I·SEOUL·U

03

Seoul Solution for Urban Development

Waterworks
Transportation
Metro
E-Government

2015

SEOUL METROPOLITAN GOVERNMENT

Table of Contents

Seoul Solution for Urban Development 03

01. Waterworks

02. Transportation

03. Metro

04. E-Government

01

Waterworks

1. Water Management Policy of the City of Seoul

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Policy Area: Waterworks

Water Management Environment & a Changing Paradigm

The concept of water management has existed since prehistoric times. When states were formed, water management became one of the most important pillars of government power.

While water is a resource that people cannot do without, it can also bring irreparable damage. It thus had to be kept in check as well as managed for human use. Reservoirs or embankments would normally be used to maintain water flow but were ineffective as a means to control water during floods (Joongang Daily, 2001).

Until modern times, water management was linear in a sense, and its sole purpose was to manage water supply and make the most effective use of it. In other words, people would intervene through social and economic means to utilize and manage the water from the rain that flows into the rivers and lakes, after which the water would once again be released into the ocean.

Today, water management has to be cyclic in nature in order to meet increasing demands, not simply due to climate change or economic considerations. Water needs to be managed in a sustainable way through the generations because this is what is required by the times and what is needed in order to develop the relevant policies.

While Seoul realized compressed growth in a relatively short period of time, its water management system (including waterworks and sewer lines) has also improved dramatically. We will examine Seoul's policy changes and experiences and what lessons can be learned.

Status

Introduction

Seoul sources all its water from the Han River. After treatment, it is piped to taps all over the city.

The raw water that the city uses comes from intake points located in Seoul (Gangbuk, Jayang, Pungnap, Amsa) and the City of Namyangju (Gangbuk). As of 2013, the total capacity was 7,120,000 ㎥/day. Seoul has 6 purification centers (Arisu Purification Center[1]) with a daily processing capacity of 4,350,000 ㎥, and average production around 3,166,000 ㎥/day.

The tap water produced at the purification centers is supplied through a network of pipes to residents, the final users. The total length of the waterworks pipes in Seoul is 13,792 ㎞ , greater than the Earth's diameter (12,756.2 km). The key facilities for the tap water supply are distribution stations and pumping stations. There are 104 distribution stations in Seoul, with a total distribution capacity of 2,418,000 ㎥. Even if the water produc-

1. Gwangam (400), Gueui (250), Ttukdo (500), Yeongdeungpo (600), Amsa (1,600), Gangbuk (1,000) * The numbers in parentheses () denote facility capacity (unit: 1,000㎥/day).

2. Transmission pipes: 85 km; conduit pipes: 9,811 km; water supply pipes: 3,335 km; industrial water pipes: 8 km.

tion and supply facilities were to encounter an emergency, everyone would be supplied with water at a normal rate for 17 hours. Facilitating the supply are 196 pumping stations: 4.6% of these are manned, while the rest are unmanned.
As of 2014, the flow rate was 95.4%, one of the best in the world. Leakage is kept very low, within the 3% range.

To respond effectively to algae and new types of unregulated harmful substances, Seoul has been working to introduce advanced purification facilities since 2007, with installation to be complete at all purification centers by 2015.
While the city has one of the world's best tap water production and supply systems, many residents are not confident about the quality of the tap water. Increasing the public's trust through communication remains one of the most important tasks for Seoul. The amount of water flow rate is very low compared to cities in the US or Europe; this is a major factor that is detrimental to the financial health of the waterworks system as well as to ensuring safety and security.

Access to the sewer system in Seoul stands at 100%. As of 2013, 3.16 million ㎥/day of sewage water can be processed at 4 water treatment centers, with 3 other facilities dedicated to processing solid human waste (10,500 ㎥/day).
Sewer pipes in Seoul were installed with a secondary purpose of draining stormwater (to prevent incidents/accidents) and were used as part of the combined sewer system by connecting to the drainage pipes for domestic wastewater. This however resulted in a number of issues such as drainage. From 1992, the city took measures to restore the intended functions of the sewer pipes – the fundamental infrastructure of the city. An internal investigation of its sewer pipes by zone was completed in 2001 to learn more about the conditions of the sewer pipes, and maintenance was carried out on a systematic basis to replace deteriorating, damaged pipes and those otherwise unable to properly perform their function of draining.
Flooding from heavy rain is largely caused by insufficient sewer pipe and stormwater pumping station capacity. Moreover, climate change is expected to increase the occurrence and severity of torrential rain, while urbanization increases the impervious surface area, exacerbating the potential for flood damage.

In a quantitative sense, Seoul's waterworks and sewer systems are sufficient. One of the policies that the government should prioritize for the future is development of an integrated water management system that will improve quality and sustainability. South Korea has enjoyed dramatic quantitative growth and achieved qualitative stability. Now that Seoul has the waterworks and sewer infrastructure in place, it needs to focus more on improving the effectiveness of operation and management of the facilities. At this juncture, it is imperative that Seoul carefully reviews the potential for an integrated management system.

Geographic Conditions & Overview

Located in the central west section of the Korean peninsula, Seoul is divided through its center by the Han River. On the northern end of the city is the administrative district called Dobong-dong (Dobong-gu); on the eastern end is Sangil-dong (Gangdong-gu); the southern end is Wonji-dong (Seocho-gu); and the western end is Ogok-dong (Gangseo-gu). Seoul is comprised of 25 gu administrative counties, with 423 dong administrative districts. As of December 2014, the city's population was 10,103,000, accounting for 19.7% of the nation's population (51,328,000). Seoul is 605.41 ㎢ in area, about 0.28 % of the total national territory (0.61 % of South Korea). The city is 30.30 km north to south, and 36.78 km east to west.
When the Joseon Dynasty was founded in 1394, Seoul soon became the kingdom's capital and has been ever since. It is now the center of politics, economics, industry, society, culture and transportation.
The administrative zone increased to 593.75 ㎢ in January 1963, and by March 1973, it encompassed 605.30 ㎢. In the 1970s, rapid urbanization sent developers to the south of the Han River. After the Asian Games in 1986 and the Olympics in 1988, Seoul grew onto the world stage.
In 1991, local governments were granted more power to govern themselves through a policy of local autonomy. The year 1994 was the 600th anniversary of Seoul as a capital city.

Seoul is located at 37.34 N latitude and 126.59 E longitude and is divided by the river system of the Han River and 4 streams (Cheonggye, Jungnang, Tan, and Anyang), surrounded by mountains on all 4 sides. To the north is Bugak Mountain, to the east is Nak Mountain, to the south is Nam Mountain, and to the west is Inwang Mountain. On the outer edge are Bukhan Mountain (north), Deogyang Mountain (west), Gwanak Mountain (south), and Yongma Mountain (east), together forming a double basin.

The city center is at 25 – 40 m altitude, with some 40% of the total city area at or below 30 m; 27% is above 70m, precluding development as a city area; 27% is at the middle range; and 6% is occupied by the river systems.
To the east, the average altitude is within the 35m range, both north and south of the Han River. In Jongno, Jung-gu, Seongbuk, Seodaemun (all north of the Han) in the center, the average altitude is higher, at around 50 m, with a similar situation in the Gwanak and Dongjak areas south of the river. Mapo, west of the Han, and Yongsan to the north are relatively low, at 25m.

River & Water Systems

The Han River is formed by the Namhan and Bukhan rivers that converge 35 km upstream to the northeast of Seoul. The river cuts through the center of Seoul from east to west, joining the Imjin River before flowing into the West Sea to the north of Incheon.

The total length of the Han is 494.44 km, which has a drainage area of 25,953.6 ㎢.
The effective basin width is 47.19 km, with a shape factor of 1.95. It is a combination of dendritic and fan shapes. The river winds and meanders and is quite wide compared to its length, making it difficult to utilize and manage. Because the river is shorter than might be expected due to the size of its drainage area, the peak flow is high, resulting in considerable flood damage. This phenomenon is concentrated on the gently sloped Namhan River and the main stream. The channel slope is the 1/250 point upstream of convergence, and at the 1/5,000 point of the main stream.
Within Seoul, 36 small and medium streams flow into the Han, with total length of the streams in aggregate being 247.99 km Stream planning has been divided into zones: Jungnang (Cheonggye Stream, Jungnang Stream), Tan Stream (Tan Stream, Yangjae Stream), Nanji (Bulgwang Stream, Hongje Stream), and Seonam (Anyang Stream).

Changes in Urban Development & the Water Reclamation System

The population of Seoul began growing in earnest in the 1960s when urban development began to take off, and continued to grow until the early 1990s. This growth was reduced somewhat in the 1990s but soon stabilized within the 10 million range in the 2000s (Figure 1).

Figure 1 - Population & Household Changes in Seoul

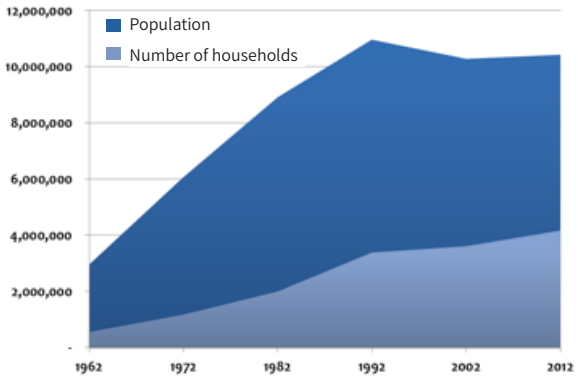


Figure 2 - Changes in People per Household in Seoul

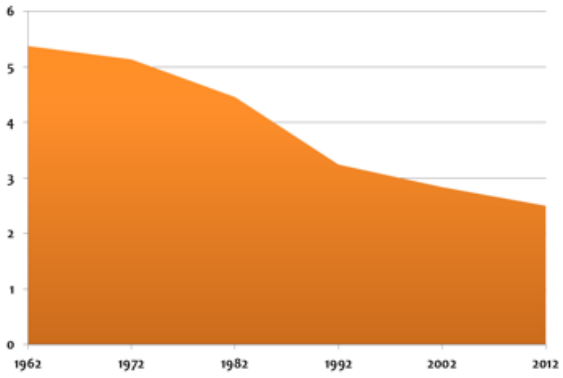


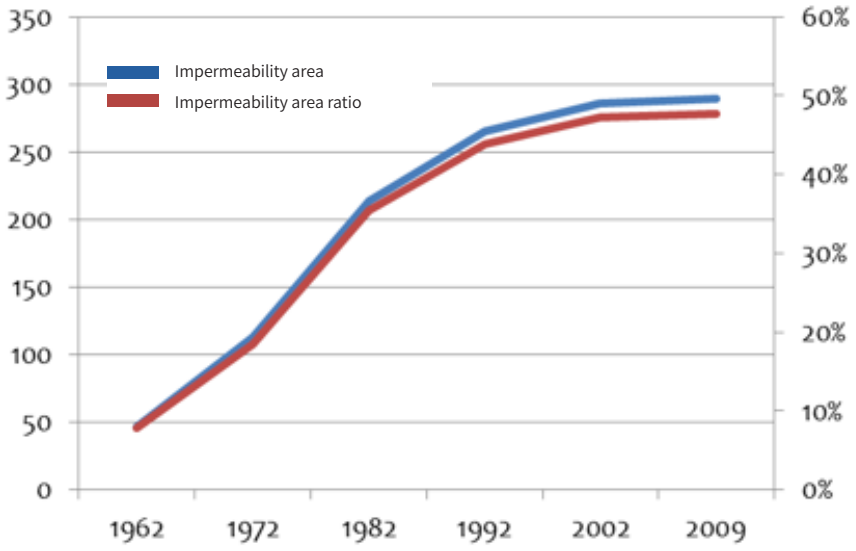
Table 1 - Population Changes in Seoul

	Population	No. of Households	People per Household	Population Density [No. of Persons/㎢]
1962	2,983,324	554,136	5.38	5,001
1972	6,076,143	1,182,655	5.14	9,912
1982	8,916,481	2,000,678	4.46	14,370
1992	10,969,862	3,383,169	3.24	18,121
2002	10,280,523	3,623,929	2.84	16,978
2012	10,442,426	4,177,970	2.5	17,255

The noticeable demographic change during this period is the number of persons per household, which fell drastically from 5.4 in the 1960s to 2.5 in 2012 (Figure 2). In 2014, the percentage of single-person households exceeded 25%, a trend which is likely to become more dominant in the future. These demographic changes are important factors that affect the pattern of water use and the water reclamation system, and should be taken into account in Seoul's water management policies (Table 1).

Seoul's urbanization began in earnest in the 1960s. Before that time, urbanization policies were mostly focused on restoring the social infrastructure that had been destroyed in the Korean War.
From the 1960s to 2012, the city's population grew 3.5 times, from 3 million to 10 million. The number of households went up 7.5 times, from 550,000 to 4.17 million[3] . However, growth was not confined to population or household. Migrant population and urban concentration accelerated, aided by development of the export industry complex in Guro-dong (1964) and construction of the expressways (late 1960s).
Such a drastic increase in population and urbanization brought about hydraulic changes in the city. One example is the increase of impervious surface area, adversely affecting the water reclamation system (Figure 3).

Figure 3 - Impervious Surface Area & Percentage of Seoul



The impervious surface area as a percentage of Seoul was 7.8% in 1962 and 47.1% by 2002, an approximately 6-fold increase. During the rainy season, surface runoff that had equaled 502,000 ㎥/day (1962 – 1971) had also increased 6 fold to 2,990,000 ㎥/day (1995 – 2004). The total runoff in the dry season was 375,000 ㎥/day between 1962 and 1971, but fell to 183,000 ㎥/day between 1995 and 2004, a decrease of about 49% (Kim Yeong-ran, 2012).

3. Changes in Seoul's urbanization rate: 21.6% (1962) → 96.0% (2010) (Kim Yeong-ran, 2012).

The increase in impervious surface area due to urbanization also brought the peak flow up during heavy rainfall while reducing natural flow, causing streams to run dry on clear days.

Seoul's population density grew 3.5 times, from 5,001 persons/㎢ in 1962 to 17,472 persons/㎢ as of 2010 (Kim Yeong-ran 2012). The amount of daily floating population from the surrounding satellite cities also jumped. The rising population and density caused many issues in water management such as reduction in the natural flow and increased stream intake, use of groundwater, expelled stormwater and wastewater, incidence of dry stream beds, ecological risks, and urban pollution.

Water Volume & Quality Management

The total volume of water resources in Seoul is 940 million ㎥/year, with 690 million ㎥/year available for use (Seoul Development Institute, 2011). Water use equaled 13.4 billion ㎥/year as of 2009, and is steadily increasing. The water resources reserve accounts for 70.3% of the total water use, 12.6 billion ㎥/year (94.1%) of which is supplied from outside, while only 78 million ㎥/year (5.9%) is sourced internally. The city depends heavily on the outside for its water. This is detrimental not only to overall supply but also to the sustainability of water reclamation in the long term.

With the launch of the Comprehensive Han River Development, more sewage treatment centers were built in the 1980s. The quality of water began to improve thanks to continued efforts in building septic tanks and sanitation facilities and strengthening regulations on wastewater discharge facilities. From 1994 however, droughts began to occur in the winter while more domestic wastewater was drained upstream of the Han River from large apartment complexes. The situation was made worse by the increasing number of restaurants and accommodation facilities near the protected reservoir area, degrading water quality again. This degradation continued until 1997 (Seoul Metropolitan Government, 2014).

The improvement of water quality after 1997 was largely due to action at the government level, including: i) institutional support such as development of the Special Water Quality Management Plan for Paldang Reservoir and the Han River System (1998), enactment and promulgation of the Act on the Improvement of Water Quality & Support for Residents of the Riverhead of the Han River System (1999), and designation of the Jamsil Water Reservoir Protection Area (1995) and Waterfront Areas (1999); and ii) continued efforts to improve water quality by strengthening guidelines and regulations on wastewater discharge facilities (Seoul Metropolitan Government, 2014).

Upstream of the Han, water quality is maintained at a higher level (BOD 1.6 mg/L or lower); than midstream and downstream, where BOD levels are between 2.1 and 2.2 mg/L.

In Jamsil, BOD was 2.6 mg/L in 1997, but from the following year, this began steadily decreasing to 1.7 mg/L in 2004 and 1.4 mg/L in 2005, thanks to measures taken to improve water quality at the upstream reservoir. Since 2006, BOD levels have remained between 1.1 and 1.9 mg/L – 'Good (I b)' – for reasons that include introduction of non-point source pollutants in the dry season and changes with the precipitation and discharge rate from

Paldang Dam. At Gayang Point, the level was 5.5mg/L in 1997, falling to 2.9mg/L in 2005 and remaining between 2.5 and 4.5mg/L ('Fair (III)') between 2006 and 2010. After 2010, quality improved again and is normally 2.2 mg/L. As for the tributaries, the BOD level depends on the quality of the upstream water. Those with higher levels were the Tan (6.9), Jungnang (14.1), and Anyang streams (5.0) (Table 2).

Table 2 - Water Quality Improvement Goals & Performance for the Han River and Major Tributaries in Seoul (Seoul Metropolitan Government, 2014)

[BOD mg/L]

	2010	Performance	2011	Performance	2012	Performance	2013	Performance
Jamsil	1.6	1.5	1.5	1.1	1.5	1.2	1.5	1.3
Gayang	3.0	3.1	3.0	2.6	3.0	2.5	3.0	2.2
Jungnang Stream	11.0	8.8	8.0	4.5	7.5	5.8	7.5	14.1
Tan Stream	20.0	10.7	15.0	6.6	13.0	6.4	11.0	6.9
Anyang Stream	8.0	6.9	7.0	4.5	6.5	4.1	6.0	5.0

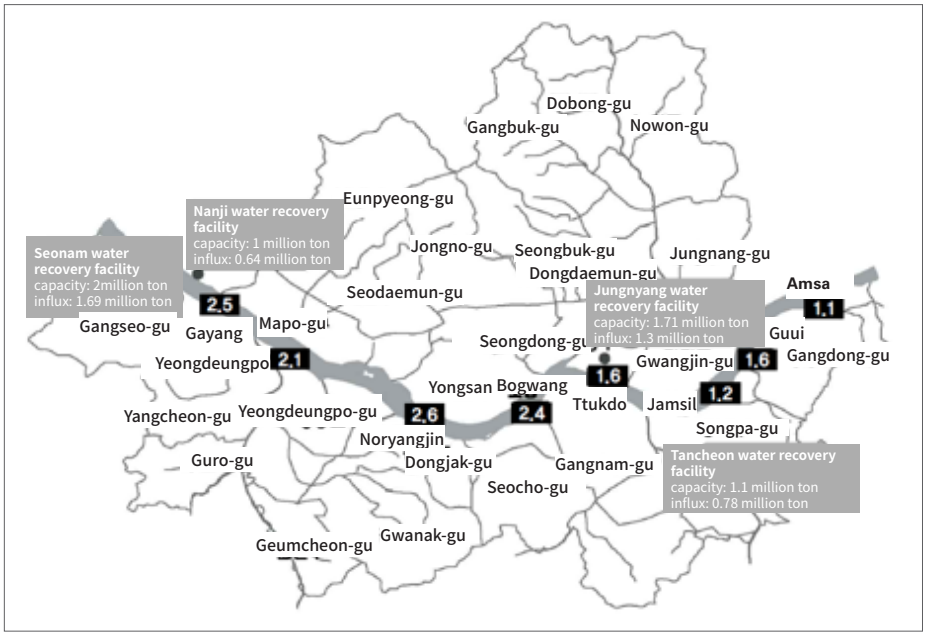
Table 3 - Han River Water Quality by Point & Parameter in 2013 (Seoul Metropolitan Government, 2014)

[Unit : mg/L (Coliform Count: MPN/100 mL)]

Item	Amsa	Gueui	Jamsil	Ttukdo	Bogwang	Noryangjin	Yeongdeungpo	Gayang
Environmental(Standards Target)	II	II	II	II	II	II	II	III
Temperature[C]	13.2	13.6	13.2	13.3	13.4	14.0	14.1	14.8
pH	7.9	8.0	7.9	7.6	7.5	7.6	7.4	7.6
DO	11.7	12.0	12.1	11.8	11.5	10.3	10.8	11.0
BOD	1.2	1.4	1.3	1.6	2.1	2.1	2.1	2.2
COD	3.4	3.9	3.6	3.9	4.3	4.7	4.7	4.6
SS	5.9	6.7	6.4	6.9	6.7	8.5	7.4	10.7
Total Coliform Count	10,675	1,346	12,845	24,473	92,482	68,290	53,364	34,461
Fecal Coliform Count	33	163	159	668	3,330	8,862	1,262	1,578
Total Nitrogen	2.156	2.262	2.277	2.649	3.029	3.412	3.481	3.409
Total Phoshorus	0.053	0.035	0.027	0.037	0.069	0.138	0.124	0.118
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND
Cyanide	ND	ND	ND	ND	ND	ND	ND	ND
Lead	ND	ND	ND	ND	ND	ND	ND	ND
6 Chrmium VI	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	ND	ND	ND	ND	ND	ND	ND	ND
Mercury	ND	ND	ND	ND	ND	ND	ND	ND
ABS	ND	ND	ND	ND	ND	ND	ND	ND
Phenol	ND	ND	ND	ND	ND	ND	ND	ND

*ND : Not Detected

Figure 4 - Water Quality at Major Points of the Han River (BOD mg/L) & Water Renewal Facilities (㎥/day)



※Water quality as of 2013 [BOD mg/L]:

Amsa: 1.2; Gueui: 1.4; Jamsil: 1.3; Ttukdo: 1.6; Bogwang: 2.1; Noryangjin: 2.1; Yeongdeungpo: 2.1; Gayang: 2.2

Stream water quality has been measured by the city and provincial institutes of public health & environment since 1974. The Ministry of Environment built an online national network in 1992 to collect the data on a regular basis. As of 2013, there were 443 points for water quality measurement on the Han River system. On the river segments in Seoul, there are 8 points on the main river and 19 points on the tributaries (Figure 4). A total of 36 parameters are measured at regular intervals (monthly, quarterly, or yearly) (Table 3).

Major Changes in Seoul's Water Management Policies

Upstream Reservoir & Stream Management Policies

So far, the policies implemented to preserve the water quality of the Han River have focused on installation of sewage treatment facilities in urban areas and managing the sources of pollution. However, quality management of Han River water is only of limited scope without management of non-point source pollution in the city. Many development projects (industrial complexes, site development, farmland and forest management, roads, parking lots, etc.) have been pursued without much consideration for non-point source pollution. As pollution from such city sources continues to affect the Han, a new approach is imperative that takes non-point source pollution into account.

Foundation for Basic Environmental Protection Facilities

The 4 water treatment centers of Jungnang, Nanji, Tancheon, and Seonam processed a total 3.16 million ㎥/day as of the end of 2013, an amount which covers all wastewater produced in Seoul. Facilities capable of processing 1.75 million ㎥/day will be installed at the 4 centers to comply with stronger discharge water quality standards and the assigned total maximum daily load.

Stronger Management of Wastewater Discharge Facilities

Wastewater discharge facilities subject to guidance and inspections[4] are provided with continued guidance and are inspected[5] by the City of Seoul. They are encouraged to replace any deteriorating facilities and improve their abilities to prevent industrial wastewater from contaminating the water (Seoul Metropolitan Government, 2014).

Citizens Environment Watch

To monitor and stop pollution, a Citizens Environment Watch was organized in 2004. The group is a collaborative organization involving regulatory authorities, local residents, and private organizations, and is designed to jointly address pollution. It will lead to the establishment of a private-public environmental watch network which will enhance transparency and effectiveness in the guidance and inspection of pollutant discharging facilities while ensuring that the environmental watch and preservation activities are led by the private sector.

Water Pollution Alert

The Water Pollution Alert system was initiated in 1998 in response to the dead fish found in the Han River and its tributaries[6] and has been in practice ever since to respond to other such incidents.

4. 1,618 out of Seoul's 3,633 wastewater discharge facilities, excluding environmentally-friendly companies and voluntary inspection workplaces (as of 2013).

5. Those that violate the regulations (e.g., installing unauthorized discharge facilities and unapproved discharges) are charged and shut down. Those that breach the standards are subject to administrative actions such as orders for improvement or suspension.

6. In June 1992, some 8,500 sharpbellies and barbel steeds were found dead between Hannam Bridge and Seongsan Bridge, between the midstream and downstream areas of the Han. The precise cause was not found, but it is estimated that the fish were vulnerable during the spawning season for various reasons, such as water degradation due to the introduction of wastewater, rising water temperature in the summer, decomposing sludge, reduced dissolved oxygen, Paldang's discharge rate, and discharges of hot water from Seoul Thermal Power Plant. To prevent recurrence, Seoul has set up special watches on wastewater discharge facilities, strengthened water inspections and river patrols, and takes other actions between May and July each year.

Automatic Monitoring System

A full-time monitoring system was introduced to prevent water pollution due to introduction of harmful chemicals to the streams, sewer pipes, and receiving waters at the water renewal facilities, while minimizing damage should pollution occur. The system is designed to monitor for and track unauthorized discharges.

The automatic system looks at 14 parameters, including cyanide, at 9 points on the main river (6 at the upstream reservoir and 3 at the streams themselves) and at 3 points along the tributaries. The water is monitored at 8 points for the presence of sixteen harmful chemicals, including the receiving water at the treatment center. Furthermore, oil fences and oil absorbents are available to handle oil spills, and emergency simulation training is held at the Han River every year.

