

Introduction of Rapid Urban Railway System - Construction of Subway Line 9

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Background of Construction of Subway Line 9

Since the 1950s, the population of Seoul has undergone such explosive growth, that it rose by 630% by 1990. Even in the early 1990s, the population continued to increase. Though the 2nd phase of construction of subway lines was in progress at that time, the need to carry on the 3rd phase of construction was raised for the first time in 1991, because of this explosive growth. In November 1993, a basic plan for the 5 subway lines including new construction of subway line 9~12 and the extension of subway line 3 was announced. At that time, the transport share of the subway lines was 32%. The goal of the basic plan was to raise the transport share to 75% after completion of the 3rd phase of construction of subway lines.

The 1995 explosion accident that occurred in the Daegu subway¹ caused all subway lines under construction or on the plan list to go through reevaluation of their plans or adjustment of construction periods before construction could be started or resumed, according to the government policies. This caused the completion of the 2nd phase of construction to be delayed. The start of the 3rd phase of construction was scheduled in 1996, but was postponed to 1998 or later because the policy on financing method could not be established in time. Even though the construction had been delayed, the station locations for subway line 9 were determined in 1996. The Seoul Metropolitan Government (SMG) announced a new plan in March 1997 to start the 3rd phase of construction; SMG made a project plan for the 3rd phase of construction, then had consultations with the central government on the financing measures for the 3rd phase project, giving priority to subway line 9 and the extension of subway line 3, and started the construction right after reaching an agreement on the financing measures. However again, the commencement of construction was delayed because of budget cuts due to the monetary crisis in 1997. In June 1998, the Mayor, newly inaugurated at the time, ordered to re-appraise all the routes of the subway lines in the 3rd phase of construction, which postponed the start of the construction indefinitely. Finally, in September 1998, the existing plan for the 3rd phase of construction was modified so that only the extension of line 3 and construction of line 9 would be executed as it was drafted, the length of line 11 would be shortened to that of the current Bundang line and the other plans would be replaced by the construction of light rail transit, small monorail and branch lines to the 1st and 2nd phases' subway lines. The feasibility investigation for line 9 with the execution designs completed was passed and its construction commencement was confirmed in 2001 as a project of private sector investment for profit (BTO).

The profitability of line 9 was estimated to be bleak in the beginning stage because the line was operated on a similar route to the Olympic Expressway, one of the urban expressways, and the overall metro transports showed stagnant results. In order to cope with such conditions, SMG planned to introduce mixed service of normal (all stop) trains and express trains for the first time in Korea. The operational plan for subway line 9 was expected to enhance the accessibility from the surrounding areas to central Seoul and improve passenger services through providing various patterns of train operation.

¹ Note) The terrible Daegu subway fire accident occurred at Jungangno Station of Daegu Metro Line 1 by arson on 18 February 2003. 12 subway train cars were completely burned out except the skeletons. The accident caused 192 deaths, 21 people were missing and 151 were injured. As the Jungangno station was also burned, train operation was stopped for recovery until 30 December 2003.

Timeline for Subway Line 9 Construction Project

History of Construction of the Subway Line 9

- Jun. 1994: Set the route for the 3rd phase of construction
- 1997: Established the implementation plan for the 3rd phase of construction
- 1998: Decided to start constructing a part of 3rd phase subway lines because of IMG crisis (Line 9 was included.).
- Oct. 2001: Acquired approval for the basic construction plan for the 1st stage sections of line 9
- Dec. 2002: Started the underground construction for the 1st stage sections of line 9
- May 2005: Execution agreement between SMG and the project implementer (private sector investment project for the above ground part of the subway lines)
- Jun. 2007: Started the above ground construction for the 1st stage sections of line 9
- O&M (Operations and Maintenance) contract between the project implementer and the subway operator
- Jul. 2009: Opening of the 1st stage sections of line 9
- Oct. 2011: Number of train operations increased (24 trains → 36 trains)

Project Process by Stage

The construction of subway line 9 has progressed in 3 stages. The train operation got started from the completed sections at each stage. As shown in <Figure 1>, the construction of subway line 9 started from the Gangseo section, which was vulnerable to the subway services and expected to have relatively higher demands on such services. In July 2009, the stage 1 section (Gaehwa~Sinnonhyeon) opened and is currently in operation. According to the operation performance of the stage 1 section over the last 5 years, the actual daily traffic reached 97% of the 2010 forecast. In 2012, it reached 103.8%, showing high utilization rate. Therefore the passenger traffic was anticipated to increase more after stages 2 and 3 were constructed and opened for operation. In the stage 2 sections which had been planned to be completed in March 2015, the transfers to the Bundang line (at Seonjeongneung Station) and to line 8 (at Jamsil Sports Complex Station) would be available, improving the accessibility of the passengers using the Bundang line and line 8 to the central city. With construction of the stage 3 sections slated for completion in April 2016, line 9 would be fully constructed and opened.

