 1, according to the Presidential Decree.
4. The Minister of Construction and Transportation shall cancel the prearranged or changed areas designated under Section 1 if the project has not commenced within 5 years of such designation or change.

Article 6 (Limitations of this Act).

1. Those who intend to change the shape and quality of land, construct buildings, install facilities, collect soil and gravel (including sand, which shall likewise apply hereunder), or conduct other acts as designated by the Presidential Decree in the prearranged areas, shall obtain approval thereof from the competent mayor, county governor, or district office head (i.e., the autonomous district office head,

which shall likewise apply hereunder). This shall equally apply to a change in approvals.

2. Notwithstanding Section 1, those who have already embarked on the construction of the project upon the designation or notice of the prearranged areas according to the relevant laws, and who have already obtained approval and permission concerning the change in the land shape and quality, construction of buildings, installation of facilities, or collection of soil and gravel (including occasions when no such approval or permission is required according to the relevant laws), may implement such project after reporting it to the mayor, county governor, or district office head according to the Presidential Decree.
3. Section 1 shall not apply to acts necessary for military operations. This shall not apply, however, when the safe operation of the high-speed rail is hampered, or when permanent buildings or facilities need to be installed.
4. The mayor, county governor, or district office head may order the violators of Section 1 to restore the original state.
5. In accordance with the Administrative Vicarious Execution Act, the mayor, county governor, or district office head may execute necessary action against those who have been given the order according to Section 4 but who have failed to perform their duty.

Article 7 (Approval of the Execution Plan).

1. The high-speed rail project implementers under Article 4 ("the project implementers") shall devise an execution plan for the high-speed rail construction, specifying the project size, outline, period, financing, and other matters stipulated in the Presidential Decree ("the execution plan"), and shall obtain approval thereof from the Minister of Construction and Transportation. In this case, as deemed necessary for the efficient implementation of the high-speed rail construction project, the project implementers may devise execution plans according to segments or facilities within the scope of the basic plan.
2. In devising the execution plan under Section 1, the project implementers shall reflect the results of their environmental impact evaluation, traffic impact evaluation, and survey of cultural heritage situations in the plan.
3. The Minister of Construction and Transportation shall publicly announce the execution plan-if approved under Section 1-according to the Presidential Decree, and shall send copies of relevant documents to the heads of relevant local

governments.

4. The heads of local governments who have received copies of relevant documents under Section 3 shall take necessary action, including land registration notice approval application under Article 13 of the Urban Planning Act, if the relevant documents include matters that need urban planning decisions. In this case, the project implementers shall submit documents necessary for the issuance of land registration notices to the heads of local governments.
5. In revising matters included in the execution plan as approved under Section 1 and designated by the Presidential Decree, the project implementers shall obtain approval thereof from the Minister of Construction and Transportation. In this case, Sections 1-4 shall apply, with modifications as deemed necessary.

Article 8 (Relations to Other Laws).

1. If the execution plan has been approved according to Article 7, it shall be regarded as among the following approvals, permissions, decisions, reports, designation, licenses, consultations, agreements, liftings of designations, and deliberations being done ("approval, permission, etc."). If the approval of the execution plan has been publicly announced, the following approvals, permissions, etc. shall be regarded as publicly announced according to relevant laws:
    1.1. Consultation on or approval of the installation of public facilities etc. according to Article 20 of the Act on the Utilization and Management of National Land, land transaction approval according to Article 21-3 of the same Act, and reporting of land transaction agreements according to Article 21-7 of the same Act;
    1.2. Permission for a change in the land shape and quality according to Article 4 of the Urban Planning Act, decision on urban planning according to Article 12 of the same Act (limited to the facilities under Article 2, Section 1, Paragraph 1, Subparagraph B of the same Act), designation of the urban planning project implementers under Article 23 of the same Act, and approval of the execution plan for the urban planning project under Article 25 of the same Act;
    1.3. Permission for the occupation or use of public waters under Article 4 of the Public Waters Management Act;
    1.4. Licensing of the reclamation of public waters under Article 4 of the Public Waters Reclamation Act, the of the execution plan under Article 9-2 of the

same Act, and consultation on or approval of the plan under Article 29 of the same Act;