Table 4 - Protection of Han River Water Source (Seoul Metropolitan Government, 2014)

Category	Paldang Reservoir Protection Area	Special Paldang Reservoir Preservation Area	Nature Preservation Zone	Jamsil Reservoir Protection Area	Waterfront Area
Date Designated	July 9, 1975	July 19, 1990	December 31, 1982	March 20, 1995	September 30, 1999
Legal Basis	Article 5, Water Supply & Waterworks Installation Act	Article 22, Framework Act on Environmental Policy	Article 6, Seoul Metropolitan Area Readjustment Planning Act	Article 5, Water Supply & Waterworks Installation Act	Article 4, Act on the Improvement of Water Quality & Support for Residents of the Riverhead of the Han River System
Area [km^2]	159	2,102	3,831	6.45	191.3
Jurisdiction	4 cities and gun counties in Gyeonggi Province	61 eub/myeon districts in 7 cities and gun counties in Gyeonggi Province	3 gun counties in 5 cities and gun counties in Gyeonggi Province	Upstream of Jamsil Reservoir, Gwangjin-gu, Songpa-gu, Gangdong-gu, and nearby riverside areas	6 cities and gun counties in Gyeonggi Province, 2 cities in Gangwon Province, Chungju in North Chungcheong Province
Description	Restrictions on fishing, car washing, and other potentially polluting activities in the protected area	Special comprehensive plan for preservation of upstream reservoir (installation of basic environmental protection facilities, special pollution source management, change of intended use in certain districts	Restrictions on development of sites, industrial lots, and tourist attractions that increase the population	Restrictions on fishing, boating, car washing, and other potentially polluting activities in the protected area	Restrictions on installation of: facilities that generate general and livestock wastewater; accommodations; public bath facilities

Total Maximum Daily Load

The water systems are divided into unit zones by total maximum daily load, with each of these zones assigned a

water quality target and a total maximum allowed production of pollutants to maintain the target water quality. Existing regulations on concentrations were limited, considering the unique environmental characteristics and concentration of pollutant sources for each zone. This new system was introduced to adopt a more effective, scientific approach, assigning more responsibility to the involved parties.

The maximum load system was made mandatory for the Han River system, as for the Nakdong, Geum, Yeongsan, and Seomjin rivers, after revision of the Act on the Improvement of Water Quality & Support for Residents of the Riverhead of the Han River System on May 31, 2010. Accordingly, Seoul established its Framework Plan on Total Maximum Daily Load. An Action Plan on Total Maximum Daily Load was also established for unit zones where the target set by the Minister of Environment is exceeded. The system went into full effect in June 2013.

The Water Use Fee System

Water use fees are charged to areas downstream of the Han River system to finance the assistance that goes to residents and organizations living and operating in the upstream reservoir protected area and are under various restrictions due to measures to protect the water source. Installation and operation of basic environmental protection facilities and the purchase of land that may have a serious impact on the quality of the upstream water are also eligible for financial assistance from the water use fee system. This system was introduced to promote the prosperity of both the upstream and downstream regions of the Han. A certain amount is charged[7] to final users who use water from the upstream source.

The collected fees are used in the following ways: the purchase of land in the water reservoir protection and waterfront area; resident assistance programs; as a proportion of local contributions for installation/operation of basic environmental protection facilities by local governments in the upstream reservoir area; operation of the Han River Watershed Management Committee; assistance for environmentally-friendly programs; and other programs launched as per the Presidential Decree towards improvement of the water quality of the upstream reservoir.

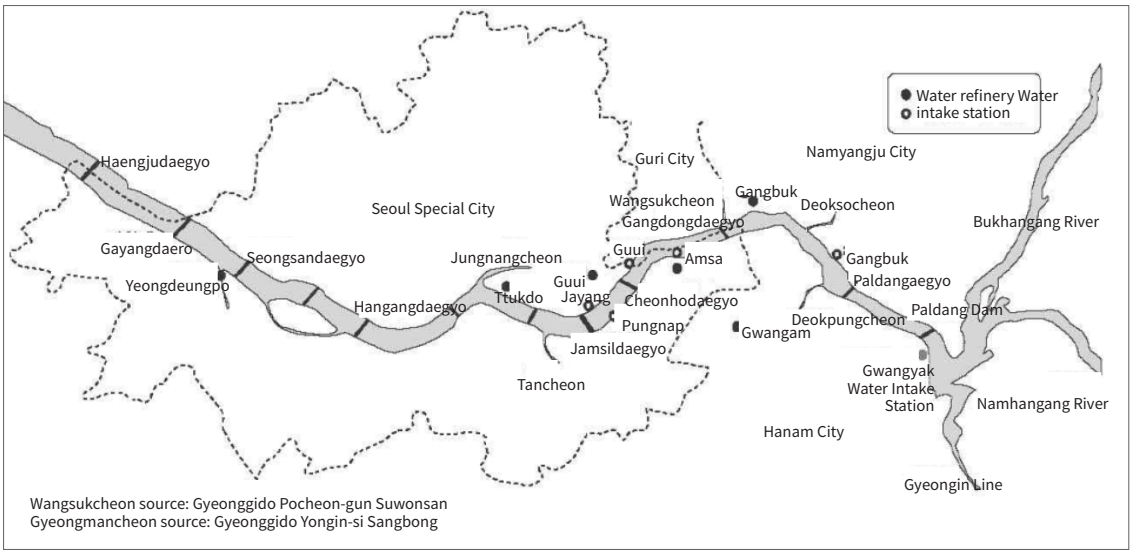
Changes in Waterworks Policies

Modern waterworks service began in Seoul when two Americans named Collbran and Bostwick obtained permission from the Korean Emperor Gojong to operate waterworks facilities and built a purification center in Ttukdo on September 1, 1908 to supply water. At the time, the production capacity was 12,500 ㎥/day, with water supplied to 125,000 people.

7. Pursuant to the Presidential Decree, the fee is determined every 2 years based on use and extent of financing by the Han River Watershed Management Committee comprised of water-related organizations of the City of Seoul, Incheon, Gyeonggi-do, Gangwon-do, Chungcheongbuk-do, and the Ministry of Environment. For the Han River system, it was KRW 160/㎥ between 2008 and 2010 and KRW 170/㎥ between 2011 and 2013.

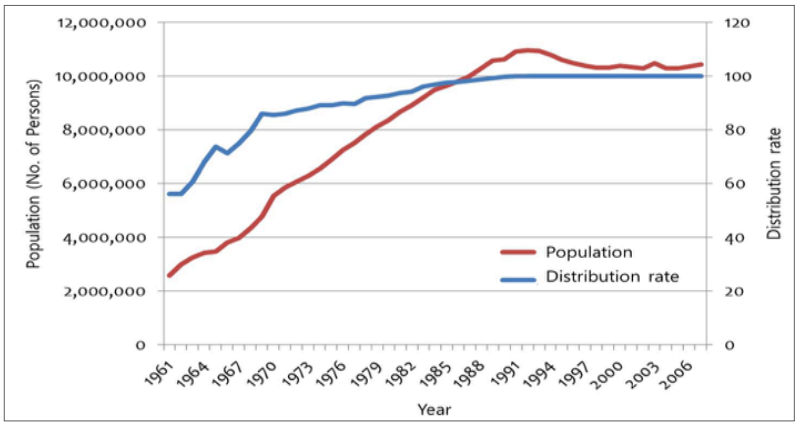
In 1946, 3 purification centers[8] were built; in 1977, there were 5 purification centers[9]. By 2004, some parts of the aging Gueui Purification Center and the purification centers in Noryangjin, Shinwol, Seonyu and Bogwang were closed. Today, there are 6 purification centers (Gwangam, Amsa, Gueui, Ttukdo, Yeongdeungpo, and Gangbuk) (Figure 5). As of the end of 2013, production capacity was 4.35 million ㎥/day[10], and the waterworks service rate is 100% (all citizens have access to the waterworks).

Figure 5 - Intake Points in Seoul (Seoul Metropolitan Government, 2014



As stated above, in 1908 the purification capacity was 12,500 ㎥ of water per day, supplied to 125,000 people. As of the end of 2013, the capacity was 4.35 million ㎥/day, giving access to some 10.38 million people. The facility capacity grew 348 times and the number of people with access by 83 times.

Figure 6 - Waterworks Service Rate in Seoul



8. Ttukdo, Noryangjin, and Gueui purification centers (facility capacity: 152,000 ㎥/day).

9. Ttukdo, Noryangjin, Gueui, Bogwang, and Yeongdeungpo purification centers (facility capacity: 2.166 million ㎥/day).

10. 6 purification centers and 5 intake points. Daily average of 3.16 million ㎥/day; maximum production of 3.52 million ㎥/day.

Until 1992, facility capacity was not sufficient for water demand, and there were difficulties with operation and supply. After 1998 however, the facilities reached sufficient capacity, ensuring a stable supply (Figure 6). In 2013, 11.6 billion ㎥ of tap water was used in Seoul, with the daily average being about 3.19 million ㎥.

Introduction of Advanced Purification Facilities

From the 1960s to the 1980s, the major focus of waterworks policy was on quantitative expansion, but from the 1990s, policies began targeting the assurance of water quality and stability of supply.

Into the 2000s, the city's waterworks system improved in both quantitative and qualitative terms, and the policies focused on providing taste-free, safe tap water to residents.

Alongside these changes, there was a growing need for countermeasures to potential degradation of water quality at source and pollution due to climate change and urbanization. Accordingly, more advanced purification facilities were introduced. With the Ttukdo Arisu Purification Center as the last target in 2015, all purification centers will have installed these advanced purification systems[11] . The currently installed system is primarily focused on controlling odor- and taste-generating particles from algae, but also seeks to respond to the potential for issues to be caused by new trace particles. When these new facilities are completed in 2015, the citizens of Seoul will have access to cleaner, safer tap water.

Flow Rate Improvement

When the Office of Waterworks was launched in 1989, the flow rate in Seoul was 55.2%. By 2000, it had jumped to 72.0%, and to 95.1% in 2014, a level of success unprecedented in the world. Flow rate refers to the percentage of the amount collected in fees for the tap water produced and supplied by a purification center. For instance, the flow rate is 90% if 100 ㎥ of tap water is supplied to users and fees collected amount to the cost of producing 90 ㎥ of tap water. The higher the flow rate is, the lower the outside funding necessary for production and supply (e.g., raw water acquisition, purification chemicals, power, etc.), thereby improving the financial health of waterworks management. From 1989 to 2013, the flow rate improved by 39.2% (55.2% (1989) → 94.4% (2013)); in financial terms, this is equivalent to saving KRW 4.665 trillion (by unit price) since the launch of the Office of Waterworks.

Seoul has been able to improve the flow rate in several ways: continuing to repair old, leak-prone pipes; securing distribution stations; and switching to the run-of-river type to stabilize the water pressure and prevent related leaks. In addition, a flow monitoring system was adopted to monitor the flow and water pressure in real time. An effective leak detection method was employed as well. Seoul was divided into 2,037 small blocks and systematic leak detection carried out to quickly identify leaks and take appropriate action. Medium blocks (100 as of 2013) were also set up to analyze and manage the flow rate at the medium block level.

By 2017, Seoul aims to increase flow rate to 96.5% and will work to find the latest technologies that will improve

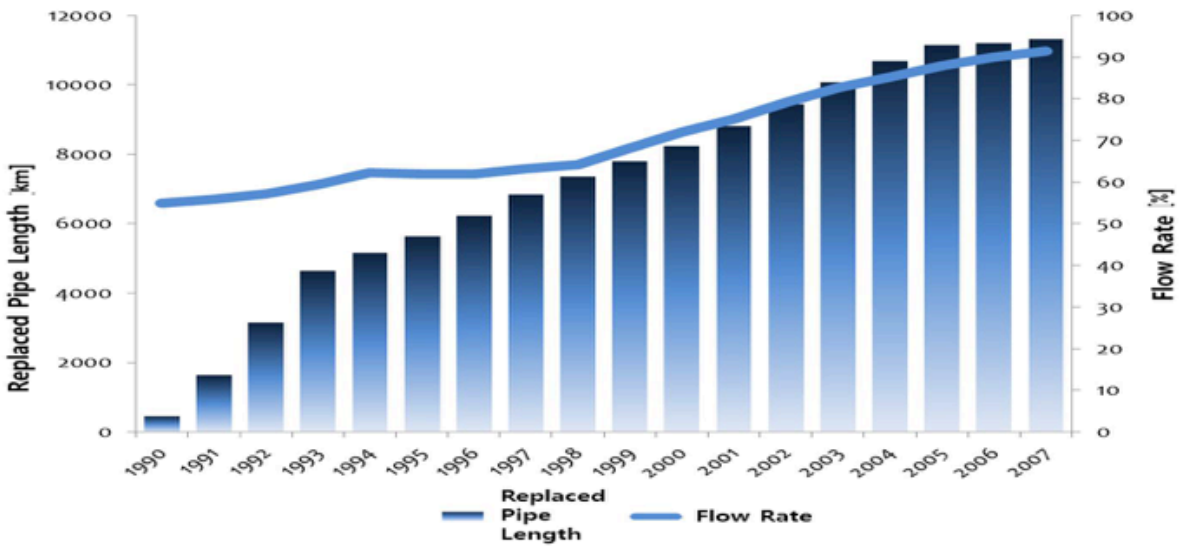
11. Advanced purification facilities in Seoul (3.8 million ㎥/day): Yeongdeungpo Arisu Purification Center (450,000 ㎥/day, 2011); Gwangam Arisu Purification Center (250,000 ㎥/day, 2012); Gangbuk, Amsa, and Gueui Arisu Purification Centers (2.5 million ㎥/day, 2014); Ttukdo Arisu Purification Center (600,000 ㎥/day, 2015).

and better manage the flow rate.

Distribution System Management

There were 13,721 km of distribution pipes installed in Seoul as of 2014. To improve the water quality and flow rate in the process of distribution, Seoul replaced deteriorating piping (13,192 km of the entire 13,728 km) from 1984 to 2013. By 2018, all deteriorating pipes will be replaced (Figure 7)

Figure 7 - Improved Flow Rate after Pipe Replacement

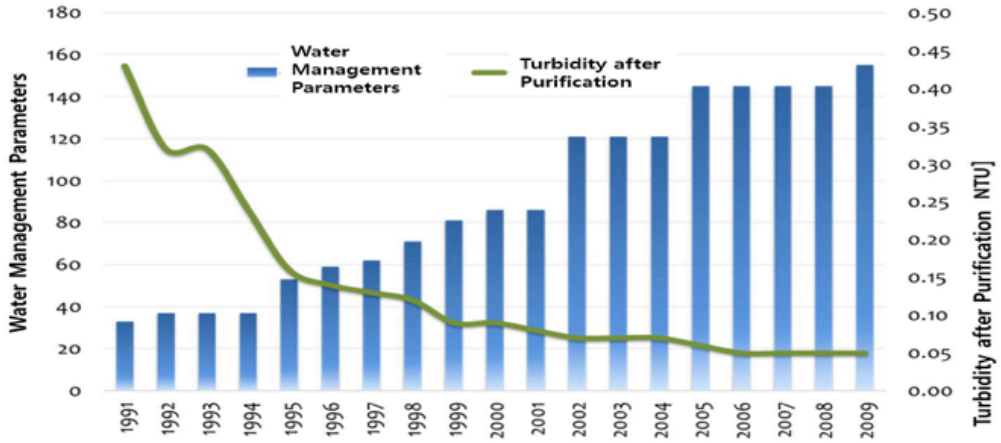


The distribution stations are capable of processing 2.42 million ㎥ of water, equal to about 13.9 hours of supply in case of an emergency. The capacity will be increased to 2.48 million ㎥ by 2030, about 15.0 hours' worth. This will enable constant and direct supply that does not require water tanks at the customers' end. The stability of water supply will be considerably enhanced, not to mention the water quality during the process of distribution.

Water Quality Management

In 1990, South Korea had 28 water quality inspection parameters. The number of parameters went up gradually, and as of 2013, there were a total of 85 parameters – 59 statutory and 26 general monitoring parameters. As of 2012, Seoul conducted regular inspections according to 164 parameters (59 statutory and 105 parameters set by the city (including the parameters of the Ministry of Environment)) (Figure 8).

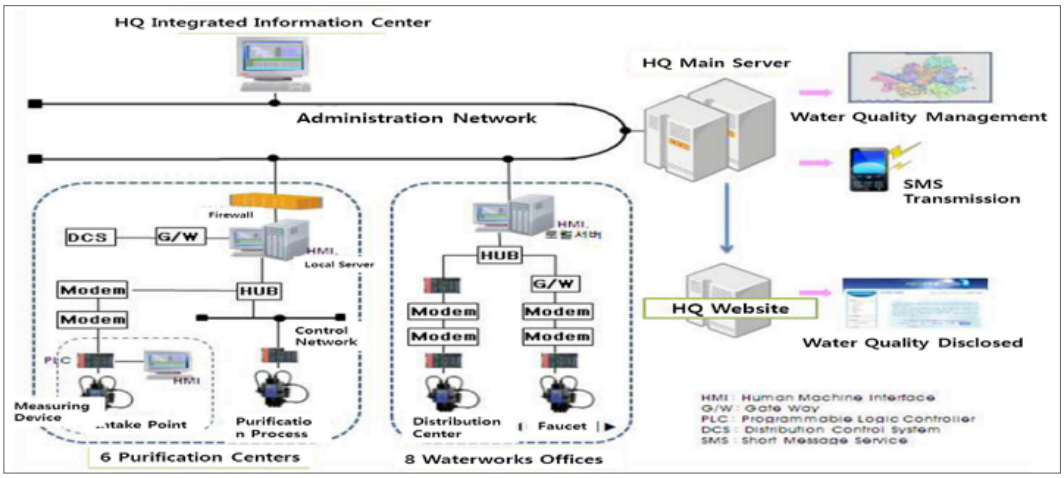
Figure 8 - Changes in Water Quality Management (Parameters) and Purified Water Quality (Turbidity)



Seoul Water-Now System

The Seoul Water-Now System monitors water quality in real time 24 hours a day, from source to faucet. It is installed at 200 locations: intake points, purification centers, distribution stations, pumping station, parks, and faucets (during the supply process) (Figure 9). The quality of the water thus monitored is disclosed to the public in real time to enhance transparency and reliability of the waterworks administration. The Seoul Water-Now System has been recognized by the international community for its excellence in providing administrative services to satisfy residents' right to know and protect their health. Along with Arisu Quality Certification, it won the grand prize at the UN Public Service Awards (UNPSA) on June 23, 2009

Figure 9 - Seoul Water-Now System[12]



12. Seoul Water-Now System: The basic system was completed on June 12, 2005. There were 30 points as of 2011 with 14 more by 2012. There are 200 points on the measuring network (6 intake points, 6 purification centers, 84 distribution stations, 13 pumping stations, and 91 faucet points). There are 3 measurement parameters (turbidity, chlorine residue, and pH). It was disclosed to the public on March 22, 2008. The data can be accessed at the Office of Waterworks website (http://arisu.seoul.go.kr → Arisu) or via smart phone.

Changes in Sewer-Related Policies

During the Joseon Dynasty, sewage flowed on street surfaces or in low-lying areas, passing through low ditches and flowing into the streams or underground. There were virtually no facilities or efforts at management. However, Cheonggye Stream, one of Seoul's major streams, had undergone dredging and other related works. In the 12th year of King Taejong (1412), full construction works were carried out at Cheonggye Stream and other streams so as to prevent them from flooding.

During the years of the Korean Empire (1897-1910), a 6,832 m long culvert built as part of the city sewer project was the first modern sewer pipe. Since then however, there is no record of maintenance or management.

The modern concept of a sewer system was applied when the 225 km long main and branch sewer lines were installed over 4 occasions, from 1921 to 1945, after Korea was forcibly annexed by Japan. This system was constructed to prevent pollution from urban flooding and wastewater and to process fecal material that was being discharged without control.

Until the 1960s, the main purpose of the sewers was to expel stormwater from the city, and lines were built in efforts to improve the street environment. After that decade, South Korea began experiencing dramatic economic growth accompanied by rapid industrialization and urbanization, improved quality of life, and change of method in treatment of fecal material[13] , amplifying the pollution load from wastewater. Accordingly, people began to take interest in the construction of sewage treatment facilities and a separate sewer system.

The sewer system as we know it began, thanks to international aid South Korea received after 1954 for post-war restoration.

In 1959, the first construction to cover Cheonggye Stream began. In 1966, the Sewerage Act was passed, and the Cheonggye Stream Wastewater Treatment Center (150,000 ㎥/day) began construction with a USAID loan[14] and completed in 1976. The early 1960s were politically challenging for South Korea, but this did not stop the government from pursuing the sewage system project. Consequently, the pre-1961 sewer pipe network more than doubled in length from 631 km to 1,462 km (Figure 10).

The 1970s was a decade of sewer expansion[15] ; the existing sewer system was actively repaired while new facilities were built and renovated with fervor.

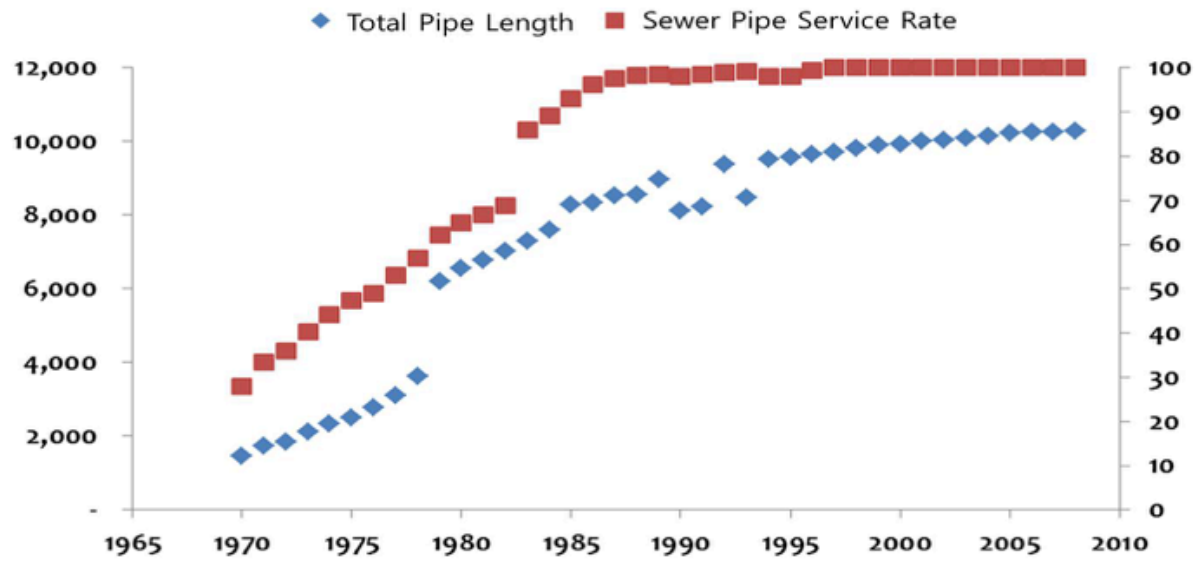
After 1987, the number of wastewater treatment facilities jumped, mainly to prepare for the Olympics in 1988. Between 1986 and 1999, sewerage capacity grew 39 times, from 150,000 ㎥/day to 5.81 million ㎥/day.

13. From collection to use of a flushing system

14. AID loan: US$ 3.5 million (July 13, 1966).

15. Changes in the sewerage service rate: 27.9% (1970) → 62.1% (1979).

Figure 10 - Sewer Pipe Length & Service Rate in Seoul (Seoul Metropolitan Government, 2010)



In 2005, the purpose and concept of wastewater treatment were clearly defined. To ensure that the system is sustainable and ready for future climate changes, the facilities, usually referred to as wastewater treatment facilities, were called water treatment centers.

In line with the strengthened standards on water discharged from water treatment centers, an advanced treatment system was introduced. In 2007, the new system, which had a capacity of 460,000 ㎥/day was applied to Jungnang Water Treatment Center; by 2012, the system was also installed at 4 other water treatment centers, representing a total capacity of 3.91 million ㎥/day. At Jungnang and Seonam Water Treatment Centers, the system was installed while some of their facilities were incorporated into the underground system while the aboveground space was modernized and transformed into a park for local residents (Table 5).

Table 5 - Introduction of Advanced Treatment System in Seoul

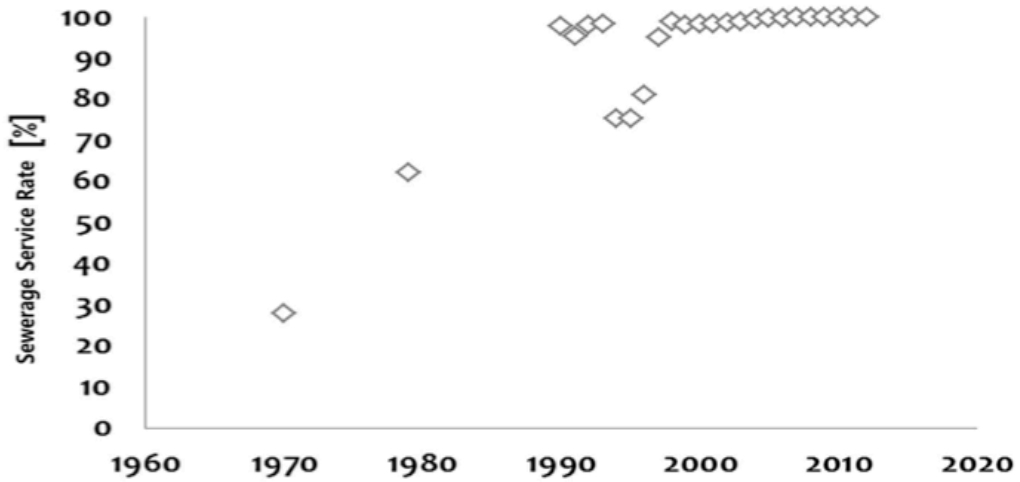
Category		Total	Jungnang	Nanji	Tancheon	Seonam
Capacity [10,000 ㎥/day]	Advanced Treatment	391	88	86	90	127
	Facility Modernization	61	25	-	-	36
Cost [KRW 1 million]		774,717	327,220	48,120	93,377	206,000
Construction Period		2009/1 – 2018/12	2009/2 – 2016/12	2009/7 – 2013/4	2009/1 – 2013/5	2009/11 – 2018/12

As mentioned earlier, focus was placed on quantitative expansion of sewerage capacity in the late 1980s. Sewer pipes were added and improved as well. The total length of the sewer network, which was 6,559 km in 1980, increased 1.4 times to 9,122 km by 1990. In each year since, 200 km of piping has been improved.

Table 6 - Sewer Repair & Maintenance Indicators in Seoul (Seoul Metropolitan Government, 2010)

	2008	2009	2010	2011
Sewerage Service Rate	100	100	100	100
Sewer Pipe Service Rate	37.9	40.5	43.5	46.4
Sewer Pipe Repair	2076	2218	2381	2544
Advanced Purification System Installation at Water Renewal Facility	38	60	82	100

Figure 11 - Sewer Service Rate in Seoul (Ministry of Environment, 2015; Seoul Metropolitan Government 2010)



In the 1990s, projects were implemented to restore the functions of sewer pipes as they are fundamental urban facilities that protect the environment. From 1992 to 2001, the network was examined by zone to replace deteriorating and damaged pipes in a systematic manner (Table 6).