<Figure 1> Construction Sections of the Subway Line 9



Operating Characteristics of Subway Line 9

Introduction of the Express Train Service

Construction of Nation's First Express Urban Railway

The biggest feature of subway line 9 is the introduction of an express route in which the train speed is faster and the express trains stop at fewer stations. Of the Seoul Metropolitan Rapid Transit routes, subway line 9 is the first one that was constructed taking the express trains into account from the construction planning phase. The express trains in subway line 9 stop at main stations, including transfer stations, and pass the rest stations. Of the 25 stations on subway line 9, the express trains stop at 9 stations. Subway line 9 was designed to operate the all-stop trains and express trains on one track. The express routes are operated at a speed about 40% faster than normal all-stop trains.

How to Operate Normal/Express Trains

As the normal trains and the express trains use one track in subway line 9, it is important to adhere to the operating schedule strictly. The operation ratio of normal to express trains is 3:1 during the rush hour, offering convenience to passengers and 2:1 during regular times. The platforms and the boarding locations of the express trains are same as those of the normal trains for the convenience of passengers in most cases. (At some stations, they use same platforms but the boarding locations of the normal and express trains are in opposite direction.)

Operation of Express Train Using Double Track + Sidetrack Method

A typical method used in operating subway express trains is to construct a four-track line for a separate express line. Another method is to have the double track plus sidetrack (or evacuation track) by which the express trains can pass the normal trains at some stations. In regard to transport and efficiency, the four-track line method is sufficient, but requires a huge amount of additional investment. Thus, the dual-track plus sidetrack method was taken for the subway line 9. In the case of the stage 1 section of line 9 currently under operation, 6 stations have the sidetracks installed and the express trains stop at 9 stations, including the transfer stations. The total travel time of the normal trains is around 47 minutes from Gimpo International Airport Station to Sinnonhyeon Station. If you use the express trains, it takes around 30 minutes. If you were to travel the same route by passenger car, then it takes around 40 minutes, and 64 minutes when travelling by bus. Therefore, the express trains are much more advantageous compared to passenger cars and buses.

<Figure 2> Normal/Express Trains Operation Method in the Subway Line 9



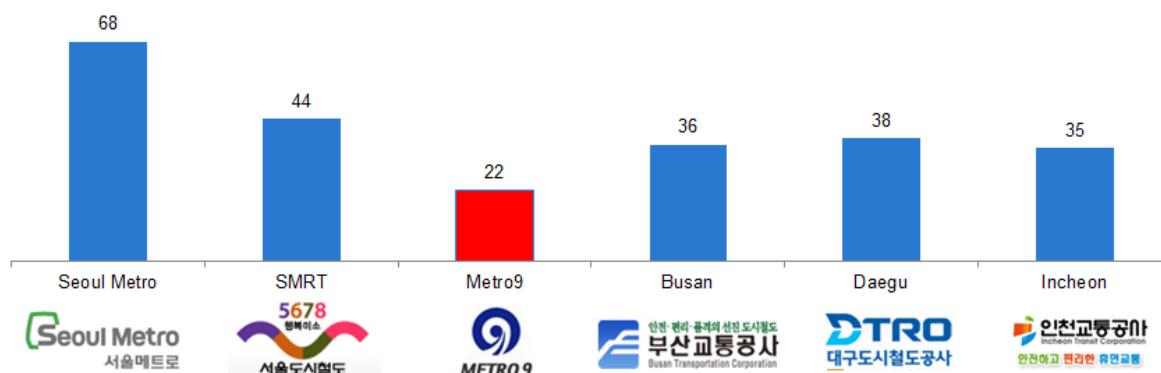
<Table 1> Travel Time of the Normal/Express Trains

Classification	Normal (N)	Express (E)	(N-E)/E×100%
Gimpo Int'l Airport ~Yeouido	26min. 25sec.	15min. 50 sec.	41%
Gimpo Int'l Airport ~Sinnonhyeon	47min. 30sec.	30min. 00 sec.	37%