1.5. Consultation with or approval by the management office under Article 6 of the River Act (limited to the approval of the implementation of river projects under Article 23 of the same Act, and to the approval of river occupation etc. under Article 25 of the same Act);

1.6. Consultation with and approval by the Road Management Office under Article 8 of the Road Act (limited to the public announcement of road recognition under Article 19 of the same Act, decisions on road areas under Article 25 of the same Act, approval of the implementation of road projects for entities other than the management office under Article 34 of the same Act, and occupation of roads under Article 40 of the same Act);

1.7. Consultation with the Park Management Office under Article 50, Section 1 of the Natural Park Act (limited to approval of the occupation and use of parks under Article 23 of the same Act, and to approval of acts inside the protected park areas under Article 25 of the same Act);

1.8. Approval of diverted use of agricultural land under Article 36 of the Agricultural Land Act;

1.9. Deliberation on traffic impact assessment under Article 13 of the Urban Traffic Improvement Promotion Act;

1.10. Permission of lumbering, etc. under Article 14 of the Land Erosion and Collapse Prevention Work Act, and lifting of the designation of erosion prevention areas under Article 20 of the same Act;

1.11. Permission for and consultation on diverted use of preserved forests under Article 18 of the Forest Act, lifting of the designation of security forests under Article 57 of the same Act, permission for lumbering of trees inside security forests under Article 62 of the same Act, permission for lumbering of trees under Article 90 of the same Act, and approval of quarrying under Article 90-2 of the same Act;

1.12. Approval of general waterworks projects under Article 12, Section 1 of the Water Supply and Waterworks Installation Act, and approval of exclusive waterworks installation under Articles 36 and 38 of the same Act;

1.13. Consultation on and approval under Article 3 of the Sewerage Act, approval of the implementation of public sewerage projects under Article 13 of the same Act, and approval of the occupation of public sewerages under Article

20 of the same Act;

1.14. Approval of the installation of electric facilities under Article 29 of the Electric Power Business Act, and approval or reporting of project plans for self-use electric facilities under Article 32 of the same Act;

1.15. Approval of the construction of factories, etc. under Article 13 of the Act on Industrial Deployment and Construction of Factories (limited to factories that are directly needed for the high-speed rail construction project and that are constructed during the construction period);

1.16. Deliberation by the construction committee under Article 4 of the Construction Act, approval of construction under Article 8 of the same Act, reporting of construction under Article 9 of the same Act, approval of the construction of temporary buildings under Article 15, Section 1 of the same Act, and consultation on construction under Article 25 of the same Act;

1.17. Approval of acts inside the grassland creation area under Article 8 of the Grassland Act, and approval of or consultation on diverted use under Article 23 of the same Act;

1.18. Deliberation by the Construction Technology Deliberation Committee under Article 5 of the Construction Technology Management Act;

1.19. Agreement on the approval of construction, etc. under Article 8 of the Firefighting Act, permission for the installation of factories, etc. under Article 16, Section 1 of the same Act, and reporting of the construction of firefighting facilities under Article 62, Section 1 of the same Act;

1.20. Approval of access to protected areas or military facilities under Article 7 of the Military Facility Protection Act, and consultation on approvals by the relevant administrative office under Article 10 of the same Act;

1.21. Approval of the relocation of tombs under Article 16, Section 2 of the Act on Burial, Tombs, etc.;

1.22. Non-approval of the establishment of mining rights under Article 29 of the Mining Business Act, and cancellation of mining rights or reduction of mine blocks under Article 39 of the same Act;

1.23. Approval of the construction of private roads under Article 4 of the Private Road Act;

1.24. Approval of land acquisition under Article 10 of the Housing Land Ownership Limitation Act;

1.25. Approval or reporting of waste treatment facilities under Article 30 of the

Waste Management Act;

1.26. Reporting of the installation of sewage disposal facilities under Article 9, Section 2 of the Act on the Disposal of Sewage, Excrement, and Livestock Wastewater, and reporting of the installation of sewage disposal tanks under Article 10, Section 2 of the same Act; and

1.27. Approval or reporting of the installation of discharge facilities under Article 10 of the Clean Air Conservation Act, Article 10 of the Clean Water Conservation Act, and Article 9 of the Noise and Vibrations Regulation Act, and approval of the design and construction of self-prevention facilities under the proviso of Article 12 of the Clean Air Conservation Act and the proviso of Article 12, Section 1 of the Clean Water Conservation Act.