By 2007, all citizens had access to the sewer system. From then on, Seoul placed more focus on quality management of the system, user satisfaction, and policy tasks designed to ensure safety (Figure 11).

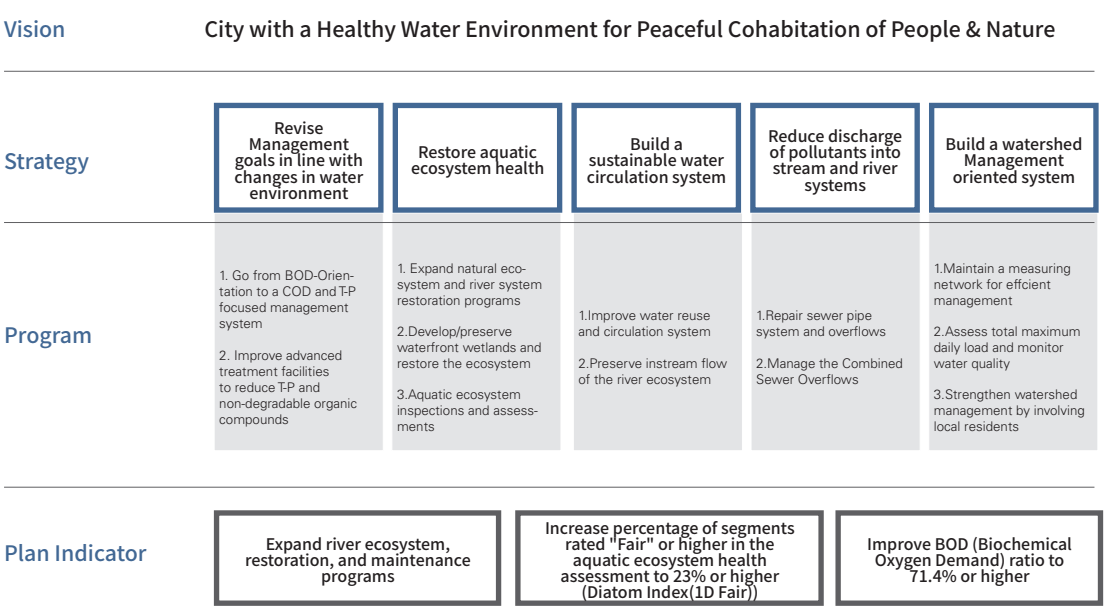
Such change and policy direction for the future are well represented in the 2020 Seoul Sewerage Vision. The policy directions as seen in the Vision are as follows:

- Enhanced capabilities to prevent potential disasters caused by climate change;
- Efficient and systematic repair and maintenance of deteriorating pipe;
- Improved living environment and service to the public;
- More realistic water billing to secure sufficient financing;
- Advanced sewage treatment and modernization;
- People-friendly water treatment centers;
- Energy saving at water treatment centers;
- Operational efficiency at water treatment centers;
- Launch of renewable energy programs.

Restoration of the Environment & Ecosystem

Restoration of the environment and ecosystem, one of Seoul's water management policies, and policy indicators and objectives are well described in the Seoul Water Quality and Ecosystem Preservation Plan 2014 - 2018 (Seoul Metropolitan Government, 2014). The vision of this plan is to create a "City with a Healthy Water Environment for Peaceful Cohabitation of People and Nature" so as to restore the balance of the city's aquatic ecosystem. The Plan includes 5 strategies and 12 programs (Figure 12).

Figure 12 - The Seoul Water Quality & Ecosystem Preservation Plan: Strategies & Programs (Seoul Metropolitan Government, 2014)



Other than steps to preserve water quality and the ecosystem, the Plan also includes action and strategies that encompass the entirety of the sustainable water reclamation system.

This is significant in that it changes the policy paradigm from water quality management to preservation and maintenance of a healthy aquatic ecosystem through various means, such as restoring stream and river ecosystems to their natural, healthy state, and conducting assessments and inspections of these ecosystems (Table 6).

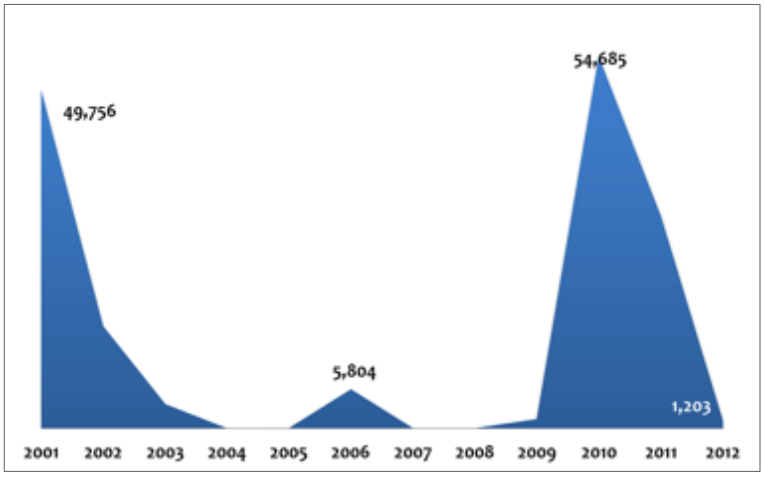
Table 7 - Water Quality Targets from the Seoul Water Quality & Ecosystem Preservation Plan (Seoul Metropolitan Government, 2014)

Area	2012 Water Quality [mg/L]			2018 Target Water Quality [mg/L]		
	BOD	COD	T-P	BOD	COD	T-P
Jungnang Stream Area (Downstream)	5.800 (Slightly Poor)	12.300 (Very Poor)	1.267 (Very Poor)	5.000 (Fair)	8.600 (Slightly Poor)	0.649 (Very Poor)
Tan Stream Area (Downstream)	6.400 (Slightly Poor)	9.600 (Poor)	0.598 (Very Poor)	5.000 (Fair)	7.000 (Fair)	0.200 (Fair)
Anyang Stream Area (Downstream)	4.100 (Fair)	8.400 (Slightly Poor)	0.211 (Slightly Poor)	4.000 (Fair)	7.000 (Fair)	0.159 (Fair)
Hongje Stream Area (Hongje Stream)	3.000 (Slightly Good)	5.100 (Fair)	0.080 (Slightly Good)	3.000 (Slightly Good)	4.800 (Slightly Good)	0.070 (Slightly Good)
Han River (Haengju Bridge Point)	4.100 (Fair)	6.800 (Fair)	0.290 (Slightly Poor)	3.800 (Fair)	5.000 (Slightly Good)	0.141 (Fair)

Staying Safe from Flood Risk

In the past decade, Seoul's annual average rainfall was 1,550 mm, 70% or more of which comes in the torrential rains occurring during the summer months (June – August). The city suffered major damage in 1987, 1990, 1998, 2001, 2010, and 2011. Every decade or so, Seoul sees 2 or 3 major floods. Most of the damage was to buildings and facilities, crippling urban functions (blocking traffic, causing blackouts, suspending communications etc.) from the flooding or avalanche, which mainly caused property damage (building and facility flooding) and crippled urban functions (traffic, blackout, suspended communications) (Figure 13).

Figure 13 - Losses in Seoul from Flooding (Unit: KRW 1 million)



For the past 30 years (1971 – 2001), rainfall has steadily increased from 1,344 mm to 1,550 mm. Analysis of the relationship between rainfall (hourly maximum and daily maximum) and financial damage in the years when flood damage was serious (1987, 1990, 1998, 2001, 2010, and 2011) shows no clear tendency but the greater the volume or intensity of rainfall, the greater the property damage. The extent of flood damage was determined largely by the climate, particularly in the amount of rain.

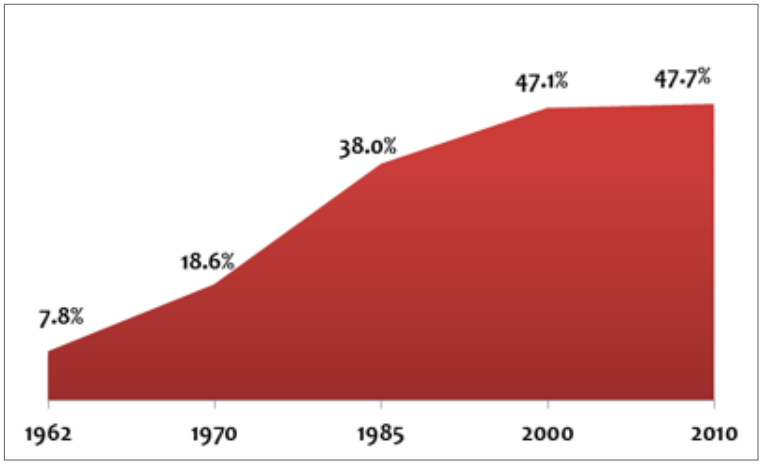
Flood damage occurs usually in flat, low-lying areas with poor drainage, especially to semi-underground housing, underground spaces (underground arcade, etc.), and roads. In some parts of the city however, the nature of the flood damage is rather complex, a combination of both inland and river (e.g., overflows) floods caused by heavy rain and the antecedent conditions of precipitation.

Seoul has for some time worked on improving its stream systems, sewer systems, inland flood control facilities, and other facilities designed to prevent water-related disasters (sewer pipes, rainwater pumping stations, reservoirs, etc.). These facilities are at a relatively advanced level, and yet storm and flood damage have not abated, owing to global climate change and the effects of urban development. The Basic Sewage Improvement Plan of 2009 planned to respond to climate change and heavy rainfall by reinforcing the recurrence interval standards for sewer pipes from 5 years (main) and 10 years (branch) to 10 years and 30 years respectively. From the 9,380 km long sewage line, 476 km (5.1%) have interruptions in their flow due to old designs. Considering the reinforced recurrence interval in the future (30 years for the main, 10 years for the branches), 618 km (6.6%) are estimated to be inadequate. Flood-prone zones should therefore be selected for repair and maintenance of any inadequate or deteriorating pipes on a continual basis, while upgrading the capacity of some of the rainwater pumping stations that have reached their limit in order to better prevent inland floods.

While the urbanization of Seoul has helped expand built-up areas, it has also increased the impervious surface

area. This reality gives rise to urban flooding, urban heat islands, and other forms of natural disasters, undermining healthy water reclamation and destroying the habitat of many lives. According to urban ecosystem research done in 2010, 47.6% of Seoul's surface area was impervious (Figure 14).

Figure 14 - Impervious Surface Area in Seoul



Green belts and open spaces with an impervious surface rate of less than 10% accounted for 43.6%; areas with an impervious surface rate of 90% or more accounted for 37.2%; areas with an impervious surface rate of between 70% and 89% were 11.1%. Since the 2000s, the most noticeable change in the impervious surface rate was a reduction of the areas with a 90% or higher or 10% or lower rate and an increase in the areas that were in the 30% – 90% range. While reduction of the areas with an impervious surface rate of 90% or more is desirable, the change in the impervious rate is rather extreme across the city. Reduction of the areas with an impervious surface rate of 90% or more seems to have been caused by redevelopment and improvement that aimed to secure sufficient green space for a more natural ecosystem. However, areas in the 70% – 90% range have increased due to the development of roads and commercial and business districts, hindering overall improvement. It is therefore necessary to devise a way to reduce the impervious surface rate in development projects undertaken.

Safety management to prevent urban disasters can be divided into 4 strategies: 1) reinforcing preventive action; 2) enhancing disaster response; 3) developing a complete restoration system; and 4) making improvements through participation and communication.

Among these, the tasks designed to prevent water-related disasters are as follows:

- Make improvements in 29 flood-prone zones
- Prevent the loss of human life in the river systems
- Reinforce management of basement housing units in flood-prone areas
- Integrate management of disaster prevention facilities by basin
- Improve street level drains

- Encourage residents in vulnerable areas to buy insurance
- Increase rainwater management capacity 8-fold by 2020 (from 5.6 mm to 46.5 mm)

Seoul's Water Management Policy: Challenges

Seoul's water management policies achieved remarkable development in a relatively short period of time. The spectrum of the city's technical and policy experience and performance is broad. However, policy challenges include finding new resolutions so as to create a more pleasant and safer city for the residents.

Of primary importance is that any policy approach should be based on the understanding that raw water and water sources must be managed more stringently to ensure the Han River system is clean and safe. While such efforts are already in place and have had some success, more emphasis is needed that management at the source must be as strict as during the supply and treatment process. We do not have to refer to US or European cases to understand the necessity. Management at the source is indeed one of the most crucial elements of integrated water management policies (WHO).

Another challenge is to be prepared for new trace particles. PPCPs[16] and CEC's (Contaminants of Emerging Concern) are detected now at low concentrations but must nevertheless be monitored and managed because they affect health and the aquatic ecosystem (EPA, 2011). Most such substances are not yet regulated but are on the increase every year, both in amount and type. It is especially important that the relevant departments work together closely to address the matter.

The Han River is the only source of water for Seoul. Climate change and urbanization have increased the possibility of water pollution, and it is critical to find other sources for the sake of economics and safety. Development of sources outside of surface water would include passive methods (groundwater and rainwater) as well as more proactive means (reuse of wastewater).
Rainwater in particular can be utilized through rainwater management facilities, as they will help water to circulate in and out of dry seasons. Policies can also consider reducing base flow by pumping in water to maintain the streams.
Effective management of rainwater and groundwater is increasingly important, not just from the perspective of water resources management, but also with an eye on prevention of disasters (e.g., road collapses, floods) and safety. Policies should pay attention to increasing surface permeability in the city to increase groundwater levels, and to developing artificial groundwater replenishment technology.

[16] PPCPs: Pharmaceuticals and Personal Care Products.

Due to climate change and urbanization, Seoul sees more torrential rain flooding, landslides, and other storm and undesirable water-related events, as well as an increase in their severity. Structural measures – improvements to disaster prevention facilities – as well as an integrated approach to built-up areas are necessary. Urban planning and management of construction is also crucial. Other necessary measures include: a warning system and provision of relevant information for prevention; upgrades to the emergency response system to minimize damage and loss of life; and consideration of regional characteristics to refine response and approach.
Countermeasures against flooding should consider direct impact on buildings and other structures but should also take on a more dimensional approach toward urban planning, housing, improvement of the residential environment, and green parks. It should also be noted that urban planning and the residential environment should include flood-related safety measures.
For the future, a more integrated water management system should be included in Seoul's water management policies. This integrated system would involve integrated management of all water resources including rainwater and groundwater, as well as technical and policies regarding the waterworks and sewer system. This system should address the technical and policy challenges in a way that assures the sustainable use of water and other energy resources related to the use and reuse of water.

As we have examined the changes in Seoul's water management policies, especially as related to waterworks and sewers, the city, with a system built in the midst of rapid urbanization and quantitative growth, will now need to focus on stability and quality so as to develop an integrated system that will provide the foundation for sustainable water management in the future.

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2. Tap Water Quality Inspection System by the Multiple Checks

Written by: Yong-Mo Cho, Senior Researcher, the Seoul Institute

Policy Area: Water Supply (Waterworks)

Background of Tap Water Quality Management

Since the Ttukdo Arisu Purification Center, the first modern water purification plant in Korea, started to generate tap water in September 1908, water quality inspection had been evaluated for 14 items including turbidity, pH, hardness, residue on evaporation, etc. until Korea was liberated from Japanese colonial rule in 1945. When the "Regulation on the Medical Examination and Sanitation" was enacted on March 11th, 1963, standards of water quality and selection of water quality inspection items were determined, and the number of legal water quality inspection items increased to 29 items including ammonia nitrogen, etc.

It was reported in the press that the tap water was contaminated with microorganisms and heavy metal in August 1989. Disinfection by-products such as trihalomathane were detected in the tap water in 1990. Nakdong River, one of the sources of tap water, was polluted because of illegal disposal of phenol by the Doosan in Gumi in 1991. Filthy odors originating from Nakdong River were reported in 1992. As these incidents kept occurring over the years, the quality of tap water emerged as one of the main social issues. The consecutive incidents of tap water contamination inevitably resulted in the distrust of tap water, and accordingly tap water was recognized by the people as contaminated water that was not suitable for drinking.

In order to overcome this distrust, the Seoul Metropolitan Government put forth efforts to prepare for contamination incidents and to establish the water quality inspection system by expanding the number of water quality inspection items and strengthening the inspection itself. Seoul selected 2 more items to be included for water quality monitoring in addition to the established legal items for water quality inspection in July 1997. Since then, Seoul has expanded the items continuously and now performs water quality monitoring for 104 items, and water quality inspection for 59 legal items. In 2014, Seoul added trace amounts of toxic substances such as disinfection by-products to the inspection item list year by year. Finally, Seoul began carrying out water quality inspections that included all items designated by WHO (World Health Organization), and announced the inspection results to the public so that Arisu, the tap water of Seoul, could be proven to be safe tap water.

To effectively cope with the problem of filthy odors generated largely due to the increasing algae around the catchment areas, Seoul has operated the algae warning system since 2000. However, the incidents of bad smelling tap water occurred even when algae warnings were not issued. Seoul started to operate a smell warning system for the geosmin and 2-MIB items for the first time in Korea in 2012 in addition to the algae warning system to respond to and treat the odorous substances preemptively and efficiently in order to supply good tasting tap water without the smell.

As of 2014, Seoul performed water quality inspection for 59 legal items.

Policy Overview

① Water quality management of the water supply source ⇒ Securing safe water quality of raw source water (Intensified management during vulnerable periods like periods of water shortage)

② Purified water quality management ⇒ Maintenance of optimal purified water quality (Turbidity: less than 0.06 NTU in annual average)

③ Water quality management during the process of water distribution and supply ⇒ Establishment of out-reach administrative services (Arisu quality confirmation system, etc.)

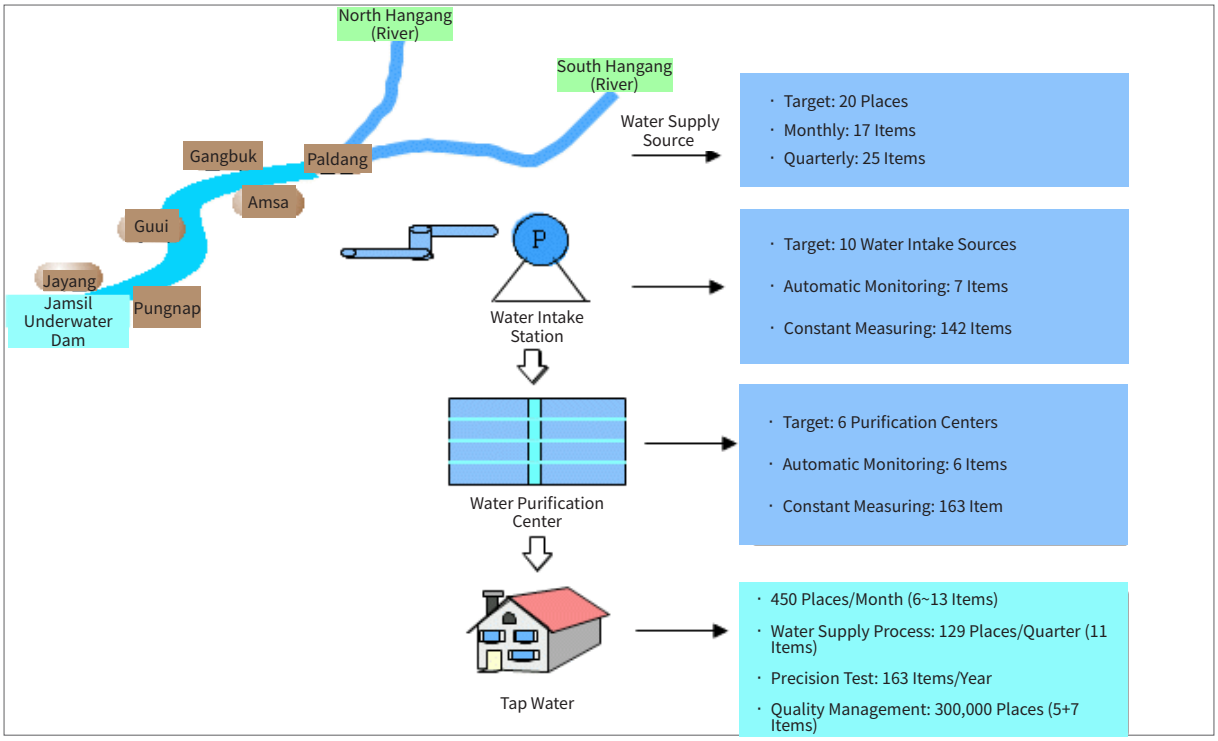
④ Water quality inspection at the faucets and supply process ⇒ Improvement of water quality experienced by the citizens (Inspection of faucets at 450 places, etc.)

⑤ Reduction of residual chlorine of the faucets ⇒ Supply of good tasting and odorless tap water (Residual chlorine: maintained at the level of 0.1~0.3mg/L)

Main Contents of Tap Water Quality Management

Water Quality Management System using the Multiple Test Methods: Water Quality Management by Raw Source Water, Purified Water and Water Supply System

Figure 1 - Water Quality Inspection System by Raw Source Water, Purified Water and Water Supply System



Source: Internal Data of the Seoul Metropolitan Government.

Water Quality Management of Water Supply Sources and Intake Raw Water

Of the 6 water purification plants in Seoul, Gwangam purification center obtains its raw water from the Paldang water source protection area (157.3㎢) and 5 water purification plants, including Gangbuk purification center, obtain their raw water from the Jamsil water source protection area (6.45㎢). Seoul makes efforts to ensure safe raw water quality by forecasting the water quality and handling pollution sources actively via water quality inspection of the main stream of Hangang and its tributaries, which influence water supply sources.

The main water quality inspections of water supply sources and intake raw water are conducted by the Water Supply Institute and the purification centers. 7 items including phenol, ammonia nitrogen, etc. are inspected using an automatic water quality measuring system in real time. Biological warning systems are operated in the Gangbuk, Amsa and Pungnap (Yeongdeungpo) purification centers to monitor the inflow of pollution sources such as heavy metal and domestic sewage constantly via multiple tests.

Table 1 - Status of Water Quality Inspection for Water Supply Sources and Intake Raw Water

Classification	Inspection Target	Total Inspection Items	Inspection Agency	Inspection Cycle
Water Supply Source	20 Places (South Hangang 5, North Hangang 5, Kyeongancheon <Stream>, Tributaries on the Paldang Downstream 9)	42 Items	Water Supply Institute	· Monthly 17 · Quarterly 25
Water Supply Source	8 Places: Tributaries (6), Main Stream of Hangang (2) · Tributaries: Gungchoncheon, Dosimcheon, Wolmuncheon, Deoksocheon, Hongneungcheon, Sangokcheon (Stream) · Main Stream of Hangang: Amsa, Guui	57 Items - Tributaries: 42 Items - Main Stream of Hangang: 15 Items(15 Items Overlapped)	Water Supply Institute Amsa, Guui	· Monthly 42 · Daily 4 · Monthly 11
Water Intake Source	3 Places · Gangbuk: Green Algae, Closterium (Heavy Metal, Agricultural Pesticides) · Amsa: Electric Active Microbes (Domestic Sewage) · Pungnap: Water Flea (Insecticide, Heavy Metal)	Biological Warning System	Gangbuk, Amsa, Yeongdeungpo	Real Time
Water Intake Source	6 Water Intake Stations: Cyan, Phenol, NH3-N, TOC, Water Temperature, pH, Turbidity (Chlorophyll-a)	Automatic Water Quality Monitoring System (7 Items)	Water Purification Center	Real Time
Water Intake Source	10 Places (Water Intake Stations 6, Hangang Confluence 4) · South Hangang: Bogpo-ri, Sinwon-ri · North Hangang: Sambong-ri, Jinjung-ri	142 Items - Legal: 31 - Self: 111 (15 Items Overlapped)	Water Supply Institute 135 Water Purification Center 22	· Weekly 21 · Monthly 12 · Quarterly 73 · Yearly 29 · Daily 10 · Weekly 12

Source: Internal Data of the Seoul Metropolitan Government.

Water Quality Management of Water Purification Centers

The goals of purified water quality management are to maintain Turbidity levels of 0.06NTU and less (Purified water turbidity 0.1NTU and less in the rainy season) and to maintain a ±0.04mg/L level of residual chlorine by purification center. The goal regarding the water purification standard is 0.3NTU of turbidity and less in 95% of the purified water measured every month. The goal in terms of water taste and smell is to produce tasteless and odorless water (by operation of odor warning system, input of powdered activated carbon, etc.).

To manage the water quality in the purification process, Seoul analyzes the water quality of raw water, secures enough disinfectant concentration and manages the turbidity of purified water. Seoul produces and supplies high quality tap water which meets the purification processing standards even in the worst conditions.

In order to manage the turbidity of purified water, which is one of the most important aspects of water quality, Seoul's system automatically monitors the turbidity during each treatment process from the point of injection of disinfectant for 24 hours. Also, it analyzes and determines the optimal operating conditions for purification processing by season (periods of water shortage, rainy season and winter season). Tap water quality inspections are performed by the Water Supply Institute, the best inspection agency in Korea, and 6 water purification centers in accordance with the WHO (World Health Organization) level of 163 inspection items (59 items for quality of drinking water and 104 monitoring items of Seoul). The items are classified into daily, weekly, monthly, quarterly and yearly ones for water quality analysis, and the inspection results are open to the public to prove the safety of the tap water.

Table 2 - Water Quality Inspection Status of Water Purification Centers

Classification	Inspection Target	No. of Inspection Items in Total	Inspection Agency	Inspection Cycle
Raw Water	6 Water Purification Centers	22 Items	Water Purification Center	Daily 10
				Weekly 12
Purified Water	6 Water Purification Centers	23 Items	Water Purification Center	Daily 10
				Monthly 13
Purified Water	6 Water Purification Centers 10 Places (Including 1 Bottle Water)	163 Items (Legal - 59, Monitoring-104)	Water Supply Institute	Monthly 63 (Legal-59, Monitoring-4)
				Quarterly 61
				Yearly 39
Purified Water	Research on the Real State of New Micro-pollutant - Residual Pharmaceutical Compounds (3), Industrial Chemical Materials (3)	130 Items (2014: 6 Items)	Water Supply Institute	Yearly

Source: Internal Data of the Seoul Metropolitan Government.