Slim Organization (Execution of 5-Free Policy)

The subway line 9 route represents the most modern construction method of all the Seoul subway lines. It introduced 5-free policy for the first time. The 5-free policy means the stations in line 9 do not have 5 things that are present in the operating procedures of the existing subway lines. The 5 things are stationmaster, station office, ticket office, general office and facilities for night duty. According to the policy, personnel for the ticket office were not assigned and the station office was not installed. Instead, a convenience store sells transportation cards and provides card charging services. And a couple of station employees and ticketing supporters stay in the station for safety instructions and to guide passengers. In addition, the on-site office that used to be operated for facility maintenance and management by the existing subway operating institutes was eliminated to make the organization have a slim structure. In order to maximize the operational efficiency, the maintenance and management tasks for trains, elevator facilities and other facilities are performed by outsourcing. As a result, the number of operating personnel per kilometer in subway line 9 recorded the lowest in comparison to those of the other subway lines in Korea as shown in <Figure 3>.

<Figure 3> No. of Operating Personnel per Kilometer of the Subway Lines in Korea



Measures to Reduce Crowded Trains of Line 9

Since its opening in July 2009, subway line 9 introduced a dual operating system of normal and express trains. The line has been spotlighted by the Seoul citizens as a new means of transportation in moving between Gangseo and Gangnam conveniently. The passengers using line 9 were continuously increasing. The daily average number of passengers in the first year of opening was 214,000, and increased consistently to 294,000 in 2011 (January to July), showing a growth rate of around 37%. In the case of the express trains with high user preference, however, the degree of congestion exceeded 250% during the rush hour because lots of passengers gathered in specific time periods, causing inconvenience in using the subway. SMG increased the number of express train runs during the most crowded rush hour (07:30 ~ 08:20) without increasing the number of trains but it was unsuccessful in improving the congestion problems fundamentally.

SMG realized the operating plan for car increase scheduled in 2014 more than 2 years earlier. In October 2011, 48 cars for 12 trains in total were added and 5 trains (with 20 cars) with their performance tests completed were added to the transportation in rush hour to increase the transport capacity. In addition, the express train intervals were shortened from 20 minutes to 10 minutes and the normal train intervals from 6.7 minutes to 5 minutes during the rush hour since October 2011, when the early investment was committed. Outside of rush hour, the intervals of express trains were shortened from 20 minutes to 13 minutes and those of normal trains from 10 minutes to 6.5 minutes to reduce the passengers' waiting time on the platforms. In spite of such efforts of SMG, the congestion issues of the line 9 remained to be taken care of in the future. When the stage 2 and 3 sections of subway line 9

would be completed, lots of commuters were expected to inflow to the line resulting in intensifying the congestion problems. In order to cope with such situations, SMG has discussed the issue of crowded trains with the operation company of subway line 9.

<Table 2> Actual State of Congestion in the Trains of Subway Line 9

Classification	Max. Degree of Congestion	Max. Congestion Section	Remarks
Express Train	251% (Noryangjin Station)	Gayang Station~Express Bus Terminal Station (exceeding 210%)	Exceeding 30% that of the opening period
Normal Train	206% (Yeouido Station)	Dangsan Station~Noryangjin Station (exceeding 206%)	

Source: Date and Time of Investigation – 19~21 Jan. (07:30~08:30)

Restructuring of Subway Line 9 as an Innovative Model of Private Sector Investment Project of Seoul

Construction and Operation of Subway Line 9 Applying MRG

SMG attracted private capital to cover the lack of public funding due to the IMF crisis and to complete the infrastructure of subway line 9 earlier. SMG tried to reduce the burden of public funding for subway line 9, to introduce the creativity and efficiency of the private enterprises and to diversify the investment sources by attracting private investment. BTO (Build Transfer Operate) scheme was adopted and it was agreed for the first time that the private sector would operate the line for 30 years. 33.3% of the total project cost was supported by the central government, 51.0% by SMG and 15.7% by the private sector investment. According to the initial execution agreement, the minimum revenue guarantee (MRG) should be set at 90% for 5 years from the operation starting date, 80% for 6 to 10 years and 70% for 11 to 15 years if there is a shortfall of expected fare earnings set in the agreement regardless of the actual operating revenue. As the financial burden grew because of the long time compensation for the revenue and the negative recognition on MRG had spread, SMG started seeking ways to complement the MRG system.