2. In approving the execution plan that includes one of the matters stipulated in each paragraph in Section 1, the Minister of Construction and Transportation shall prepare relevant documents submitted by the project implementers and shall have prior consultation with the heads of relevant administrative agencies. In this case, the heads of the relevant administrative agencies shall provide their opinions within the period designated by the Presidential Decree for such a request.

Article 9 (High-speed Rail Construction Review Committee).

1. To deliberate on important matters concerning architectural technologies, construction technologies, and the traffic impact of the high-speed rail construction project, the high-speed rail construction review committee ("the review committee") shall be established under the control of the Minister of Construction and Transportation.
2. In approving the execution plan that includes Paragraphs 9 and 16 of Article 8 (excluding the approval of the construction of temporary buildings under Article 15, Section 1 of the Construction Act) or matters in Paragraph 18, the Minister of Construction and Transportation shall have prior consultation with the review committee.
3. The review committee shall have up to 100 members, including the committee chairperson, and these members shall be appointed by the Minister of Construction and Transportation from among those described below:

3.1. Fourth-grade or higher officials related to the high-speed rail construction project in the relevant central and local administrative agencies and local governments;

3.2. Officers of public organizations and research institutions; and

3.3. Personnel with ample knowledge and experience in high-speed rail construction, civil engineering, and environment protection, as defined by the Minister of Construction and Transportation.

4. As deemed necessary, the Chairperson may form and operate subcommittees by field according to the agenda for the review committee's deliberation of relevant matters.

5. Necessary matters concerning the composition, functions, and operations of the review committee under Section 1 shall be defined by the Presidential Decree.

Article 10 (Special Cases Concerning the Promotion of the High-speed Rail Construction Project and the Improvement of the Quality Thereof).

1. Under each of the following circumstances, the relevant high-speed rail facilities shall not be governed by Articles 39 and 40 of the Construction Act, Article 44 of the same Act, Article 17, Section 1 of the Firefighting Act, and Article 30, Section 1 of the same Act:

1.1. In the event that special technologies or special machines, which were admitted by the Minister of Construction and Transportation after undergoing the review thereof by the review committee, are used; and

1.2. In the event that the structures and types of high-speed rail facilities are admitted by the Minister of Construction and Transportation to be equivalent to the criteria for firefighting, accident prevention, fire prevention, and escape stipulated under relevant laws, after they are reviewed by the review committee.

2. In placing orders for the construction of the high-speed rail facilities with diverse functions and characteristics, such as high-speed rail stations, the project implementers may place a combined order for all such facilities according to the Presidential Decree, if any, if separate individual orders are difficult due to the nature of the construction work or to the technical inseparability of the construction, electricity, and electricity and communication works.

3. The project implementers may, notwithstanding Article 20 of the Act on the Industrial Deployment and Construction of Factories, install, expand, or relocate to the production facilities various materials necessary for the high-speed rail project that are admitted by the Minister of Construction and Transportation as directly necessary for the high-speed rail construction project in the prearranged

areas or surrounding areas. In this case, the relevant production facilities for the construction materials shall be limited to those that are installed for the construction works during the construction period.

Article 11 (Access to and Use of Land, etc.).

1. Regarding investigations and surveying or implementation of the high-speed rail construction project with a view to the drawing up of the execution plan, as deemed necessary, the project implementer may access third-party land or temporarily use third-party land as material accumulation sites, passages, or temporary roads. Notably, as deemed necessary, the project implementer may change or remove bamboos and trees, soil, and other obstacles from such land.
2. Article 5, Sections 2-7 of the Urban Planning Act, and Article 6 of the same Act, shall apply to Section 1 with modifications, as deemed necessary.

Article 12 (Expropriation of Land, etc.).