From the Water Purification Center to the Faucet

Chlorine levels have the most influence on whether or not people drink water directly from the tap. Previously, the chlorine was added mainly at the water purification centers. As a result, civil complaints about the chlorine smell were raised by people near the purification centers and the content of residual chlorine was below the standard compared to the faucets far away from the centers. To solve these problems, in 2012 Seoul reduced the amount of chlorine added at the Gangbuk and Amsa purification centers, which provide the largest areas with tap water, and began adding chlorine at places like water distributing reservoirs (17 places) during water transportation. It planned to the system more to the other places to maintain a chlorine level within 0.1~0.3mg/L.

The time-worn water supply pipes made of gray cast iron, galvanized steel and non-corrosion resistant steel were vulnerable to water leaks and rusting inside them. Especially in the case of the cast iron pipes and steel pipes without cladding, the inside of the pipes became covered with rust after a long time of use and accordingly, caused to lower the water flow rate and to reduce the concentration of residual chlorine. The use of galvanized steel pipes for water supply was prohibited in April 1994. Seoul is planning to change the entire pipe system with corrosion-resistant pipes by 2018.

Water tanks on apartment rooftops were installed in the past because of restricted water supply. Due to the insufficient infrastructure, the water supply had been available for a limited time only. In most cases, the water for personal use was supplied after pulling up the from the underground water tank to the rooftop water tank to store it for a necessary period. Because the water was stored for a long time in the water tanks, the loss of residual chlorine occurred, and the water quality could be deteriorated because of the polluted tanks. To address these problems, Seoul started directly supplying water to the households to increase the amount of residual chlorine (0.18mg/L) and to ensure cleanliness and safe water quality.

Figure 2 - Reduction of Disinfectant Smell (Chlorine)

Source: Internal Data of the Seoul Metropolitan Government.

Water Quality Management of Water Distribution and Supply System

To keep the water named Arisu that was produced in the water purification centers clean and safe until it arrives to the household using thorough water quality inspection and management of the water distribution and supply system, Seoul operates and performs several programs and inspections; legal water quality inspections, water quality inspections during each stage of the water supply process, the Arisu quality confirmation system which included participation from citizens, enhancing user confidence and satisfaction to raise the rate that people drank water directly from the tap with the Arisu system.

Table 3 - Water Quality Inspection Status of Water Distribution and Supply System

Classification	Inspection Target	No. of Inspection Items in Total	Inspection Agency	Inspection Cycle
Faucets	450 Places (Legal 419 + Basic Inspection Places)	6 Items (Guidelines 4, Self 2)	Water Supply Institute	Monthly
Old Water Pipes	20 Places	13 Items	Water Supply Institute	Monthly
During Water Supply Stage	120 Places (Purification Center 8, Before Reservoir 26, After Reservoir 26, Inflow to Water Supply Area 26, Booster Station 8, End of Pipe 26)	11 Items	Water Supply Institute	Quarterly
Arisu Quality Confirmation System	300,000 Households	12 Items (Primary 5, Secondary 7)	Water Supply Office	Frequently
Booster Station of Reservoir	113 Places (Reservoir 104, Manned Booster Station 9)	Residual chlorine	Water Supply Office	Daily
	Auto Measurement of Water Quality at 188 Places	Turbidity, pH, Residual Chlorine, Water Temperature, Electrical Conductivity	Water Supply Office	Real Time (Open via SWN)
Distributing Reservoir	104 Places	12 Items	Water Supply Office	Quarterly
Water Pipe (After Construction)	Reservoir, Booster Station, Water Pipe	4 Items (Plumbing 2)	Water Supply Office	Frequently
Water Pipe and Water Tank	Water Pipe 1,079 Places	7 Items	Water Supply Office	Yearly
	Water Tank 12,089 Places	6 Items	Private Drinking Water Quality Inspection Agency	Yearly
Arisu Drinking Fountain	2,674 Places (30,807 Units)	5 Items	Water Supply Office	Monthly: Subways
				Quarterly: Schools, Public Offices
Monitoring Items	Faucets at 25 Places (1 per District)	163 Items (Legal-59 + Monitoring-104)	Water Supply Institute	Yearly (September)
Residual Chlorine Monitoring	Watershed-based Faucets of Water Purification Center at 90 Places (in 2013)	Residual chlorine	Water Supply Office	Weekly

Source : Internal Data of the Seoul Metropolitan Government.

Water Quality Management Using Multiple Checks for Main Materials: Micro-pollutant and Algae Warning System

Micro-pollutants

Seoul selected 130 inspection items (6 items added in 2014) in addition to the original 163 items and performed research on the actual conditions of the endocrine disruptors like non-regulatory chemicals, pesticides, cancer-causing toxic substances, etc. every year.

Algae Warning System

To reduce the occurrence of substances causing odors in the tap water, Seoul operates the algae warning system, which issues warnings for efficient water purification process when the blue-green algae are present in large amounts in the raw water. The algae warning was issued in section 1 of the upper region of Jamsil underwater dam for 15 days in 2012. 6 algae warnings were issued in the Seoul area of Hangang since 2000. The damages caused by algae include generation of filthy odor and toxic substances, malfunction of water purification facilities, etc. Together with the algae warning system, Seoul started to operate a smell warning system for the geosmin and 2-MIB items in 2012 in order to respond to the presence of odorous substances preemptively to reduce the smell of tap water. In cases when warnings are issued due to the generation of algae and odorous substances in large amounts, the water quality inspections which would normally be performed once a week are carried out one or more times a day, and the input of powder activated carbon and interchlorination after injecting the activated carbon at the purification centers with prechlorination of water intake station stopped are performed to supply the tap water after removing as much of the odorous substances as possible.

Table 4 - Standard of Algae Warning System (Issued when exceeding 2 Items consecutively 2 times)

Items of Algae Warning	Algae Watch	Algae Warning	Large Algae Alarm
Chlorophyll-a Concentration (mg/㎥)	Over 15	Over 25	Over 100
No. of Cells of the Blue-Green Algae (Cell/mL)	Over 500	Over 5,000	Over 106

Figure 5 - Smell Warning System (Reflecting the Purification Processing Efficiency)

Items of Smell Warning	Smell Watch	Smell Warning	Large Smell Alarm
Geosmin (ng/L)	20	500	1,000
2-MIB (ng/L)	20	50	100

Source: Internal Data of the Seoul Metropolitan Government.

Water Quality Management System using Multiple Checks: Arisu Quality Confirmation System, Selection and Management of Water Quality Monitoring Items, Water Quality Monitoring through Public-Private Partnership, Monitoring

Arisu Quality Confirmation System

Seoul inspects the water quality during every process of tap water generation and supply and carries on the automatic measurement of water quality. The results are made available to the public via the Seoul Water Now System and the Seoul City Home Page to prove the safety of the tap water of Seoul. However, the citizens drinking the water in their own households are skeptical because rust eluted the insides of the old water pipes in buildings. Seoul visits citizens to check the situation and to inspect the water quality according to the Arisu Quality Confirmation System. It investigates the causes and implements a process to improve the conditions and to gain the trust of citizens.

Selection and Management of Water Quality Monitoring Items in the World Best Class (104 Items)

Seoul legislated and revised the related laws and regulations in cooperation with the Ministry of Environment and related government organizations to set up the management system for tap water quality and water purification standards. In addition to the legal water quality inspection items prescribed in the Water Supply and Waterworks Installation Act, Seoul selected 104 items autonomously to monitor the water quality based on its related ordinances while establishing the laws and regulations related to water supply.

Water Quality Monitoring through Public-Private Partnership

According to Article 30 of the Water Supply and Waterworks Installation Act and the ordinances of the Seoul Metropolitan Government, Seoul organized the Seoul Tap Water Evaluation Committee consisting of external city council members, professors and experts in environmental groups. Seoul collects specimens at 10 points within the water transportation route from the water intake source to the faucets of 2 water purification centers and requested an external private inspection agency designated by the Seoul Tap Water Evaluation Committee to inspect the water quality in regard to the 59 legal water quality inspection items. The inspection results were released via the home pages of Seoul City and the Seoul Tap Water Evaluation Committee to build up the citizens' confidence in the tap water.

Monitoring System in the Main Points

The residual chlorine is checked every day at 113 places including reservoirs and booster stations. The automatic water quality measuring systems are installed at 188 points to monitor 5 items including turbidity and residual chlorine in real time and the results of measurement are open to the public via the Seoul Water Now System (SWN).

Main Achievements

Healthy and Safe Water Supply

Seoul provides its citizens with healthy and safe water through systematic water quality inspection and management of the entire tap water production and distribution processes from the water supply sources to the faucets. It also has proven the safety of tap water by performing water quality inspections which include the 163 items recommended by WHO and annual research on the actual conditions of micro non-regulatory substances totaling 130 additional items. In order to remove the bad smell and the disinfectant odor which were the main obstacles people had to drinking water directly from the tap, Seoul has operated an algae warning system and a smell warning system which are issued when the algae and bad smell increase in the raw water, reacting preemptively to the substances causing the filthy smell. In order to reduce the disinfectant odors of chlorine, Seoul introduced a system that inputs chlorine at the water reservoirs in the middle of water supply process, maintaining the residual chlorine at the faucets in the range of 0.1~0.3mg/L according to the guideline for tasty water. Once the installation of advanced water purification facilities would have been completed at 6 purification plants in Seoul by 2015, the algae related odor would be reduced remarkably.

Implications and Possibility to Be Applied to Developing Countries (Ripple Effects)

Seoul manages the quality of raw water in the Paldang water supply source and performs constant monitoring at the water intake stations to check the inflow of pollutants. According to the recommendation of WHO, Seoul inspects and analyzes the water quality for many items. It also introduced a smell warning system for the first time in Korea in order to preemptively respond to the algae increase. In addition, Seoul operates Arisu quality confirmation system to inspect the tap water quality at the faucet, and the distributed chlorine injection system to reduce the bad smell of tap water, and performs monitoring and research on micro toxic substances. Tap water quality inspection using the multiple check method contributes to the supply of safe and healthy water. Seoul also selects research subjects for each water purification center and holds workshops to present the research results, problems and improvement cases by purification center. Such research results and cases are used as benchmarks for the other cities, provinces and overseas developing countries.

Q&A

Why do you manage the tap water by checking it multiple times?

The Paldang water supply source for water supply to Seoul is not perfectly free from algae and sources of point pollution. In order to supply safe and healthy water to over 10 million Seoul citizens, Seoul performs water quality inspection and monitoring for various items in multiple levels throughout the entire process of tap water production and distribution including water supply sources, water intake stations, water purification centers, distribution and supply systems, etc.

What are the water quality criteria of Arisu?

The standards of drinking water quality in Korea include microorganisms, inorganic substances with harmful effects, organic substances with harmful effects, disinfectants, disinfection by-products and substances with aesthetic effects. The reference values of water quality are set by the amount of water that is not harmful to health when an average person drinks 2 liters of water per day for 70 years and in consideration of a 1/100~1/1,000 of safety rate. Therefore, the water within the reference drinking water quality values is harmless to humans.

What are the bases of selection of water quality monitoring items and inspection items?

According to Paragraph 3 of Article 26 of the Water Supply and Waterworks Installation Act, Seoul selected highly detectable items based on the research on the actual condition of micro toxic substances, etc. and self-inspection results, the necessary items to cope with social issues by inspection, and the items that became issues of tap water in overseas countries which seem to be detectable in Korea as water quality monitoring items. The inspection standards and methods are made and implemented taking the related regulation of WHO and foreign cases into account. (30 items recommended by the Ministry of Environment and 104 items determined by Seoul including the monitoring items for the Ministry of Environment)

What are the guidelines for healthy and tasty water?

Seoul carried out research and service agreements with specialized organizations, water tasting events, opinion surveys, public hearings, meetings with advisory committees, etc. since May 2010 to set the guidelines for healthy and tasty water. The guidelines were completed in December 2010.

Table 6 - Guidelines for Healthy and Tasty Water

Classification	Item	Unit	Standards of Drinking Water Quality	Guideline	Background
Items Related to Health	Mineral (Ca, Mg, Na, K)	mg/L	-	20~100	· Essential element for body
	Total Organic Carbons	mg/L	5.0 (Monitoring Items of Seoul)	1.0 and less	· Good for health by removing the disinfection by-products
	Turbidity	NTU	0.5	0.3 and less	· Good for health by removing microorganisms (Protozoa, virus, etc.)
Items Related to Taste	Residual chlorine	mg/L	4.0	0.1~0.3	· Smell of Disinfectant
	2-MIB	ng/L	20 (Monitoring Items of the Ministry of Environment)	8.0 and less	· Substance causing moldy odor
	Geosmin	ng/L	20 (Monitoring Items of the Ministry of Environment)	8.0 and less	· Substance causing soil odor
	Copper	mg/L	1.0	0.05 and less	· Substance causing blue water
	Steel	mg/L	0.3	0.05 and less	· Substance causing red water and smell of rust
	Temperature	℃	-	4~15	· Feeling of refreshment and good to drink

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· Water Circulation Policy Division of the Seoul Metropolitan Government, http://arisu.seoul.go.kr/

· Water Circulation Policy Division of the Seoul Metropolitan Government, 2013, Report on Tap Water Quality

· Ministry of Environment, 2008, 100 Year History of Korean Water Supply

3. Seoul's Flood Control Policy

Writer : Seoul Institute Dr. Young-Ran Kim

Policy Area: Waterworks

Flood Control Policy Trends & Changes in Seoul

Background to Flood Control Policy Changes

Seoul is a city with an intense concentration of political, economic and other urban functions. Its population is dense, and its buildings and underground networks are intricately structured. Flooding in such a city would result in considerable loss as well as prohibitive costs and restoration time. The flood damage of July 2011 was caused not only by heavy rainfall that exceeded designed drainage capacity (the primary cause), but also by a number of other situations, such as surface runoff going to low-lying areas, insufficient flow capacity of sewage pipes, reduced conveyance due to sediment runoff, and backwater. There were also other reasons: road designs that failed to respond to climate change; vulnerable aspects of land use (e.g., underground arcades); inadequate warning/alert systems, ineffective traffic control, and poor management of vulnerable areas/facilities, in addition to poor restoration systems and disaster follow-up. Recent climate changes aggravated by global warming have brought about torrential rains and storms, and their increasing severity and frequency tends to compound the damage.

Around the world, global warming has shown its effect. Climate change has led to heavy rains, storms, and other full-scale damage in many countries. Large global cities are working to introduce new disaster prevention systems, to prepare themselves for climate change and remain safe. In South Korea, two thirds of the annual rainfall is typically concentrated during the wet season from June to September, usually in the form of monsoons, typhoons or torrential rains. The increasing volume of precipitation has led to an increase of intensity, and this tendency is clearly found during the summer months, which is why it is all the more important to prepare for potential disasters prior to the season. To be able to respond to extreme weather changes, Seoul has also improved its disaster management at the ground level. The paradigm was shifted to adopt more fundamental preventive measures and establish/execute an evacuation and restoration system so that the city could protect its citizens and their property and preserve urban functions.

To ensure that its flood disaster policy vision is consistently maintained, Seoul checked its disaster prevention system every time there was a major flood (in 1984, 1987, 1990, 1998, and 2001) and came up with mid- to long-term countermeasures to supplement the existing system. However, the city is seeing more extreme weather conditions and localized torrential rains, which inevitably leads to reduced conveyance, increased areas with impervious surfaces, changes with the drainage system, and inland flooding due to a reduced base flow. Over time, extreme weather conditions have become a common occurrence, while the extent of flood damage increases in scale. The inland flooding in the city caused by the torrential rains of 2010 and 2011 was the turning point after which the city decided to review its drainage and disaster prevention systems. Unlike other times, the heavy rains in July 2011 fell at a rate of 100mm per hour, which was more than the city's capacity to handle. Some of the low-lying and riverside areas were flooded. Rain continued for a long time, weakening the ground and causing landslides. The annual maximum daily precipitation (300 mm) had already been exceeded, which

wreaked havoc in its localized and concentrated form. This tendency is expected to worsen. Seoul therefore aims to adjust its existing disaster prevention plan to be more responsive to and ready for extreme weather conditions, and has been directing its focus on the improvement of the system to become better prepared for potential flooding in the city.

Flood Control Policy to Date

(1) Flood Control Policy

In 1984, 1987, 1990, 2001, 2010, and 2011, Seoul experienced major flooding caused by torrential rains. To minimize the damage from a recurrence, the city has been repairing and improving its flood prevention facilities since the 1990s, including the river embankments, rainwater pumping stations, and sewage facilities. Pursuant to the Basic River System Improvement Plan, the design flood volume was calculated and the design flood elevation was assigned by points. The levee height was determined based on levee clearance, depending on the significance of the river stream (national rivers with a frequency of flooding 100 – 200 years and local rivers, 50 – 100 years). The existing sewer pipes in Seoul were designed for 10 years' (main) and 5 years' usage (branch), and between 10 and 30 years for the retarding basin and drainage pumps. To upgrade the capacity lifespan in the vulnerable areas to 30 years, Seoul is working to upgrade the design standards for the sewage and pumping stations while installing rainwater reservoirs and other facilities to reduce the storm water runoff.

(2) The Restoration Plan of 1998

The flood damage in 1987 and 1990 was amplified by intensive rainfall over a prolonged period of time, which increased the runoff, which in turn increased the cumulative inflow to the retarding basin. The existing facilities did not have sufficient capacity for such prolonged precipitation. The drainage systems on higher ground overflowed with the abrupt onset of torrential rain flowing into the receiving reservoir. This in turn resulted in flooding in the low-lying areas. The reduced conveyance of the sewage pipes did not help either. Seoul therefore spent KRW 456.855 billion from 1999 to 2003 for the Restoration Plan of 1998, made up of some 369 projects in 6 different sectors such as river, sewage, and pumping stations. From 2002 to 2007, KRW 315.434 billion was spent pursuant to the 2001 Revision to the Restoration Plan of 1998 to execute 113 projects in 3 sectors – river, sewage, and pumping stations.

(3) The 4-year Flood Control Improvement Plan of 2007

The record rainfall in July 2001 wreaked havoc on Seoul. From 2002 to 2005, KRW 680 billion was spent to build more rainwater pumping stations, reinforce the river embankments, and expand the sewage system to be prepared for future flooding. In the meantime, global warming continued to cause extensive damage around the world. Typhoon Rusa (870㎜/day) in 2002, Typhoon Maemi (550㎜/day) in 2003, and Typhoon Nari (556㎜/day) in 2007 each set new records. The city had to heighten the capacity of its flood control facilities.

Fifty-two rainwater pumping stations were improved to the 30-year frequency. To ensure their safety, the electrical facilities of 111 rainwater pumping stations were doubly-reinforced. Some 28 km of segments along the embankments of 13 streams, such as Uicheon, were fortified to keep the overflow in check. Twelve dilapidated bridges that could impede the water flow were removed and/or rebuilt. The sewage systems were upwardly adjusted to achieve 10 – 30 years capacity in intervals. They were also repaired according to their age to ensure their stability and safety.

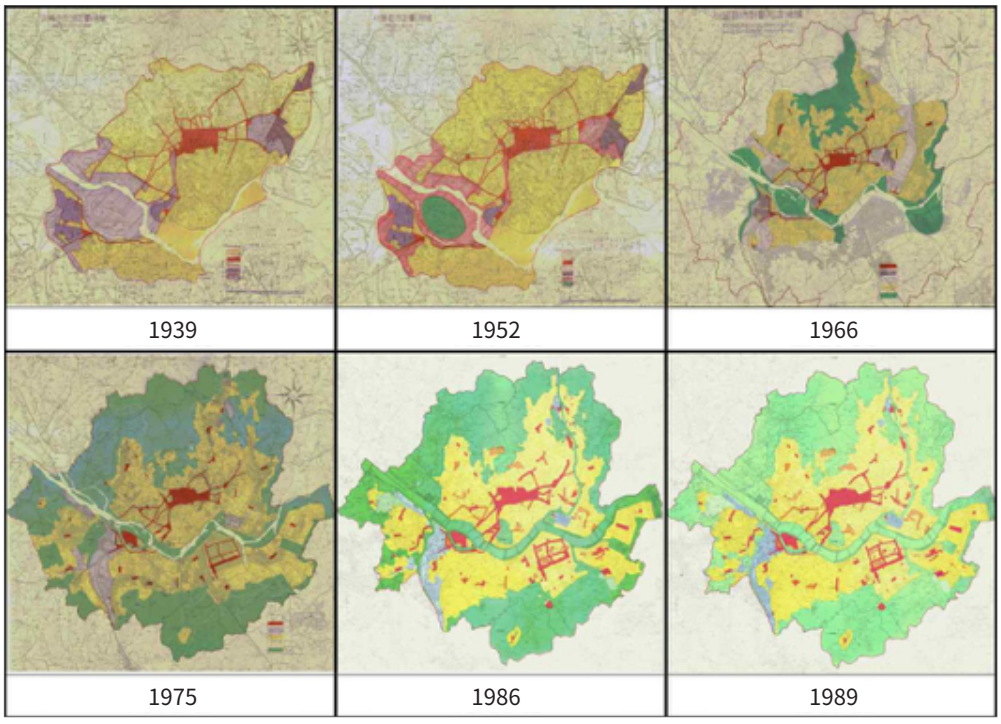
Increasing Flooding & Damage due to Urbanization and Climate Change

(1) Urban Development & Change in Size

The growth of Seoul accompanied the concentration of population and their assets. In Joseon Dynasty, the built-up area was confined to and around the walled city of Hanyang. By the time of Japanese colonial rule, Yongsan, Itaewon, and their vicinity were developed into a Japanese army post. The Japanese population slowly formed a village to the south of Cheonggye Stream –called Namchon ('South Village') – after the Korean seaports opened their doors to the outside world, and this area became the new center of commerce and business.

The 1960s was marked by rapid industrialization and urbanization, propelled by the first and second 5-Year Economic Development Plans. The concentration of population became even more accelerated, and the city's urban planning districts were expanded to include the areas northeast and south of the Han River, or 'Gangnam'. In the 1990s, the influence of Seoul spread and became even more far-reaching, and the city gradually shifted from its growth-oriented urban development policy to a sustainable urban development approach.

Figure 1 - Changes in Seoul's Urban Development



(2) Increasing Population & Growing Percentage of Impervious Surfaces

The population growth of Seoul picked up speed after the Korean War. According to Statistics Korea, the population surpassed 1.57 million in the 1955 census; by 1960, it was over 2.44 million. Up until 1970, the city's rate of population growth stayed at over 50% on an annual average. After that, the population continued to grow at 10 – 20% each year until 1990 until, by the early 1990s, the population was around 10 million.

In 1980, the city center was 240.35㎢, about 39.71% of the total area. By 2010, it grew to 349.65㎢ (57.77%). Farmland and forested areas were reduced from 115.96㎢ and 147.21㎢ respectively in 1980 to 22.09㎢ and 144.75㎢ in 2010. As of today, the arable land is 27.80㎢ (4.59%) of the total area (605.21㎢) of Seoul. The forested area is 145.62㎢ (24.06 %); the lot area is 216.54㎢ (35.78%), and other areas account for 35.57% (215.25㎢).

Figure 2 - Changes in Farmland and Built-up Areas in the Past 30 Years

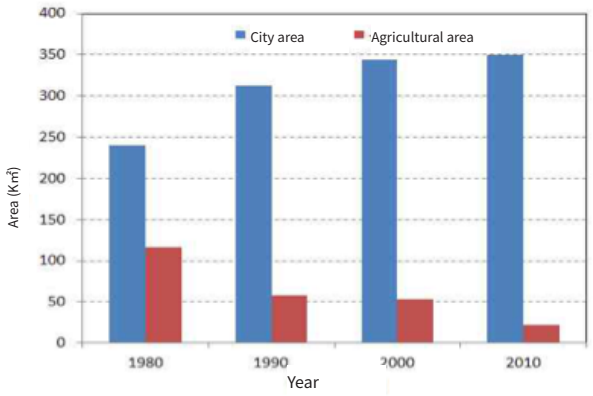
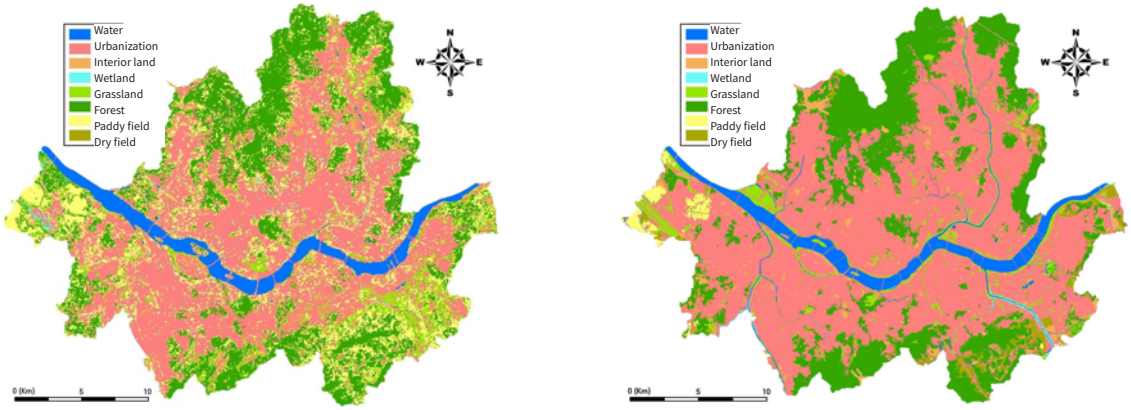


Figure 3 - Changes in Land Use in the Past 30 Years



(3) Climate Change & Increasing Torrential Rains

For the last half century (1962 – 2011), Seoul's average annual precipitation was 1,429.5㎜. The period between 1962 and 1971 was 1,498.4㎜, while recently (2002 – 2011) it has increased by 115.3㎜ to 1,613.7㎜. The annual rainfall in 1966, 1990, 1998, and 2010 was over 2,000㎜, but was 1,000㎜ or less in 1962, 1973, 1982, and 1988, which shows quite wide fluctuations. By season, the rainfall in the summer was 720.0㎜ (1972 – 1981), going up by 44.3% to 1,038.8㎜ in the period 2002 – 2011. In the winter, it dropped from 74.8㎜ to 62.1㎜ (17.0%), making

it more vulnerable to flooding from summer rains. In the last 50 years (1962 – 2011), there were 6.5 days with precipitation of 50㎜ or more; between 1962 and 1971, it was 6.5 days, while it was 7.8 days between 2002 and 2011, up by 1.3 days. The number of days with precipitation of 80㎜ or higher was 3.0; it was 3.3 between 1962 and 1971, going up by 0.7 to 3.9 days in 2002 – 2011.