Restructuring of the Subway Line 9 Project

The existing business agreement contained too many advantageous terms for the private operator. According to the agreement, the right to decide the fare was granted to the private operator and the earning rate higher than the market interest rates was guaranteed. That was the reason why the need to improve the overall conditions of the project was raised continuously. The Seoul Metro 9 who operates subway line 9 as a private implementer attached fare increase statement unilaterally in April 2012 during the period of fare negotiation with SMG, causing confusion among the Seoul citizens. SMG started reviewing the restructuring of the subway line-9 project in July 2012. SMG constituted a task force for subway line 9 in January 2013, organized a negotiation group consisting of lawyers, accountants, transportation experts, etc. and proceeded with negotiations for the alternation of the execution agreement with new potential investors. The negotiation occurred mainly in 3 tracks; ① dealing in stocks between the existing shareholders and the new investors, ② modification of execution agreement between SMG and the new investors and ③ management and operation agreement between the new investors and the operating company. SMG entered into a modified execution agreement with the Seoul Metro 9 in October 2013 through such negotiation processes, finalizing the one-year process of restructuring subway line 9. The main contents of the modified agreement are as follows.

Overall Replacement of the Existing Private Sector Shareholders

SMG made the existing construction investors and financial capitalists including Macquarie, who had caused preferential controversy, dispose of their shares and attracted new asset management firms and financial capitalists. According to the measures taken by SMG, 7 construction investors including Hyundai-Rotem, who completed the construction of the 1st stage section of subway line 9, sold all of their shares to recede from the operation of line 9. Of the existing financial capitalists, Macquarie and Industrial Bank of Korea disposed of their shares and completely handed off the operation of line 9.

<Figure 4> Changes of Investors according to the Restructuring of Subway Line 9

Before Restructuring	After Restructuring
<ul style="list-style-type: none"> ○ Construction Investors (7) Hyundai-Rotem, POSCO ICT, Hyundai Engineering & Construction, POSCO Engineering, Sampyo E&C, Ultra Construction & Engineering, Ssangyong Engineering & Construction, ○ Financial Capitalists (6) Macquarie, Shinhan Bank, LG Fire & Marine Insurance, Shinhan Life Insurance, Industrial Bank of Korea, Dongbu Insurance 	<ul style="list-style-type: none"> ○ Asset Management Firms (2) Hanwha Asset Management, Shinhan BNP PARIBAS Asset Management ○ Financial Capitalists (11) Kyobo Life Insurance, Hanwha Insurance, Shinhan Bank, Heungkuk Life Insurance, Samsung Life Insurance, Dongbu Insurance, Hanwha, Hanwha General Insurance, Shinhan Life Insurance, LIG Insurance, Nonghyup Life Insurance, Heungkuk Fire & Marine Insurance

Source: Press Release of the Seoul Metropolitan Government (2013)

SMG Came to Have the Rights to Decide the Fares of Subway Line 9

The right to decide the fares of subway line 9 belonged to the private operator. In 2012, the private operator confused the citizens by announcing the fare increase arbitrarily without any consultation with SMG. In order to avoid such confusion, SMG decided to have the actual right to set the fare rate and to correct the deformed fare increase structure. According to the initial agreement, the private operator was allowed to decide the fare rate autonomously within the fare rate range prescribed in the execution agreement, and then report such changes to SMG before implementing the increased fare. After the SMG's decision, the private operator must acquire approvals of SMG on fare related matters (charging, collecting and increasing). In addition, SMG solved the problems related to the rapid fare rate increase that had to be allowed every year to ensure the yield that was promised to the private operator.

<Table 3> Table of Subway Line 9 Fare Rate before the Right for Fare Decision Belonged to SMG

Operation Year	'09	'10	'11	'12	'13	'14	'15	'16	'17	'18	'19	'20	'21	'22	'23	'24~38
Unchangeable Basic Fare (KRW)	1,264	1,307	1,352	1,398	1,446	1,495	1,546	1,599	1,653	1,710	1,735	1,761	1,787	1,814	1,840	1,840
Fare Increase Rate (%)	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41	1.49	1.49	1.49	1.49	1.49	-

Source: Press Release of the Seoul Metropolitan Government (2013)