1. In implementing the high-speed rail construction project, as deemed necessary, the project implementers may expropriate or use the land, properties, or rights ("land, etc.") stipulated in Article 2 of the Land Expropriation Act.
2. When the execution plan is approved or publicly announced, it shall be regarded as the project admission and the issuance of the notice of the project admission under Article 14 of the Land Expropriation Act and Article 16 of the same Act, and an application for a decision may, notwithstanding Article 17 of the Land Expropriation Act and Article 25, Section 2 of the same Act, be made within the project implementation period stipulated in the execution plan.
3. The central land expropriation committee shall be the competent land expropriation committee for the decision-making on the expropriation or use of land, etc. under Section 1.
4. The Land Expropriation Act shall apply to the expropriation or use of land under Section 1, with modifications as deemed necessary, except otherwise stipulated in this Act.

Article 13 (Limited Disposition of National and Public Lands, etc.).

1. Land owned by the central government or local governments, that is situated inside the prearranged areas, and that is necessary for the high-speed rail construction project, shall not be sold or transferred for purposes other than the

implementation of the high-speed rail construction project.

2. The properties located inside the prearranged areas and owned by the central government or by local governments may, notwithstanding the State-owned Property Act, the Local Finance Act, and other laws, be sold to the project implementers on a negotiated contract basis. In this case, regarding the disposition of the use or sale of the relevant property, the Minister of Construction and Transportation shall have prior consultation with the heads of relevant administrative agencies.
3. Upon a request for consultation according to the second part of Section 2, the heads of relevant administrative agencies shall take necessary measures such as the disposition of the use and sale within 90 days of their receipt of the request.
4. Regarding state-owned properties that are intended to be sold to the project implementers under Section 2, but the management offices of which are not known, the Minister of Finance and Economy shall, notwithstanding other laws, be responsible for their management and disposition.

Article 14 (Confirmation of the Completion of the Construction).

1. After completing the construction work in the high-speed rail construction project, the project implementers shall, without delay, submit a construction work completion report to the Minister of Construction and Transportation, and shall obtain confirmation of their construction work completion from the minister. In this case, the Minister of Construction and Transportation may request that the inspection necessary for the confirmation of the construction work completion be conducted by heads of relevant central administrative agencies, local governments, government-invested institutions, and the Korea High-speed Rail Construction Authority, research institutions, or other specialist institutions.
2. Upon the receipt of an application for confirmation of construction work completion under Section 1, the Minister of Construction and Transportation shall, in the event that the works are admitted as implemented as approved after the confirmation of the construction work completion, issue a certificate of construction work completion to the applicant, and shall send the relevant documents to the relevant administrative agency if the completed facility is a building.
3. When the project implementers are issued a certificate of construction work confirmation under Section 2, it shall be taken to mean that the construction work

completion has been inspected or the construction work completion has been approved under the relevant project, in line with the permissions and approvals under each paragraph in Article 8.

4. The project implementers shall not, before being issued a license for the confirmation of their construction work completion under Section 2, use the lands and facilities created or established under the high-speed rail construction project, except when the use thereof before the construction work completion is approved by the Minister of Construction and Transportation.
5. As deemed necessary for the efficient implementation of the high-speed rail construction project, the project implementers may apply for the confirmation of their construction work completion according to individual segments or facilities within the scope of the execution plan.

Article 15 (Ownership of Facilities, etc.).

1. The lands or facilities that are created or established under the high-speed rail construction project shall, upon their completion, be owned by the state, except with respect to the lands and facilities that are defined by the Presidential Decree.
2. The Minister of Construction and Transportation may allow the project implementer of the facilities owned by the state under Section 1 to use and profit from the facilities for free within his total project investment costs according to the Presidential Decree.
3. If the project implementer is the Korea High-speed Rail Construction Authority and an implementer of a private-capital-attracting infrastructure facility project according to the Private Capital Attraction Promotion Act, the ownership of the lands and facilities that are created or installed under the high-speed rail construction project shall, notwithstanding Sections 1 and 2, be determined by the respective Korea High-speed Rail Construction Authority Acts and the Act on Private Capital Attraction Promotion for SOC Facilities.
4. The calculation method for the total project cost under Section 2, and the period of the use of the facilities for free, shall be determined by the Presidential Decree.