Table 1 - Changes in Precipitation by Decade for the Past 50 Years (1962 – 2011) in Seoul

Category		1962 – 1971	1972 – 1981	1982 – 1991	1992 – 2001	2002 – 2011
No. of Rain-days	50mm or more	6.5	5.3	6.7	7.5	7.8
	80mm or more	3.3	1.9	2.6	3.5	3.9

With the frequency of downpours increasing, the years 2010 and 2011 saw unprecedent
ed and relentless torrential rains. Seoul is unique in that the increase in the number of rain-days is not significant, while its annual precipitation is steadily rising. This indicates that the intensity of precipitation could grow, intensifying any flood damage. Generally, precipitation of 30㎜ or more per hour (a potential risk for disaster) happened 158 times in the last 50 years, which is an average of about 3.4 times per year. It was highest (14 times) in 1998; between 1962 and 1971, it happened 36 times, going up to 41 times in the period 2002 – 2011.

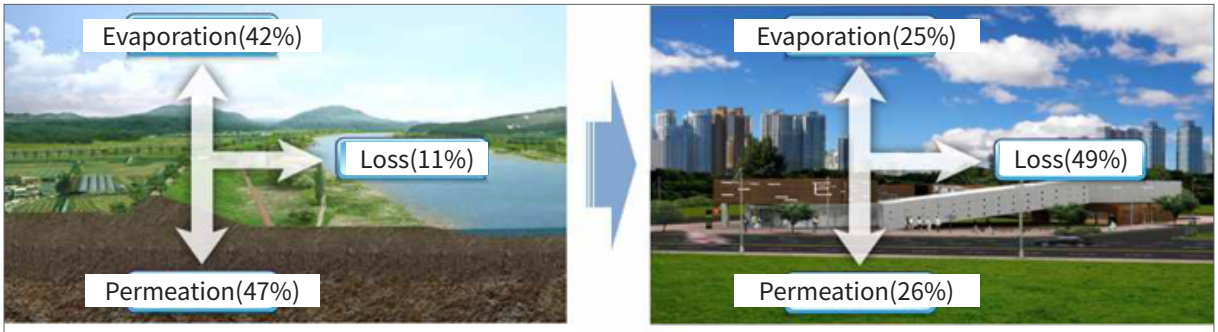
Table 2 - Occurrence of Torrential Rains (30㎜ or More per Hour) in Seoul

Category	1962 – 1971	1972 – 1981	1982 – 1991	1992 – 2001	2002 – 2011
No. of Rain-days (30mm or more per hour)	36	11	27	41	41

(4) Increasing Runoff due to Changes in the Impervious Surface Area

From the 1970s to the 1980s, there were no systematic measures to prevent flood disasters in the sites and commercial districts developed near the water and in low-lying areas. Some 40,000 out of 350,000 households living in basement units were located in areas vulnerable to flood risk. The loss of natural grounds in the city area reduced the permeable green zones under which water could be recharged. Naturally, the increasing area of impervious surfaces and pavement overloaded the drainage facilities. In Seoul, the impervious area went from 7.8% in 1962 to 47.7% in 2010. Surface runoff also jumped proportionately, from 11% (1962) to 49% (2010).

Figure 4 - Changes in Water Circulation due to Changes in Impervious Surfaces over the last 40 Years in Seoul



<Seoul City in 1962 (Before urbanization)> <Seoul City in 2010 (After urbanization)>

(5) Formation of Low-lying Areas

In flat areas or low-lying basins, the catchment of rain or storm water or the introduction of storm water from higher ground usually causes flood damage. In low-lying areas near a river, the effect of backwater, (combined with many other reasons), prevents the storm water from being expelled. For this reason, across Seoul, in a downpour of 40 – 60㎜ per hour, there are a number of areas that have a high risk of flood.

Figure 5 - Flat Basin

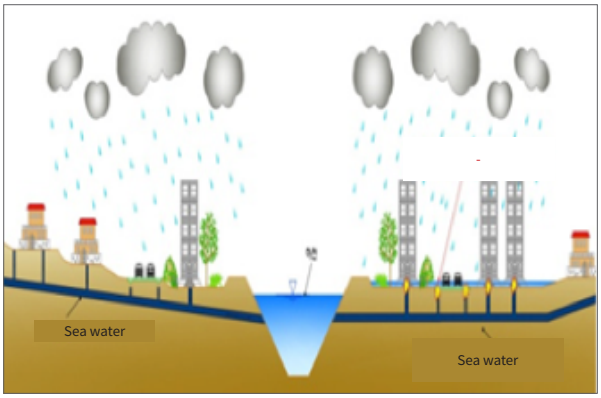
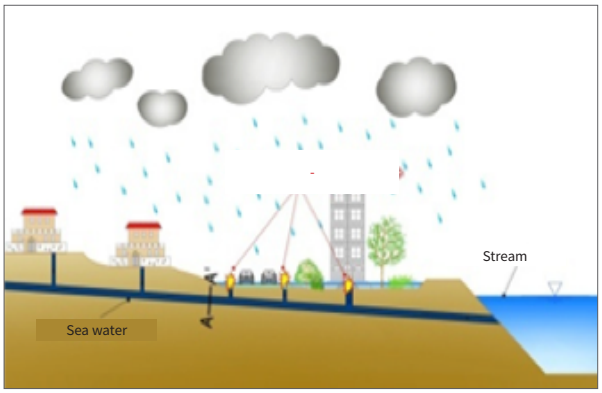


Figure 6 - Effect of Backwater



Frequent Flood Damage due to Torrential Rains

Extent of Flood Damage due to Torrential Rains

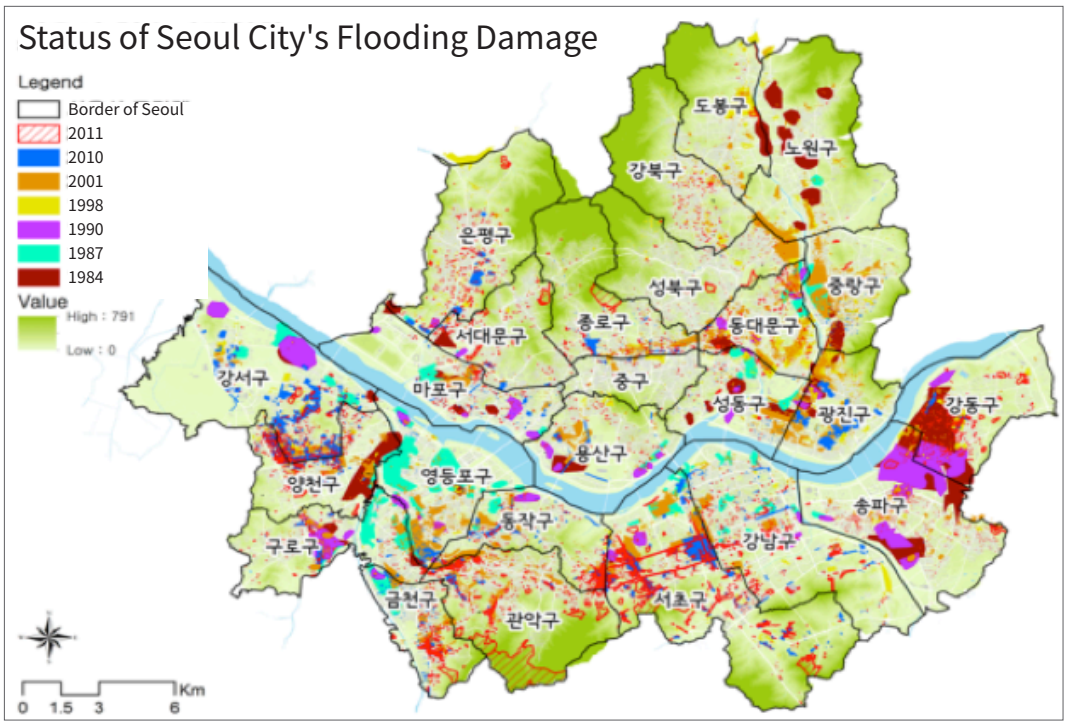
Unprecedented torrential rains fell in 2010 and 2011. The following gu districts suffered damage both years: Jongno-gu, Yangcheon-gu, Gangseo-gu, Guro-gu, Geumcheon-gu, Dongjak-gu, Gwanak-gu, Seocho-gu, Gangnam-gu, and Gangdong-gu[17] . The annual loss was KRW 2.867 billion/year from 1965 to 1980, amplified 3.5 times to KRW 9.983 billion/year between 1981 and 2010. Into the late 1980s, the frequency and extent of flood damage grew steadily. In terms of the damage from building flooding, 2001 was the most serious year, followed by 1998, 1984, 1987, and 2010.

Table 3 - Major Flood Damage from Torrential Rains in Seoul

Damage Period & Precipitation	Major Cause of Flooding	Damaged Areas	Damage
1984 (8.31 – 9.2, 335㎜)	Gate destroyed at the Mangwon retarding basin, Seongnae Stream flooding	Major floods in Pungnap and Mangwon, Seongdong, Dobong, Gangseo, Gangdong, Mapo, etc.	Casualties: 43 Flooded Buildings: 34,905 Losses: KRW 20.3 billion
1987 (7.26 – 27, 352.1㎜)	Insufficient capacity at retarding basin and pumping stations	Guro, Gaebong, Mangwon, Shinjeong, Banpo, etc. Gangnam Express Bus Terminal area	Casualties: 38 Flooded Buildings: 17,603 Losses: KRW 15.6 billion
1990 (9.9 – 11, 486.2㎜)	Torrential rain at upstream Han River; Insufficient capacity at pumping stations	Major floods in Seongnae and Pungnap; Floods in the low-lying areas from the Banpo and Jungnang Streams	Casualties: 36 Flooded Buildings: 21,599 Losses: KRW 22.5 billion
1998 (7.31 – 8.18, 1,237.8 ㎜)	Rising flood elevation; Insufficient capacity at pumping stations	Flood from Jungnang Stream (Nowon, Dobong, etc.); Landslides in Ui-dong, Jingwan-nae-dong	Casualties: 19 Flooded Buildings: 40,251 Losses: KRW 51.4 billion
2001 (7.14 – 15, 316㎜)	200-year interval torrential rain; Insufficient capacity of the sewage system	Flooding from Dorim Stream (in Gwanak, etc.)	Casualties: 35 Flooded Buildings: 94,375 Losses: KRW 43.976 billion
2010 (9.21, 259.5㎜)	98.5mm/hr (Gangseo) 233mm/3hr	Most areas in Seoul, except for Dobong-gu and Nowon-gu	Casualties: none Flooded Buildings: 17,905 Losses: KRW 42.877 billion
2011 (7.26 – 28, 587.5㎜)	113mm/hr (Namhyeon) 203mm/3hr	Landslide at Umyeon Mountain in Seocho-gu and major floods in Gangnam area	Casualties: 16 Flooded Buildings: 14,806 Losses: KRW 30.769 billion

17. Seoul Metropolitan Government, 2011 Flood Disaster White Paper, 12p.

Figure 7 - Major Flooded Areas in Seoul (1984 – 2011)

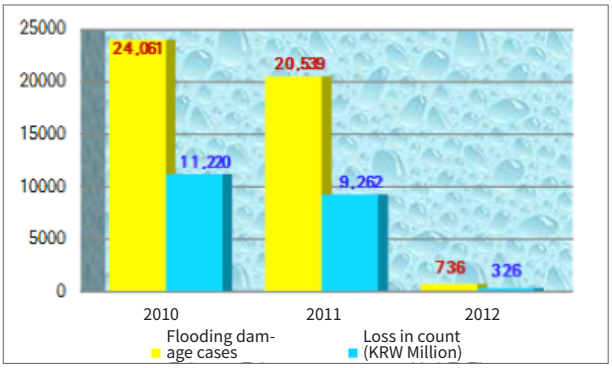


Causes & Types of Flood Damage

(1) Flooded Basement Housing in Low-lying Areas

There are 300,000 basement housing units in the city, with 40,000 of them are located in flood-prone low-lying areas. The sewer pipes for basement housing are installed lower than the public sewage system, and they regurgitate when it rains. Furthermore, a massive volume of storm water was also introduced into the low-lying areas, and the surface runoff flowed into the basement housing.

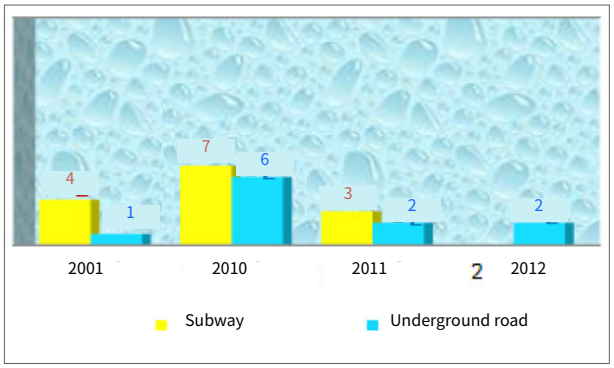
Figure 8 - Flooded Basement Housing



(2) Flooded Underground Facilities

With the urbanization of Seoul, the city's underground system (subway and underground motorways) was aggressively developed and is heavily utilized. However, these systems are extremely vulnerable to flooding when they are located in low-lying areas. When flooded, the subway in particular has a direct impact on the citizenry as the flooded tracks and stations cannot be used; the service could also be discontinued due to blackout, or transportation to the flooded area could be severed.

Figure 9 - Flooded Underground Facilities



(3) Flooded Roads

Riverside roads are usually flooded due to rising river elevation, but in recent years, there has been an increasing number of floods in the low-lying areas of the city, caused by the lack of storm water facilities and insufficient capacity for sewage in the event of heavy rains. The number of flooded roads near the rivers and in the low-lying areas was 33 in 2010, 28 in 2011, and 7 in 2012, all requiring traffic control.

(4) Flooded Rivers

When the rain exceeds the capacity of the design or there are facility interruptions to the flow of the river, the river elevation rises and ultimately causes flooding in the riverside low-lying areas. The effect of backwater in particular reduces the capability of the sewage system to expel the inland flooding, further aggravating the damage.

(5) Landslides

On the lower part of a slope, the weakened foundation due to prolonged rain collapses and the earth slides down, potentially killing people and destroying property. On the hills in the city in particular, landslides could be worse due to the inadequate installation of ecoparks, walkways, and other artificial structures as well as the inadequate management of private land. Dilapidated stonework and retaining walls and mountain cut areas frequently collapse in torrential rains, but management is difficult as many of them are privately owned. In 2010, there were 33 landslides in Seoul. The following year, there were 50 landslides, including one on Umyeon Mountain. In 2010, building stonework and slopes collapsed in 4 locations, and in 31 locations in 2011.

Figure 10 - Landslide (Umyeon Mountain)

Figure 11 - Collapsed Stonework

(6) Casualties in River Valleys

Hillside valleys and riversides in the city are frequently used for picnics during holidays in the summer. However, in and around the smaller rivers and valleys, the water level can rise quickly after a short period of downpour, leaving people isolated and in danger. At times, the rapid torrents have taken lives. In 2010, 69 people were rescued from the river valleys; in 2011, 38 were rescued and 2 remained missing. In 2012, 8 were rescued.

Figure 12 - Flooded Stream (Dorim Stream)

Figure 13 - Evacuation

(7) Typhoons

A typhoon occurs when the warm air at a low altitude meets the vapor from the ocean and moves to a higher altitude, carrying with it strong winds and heavy rain. (In the summer, it brings heavy rain; in the autumn, it brings fierce winds). In 2010, Seoul was located in the danger zone to the right of the path of "Kompasu"; 20,000 trees fell, and an electric pole collapsed, cutting power to some 400,000 households.

Improvement of Existing Flood Control Policy

Reinforced Responsiveness to Torrential Rains

Seoul is unique in that the increase in the number of rain-days is not significant, while its annual precipitation is steadily rising, but this indicates that the possibility of a downpour can increase. In 2010 and 2011, 100㎜ of rain fell per hour, but this kind of heavy rain cannot be processed by the current facilities. In continuous heavy rain, as on July 27, 2011, the permeability of the ground is lost and runoff increases, seriously increasing the potential for disaster. Precipitation of 30㎜ or more per hour – a potential risk for disaster – has happened an average of 3.4 times a year over the last 50 years, and the number has jumped by 0.7 to 4.1 in the last 10 years (2002 – 2011). It happened 7 times in 2010, 8 times in 2011, and 9 times in 2013.

Table 4 - Extreme Precipitation due to Climate Change

Category	July 2001	September 2010	July 2011
Precipitation	99.5mm/hr (Jongno) 227mm/3hr	98.5mm/hr (Gangseo) 233mm/3hr	113mm/hr (Namhyeon) 203mm/3hr

※ Probable precipitation in Seoul (Ministry of Land, Infrastructure and Transport): 99.2㎜/hr (50-year timeframe), 243㎜/3hr (50-year timeframe)

Seoul's sewage system can process the 5-year frequency for the branch (65㎜/hr) and the 10-year frequency for the main (75㎜/hr). Currently, the aim is to upgrade the capacity to 10 years (75㎜/hr) and 30 years (95㎜/hr) respectively. When a sewage system is designed, it assumes that 35 – 40% of the precipitation is permeated or evaporated, but in prolonged rain, the permeability of the ground is lost and runoff increases. When the sewage system already has water from previous days of rain, the system will no longer be able to process the water and its conveyance will be significantly reduced. In Seoul, 16.6% of the sewage system is 30 years or older, and this also contributes to the reduced conveyance. The rainwater pumping stations are being upgraded from a 10-year to a 30-year frequency, but as of today, only 49 out of 111 rainwater pumping stations have been upgraded to that 30-year frequency (95㎜/hr).

Urban Development Designed for Disaster Prevention

Rapid urbanization gave rise to the expansion of impervious areas. In addition, basement housing in the low-lying areas and the inadequate provision of systematic disaster prevention planning also left the city vulnerable to flooding. In the 1970s and '80s, developers moved from the built-up areas into the undeveloped low-lying areas for site and land development (Banpo, Jamsil, Cheonho, Amsa, Siheung, Gimpo, Seongsan, Shillim, Janghan-pyeong, Guro, Mokdong, etc.). The built-up areas had been developed without a careful design for rainwater pumping stations and other adequate storm water facilities, resulting in flooding in the low-lying areas. The loss

of natural grounds – green belts and farmlands – in the city reduced the permeable green zones under which water could be recharged. The impervious surface expanded in size, sending the surface runoff from heavy rain to the low-lying areas (runoff: 11% (1962) → 52% (2010) (impervious surface: 7.8% → 47.7% in the same time frame). Seoul in particular, has a heavy concentration of political, economic and other urban functions, and its underground space is heavily used. Flooding in the city would result in considerable loss as well as prohibitive costs and time for restoration.

Need to Move Basement Housing in Low-lying Areas

The development of the low-lying areas and the basement housing for low-income urban dwellers has left some 40,000 households exposed to flood risk. In these basement homes, floods occur even when the precipitation is less than the sewage capacity. This is because the water is regurgitated by the sewer pipes in the basement housing, which is installed lower than the public sewage system. In some areas, the runoff from the road surface flows into the basement through windows and doors. In many of these basement units, flood prevention facilities were not installed, and even where they were installed, they are not adequately managed due to lack of interest by the owner and on the part of the frequently-moving tenants. In the meantime, flood damage happens again and again.

Need for Responsiveness to Landslides

Landslides occur when a slope is made unstable by rain or other external factors and the weakened soil and rocks slide down. Due to the recent increase of heavy rain, Seoul has become more vulnerable to the risks of landslide. Landslides can happen as a result of natural causes (e.g., geography, soil, geology, planting, rain, groundwater, erosion, earthquake etc.), or artificially (e.g., land development or ground cuts). The damage is especially serious in those areas where the mountain torrents and cities meet, but as the mountains, roads, sewage, rivers, and such all entail different management plans, it is crucial to adopt a comprehensive system to manage landslides and ground foundation together.

Flood Control Policy for a Better Response to Climate Change

Paradigm Shift to Help Citizens Feel Safer

Seoul has accepted that the climate has changed as a result of global warming. Accordingly, it is working to change its flood control measures, which previously had been focused on building facilities for flood control, to become more prepared and responsive to floods by involving the citizens. Aside from reinforcing the disaster preventive infrastructure, the city works with the citizens to build a thorough system, such as the installation of flood gates to minimize damage. Flood gates and other small devices are distributed to basement units in

low-lying areas, commercial arcades, factories, and other buildings so they can protect themselves. For the first time in South Korea, the city worked with an online portal site (Daum Agora) to build a community map with flood data. This enables the citizens to use social networking such as Twitter to report or find out about flood situations in real time. At various rivers, the crisis management system alerts citizens to evacuate to safety in an emergency. The sewage elevation monitoring system is provided in the flood-prone low-lying areas, and the data collected is sent to a control room in real time to activate a flood or evacuation alert when necessary.

Flood Control Policies Adapted to Climate Change

There are 2 types of flood control measures: structural (e.g., sewage pipes, rainwater pumping stations, rainwater storage) and non-structural (e.g., rescue and evacuation). In preparation for rain that exceeds the design frequency, Seoul has reached beyond its government-led approach to adopt a comprehensive system that involves the private sector and non-structural measures.

Table 5 - Structural Measures for Flood Prevention

Category		Objective	Description
Maintenance and Expansion of Sewage System		· To enhance the flow in the sewage system	· Increase the number of pipes and capacity · Remove soil/sediments to enhance conveyance
Construction and Expansion of Pumping Stations		· To build and expand pumping stations to expel inland flooding	· In city areas where the catchment is small · In areas where it is difficult to expel the inland flooding
Flood Control		· To install flood control sites and retarding basins	· Store some of the flood water upstream of the areas where flood control policies are inplace (such as the inner city)
Flood-way Maintenance (Diversion Channel(s), Short-cuts, New Channels)		· To change the basin area to divert some of the flood water to other basins · To install flood control facilities and underground diversion channels	· This can be a fundamental way to prevent flood damage, but the excessive construction costs are an issue.
Storm water Run-off Reduction	Storage	· To minimize the flooding in the downstream area from the reduction of the flood peak	· On-site or off-site methods (to be determined) · On-line and off-line methods (TBD) · Dams, excavation, underground structures (TBD)
	Absorption	· To minimize the movement of rainwater to allow the rain to be absorbed where it falls	· Select the target areas · Select the installation locations

Table 6 - Non-structural Measures for Flood Damage Control

Category	Objective	Description
Flood Alerts (Flood Alert System)	· Establish and improve the Flood Alert System	· Improve the efficiency of the alert system to prevent flood damage
Storm & Flood Insurance	· Provide government compensation and benefits from private storm and flood insurance; provide more information about the insurance system	· As government compensation is limited and involves an extra tax burden, use of private insurance helps victims to be adequately and quickly compensated
Flood Maps	· Identify the flood-prone areas by frequency and establish an evacuation plan	· Lack of data from the past required to chart the map
Basin Management and Land Use Regulations	· Control flood and sediment runoff · Control land use and construction	· Migration, restriction on land use, expropriation, advance sale, purchase of development rights, etc. · Restriction of building extensions, mandatory installation of prevention facilities in flood-prone areas
Institutional Support	· Develop a disaster management organization and planning system · Support restoration and secure funding	· Establish plans for emergency prevention and response. · Provide support with disaster funds, storm insurance, etc.
Standards for Rainwater Use and Storm Water Runoff Facilities	· Develop standards for the installation of rainwater-related facilities	· Establish local government ordinances and a legal and institutional framework, and provide incentives

Disaster Prevention Programs Tailored to Local Needs

(1) Disaster Prevention Plan for Enhanced Responsiveness to Climate Change (2011)

After the major flood in 2010, a plan was established to invest KRW 669.3 billion for 4 years to upgrade the disaster prevention level of major low-lying areas to 95㎜/hour. When another flood hit in 2011, a comprehensive improvement plan was announced, investing KRW 5 trillion over the next 10 years to build an urban safety network for disaster prevention. The plan aims to shift the disaster prevention paradigm into a system that is more responsive to extreme weather conditions and to increase the financial investment for decreasing the number of flood-prone areas.

Table 7 - Disaster Prevention Plan for Enhanced Responsiveness to Climate Change (February 2011)

Category	Total	No. of Rainwater Pumping Stations		Improved Pipe (km)	No. of New Rainwater Storage Facilities	No. of Divided Watersheds	River Improvement (m)	Other Grit Chamber
		New	Expansion					
Programs	70	1	40	81	22	3	670	2
Cost (KRW 100 million)	6,693	115	2,500	2,281	1,140	543	87	27

Table 8 - Comprehensive Improvement Plan on the Urban Safety Network for Disaster Prevention (August 2011)

Category	Total	Enhanced Sewer Pipe Performance	Improved Pipe (km)	No. of Rainwater Pumping Stations	No. of New Rainwater Storage Facilities	River Improvement (m)	No. of Deep Underground Facilities	Steep Slope Management, etc.	Other **(State Funded)**
Programs		47 divisions	154	47	25	45	7	Landslides, etc.	Areas with potential disaster risk
Cost (KRW 100 million)	50,201	21,551	7,952	4,923	2,040	432	8,502	4,600	201

(2) Disaster Prevention Programs Tailored to Local Needs (2011 – 2014)

Seoul aims to change its old way of relying on physical expansion of the facilities and involve the general public in developing disaster prevention plans that are tailored to local needs. Various issues are addressed in the programs, such as problems with the existing sewage pipes, improved water reclamation for flood control, and small, distributed rainwater storage. To control the flooding in the vulnerable low-lying basin areas such as Shinwol (Yangcheon) and Hwagok (Gangseo), rainwater storage and drainage facilities have been introduced, along with other necessary facilities based on input from both experts and citizens.