Abolition of the MRG System

In 1988, when Korea was suffering from the foreign exchange crisis, the MRG system was introduced to Korea to attract private capital for the SOC projects such as construction of railways, roads, tunnels, etc. As the financial burden on the long-term revenue guarantee for the private operators got increased, negative perceptions on the MRG system became widespread. The central government abolished the MRG system for the projects suggested by the private sectors in 2006 and the MRG system for the projects officially announced by the government in 2009 respectively. SMG also stopped the payment according to the existing MRG system in order to solve the problems caused by the revenue compensation for subway line 9. Instead, the MRG system was converted to the Minimum Cost Compensation (MCC) system according to which the private operator shall cover its operating costs with the actual business income and SMG shall compensate for the cost shortage. To put it concretely, the compensation based on the newly applied MCC is determined based on the difference calculated every quarter by subtracting the sum of fare income, affiliated business income, etc. generated by operating subway line 9 from the sum of depreciation amounts on the managing and operating rights, interest amount (interest rate: 4.86%) and operating costs. In this case, the value of managing and operating right will be amortized equally every quarter, and become zero in 2039. The interest amount also will be decreased every year so that the financial burden of SMG will decrease sharply. Under the new system, the private project operator cannot require the compensation for the excess amount even when its costs for management, operation, maintenance, etc. exceed the amount for management and operation agreed upon in the agreement.

Nation's First Introduction of KRW 100 Billion "Citizen Fund"

SMG decided to introduce KRW 100 billion scale of 'Citizen Fund' in bond type for the first time in Korea during the process of project restructuring in order to cope with the issues of subway line 9 together with the citizens. When the increase of fare rate of line 9 became an issue in 2012, the then Seoul Mayor suggested the citizen fund as an alternative, evaluated as a revolutionary win-win attempt for both SMG and the citizens. The citizens could invest in the subway line-9 fund with guaranteed returns higher than the interest rates of the commercial banks. SMG made the best use of fund by concentrating on stable operation of subway line 9 and on drastic reduction of SMG's financial burdens. SMG issued long-term confirmed bonds with 4, 5, 6 and 7-year maturity, KRW 25 billion each, with different earning rates according to the period but around 4.3% on average. A citizen could invest up to KRW 20 million. SMG also decided to receive surveillance of the Financial Supervisory Service to protect the citizens who invested in the funds and to allow the fund to be repurchased even before maturity for the citizens' convenience.

<Table 4> Earning Rate of the Citizen Fund for Subway Line 9

Classification	4 Year Maturity	5 Year Maturity	6 Year Maturity	7 Year Maturity	Average
Earning Rate (Excluding Commission)	4.15%	4.25%	4.35%	4.45%	4.30%

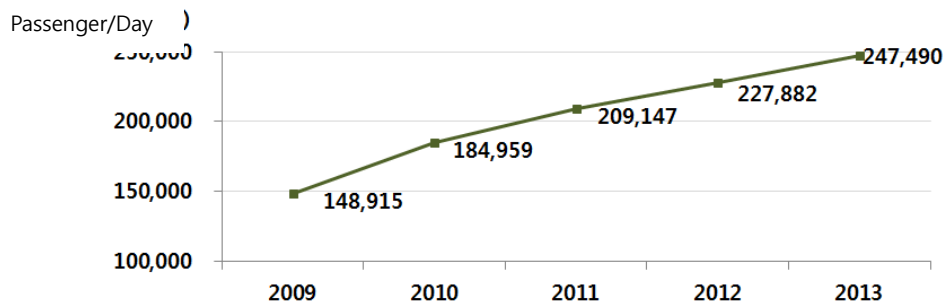
Source: Press Release of the Seoul Metropolitan Government (2013)

Main Achievements

Increase of Passenger Transport

Right after the opening of subway line 9 in July 2009, lots of people began to use it. The line seemed to have absorbed the passenger transport demands in the Gangseo section which had relatively poor accessibility to the subway lines and the public transportation. In the beginning stage of the line, average daily traffic of subway line 9 was 184,959 passengers, reaching 97% of the 2010 forecast. The traffic had increased continuously and the number of line users reached 227,882 every day on average in 2012 showing 103.8% of the forecasted daily traffic.

<Figure 5> No. of Passengers Using Subway Line 9 by Year



Source: Statistic Data of METRO 9 (<http://www.metro9.co.kr/>)

Reduction of Transportation Expenses of around 40 Million Passengers Carried by over KRW 4.1 Billion (Reduction of KRW 100~200 per Pass)

Construction of subway line 9 connecting Gangseo region, a vulnerable area of public transportation, to the Gangnam region of Seoul, significantly shortened the travel time and the transportation expenses of citizens using that section of the line. According to SMG's analysis, most of the passengers using subway line 9 could save around KRW 100~200 per pass, resulting in the transportation costs reduction of around 41 million passengers by over KRW 4.1 billion every year.