Article 16 (Installation of Replaced Public Facilities, etc.).

1. The Minister of Construction and Transportation may, if there are public facilities, military facilities, or communal buildings (excluding high-speed rail facilities, which shall be referred to as “public facilities” herein) that are incorporated into

the sites under the high-speed rail construction project and that are designated by the Presidential Decree, upon the application by the management office or owner of the public facilities, allow the project implementer to install public facilities etc. that will replace the existing facilities (which shall be referred to as "replaced public facilities etc." herein).

2. In allowing the project implementer to install the replaced public facilities etc. under Section 1, the Minister of Construction and Transportation shall specify this fact in his/her approval of the execution plan under Section 7 according to the Presidential Decree.
3. When the replaced public facilities etc. have been given a confirmation of completion under Article 14, notwithstanding the State-owned Property Act, Local Finance Act, and other laws, the existing public facilities etc. shall be owned for free by the project implementer, and the replaced public facilities etc. shall be owned for free by the central government and the local governments or the owners of the existing facilities.
4. With regard to the registration of the replaced public facilities under Section 3, the approval of the execution plan, or the approval of the revision thereof and the confirmation of the construction works, shall replace the documents that prove the registration causes according to the Realty Registration Act.

Article 17 (Supervision).

1. Under the following circumstances involving the project implementer, the Minster of Construction and Transportation may cancel the permission or approval granted under this Act, or give orders to suspend or change the construction works, or to reconstruct, change, or relocate the facilities or properties:
   1.1. In the event that the project implementer obtained the permission or approval using illegal methods under this Act;
   1.2. In the event that the project implementer violated this Act or the orders or dispositions made under this Act; and
   1.3. In the event that due to a change in circumstances, it is impossible for the project implementer to continue implementing the high-speed rail construction project.
2. With regard to the dispositions or orders made under Section 1, the Minister of Construction and Transportation shall notify the public of the corresponding results according to the Presidential Decree.

Article 18 (Reporting, Inspection, etc.).

1. As deemed necessary for the implementation of this Act, the Minister of Construction and Transportation may require the project implementers to submit necessary reports on the high-speed rail construction project, or to submit relevant data. Also, the minister may order relevant officials to access the offices, workplaces, or other necessary places of the project implementers so as to inspect the works concerning the high-speed rail construction project.
2. Officials who inspect the works concerning the high-speed rail construction project under Section 1 shall show a certificate of their authority to the relevant personnel.
3. Necessary matters concerning the certificate under Section 2 shall be determined by the Construction and Transportation Ministry Decree.

Article 19 (Commissioning of the Land Purchase Project, etc.).

1. The project implementers may commission land purchase work, loss compensation work, and relocation measure projects under the high-speed rail construction project to the heads of competent local governments according to the Presidential Decree, or to government-invested institutions according to the Basic Act on Governmentinvested Institution Management.
2. The fees for the commissioning of land purchase work, loss compensation work, and relocation measure work under Section 1 shall be determined by the Presidential Decree.

Article 20 (Penalties).

1. Those who shall fail to obtain approval under Article 6, Section 1, or who shall obtain approval by illegal methods, shall be sentenced to up to one year imprisonment or fined up to KRW 5 million.
2. Those who shall be involved in each of the following circumstances shall be fined up to KRW 3 million:
   2.1. Project implementers who, without justifiable reasons, refused to perform their duties under Article 11, Section 1;
   2.2. Those who violated orders given under Article 17, Section 1;
   2.3. Those who failed to submit reports or data under Article 18, Section 1, or submitted false reports or data; and
   2.4. Those who refused to receive inspections or hampered inspections under

Article 18, Section 1.

Article 21 (Joint Penal Provision).

If the corporate representative, the corporation's or individual person's proxy, or a worker or employee has violated the acts under Article 20 with regard to the corporation's or individual person's works, the violator shall be punished and a fine shall be imposed on the corporation or individual person under this Article.

Not for sale
ISBN 978-89-5503-559-9