Table 9 - Disaster Prevention Programs Tailored to Local Needs

Program Unit	Total (KRW 1 million)	2011	2012	2013	2014
Total (KRW 1 million)	687,428 (120,660)	70,160 (17,190)	177,461 (22,100)	240,107 (7,300)	199,700 (74,070)
Enhanced Conveyance of the Sewage System (158km)	410,670	70,160	112,410	125,900	102,200
Construction and Expansion of Rainwater Pumping Stations (41)	140,031 (86,350)	- (3,180)	17,341 (20,000)	57,790	64,900 (63,170)
Installation of Rainwater Storage Facilities (15)	104,926 (8,010)	- (8,010)	41,710	41,216	22,000
Improvement of Rivers (8.4Km)	28,801	-	3,000	15,201	10,600
Maintenance of Basement Homes and Development of a Disaster Management System	3,000 (26,300)	- (6,000)	3,000 (2,100)	3,000 (7,300)	- (10,900)

※ ( ): Disaster Management Fund

Outcome of Localized Flood Control Policies

Areas Where Citizens Feel Safer

(1) Fundamentals: Reinforced Facility Management

In the repeatedly-flooding areas, the sewage systems were upgraded and the disaster prevention facilities (e.g., rainwater pumping stations and storage facilities) were checked. Any installations or structures that impeded the water flow were removed, while temporary storage facilities were installed in areas where the existing facilities were insufficient. Before the end of June, when the rainy season begins, the sewage systems were dredged and the street inlets were cleared for improved performance. The street inlet covers were also removed beforehand to allow the runoff to dispel quickly.

(2) Small but Effective: Expansion of Small Facilities

Small facilities such as flood gates or check valves that are designed to prevent basement flooding are small and relatively inexpensive and yet their effect in minimizing the damage is excellent. To help citizens protect themselves, flood gates and water pumps were provided to the houses and stores located in flood-prone areas. Equipment that prevents the regurgitation of storm water from the sewage pipe was also installed. To expel rainwater from the roads into the sewage system, various types of street inlets were installed (curb openings, continuous grades, and traverses), taking into consideration the characteristics of each installation location. Flood gates were also installed to block the inflow of rainwater from the roads into basements.

Figure 14 - Installation of Small Facilities

(3) Careful Urban Planning & Management to Enhance the City's Overall Responsiveness

Upon development, the flood-prone areas must implement disaster-prevention measures. Flood gates and other facilities must be made mandatory for underground parking and other such facilities. In areas where flooding is a concern, there must be an effort to regulate the use of underground space for residences. Low-impact development (LID) should be adopted to reduce the effect of storm water and there should be adequate urban development and management guidelines.

Flood Control Policy

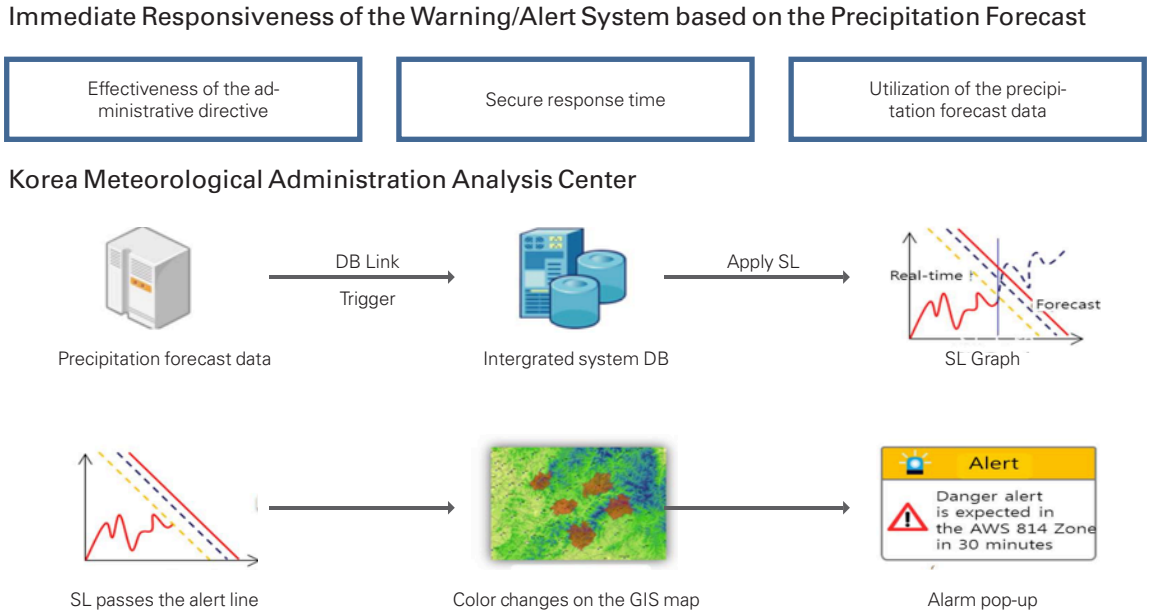
(1) Disaster Prevention Facilities to Improve City Response to Flooding

Recently, downpours have reached 100㎜ per hour, easily exceeding the capacity of the existing facilities. Flooding can also occur for other reasons, such as basin geography or rising backwater. Seoul has therefore upgraded its 10-year frequency to 30 years to be more prepared for the onset of extreme weather conditions. It seeks to improve its rigid, physical expansion-oriented approach and diversify its preventive measures and meet the unique needs of different districts with different geographical and environmental features. In the vulnerable areas, the river and sewage systems were improved and new rainwater pumping stations were built. As for the areas where the existing facilities are insufficient, rainwater storage and deep underground facilities were introduced. Because construction of deep underground facilities are prohibitive in cost and time (about 4 – 5 years), a feasibility study was conducted. These issues were discussed in depth with both experts and citizens to ensure that the measures were indeed effective in minimizing flood risk and damage.

(2) Stronger Disaster Response System Using the Latest Technology & Available Manpower

At various rivers, the crisis management system is available to prevent the risk of being isolated in a flooded area and help citizens to evacuate to an evacuation facility. A sewage elevation monitoring system is also established in the flood-prone low-lying areas to send the collected data to the control room in real time to activate a flood or evacuation alert when needed. The Central Disaster and Safety Counter-measures Headquarters supervises the disaster management and is comprised of the teams that operate the comprehensive situation room and various crisis management departments. It has an emergency contact system and monitors the weather and disaster situations 24 hours a day. When special warnings for heavy rain, typhoons, or other weather conditions are activated, the Headquarters initiates a 3-step emergency protocol and shares the relevant information with the Fire & Disaster Headquarters, local governments, and other pertinent authorities to allow them to take control of the crisis. Public servants are dispatched to the flood-prone areas to help minimize the damage. Disaster simulations and training sessions are also held to facilitate restoration and rescue missions during an actual crisis. There is also a safety governance system at the dong district level to encourage local governments to customize their own crisis management systems. An MOU was signed between the city and the gu district offices to facilitate rescue and restoration. At each gu level, they also signed an MOU with military troops to help them in crisis situations.

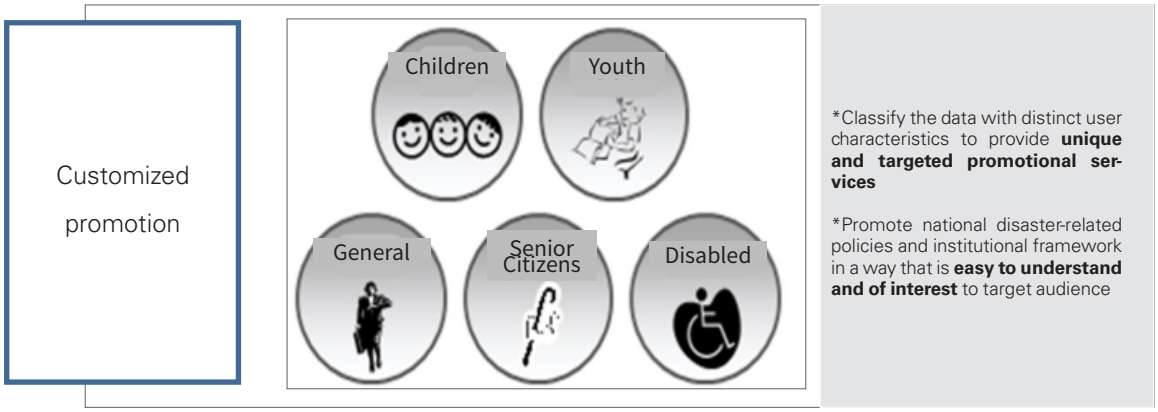
Figure 15 - Warning/Alert System Using the Precipitation Information



(3) Citizen Involvement in Disaster Prevention

Citizens can access a web-based community flood map and/or social networking to view the information on disasters and learn what to do in an emergency. They can see the damage in real time and share their ideas online. Public servants are dispatched to the flood-prone areas to help the citizens protect themselves. The public and private sectors work together to hold training sessions to ensure efficiency in rescue and restoration. Input from experts and citizens is encouraged, to identify the most effective and simplest resolution to flood damage. There is also a safety governance system at the dong district level. The citizens are encouraged to take part in the project of building a safe town, which is designed as part of the disaster prevention system. In the event of a crisis, the private sector, military, police, and all other available manpower and equipment are utilized for restoration and security. To operate this system, Seoul is developing disaster management governance that will involve all relevant authorities and private organizations.

Figure 16 - Safety Training and Promotion for Citizens



A City Enriched by the Natural Circulation of Water

Seoul adopted a water circulation system to restore natural water circulation and increase the amount of rainwater absorbed into the ground. This type of new rainwater management is critical as it eases the burden on the existing sewage system and rainwater pumping stations, and helps the city to be more prepared for urban flooding. In 2006, Seoul became the first city in South Korea to enact an ordinance on the management of rainwater. To date, the city has installed facilities that store and utilize rainwater, and plans to install more. Government offices are assisted in improving the permeability of road pavement and parking lots, and citizens are supported in installing small and simple devices that enable them to make use of the rainwater. The water circulation system is expected to reduce the 'heat island' effects and help the ground absorb and store the rainwater when it rains. This is all expected to help with the urban flooding issue.

Overseas Applicability

Applicable as a Policy to Adapt for the Future & for the Changing Climate

One of the main reasons for flooding in Seoul is that the torrential downpours in a concentrated period of time far exceed the design capacity of the drainage system, aggravated by the inflow of road surface runoff into the low-lying areas, insufficient sewage capacity and conveyance, inadequate slope, lack of pumping capacity, and reduced conveyance due to sediment runoff. Various flood control measures have been undertaken and improved to address many compounding issues: the road design that has not considered the extreme weather changes; underground arcades and other vulnerable areas in the land use; inadequate warning and alert systems; poor traffic control; lack of management for vulnerable districts and facilities; and inadequate restoration and follow-up systems.

The focus of Seoul's flood control policy is on adapting to climate change and enhancing the city's responsive-

ness to flooding. In order to achieve this goal, the city has improved its basic disaster prevention facilities and upgraded their 10-year frequency to a 30-year frequency. The city has also revised its rigid, physical facility-oriented approach to ensure that its policy is tailored to the needs of the local districts, each with different geographical and environmental features and vulnerabilities. Seoul has also reinforced its crisis response system of utilizing the latest systems and available manpower. It conducts simulations and training to facilitate the restoration process quickly in case of an actual incident. Citizens are encouraged to take part in the disaster prevention efforts In a crisis occurs, the private sector, military, police, and all other available manpower and resources are utilized to restore the damage as soon as possible. To operate this system, Seoul is establishing disaster management governance that will involve the relevant authorities and private organizations.

Seoul's flood control and countermeasures can be a reference model to other flood-stricken Asian countries. The collaboration with other developing nations at the city level could help those cities and their constituents to protect themselves and ensure their safety.

Application of Disaster Prevention Measures from the Beginning of Urban Development

Seoul has transformed its flood control policy to go beyond simple prevention to embrace the environment, urban planning and transportation aspects. Some of the main elements that affect flood damage in Seoul include precipitation, geography, land use, and the sewage system. The combination of these factors results in flood damage.

Due to climate change, torrential downpours intensify and become more and more frequent, easily exceeding the capacity of the drainage system. Naturally, the road surface runoff quickly floods the roads and districts, threatening the lives of the citizens and damaging their property. Because of potential accidents, congestion and other risks, it is crucial that the districts are structurally well-designed from the beginning, so as to ensure that the surface runoff from roads, buildings, etc. is stored for a certain time and then expelled without flooding. Furthermore, flood gates and other facilities must be made mandatory at existing buildings with underground parking and entrances. In areas where flooding is a concern, there is an effort to regulate the use of underground space for residences. As such, the cities and countries where development is underway could refer to Seoul's model to introduce the concept of disaster prevention where there are concerns of flooding, from the very beginning of urban development.

Disaster Management Governance Involving the General Public

In the past, Seoul mostly focused on building facilities and implementing government-led measures. However, that approach was limited in its effectiveness against extreme weather change, and the city needed a new paradigm.

Seoul developed a web-based community map showing flood data and utilized social networking (e.g., Twitter).

Citizens can access the map or social networking to view and share information on the disaster in real time and learn what to do in an emergency. There is also a safety governance system at the dong district level. Citizens are encouraged to take part in the project of building a safe town, which is designed to constitute part of the disaster prevention system. In case of a crisis, the private sector, military, police, and all other available manpower and equipment are utilized for restoration as quickly as possible, as part of the disaster management governance involving the relevant authorities and private organizations. With the help of the citizens and all the available manpower and resources, the flood damage could be minimized and the city could stay safe. This could and should be the underlying principle of flood control governance.

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4. Tap Water Inspection: Multi-Check Quality System

Writer : Seoul Institute Dr. Young-Ran Kim

Policy Area: Waterworks

Background to Tap Water Quality Management

Ttukdo Arisu Water Purification Center, the first modern facility of its kind in Korea, commenced operations in September 1908. From then until Korea was liberated from colonial Japanese rule, the water quality was examined in accordance with 14 parameters, such as turbidity, pH, hardness, and dissolved solids.

On March 11, 1963, the Regulation on Health Diagnosis & Hygiene was passed, setting new standards for water quality. New criteria for inspections and additional parameters were set to include ammonium nitrate and 28 other items.

However, the quality of tap water became the subject of controversy. In August 1989, it was reported by the media that tap water was contaminated with microorganisms and heavy metals. In 1990, trihalomethane and other disinfectant byproducts were found in the tap water. In the following year, phenol leaked from Doosan Plant in Gumi, contaminating the source water for the Nakdong River, where odor was detected in 1992. This succession of reports on contaminated tap water created profound distrust in the general public, who were convinced that all tap water was contaminated and was unfit for drinking. To reverse this distrust, efforts were made to prevent contamination, expand the scope of water quality inspection, and establish a systematic framework for those inspections. From July 1997, Seoul instituted 2 more of its own inspection criteria on top of the statutory parameters. Today, the city has 104 monitoring and 59 statutory inspection parameters. Beginning in 2014, new items are added each year, such as disinfectant byproducts and trace contaminants. Arisu, Seoul's tap water, is monitored and inspected in accordance with WHO (World Health Organization) guidelines and announced to the public as evidence of its safety.

Seoul instituted an algae alert system in 2000 to respond effectively to an increase of odor-generating algae at the water source. However, there have been cases where odor was detected in the tap water even though the algae alert was not activated. In addition to the algae alert system, Seoul introduced an odor alert system in 2012 to monitor geosmin and 2-MIB to react preemptively and proactively to odor-generating particles in order to keep tap water free of odor and bad taste.

As of 2014, there are 59 parameters in the statutory water quality inspection.

Introduction to the Policies

① Water source management ⇒ Ensures safety and quality at source (intensive management during dry and other vulnerable seasons).

② Purification management ⇒ Maintains the best possible purification quality (turbidity kept below 0.06NTU on annual average).

③ Supply-level management ⇒ Provides proactive administrative services (Arisu Quality Certification, etc.).

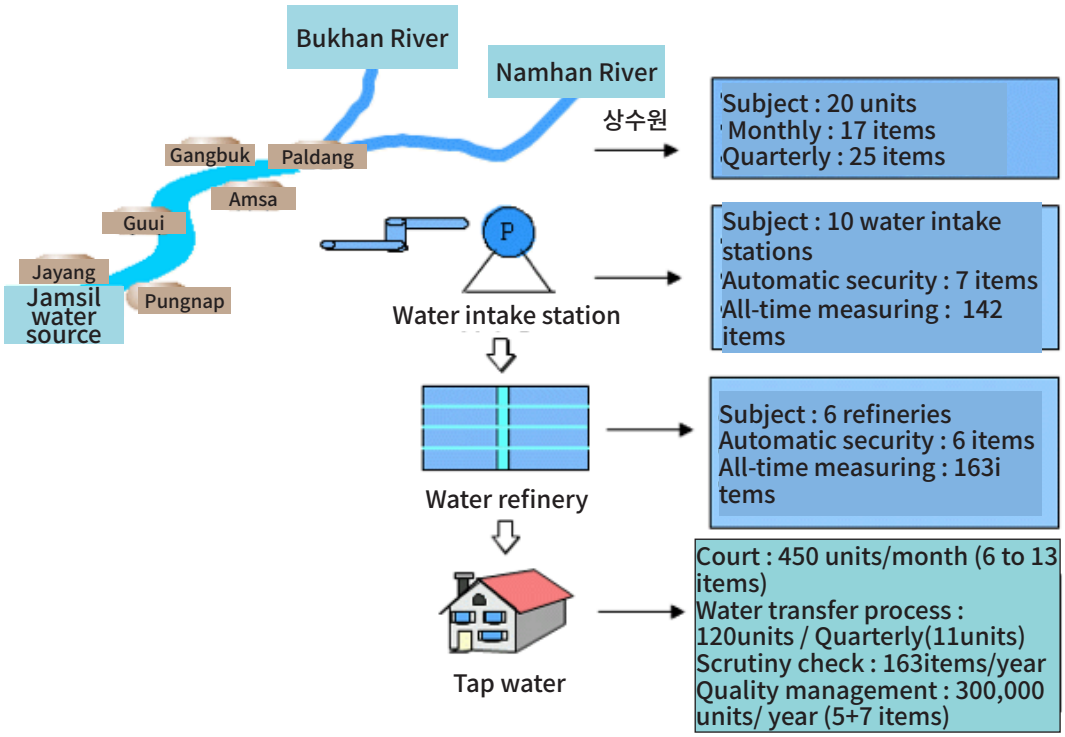
④ Inspection at faucet and supply level ⇒ Improves acceptability and quality of the tap water as felt by residents (inspection at faucet in 450 different locations).

⑤ Reduction of chlorine residue at faucet ⇒ Removes odor from tap water (chlorine residue maintained within the range of 0.1 – 0.3mg/L).

Process of Tap Water Management

Multi-check Quality Inspection System for Tap Water: Management at Water Source, Purification & Supply Process

Figure 1 - Water Quality Inspection at Water Source, Purification & Supply Process



Source: Internal data, Seoul Metropolitan Government

Water Quality Management at Source & Intake

Of the 6 purification centers in Seoul, Gwangam is the one that takes raw water from the Paldang Reservoir Protected Area (157.3 ㎢). The rest take their water from Jamsil Reservoir Protected Area (6.45 ㎢). Inspections are conducted on the main Han River stream and tributaries that affect intake points. Water quality is then forecast to ensure aggressive and proactive response to the source of any contamination and to safeguard the safety of the water.

Major water quality inspections at source and at intake are carried out by Seoul Waterworks Research Institute (WRI) and purification centers. Water measurements for such contaminants as phenol and ammonium nitrate, are done automatically in real time. The intake points at Gangbuk, Amsa, and Pungnap (Yeongdeungpo) operate a bio alert, constantly monitoring for contaminants such as heavy metals and domestic sewage.

Table 1 - Water Quality Inspection at Source & Intake

	Target	Total Parameters	Inspector	Inspection Frequency
Water Source	20 points (Namhan River: 5, Bukhan River: 5, Gyeongancheon River, tributaries from Paldang: 9)	42 parameters	WRI	Monthly: 17
				Quarterly: 25
Water Source	8 points: tributaries (6), main Han River branch (2) - Tributaries: Gungchoncheon River, Doshimcheon River, Wolmuncheon River, Deoksocheon River, Hongneungcheon River, Sangokcheon River - Main Han River branch: Amsa, Gueui	57 parameters - tributaries: 42 parameters -Main Han River branch: 15 parameters (15 overlapping parameters)	WRI	Monthly: 42
			Amsa, Gueui	Daily: 4
				Monthly: 11
Intake Point	3 points - Gangbuk: Green algae (closterium) (heavy metals, agricultural pesticide) - Amsa: Electrically active microorganisms (domestic sewage) - Pungnap: Water fleas (pesticide, heavy metals)	Bio alert	Gangbuk, Amsa, Yeongdeungpo	Real-time
Intake Point	6 intake points: Cyanide, phenol, NH3-N, TOC, temperature, pH, turbidity (chlorophyll-a)	Automatic water quality monitoring device (7 parameters)	Purification Center	Real-time
Intake Point	10 points (intake points: 6, Han River convergence: 4) - Namhan River: Bukpo-ri, Shinwon-ri - Bukhan River: Sambong-ri, Jinjung-ri	142 parameters - Statutory: 31 - Seoul: 111 (15 overlapping parameters)	WRI 135	Weekly: 21
				Monthly: 12
				Quarterly:73
				Yearly: 29
			Purification Center: 22	Daily: 10
				Weekly: 12

Source: Internal data, Seoul Metropolitan Government

Water Quality Management at Purification Centers

With an aim of managing the quality of purified water, turbidity is kept at 0.06NTU or lower (flood season: 0.1NTU or lower in turbidity), and the chlorine residue goal of each purification center is ±0.04mg/L. The turbidity of purified water at the processing level aims to achieve 0.3NTU or lower for 95% or more of the monthly measured sample. Goals for tasteless, odorless water are achieved through odor alerts and powdered activated carbon, etc.

Source water is inspected for quality to enable effective management at the purification processing level while ensuring sufficient disinfection concentration and management of filtered water turbidity, with the utmost effort made to produce tap water of the highest quality even in the most undesirable conditions.

Turbidity is one of the most important parameters in tap water inspection. It is managed 24 hours a day at each step of the process from injection of chemicals for purification. Management is adjusted according to season (dry weather, flooding, winter, etc.) to ensure optimal conditions for processing. The quality of tap water is inspected according to 163 parameters (59 drinking water parameters, 104 monitoring parameters), as strict as WHO guidelines. The inspection agency is the WRI, the highest tap water inspection authority in South Korea, and 6 purification centers, classifying the parameters daily, weekly, monthly, quarterly, and yearly. Results are disclosed to the public as evidence of the safety of the tap water.

Table 2 - Water Quality Management at Purification Centers

	Target	Total Inspection Parameters	Inspection Agency	Inspection Frequency
Water Source	6 purification centers	22 parameters	Purification Center	Daily: 10
				Weekly: 12
Purified	6 purification centers	23 parameters	Purification Center	Daily: 10
				Monthly: 13
Purified	6 purification centers 10 points (bottled water 1)	163 parameters (59 statutory, 104 monitoring)	WRI	Monthly: 63 (Statutory:59, Monitoring: 4)
				Quarterly: 61
				Yearly: 39
Purified	Inspection for new trace materials -Residual pharmaceutical compounds (3), industrial chemicals (3)	130 parameters (2014: 6 parameters)	WRI	Yearly

Source: Internal data, Seoul Metropolitan Government.

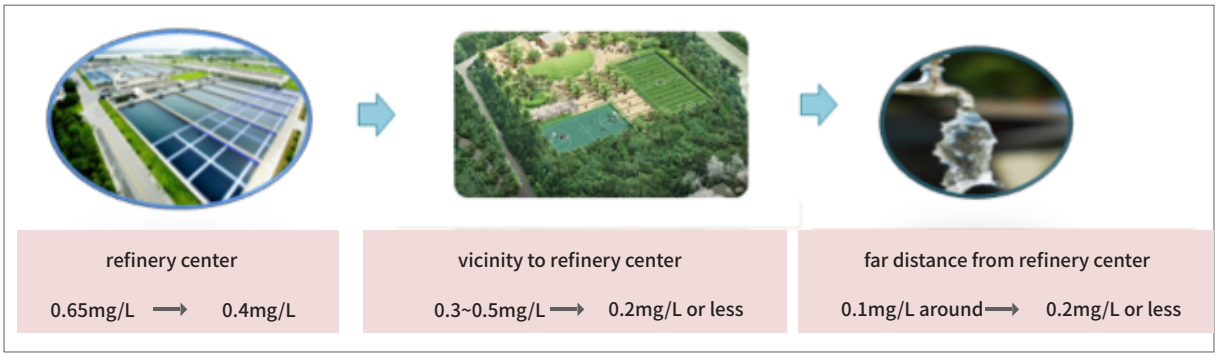
From Purification Center to Faucet

In the past, chlorine, one of the most influential factors on people drinking straight from the tap, was injected intensively at the purification centers. This resulted in complaints about the odor in the vicinity; there was also the issue of meeting the chlorine residue standards at the faucet. To resolve these issues, injected chlorine was reduced at Gangbuk and Amsa Purification Centers that supply to wider areas and a system introduced to inject it at the distributing points (17 locations) from 2012. The plan is to introduce the system in phases and maintain 0.1~0.3mg/L at the faucet.

The pipes in use are deteriorating and range from cast iron to galvanized steel to non-corrosive materials. They frequently leak and develop rust inside. The long use of uncoated cast iron and steel pipes left the inside of the pipes covered in rust, interrupting flow and reducing chlorine concentration. In April 1994, galvanized steel pipe was no longer permitted for waterworks. The City of Seoul plans to replace all pipes with a corrosion-resistant network by 2018.

Rooftop water tanks at apartments are a byproduct of the time-restricted water supply system of the past due to poor infrastructure. Because tap water was supplied only at certain hours, most of the water for domestic use was pumped, not directly, but from the underground tank to the rooftop tank. The water would stay in the tank for a prolonged period of time, resulting in the loss of chlorine residue. This could lead to degradation of water quality, including unhygienic storage. The city decided to take the direct supply approach without going through the water tanks. This increased the amount of chlorine residue (0.18mg/L) at the faucet, enhancing the quality and safety of the tap water.

Figure 2 - Reducing Disinfectant Odor (Chlorine)



Source: Internal data, Seoul Metropolitan Government

Water Quality Management at Distribution/Supply Level

Several inspection and management methods are adopted at distribution level to ensure that the quality and safety of the water produced at the purification centers is maintained when it is delivered to users. These include statutory inspections, inspections at each distribution and supply process, Arisu Quality Certification, and other such tests that involve resident participation. The city takes various measures to enhance satisfaction and reliability, and to encourage more to drink the tap water.