<Table 5> Annual Effect of Transportation Expense Reduction according to the Opening of Subway Line 9

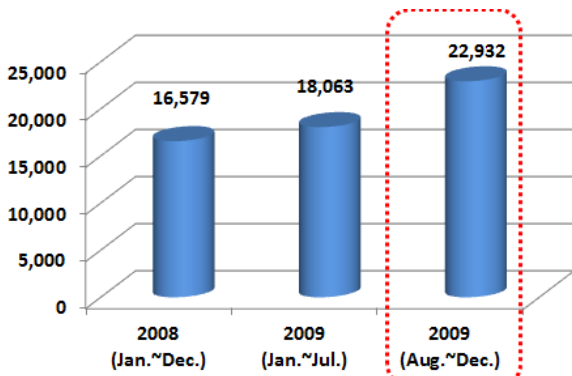
Cut by KRW 100		Cut by KRW 200		Total	
Passengers (Persons)	Reduced Expense (KRW)	Passengers (Persons)	Reduced Expense (KRW)	Passengers (Persons)	Reduced Expense (KRW)
39,936,110	3,993,611,000	807,015	161,403,000	40,743,125	4,155,014,000

Source: Press Release of the Seoul Metropolitan Government (2010)

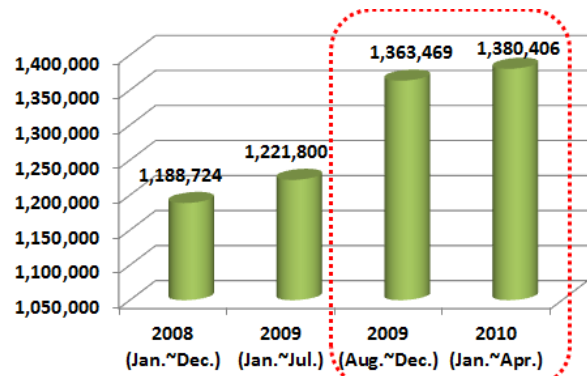
Strengthened Connection to Other Public Transportations including Airport Railroad

The opening, stable operation and increase in passengers of subway line 9 have had a positive effect on the increase of traffic of the other linked public transports. In particular, passengers on line 9 can transfer to the Airport Line on the same floor at the Gimpo Int'l Airport Station resulting in more convenient transfers. According to a survey, the number of passengers using Gimpo Int'l Airport Station was increased by 14.2%, showing the synergy effect of subway line 9 on other linked public transportations. Also, the number of passengers using the Airport Railroad increased by 33.8% mainly due to the high accessibility to the central areas of Seoul since the opening of subway line 9.

<Figure 6> Increase/Decrease of Passengers Using Airport Railroad before and after the Opening of Subway Line 9 (Persons/Day)



(a) Changes in Passenger Number Using the Airport Railroad



(b) Changes in Passenger Number Using Gimpo Int'l Airport

2nd Golden Route Following Subway Line No. 2

The most crowded of all the subway lines in Korea is subway line 2, constructed in the 1st phase project of subway lines, the only circulation line in Seoul. Subway influential areas were largely formed around the stations of the line 2 and the land price of those areas are rated highest in Seoul. That is the reason why line 2 is known as a golden route. Subway line 9 got the nickname of the second golden route because of the rapid increase in the number of passengers, development of subway influential areas, etc. since its opening. With the completion of stage 3 construction, subway line 9 would give better accessibility to the Gangnam region and increase possibility for further development. As the surrounding areas of Magongnaru Station located in Dunchon-dong, Gangdong-gu would also get better accessibility to the Gangnam areas through subway line 9, many plans for station area development are recently in process.

Since the opening of subway line 9, the apartment trading volumes including lease and sales in the Gangseo region has been increased by 64%, enjoying the special demands caused by line 9. This shows that the route of subway line 9 confirmed in consideration of balanced regional development of Seoul has contributed to the economic recovery of the southwestern area of Seoul from the beginning state of opening. Such increased apartment trading would lead to the influx of population to the southwestern region of Seoul. SMG is evaluated to pave another way to the balanced development and improvement of Seoul through the construction of subway line 9.