Table 3 - Water Quality Management at Distribution/Supply Level

	Target	Total Inspection Parameters	Inspection Agency	Inspection Frequency
Faucets	450 points (419 statutory + basic inspection points)	6 parameters (4 according to guidelines, 2 independent)	WRI	Monthly
Deteriorating Pipes	20 points	13 parameters	WRI	Monthly
Distribution & Supply Process	120 points (8 purification centers, 26 before and 26 after going through the distribution reservoir, 26 feeding points into the supply, 8 pumping stations, 26 pipe-ends)	11 parameters	WRI	Quarterly
Arisu Quality Certification	300,000 households	12 parameters (5 Phase 1, 7 Phase 2)	The Office of Waterworks	Constantly
Pumping Stations, Distribution Reservoirs	113 points (104 distribution reservoirs, 9 manned pumping stations)	Chlorine residual	The Office of Waterworks	Daily
	Automatic water quality measurements at 188 points	Turbidity, pH, chlorine residual, temperature, conductivity	The Office of Waterworks	Real-time (Disclosed on SWN)
Distribution Reservoirs	104 points	12 parameters	The Office of Waterworks	Quarterly
Before Release (After Construction)	Distribution reservoir, pumping station, water pipe	4 parameters (2 pipe repair works)	The Office of Waterworks	Constantly
Water Pipes & Tanks	1,079 points (water pipes)	7 parameters	The Office of Waterworks	Yearly
	12,089 points (tanks)	6 parameters	Private drinking water quality inspection body	Yearly
Arisu Drinking Fountains	2,674 points (30,807 fountains)	5 parameters	The Office of Waterworks	Monthly: metro/subway Quarterly: schools, government office buildings
Monitoring Parameters	25 locations (1 per gu district)	163 parameters (59 statutory + 104 monitoring)	WRI	Yearly (September)
Chlorine Residual Monitoring	By water system of the purification center, at 90 faucets (2013)	Chlorine residue	The Office of Waterworks	Weekly

Source: Internal data, Seoul Metropolitan Government

Multi-check Quality Inspection for Major Particles: Trace Particles & Algae Alert System

Trace Particles

In addition to the 163 parameters, Seoul set 130 parameters for other items (6 more added in 2014), mostly comprised of endocrine disruptors, unregulated chemicals, agricultural pesticide, and carcinogenic substances, to identify any new trace particles in the annual inspection.

Algae Alert System

To reduce the source of odor in tap water, an algae alert system is activated when blue-green algae are identified at the water source, after which the water can be treated accordingly. In 2012, the algae alert was activated for a total of 15 days at Upstream Point 1 of Jamsil Reservoir. From 2000 to date, 6 algae warnings were issued at Han River segments in Seoul. The effects of green algae include odor, water toxicity, and damage to water purification devices, etc. Along with the algae alert system at Jamsil, Seoul introduced an odor alert system for odor-generating substances – geosmin and 2-MIB – in 2012. The city has been able to respond proactively to such substances, thereby effectively reducing odor before the water reaches the tap. When an alert is issued due to significant amounts of algae and odor generating substances, water inspections increase in frequency from weekly to daily, accompanied by various purification measures (injecting powdered activated carbon, stopping the injection of chlorine before the intake points and injecting it after PAC treatment at the purification centers), in order to minimize odor before the tap water goes into the supply pipes.

Table 4 - Algae Alert System (Issued after 2 Parameters are Breached 2 Consecutive Times)

	Algae Warning	Algae Alert	Serious Algae Alert
Chlorophyll-a Concentration (mg/)	15 or above	25 or above	100 or above
Blue-green Algae Cell Count (Cell/mL)	500 or above	5,000 or above	106 or above

Table 5 - Odor Alert (Reflects Purification Process Effectiveness)

Odor-Generating Substances	Odor Warning	Odor Alert	Serious Odor Alert
Geosmin (ng/L)	20	500	1,000
2-MIB (ng/L)	20	50	100

Source: Internal data, Seoul Metropolitan Government

Multi-check Quality Inspection System: Arisu Quality Certification, Selection & Management of Water Quality Monitoring Parameters, Private-Public Monitoring, General Monitoring

Arisu Quality Certification

Seoul inspects tap water quality at production and supply level. At major points the inspection is conducted automatically, sending the results in real time to the Seoul Water-Now System and website for public disclosure. While the safety of the tap water is thus proven, some citizens who drink from the tap are anxious about rust from old piping. Seoul therefore offers the Arisu Quality Certification service by visiting citizens at home where they can take part in the water quality inspection. This system helps them identify the problems and the service is provided until a solution is found. It has successfully earned the public's trust in the quality of tap water in Seoul.

Selection & Management of Industry-Best Water Quality Monitoring Parameters (104 Parameters)

The Ministry of Environment and relevant institutions work together to build a legal framework and institutional measures to ensure tap water quality and aid in management of purification, such as the Water Supply & Waterworks Installation Act. In addition to water quality inspections as required by this Act, Seoul adopted 104 of its own water quality monitoring parameters based on the relevant City of Seoul Ordinance, actively improving its activities based on the necessary legal and government systems.

Private-Public Water Quality Monitoring

Pursuant to Article 30 of the Water Supply & Waterworks Installation Act and the City of Seoul Ordinance, an advisory group – the Seoul Tap Water Assessment Committee consisting of external city councilors, professors, and environmental experts – is organized for a monthly meeting. Samples are directly taken from 10 points – from intake points to the faucet of 2 purification centers – and sent to a private inspection body appointed by the Committee, where they are analyzed in accordance with the 59 statutory parameters, and the results disclosed on the Seoul Metropolitan Government and the Committee websites to earn the public's trust.

Monitoring at Major Points

The chlorine residue level is checked daily at 113 distribution reservoirs and pumping stations. There are automatic measurement devices at 188 points to ensure adherence to 5 parameters, including turbidity and chlorine residue, in real time. The results are disclosed on the Seoul Water-Now (SWN) System.

Major Achievements

Supply of Healthy, Safe Water

Seoul's water quality inspection and management is a systematic process that covers start to finish, from water source to production to supply at the faucet. The city delivers tap water that is safe and healthy, and complies with WHO guidelines with the 163 parameters in water quality inspections as well as with the 130 parameters concerned with unregulated trace particles in the annual inspection. The city is aware that odor is the biggest reason people avoid drinking from the tap and has therefore adopted the algae and odor alerts that are activated upon detecting odor-generating substances or algae at the water source. This preemptive action has helped the city detect and remove odor-generating substances. To reduce chlorine and disinfectant odor, Seoul injects chlorine at the distribution reservoir, limiting the chlorine within the guideline range of 0.1 – 0.3mg/L. When more advanced water purification facilities are completed and adopted by all 6 purification centers in Seoul by 2015, the city will be able to drastically reduce odor and taste-generating substances in the tap water.

Implications & Applicability in Developing Countries (Repercussions)

Seoul endeavors to maintain the safety of the raw water at its source at Paldang Reservoir and constantly monitors for contaminants at intake points. Raw water is analyzed by the purification centers in accordance with various parameters as stringent as WHO guidelines. Seoul's odor alert, the first in South Korea to respond proactively to increases in algae, as well as the at-faucet inspection called the Arisu Quality Certification, distributed chlorine injection, and monitoring and analysis of trace particles are all part of the multi-check approach adopted by the city to supply safe, healthy tap water to its residents. Each year, research topics are selected and studied by each purification center, and the outcome presented in workshops where the issues and improvements are examined for other cities and developing countries to refer to.

Q&A

Why take a multi-check approach in producing tap water?

Paldang Reservoir, Seoul's water source, is not algae- or contaminant-free, making it necessary to conduct statutory inspections and monitor water quality across the whole process, from source and intake points to purification centers and distribution and supply points, so as to ensure safety of the tap water supplied to some 10 million people.

How were the quality standards developed for Arisu?

In South Korea, the drinking water standards govern the amount of microbes, harmful inorganic and organic substances, disinfectants and disinfectant byproducts, and substances for aesthetic considerations. The parameters are usually determined by the amount that would not be detrimental to health for an ordinary person drinking 2L of water daily for 70 years, with the additional consideration of a safety factor of 1/100 – 1/1,000. This means that drinking water that meets the standards will not be detrimental to human health.

How are the water quality monitoring parameters selected and what is their basis?

Pursuant to Article 26.3 of the Water Supply & Waterworks Installation Act, tap water quality inspections are reinforced by selecting specific parameters on such contaminants as: i) trace particles that are harmful and are highly likely to be detected in the annual inspection or the city's inspections; ii) those that have become the subject of social controversy and need to be tested; and iii) those that have caused problems in the international community and may be found in South Korea as well. The inspection standards, methods, etc. are in compliance with WHO regulations and examples from other countries (30 parameters selected by the Ministry of Environment and 104 parameters by the City of Seoul (including the monitoring parameters from the Ministry of Environment)).

How were the Healthy, Taste-Free Water Guidelines developed?

Since May 2010, various activities have been undertaken such as studies by research institutes, tasting events, public polls, public hearings, and expert advisory meetings, etc. The Guidelines were developed and completed in December 2010

Table 6 - Healthy, Taste-Free Water Guidelines

	Substance/Measurement	Unit	Drinking Water Standard	Guidelines	Why Selected
Health	Minerals (Ca,Mg,Na,K)	mg/L	-	20 – 100	· Vital for human health
	Total Organic Carbon	mg/L	5.0 (Seoul's monitoring parameters)	1.0 or lower	· Disinfectant byproducts removed to protect health
	Turbidity	NTU	0.5	0.3 or lower	· Microbes (protozoa, viruses, etc.) removed to protect health

Taste	Chlorine Residue	mg/L	4.0	0.1 – 0.3	· Disinfectant odor
	2-MIB	ng/L	20 (Ministry of Environment's monitoring parameters)	8.0 or lower	· Generates moldy odor
	Geosmin	ng/L	20 (Ministry of Environment's monitoring parameters)	8.0 or lower	· Generates dusty odor
	Copper	mg/L	1.0	0.05 or lower	· Gives a bluish tinge to water
	Iron	mg/L	0.3	0.05 or lower	· Gives a reddish tinge to water and gives off metallic odor
	Temperature	℃	-	4 – 15	· Fresh, crisp drinking temperature

References

· The Office of Waterworks, Seoul Metropolitan Government, http://arisu.seoul.go.kr/

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· Ministry of Environment, 2008, The 100-Year History of Waterworks in Korea.

02

Transportation

1. A Guide to Transportation Policy

Writer : Seoul Institute Dr. Joon-Ho Ko

Policy Area: Transportation

Development of Transportation in Seoul

As a major city and the capital of South Korea, Seoul has undergone various stages of change with its transportation system over the passage of time. In the 1400s, streets were structured in and around the area within the four ancient city gates (the current city center) where most of the travel was by pedestrians. When tram and bus services were introduced in the late 19th century, urban functions spread beyond the boundaries of the city, modifying or expanding the existing street systems and continuing to change the city's transportation system until the Korean War (beginning in 1950) when most of the infrastructure and facilities were destroyed. However, the War presented an opportunity to revamp the urban transportation system while rebuilding infrastructure, but this was lost as an explosive growth in population and the consequent unmanaged urban development created structural deformity. This has led to chronic transportation problems in Seoul, some of which continues today.

Since the ceasefire, Seoul has endeavored to keep pace with the rapidly growing economy and trends changing the paradigm of transportation policy. War in the 1950s wreaked havoc on the nation, and the capital was captured and recaptured several times, with more roads, bridges, and other urban facilities razed to the ground each time. During the rest of the decade, one of the pressing matters, understandably, was to restore the city from the ashes and reopen the bridges and road networks. In the next decade, the nation set up a framework for self-sustainable and independent growth pursuant to the government's economic development plan. The speed of urbanization in Seoul and other cities accelerated, and the population inflow to Seoul grew. From the perspective of transportation policy, public transport was urgently needed. The city's transportation policies of the time were mostly such agendas as providing 100 buses to carry students to school every day, introducing express buses, increasing the number of bus services, and suspending operation of the downtown tram.

The 1970s was marked by noticeably significant growth of the scale of the Korean economy. With more and more of the industrial workforce flowing into the industrialized capital, overpopulation was inevitable, as were the accompanying problems. Transportation policy in the 1970s focused on addressing congestion in public transport and the city and building more roads and bridges. Subway Line 1 was opened in 1974, heralding the age of underground transportation, and new policies were introduced to disperse traffic volume. In 1971, the traffic control center was launched at the police agency in Seoul as part of the effort to take a scientific approach to resolving transportation issues. At the same time, intersections and signal systems were modernized.

Based on the remarkable economic growth up to that point, Seoul was quickly urbanized in the 1980s, to a level similar to cities in more advanced countries. It was also a period when more people began buying and driving their own cars. By 1989, the Transportation Systems Management (TSM) program was implemented. Urban expressways and bridges continued to be built. After a decade of Subway Line 1, Lines 2, 3, and 4 followed between 1984 and 1985. To strengthen the public transit system, the bus system was fully reorga-

nized.

The 1990s was a time of major contrasting changes: economic growth that pushed the national per-capita income up to $10,000 and the financial crisis that resulted in aid from the IMF. Nonetheless, urbanization progressed rapidly. The population in Seoul and its vicinity accounted for nearly half of the total population of South Korea. Housing, water, and power were serious problems, but transportation also surfaced as one of the most serious issues. The focus of Seoul's transportation policy at this time was on improved public transit to ease congestion and on pursuing a transportation demand management policy. Major measures included the initiation of the congestion impact fee, opening of Subway Lines 5 – 8, comprehensive mid- to long-term parking plans, transportation demand management system for companies, and the 1-10 Road Space Rationing Program, etc.

In the 2000s, discussions were held on congestion due to the steady increase of vehicles, air pollution from exhaust, and high accident rates that did not match the nation's goal of joining the ranks of advanced countries. The key global agenda of the time was sustainable development, and Seoul modified its transportation policy in line with this trend. To bring sustainability to the transportation system, Seoul brought in various measures such as revising the public transit system, introducing a center bus lane, strengthening the transportation demand management policy, introducing a car sharing service, and providing assistance with electric car purchases.

History of Transportation System Construction by Period

1. Pre-modern (1394 – 1945)

Major Changes in Public Transport in Seoul

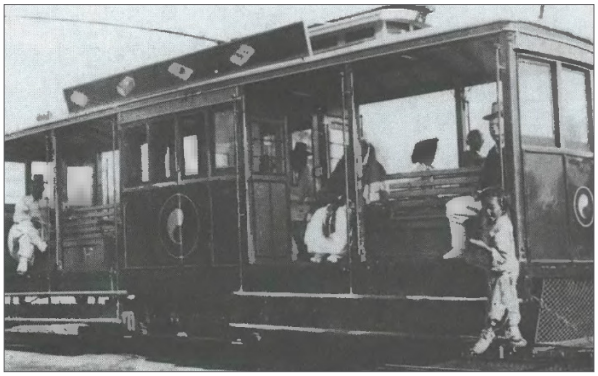
From 1394, when Seoul became the new capital, to the time when Korea finally opened its ports to the outside world, the transportation system was pedestrian-oriented. Within the boundaries of the four ancient city gates, the street networks were in a grid pattern according to the specific geographical features of the city: a network of streets flanking the three wide roads was the main route of travel. In 1426, a system was introduced to sustain the city's role as the capital and as an exercise of the dynasty's authority, dividing the road network into small, medium, and large roads. When Korea opened its doors to the outside world in the late 19th century, a new, modern mode of transport was brought in, altering the city's transportation system altogether: electric trams. These vehicles ran on tracks on downtown roads. Then, in the early 1900s, rail was introduced to provide arterial transportation between regions.

The tram was an innovative novelty. Starting with the 8 km leg connecting Seodaemun and Cheongnyangni in 1899, the tram quickly changed the pattern of travel, which had been mostly on foot. The popularity of this fast, convenient mode of transport grew, and the tracks were extended. Until the tram was completely removed in 1968, it was the main mode of public transport in Seoul. The first tram was 8.7 m long and 2.5 m wide, with a capacity of 40 passengers. It had no specific stops; when a passenger requested it, the operator stopped the tram. Routes were added along the major arterial roads downtown, and by 1945, the number of passengers jumped to 500,000 per day: nearly half of the city's population used the trams.

Construction of the Road Networks in Seoul

Town planning in the 1910s and 1920s helped build or expand the road networks, which was how modern improvements to the roads began. The city walls and gates that separated the downtown space from the outside were torn down, and Seoul's administrative and spatial area was expanded. Systematic improvement of the roads began with construction of 28 roadways in 1912. By 1919, this number had expanded to a network of 42 roads, with 25 more by 1929. In 1936, plans were announced to build/expand 220 routes (1 wide road, 55 large roads, 164 medium roads) downtown pursuant to the Seoul Town Planning, laying the foundation for today's road networks in downtown Seoul. There were only 2 cars in the country in 1912, but by the late 1920s, this number had grown enough to begin a full-scale automobile transportation industry. By then, the automobile was the main mode of transport in Seoul. Most of the vehicles introduced during this time period were city buses and taxis, competing with the tram to attract passengers.

Figure 1 - Seoul Downtown Transportation before 1945



Source: City History Compilation Committee of Seoul (2000).

2. Tram-Oriented System in the Chaos of the Korean War (1945 – 1960)

Destruction of the Transportation Infrastructure

From 1950, the Korean War ravaged the nation. In the chaos, it was difficult for any kind of economy to be built or any urban infrastructure for that matter. GNP per capita was $40 in 1950, $65 in 1955, and $86 in 1960; people were in absolute poverty. After the War, aid from the international community helped rebuild road networks, and in 1957, the state route from Seoul to Busan was paved as part of a rehabilitation program and the 5-year Plan on Road Construction for Economic Prosperity was developed, which could not be put into action due to the lack of funds. In the meantime, Seoul's transportation system remained in its pre-modern form, and problems from the ever-growing population plagued the city. People were particularly distressed about transportation, but the government focused solely on building or rehabilitating roads. Society remained in chaos, with the government lacking funds to provide any other programs.

City Buses & Taxis as the Major Modes of Transport

People in Seoul relied mostly on the trams that traveled the major arterial roads, with, as mentioned, an estimated 500,000 people – nearly half the city population – using the tram daily. By late 1953, the city was home to more than a million people, and the demand for transportation grew louder. The existing tram system could not keep up with this growth, and the city buses and routes were added. In 1953, 230 buses traveled some 1.688 million km. They, along with the trams, shouldered the city's transportation system. Another important mode of transport after the War was taxis. In 1950, Seoul adopted a downtown taxi license system, and the shared taxis appeared. In 1957, 900 taxis were added to 24 routes, making them the third major mode of transport after trams and buses. Production of vehicles used as taxis began in 1956, after which the number of taxis exploded. By 1957, the industry had grown significantly, with 123 carriers operating 1,576 vehicles. This was a time characterized by the growth of the public transit system of trams, buses, and taxis, introduction of high-capacity means of transport, and vehicles operating along designated routes.

3. Public Transit Expansion & Discontinuation of the Tram Service (1960 – 1970)

Establishment of Road Plans for National Economic Development

The nation had one goal in the 1960s: economic development. At the beginning of the decade, the priority of transportation policy was on building nationwide railroads for industry. With motorways, focus shifted from building new ones to paving and widening the national route, and improving the flow and shape of the roads. In 1961, the Road Act was passed, providing a basis for the designation of state routes. In the early 1960s, the Act on Comprehensive Plans for Construction in the National Territory and the Urban Planning Act were key to national policy, alongside securing social overhead capital through establishment of a Ministry of Construction, or the like. Here, transportation assumed absolute importance.

Seoul had to next address the rapidly growing population and a transportation system that could not keep up. In 1960, a comprehensive transportation policy was developed, focusing on expansion of the public transit system (e.g., adding more buses and taxis) and extending the bus routes. In 1965, 301 buses on 10 routes were approved for the first express bus program in Korea. In 1967, the city took over operation of unprofitable bus services. At this time, Seoul adopted a bus-oriented urban transportation policy. As a result, buses accounted for 54.4% of the total means of transport.

Figure 2 - Traffic in Seoul in the 1960s

Source: Seoul Metro website.

Increased Number of Cars & Discontinuation of Tram Services

In the 1960s, the share of buses against the total means of transport continued to rise sharply. This caused the tram, the main mode of public transport in the city until the 1950s, to fade into history, finally being removed in 1968. It was argued that trams were slow and interfered with traffic flow, and people were more exposed to danger when boarding or alighting. It was also during the 1960s when the number of vehicles in Seoul gradually increased. In 1960, the number soared from 11,533 to 16,624 in 1965 and then to 60,422 by 1970. Most were buses or taxis, but the wealthy also began purchasing their own cars. By the late 1960s,

the government had set as a policy goal the building of roads between regions and embarked on the program in earnest. Following construction of the Gyeongin Expressway (Seoul – Incheon) in 1968, the Gyeongbu Expressway (Seoul – Busan) was opened in 1970. These two later served as the major drivers behind the rapid economic growth of the 1970s.

Table 1 - Share of Public Transport in Seoul (1965)

Buses	Taxis (Including Shared Taxis)	Trams
54.4%	26.20%	19.4%

Source: City History Compilation Committee of Seoul (2000), History of Transportation in Seoul

Table 2 - Major Transportation-Related Changes in Seoul in the 1960s

	Major Events
1960	Comprehensive transportation policy developed
1965	Express bus licenses approved for 301 buses running on 10 routes
1968	Tram services discontinuevd
1968	Gyeongin Expressway (Seoul – Incheon) opened
1970	Gyeongbu Expressway (Seoul – Busan) opened

4. Increased Number of Cars & Road Networks, Introduction of Subway during Period of Economic Growth (1970 – 1980)

Systematic Transportation Policy for Urbanization

This was a time when Korea had significantly industrialized and began SOC investment. The transportation system became ever more important to boosting economic growth, and had been continuously augmented since the 1960s. Expressways brought economic benefits such as a reduction of both time and costs associated with travelling, and out of these changes, phrases such as "one-day sphere" were coined. Road-related policies in the 1970s emphasized the importance of road networks that connected the major points of economic activity, such as major cities, industrial complexes, and ports.

In the meantime, the City of Seoul began more systematic development of transportation policy. There had been some previous effort to connect policies, but the Basic Design for Seoul Urban Plan (1977) provided a firm ground for a more comprehensive, long-term framework.

The First Subway System in Seoul (Metro Line 1)

By the 1970s, roads were relatively superior to the railway, in both quality and quantity. While the role of rail had diminished slightly, the City of Seoul used it to bring a new aspect to its transportation system. The tram,

a major pillar of public transport in downtown Seoul for nearly 40 years since the early 1900s, had been taken out of service in the late 1960s, and in the next decade, Seoul finally had its own subway system.

Policies to Improve City Bus Services

Due to poor management, bus services run by the City of Seoul ended up in debt, and were sold to the private sector and operated from 1972 to 1974. Management of the bus services had been rife with negligence, inefficiency, and the following of corrupt hiring practices. Under private sector management, these services became the leading mode of transport in the 1970s. Even when the first subway line opened in 1974, it only accounted for 6 – 7% of the use of transport until Line 2, 3, and 4 were built in the mid-1980s, while buses were responsible for a whopping 73% by 1974, indicating it was the preferred choice of the people.

As a way to improve operational efficiency of the transportation system, Seoul established a city traffic control center (1971) and developed plans to modernize intersections and signal systems (1973). In the late 1970s, the reversible lane system (1979) was introduced to arterial roads to improve traffic flow. From 1977, the Seoul Metropolitan Area Readjustment Plan was implemented in earnest, and the City of Seoul adjusted the city bus routes and installed electronic signal systems at 97 intersections within a 5km radius of the city center to keep pace.

Figure 3 - Subway Line 1: the First subway line in Korea (1974)

Source: Seoul Metro, "The 30 Years of Seoul Metro".

Table 3 - Major Changes Related to Transportation in the 1970s

Period	Major Policies
1971	City traffic control center launched
1973	Plan developed to modernize intersections and signal systems
1974	Subway Line 1 opened (construction started in April 1971)
1977	Basic Design for Seoul Urban Plan developed
1979	Use of reversible lane system decided

5. Motorization & Road Network Readjustment during Industrialization & Expansion (1980 – 1990)

Traffic Congestion Aggravated by Overpopulation

Development of the urban transportation system in Seoul in the 1980s was due more to external factors (industrialization, urbanization, development boom, inflation) than to policy. Urbanization particularly influenced the formation of a large built-up area, with Seoul's transportation policy only ancillary in nature, bent on connecting roads between large residential complexes and the city center.

The overpopulation that started in the 1980s only exacerbated the transportation problems. Some have described this as a vicious cycle: urban infrastructure is built, people populate the city, and the city again needs to expand its infrastructure. Seoul and other cities in the capital area became ever larger, and Seoul's transportation policy had to take a broader approach. In the late 1980s, the government built new cities near Seoul pursuant to its plan to supply 2 million housing units; Seoul had no choice but to focus on providing sufficient road networks connecting the new cities to the capital. In the meantime, explosive population growth and poorly-managed urban development intensified the transportation problems.

Sudden Increase of Cars & Response through Transportation Policy

The number of vehicles in Seoul skyrocketed from 200,000 in 1980 to 450,000 in 1985 and 1.2 million in 1990. Congestion worsened by the day, becoming a chronic problem across the city. The vehicle-to-road ratio in the late 1980s was around 19%, a significant jump from 11% in the 1970s and yet insufficient for the number of cars hitting the road.

Around this time, Seoul's public transit system was anchored by buses and the subway, with Line 2 starting service in 1984 and Line 3 and 4 in 1985. The subway carried 16.5% of the traffic that year, well on its way to becoming a key mode of transportation in the city. From the mid- to late 1980s, the city's transportation system transformed, thanks to international events such as the Asian Games (1986) and the Olympics (1988). In 1986, the Olympic Expressway was opened to connect eastern Seoul to its western half, and the major arterial roads, especially those in the eastern outskirts, also saw some improvement.