Limit and Required Improvement in the Future

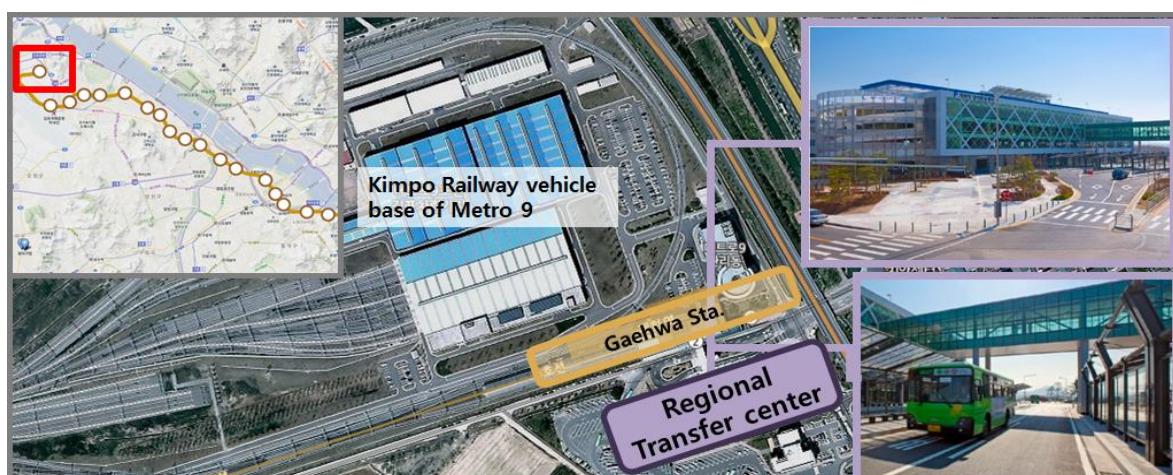
Continued Requirement for the Increase of Number of Trains

The express trains of subway line 9 connecting the Gangseo region and the Gangnam region of Seoul showed a degree of complexity almost approaching 240% during the rush hour, gaining notoriety as a hell train. It is mainly because the difference of average moving speed between the normal trains and the express trains is around 16.6km/h so that the passengers continued to concentrate on the express trains. SGM increased express train services by increasing the operating rate of the express trains, but the degree of complexity was still in a serious situation as the passengers using line 9 were increasing continuously. With the completion of stage 2 and 3 construction, it was anticipated that the number of passengers would grow more and more and the degree of complexity would get worse. SMG reviewed a plan to operate the normal trains and the express trains in the same ratio all day long but the passengers using the 16 stations, where only the normal trains would stop, would suffer disadvantages. Therefore, efficient deployment of the normal and express trains is required to alleviate congestions and to reduce inconvenience to the passengers of subway line 9.

Requirements for the Introduction of Express Trains at Gaehwa Station with the Regional Transfer Center

At Gaehwa Station, the first and the last train station of line 9, there are garages for the line 9 trains, Gangseo public garages, a regional transfer center and transfer parking lots. The transfer system in Gaehwa Station was prepared to provide necessary services for the passengers living in the western part of the Seoul Metropolitan area to transfer to subway line 9 for Seoul. The main intent of such regional transfer center installed in Gaehwa Station was to improve accessibility to the metropolitan area of Seoul. But, the station was designed for only the normal trains to stop, without the express trains being operated. The passengers using line 9 at Gaehwa Station are inconvenienced because they have to take the normal trains for Gimpo Int'l Airport Station to get on the express trains there. The passengers using line 9 at Gaehwa Station filed civil complaints steadily and organized various signature-receiving campaigns. However, Seoul Metro 9 sticks to its position that it is difficult to comply with the citizens' requests because the signal systems and the rail configuration were designed for the express trains to depart from Gimpo Int'l Airport Station. In order for subway line 9 to become a convenient transportation connecting the western part of the metropolitan area and Seoul, it is required to introduce the express trains at Gaehwa Station.

<Figure 7> Regional Transfer Center of Gaehwa Station



References

- ♦ Press Release of the Seoul Metropolitan Government, 2010, "Subway Line 9 Going together with the Citizens of Seoul!"
- ♦ Press Release of the Seoul Metropolitan Government, 2013, "Subway Line 9 Born Again as an Innovative Model of Private Sector Investment Project of Seoul, Reducing KRW, 3.2 Trillion"