In short, the 1980s was a time of improvements to the transportation system, and ushered in the era of the subway and strengthened the transportation infrastructure as a whole in preparation for international events. Seoul began instituting transportation-related systems early with its Transportation Impact Assessment (1987) that estimates, and provides countermeasures for, transportation demand in line with construction of large facilities. By 1989, the TSM program was set in motion to utilize the existing facilities to manage demand, improve signals systems, and control parking, covering the major transportation axis in Seoul. Despite the multi-faceted nature of these efforts, criticism of transportation policy in the 1980s pointed out the failure to link each mode of transport and to optimize mobility, as policies on roads, the subway system, and other types of public transit were carried out independent of each other.

Table 4 - Major Changes Related to Transportation in the 1980s

	Major Policies
1984 – 1985	Subway Line 2 (May 1984) and Line 3 & 4 (October 1985) opened
1986	Olympic Expressway built
1987	Transportation Impact Assessment conducted
1989	TMS program implemented

6. Transportation System Restructuring in the City of Automobiles (1990 – 2000)

Construction of the Expressway Network

The number of vehicles registered in Seoul passed 1 million in 1990 and 2 million in 1995. Despite continued efforts to expand them, the road networks simply could not keep up with such drastic increase in demand. In the 1990s, congestion on major arterial roads continued to worsen. Seoul therefore augmented the infrastructure with major projects such as construction of urban expressways, arterial roads, and the expressway network connecting new cities in the capital area.

Basic Plans for Transportation System Improvement at Gu District Office Level to Mitigate Congestion due to Poorly Managed Urban Development

The local autonomous government system that had been adopted in the early1990s laid the foundation on which each gu district office could develop its own Transportation Improvement Program (TIP) and resolve transportation-related issues individually. Moreover, the district transportation improvement program by block unit had an enormous influence on improving the transportation environment in residential areas. In the meantime, transportation infrastructure was still insufficient, but the bulk ratio was set excessively high for large urban construction programs (e.g., redevelopment, reconstruction), compounding the congestion. In other words, the failure to consider the relationship between transportation capacity and influences on congestion resulted in development of large residential complexes which further worsened an already-bad transportation environment. In particular, development programs were pushed through whether or not financing for roads and transportation facilities had been confirmed. Naturally, transportation infrastructure continued to fail to meet demand.

Phase 2 Subway Lines

Subway lines continued to be built, and the share of traffic using the subway grew with the introduction of Phase 2 – Line 8 (1996), Line 5 (1996), and Line 7 (2000). According to the Seoul transportation census in 1998, buses and subway lines carried roughly the same number of people, but the subway had jumped from 6.8% in 1980 to 30.8% in 1998, while buses carried 29.4% that same year. Bus operators began feeling the pinch as their share decreased, which in turn affected the bus route services. In response, the City of Seoul

came up with a Comprehensive Plan for Bus Services (1997), but this was not followed through, and efforts to reorganize the bus system faded away.

Implementation of a Transportation Demand Management Policy

In the 1990s, a transportation demand management policy was adopted to ease congestion by discouraging vehicles from entering the city center. A "congestion impact fee" was introduced in 1990, seeking to impose the cost of traffic on owners of facilities responsible for congestion of an area. In 1995, a transportation demand management policy for companies was introduced to reduce congestion impact fees for those facilities that participate in programs to reduce traffic volume. In the same year, the 1-10 Road Space Rationing program began. From 1996, a "congestion charge" was levied on drivers using Namsan Tunnel 1 and 3.

Introduction of the Intelligent Transportation System (ITS)

Along with the transportation demand management policy, a new transportation system was introduced. This one steered away from supply-oriented policies and embraced advanced technologies (i.e., computers, electronic devices, communications, and automation) for use in transportation infrastructure and vehicles – the Intelligent Transportation System (ITS). In the 1990s, at the behest of the central and Seoul city governments, research was done on the ITS and pilot programs were developed. This system provides various services which allow more efficient operation of transportation facilities and infrastructure, along with useful information for users, ultimately to ensure safety and convenience. Subsystems in the ITS include a traffic control system that manages traffic flow on expressways and backbone network and a transportation information system that delivers relevant advance or real-time information to users of the roads. The FTMS (Freeway Traffic Management System) was introduced to the city's urban expressways in the early stages of the ITS program, and was comprised of: i) a ramp metering system that controls traffic at entry ramps to facilitate flow on the major urban expressways; ii) an incident detection system that quickly detects and processes information on accidents or events such as road construction; and iii) a transportation information system that provides data on urban expressway traffic and adjacent roads to drivers and system administrators at regular time intervals. A new signal transportation system, an automatic signal control system, and a bus arrival time system were also introduced.

Table 5 - Major Changes Related to Transportation in the 1990s

	Major Policies
1990	Congestion impact fee system introduced
1995	Transportation Demand Management system introduced for companies
1996	New subway lines opened: Line 7 (Oct. 1996), Line 8 (Nov. 1996), and Line 5 (Dec. 1996)
1996	Congestion charges introduced for drivers using Namsan Tunnel 1 and 3
1997	FTMS introduced on urban expressways

7. Paradigm Shift Towards a Sustainable Transportation System (2000 – Present)

Emergence of a New Paradigm – A Sustainable Transportation System

The enormous increase in the 1990s of the number of vehicles in Seoul could not be accommodated by the existing inefficient transportation infrastructure, and poor management of the public transit services made traffic congestion worse. More cars meant more exhaust, more air pollution, and more traffic accidents. Inconsistency in transportation administration systems also added to the bleak state of urban transportation in Seoul.

In the meantime, the rest of the world grew more conscious of the importance of preserving the environment, as proved in the Rio Summit of 1990. Since then, the concept of environmentally sound and sustainable development (ESSD) became a hot topic, with more interest in the environment as a whole and including the physical and even socioeconomic environments. Efforts were channeled to enhancing sustainability across various sectors, including the environment, energy, and the economy, with the concept embraced for transportation as well. The government of Seoul proposed various directions for its transportation policy in pursuit of sustainability, which include: a strengthened transportation demand management policy; restructuring of the public transit system; eco-friendliness in transportation policy; and improvements to the pedestrian environment.

Strengthening Transportation Demand Management Policy

Efforts were made to improve the transportation demand management policy put in place in the 1990s: the city improved the congestion impact fee program and the transportation demand management program for companies, while developing other programs (the weekly no-driving day, car sharing (Nanum-Car), better connectivity between modes of public transit) to better manage transportation demand. The Weekly No-Driving Day allows drivers to pick a day between Monday and Friday when they will not drive. Participation was high, reaching above 40% of all vehicles in Seoul. Participants were given incentives such as car tax cuts and discounts for parking in public lots. The car-sharing service was designed to discourage people from purchasing cars and facilitate car use by the low-income population that would not usually have such access. This program has grown in popularity recently. Measures were also taken to encourage the use of bicycles to get to areas serviced by public transit. Other policies included expansion of public transit routes.

Restructuring the Public Transit System

One of the most distinct transportation policies of this time was restructuring of the public transit system begun in July 2004, which aimed to enhance the quality of public transit services and make them efficient and logically. The most noticeable changes included: subway fares that varied according to distance traveled; fare integration; new transport cards; center bus lanes; and transfer points. Fare integration lightened the burden of transfer fare, changed the system of charging unreasonable fares for different downtown zones into one

based on the distance traveled same as in the zones outside the city, thereby encouraging more people to use public transit.

Eco-friendly Mode of Transport

As of 2008, the share of citywide energy consumption by the transportation sector in Seoul was second largest at 31.9%, following the residential/commercial sector. Road travel was responsible for 95.2% of greenhouse gas emissions by the transportation sector. Ever-increasing oil prices placed a backbreaking strain on residents, and eco-friendly cars became more attractive due to their lower consumption of fuel. In the late 2000s, the City of Seoul was aggressive in introducing these eco-friendly vehicles as a way to reduce carbon emissions by the transportation sector and to respond to the rising oil prices. As part of the policy, all city buses were switched to compressed natural gas (CNG), electric buses were used on Nam Mountain, and electric cars were offered through the car-sharing service.

Transportation Policy Oriented Towards Pedestrians & Public Transit

One of the differentiating features of Seoul's transportation policy in 2000 was the policy shift towards pedestrians and public transit. It was against this backdrop that overpasses were removed and a transit mall created. Overpasses, while facilitating traffic and city access, have long been criticized by residents as blighting the cityscape, isolating some areas from the rest of the city, and being detrimental to regional development. The city responded to these complaints by demolishing a significant number of these overpasses. After the Cheonggyecheon Overpass that connected the city's east and west was demolished in 2003, public demands grew even stronger for demolition of other overpasses throughout the city. In addition, introduction of a transit mall was discussed in June 2012, to accompany a new vision for the city which had as its slogan "Walk-Friendly Seoul". A transit mall is an area designated for pedestrians and public transit (trams, light rail, buses), strictly prohibiting access by any other vehicles. Starting with one in Shinchon in January 2014, Seoul is currently developing plans to create more across the city.

Table 6 - Major Changes Related to Transportation (2000 to the Present)

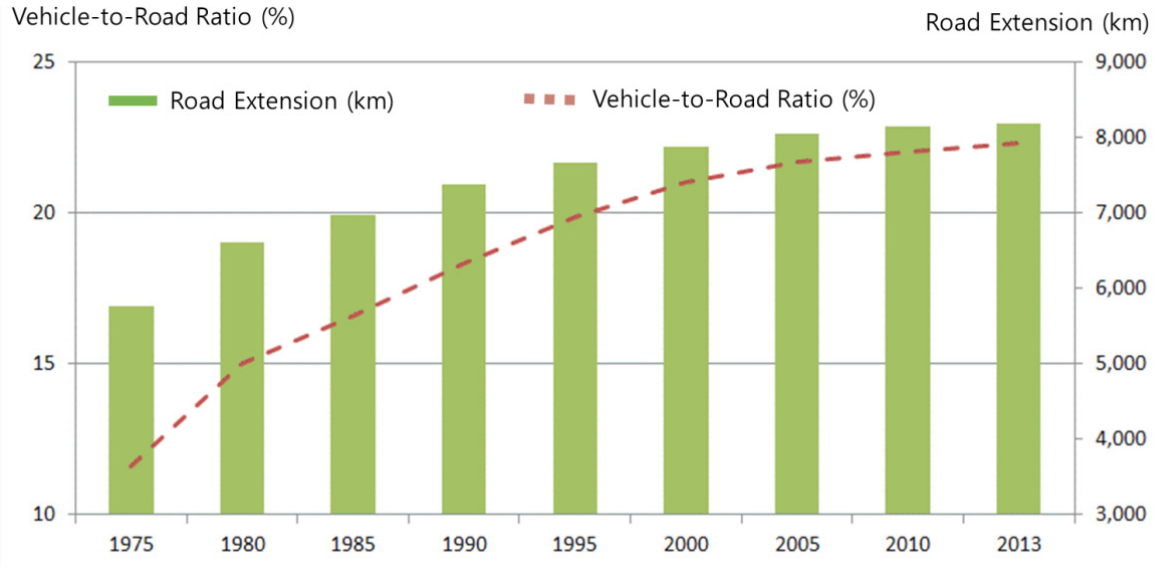
Period	Major Policies
2003	Weekly No-Driving Day program launched
2003	Cheonggyecheon Overpass removed
2004	City bus system restructured (bus system reform)
2007	Seoul Transport Operation & Information Service (TOPIS) implemented
2010	Eco-friendly electric buses begin operating on Nam Mountain (3 routes, 15 buses).
2013	Car-sharing services introduced
2014	First transit mall opened (Shinchon-ro)

Achievements of Seoul's Transportation Policy

Continued Road Expansion

The City of Seoul has continued to expand its roads to address the increasing population and number of vehicles while the city grew. As seen in Figure 4 below, roads expanded in Seoul by an average of 1.1% per annum over the past 40 years (1975 – 2013); as of 2013, the total extension was 8,198 km, with a vehicle-to-road ratio of 22.3%, higher than other major Asian cities such as Tokyo (15.8%) or Singapore (12.0%).

Figure 4 - Road Extension and vehicle-to-road ratio by Year

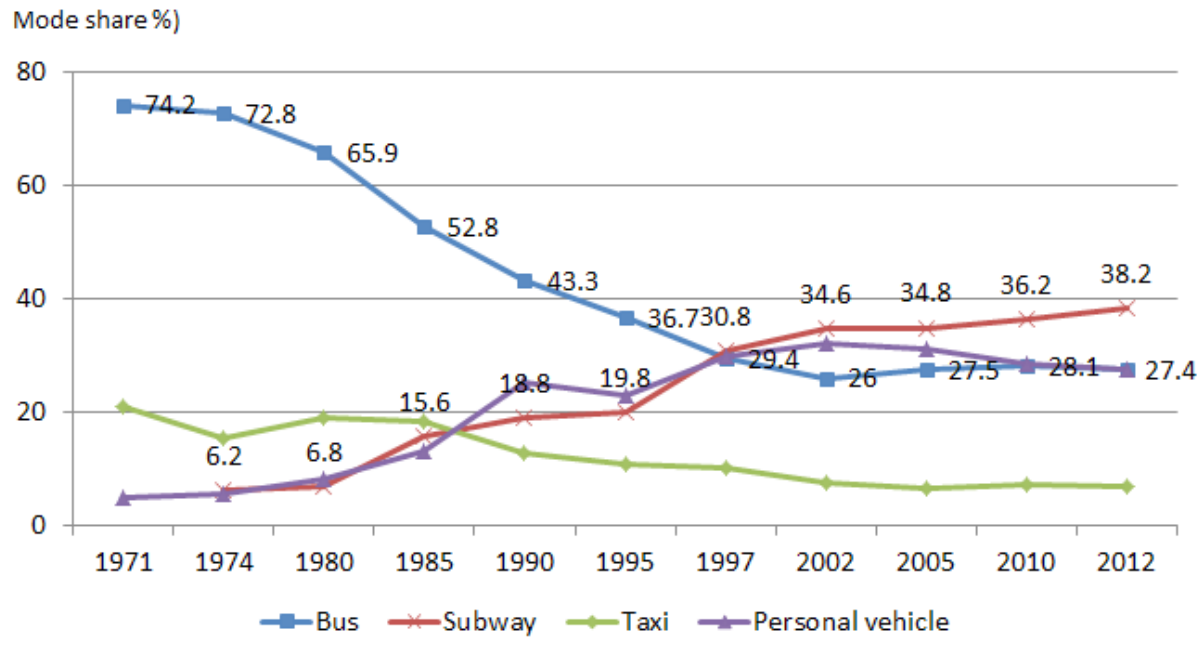


Emphasis on Public Transit

In the 1960s, the flow of people into the capital area accelerated and transportation demand grew even faster. The City of Seoul responded by developing transportation policies that focused on public transit, especially buses. However, this bus-oriented approach was not as efficient as expected in resolving the fundamental issues of congestion, spatial expansion of the capital area, and the rapid increase in transport users. The city worked consistently on expanding the city subway lines since opening Line 1 in 1974. By 1997, the subway began to surpass other modes of transport in terms of transportation share: as of 2010, the subway was carrying 2.4 billion people annually (refer to Figure 5). While the subway system carries a large number of people at high speed, significant amounts of time and financial resources are required for construction and expansion, making it harder for the system to respond immediately to rising demand. On July 1, 2004, Seoul decided to restructure its bus services to enhance connectivity to the subway and to maximize synergy. Bus routes leading to the subway system grew in use, and an integrated network of public transit was formed. More and more people began using transit cards, and management of revenues grew in transparency. Such

restructuring of the bus system led to improved air quality, shorter travel times, and increased safety, as seen in Table 7. Seoul's continued efforts to enhance its public transit system were recognized internationally for its use of innovative technology and effective policy, with the city receiving many international awards (Refer to Table 7).

Figure 5 - Transportation Share by Transport Mode & Year



Source: Seoul Statistics

Table 7 - Public Transit System Restructuring: Outcomes

	Performance Index		Achievement	
Speed	Travel Speed (km/h)		16.7 → 22.0	
Safety	Number of Accidents		659 → 493	
Affordability	Fare per Trip (KRW)		620 → 592	
Financial Management Transparency	Transit Card Use (%)		77.4 → 88.9	
Effect of Boosting Public Transit Use	Public Transport Share (%)		61.2 → 62.3	
Improved Air Quality	Fine Dust (PM10)	Carbon Monoxide (CO)	69 → 61	0.7 → 0.6
Reduced Cost	Reduced travel cost		KRW 225.1 billion less	

Source: Seoul Metropolitan Government (2006)

Table 8 - Public Transport Awards Won by Seoul

Year	Award	Awarded by
2006	The 2006 Sustainable Transportation Award	Institute for Transportation & Development Policy (ITDP)
2006	The 2006 UITP Award for Innovative Solutions	The International Association of Public Transport (UITP)
2007	EASTS Outstanding Transportation Project Award	Eastern Asia Society for Transportation Studies
2011	Golden Chariot Awards	Parliament of the Russian Federation, The Ministry of Transport, The Government of the Russian Federation
2011	UITP PTx2 Regional Award	The International Association of Public Transport (UITP)
2011	UITP PTx2 Showcase Award	The International Association of Public Transport (UITP)
2013	Local Government Award	The Intelligent Transportation Systems Society

Improved Air Quality

The steadily rising number of privately-owned vehicles led to greater greenhouse gas emissions and air pollution and deteriorated the urban climate, leading the city government to adopt different policies to improve air quality: limiting the use of personal cars, boosting public transit, and improving the pedestrian environment, etc., all as part of the drive towards energy efficiency and use of eco-friendly transport as the main mode of transportation. Continued efforts to make transportation policy kinder to the environment led to personal vehicle use falling in terms of transportation share and consequently increased use of public transit, shortening travel times and improving air quality. Fine dust – one of the most serious causes of respiratory conditions and a hotly-debated subject – was 60μg/㎥, higher than the normal level of 50μg/㎥ in 2004; this has dropped each year since, falling to 44μg/㎥ by 2013.

A "Smart" City

Seoul's transportation policies have made the city "smarter". Introduction of center bus lanes and transportation data devices at bus stops has enhanced speed, timeliness, and efficiency, and reduced overall costs, also sparking widespread use of smart cards. The new transport card system adopted by this megacity of 10 million+ people is praised by the international community as an example of successful reform of a transportation system. In addition, the car-sharing service accessible via smart phone provides a novel example of a smart transportation system.

Limitations & Implications

In the past, Seoul's transportation policy focused on road infrastructure, signal systems, pedestrian and vehicle overpasses, and other vehicle-oriented approaches to accommodate increasing demand for transportation. However, this led to a soaring volume of cars for personal use; transportation alone consumed 30% of all energy use in Seoul. Personal cars particularly accounted for 60% of all energy use in the transportation sector, not to mention a large percentage of air pollutant emissions. Older policies were introduced in an environment that did not allow citizens to have a say in their development, simply focusing on building large facilities and infrastructure, mostly uninterested in details of actual public demand for a better transportation system. In order to resolve these issues and achieve sustainability, Seoul will need to consider the following:
First, transportation policies need to shift their focus from individual transportation to people-oriented policies. Future policy needs to focus on providing infrastructure for the benefit of the public (pedestrians, bicycles, and public transit), while ensuring that effective transportation demand management (i.e., restricting the volume of personal cars) is warranted to place priority on creating an environment dedicated to pedestrians, bicycles, and public transit. The current system is mostly aimed at encouraging car ownership and development. This needs to change so that sharing transportation and preserving the environment are encouraged instead.
Second, a more systematic and environmentally-friendly transportation policy is key to improving the city's air quality. Collaboration between the city, the central government, the private business sector, and the people is critical to shaping the transportation system in this way. Under the auspices of the central government, Seoul needs to develop and systemize its own environmentally-friendly transportation policies and encourage private companies to help. Insistence on a city government-led approach is not the only answer to the problems: residents need to able to take part in the effort to transform Seoul's transportation system so that it preserves and even improves the environment.

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2. Seoul's Transportation Demand Management Policy

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Policy Area: Transportation Outline

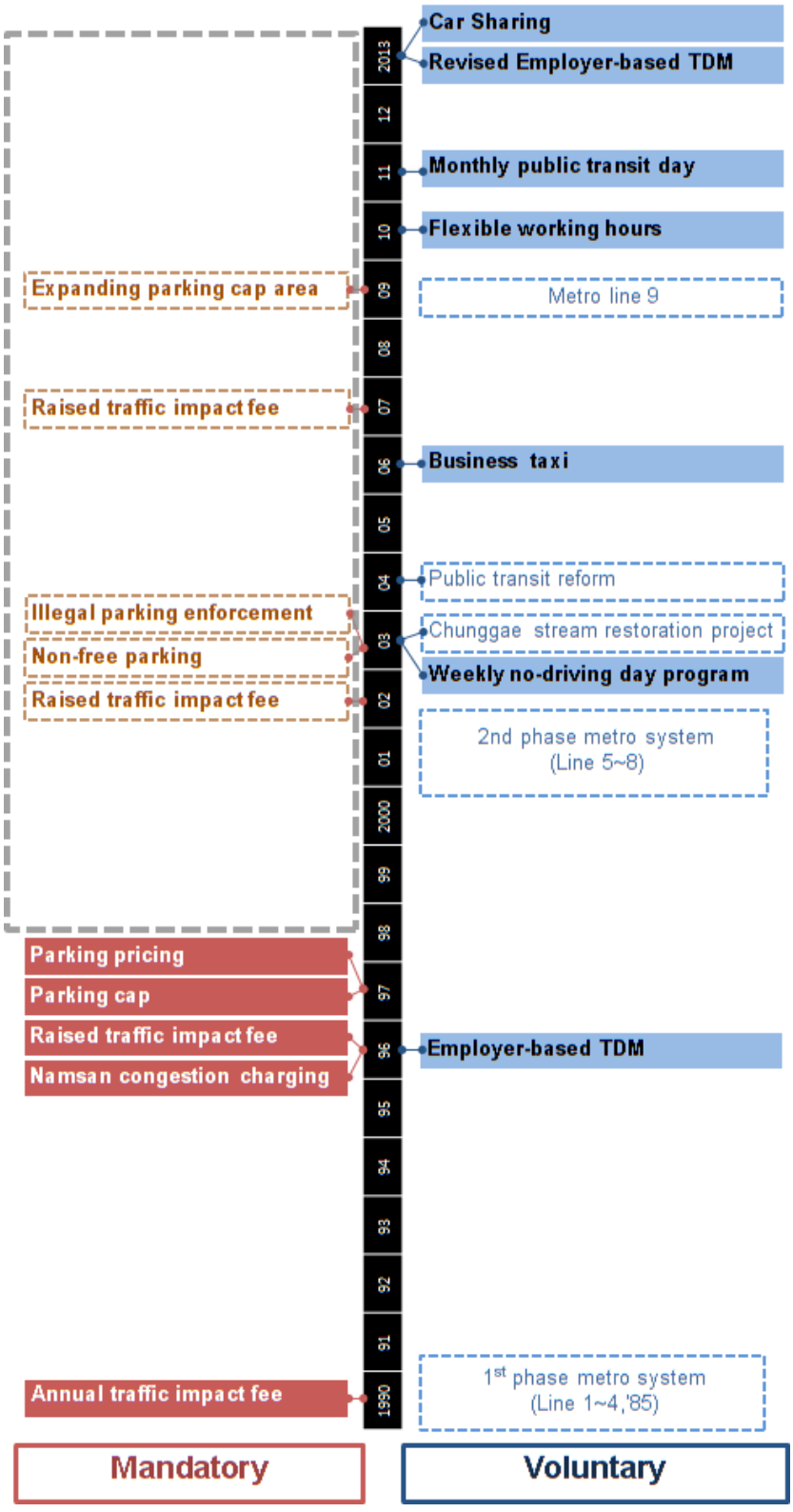
Outline

In the past, South Korean transportation policy was tuned to the supply side, with much emphasis on construction and expansion of road networks to make up for the absolute shortfall in capacity. Beginning in the 1990s, economic growth and the popularity of owning a car led the number of personal cars on the road to soar and consequently to ever more serious traffic congestion. Naturally, travel speeds decreased. In this context, transportation demand management (TDM) is effective in changing the elements that affect people's travel patterns to influence their choice of transport and to mitigate traffic congestion.

In this era of low carbon/green growth, sustainable economic development is becoming more important, with much focus on environmental preservation and reduction of greenhouse gases. Incidentally, TDM is also considered increasingly significant. "TDM" generally refers to a set of policies that help influence the choice of transport, the number of trips, and efficient use of vehicles. TDM is defined in the Urban Traffic Readjustment Promotion Act as a policy designed to mitigate traffic congestion by reducing car travel, dispersing trips in terms of time and space, and encouraging people to utilize forms of transport other than their personal vehicles. Article 15 of the Urban Traffic Readjustment Promotion Act indicates that when a city mayor deems it necessary to adopt the TDM approach within a specific area under his or her jurisdiction to facilitate traffic flow, improve air quality, or promote the efficient use of the transportation infrastructure, it may be undertaken after review by the Regional City Transportation Policy Deliberation Committee.

In accordance with the higher level nature of the Urban Traffic Readjustment Promotion Act, the City of Seoul has developed various TDM programs that reflect the urban characteristics of the city. These programs can be divided into 2 types: mandatory programs regulated by law; and voluntary programs that encourage residents and/or businesses to become involved. The first TDM program was the congestion impact fee in 1990. In the late 1990s, the scope was expanded to include the Namsan tunnel congestion charge, the parking threshold, and mandatory charging of parking lot fees. Into the 2000s, the city began to explore and adopt TDM programs that involve residents on a voluntary basis, such as the Weekly No-Driving Day Program and the car sharing service. Seoul's TDM programs can be seen below in Figure1:

Figure 1 - Seoul's TDM Programs by Year



Summary & Status

The Congestion Impact Fee System

Background

In the 1980s and 1990s, income levels improved and the number of cars increased. As a result, transportation demand escalated but infrastructure was unable to keep up, deteriorating the traffic situation. Buildings such as wedding halls and department stores induced a sudden rise in traffic at specific hours and caused congestion, and the socioeconomic costs to address the issues were phenomenal. The congestion impact fee was first introduced in 1990 as part of Seoul's TDM policy, and was levied against such facilities, with fees used to build and improve the transportation infrastructure.

The congestion impact fee was designed to indirectly curtail urban concentration of the facilities that attract a large volume of traffic and to have the owners of these facilities assume the financial cost according to the "causer-pays" principle, which would then be used to improve urban transportation. This system was faced with a certain level of resistance from potential fee payers, but generally, social consensus was reached as the public understood the need to reduce congestion and the related costs and to offer quality transportation services to people from all classes.

Summary

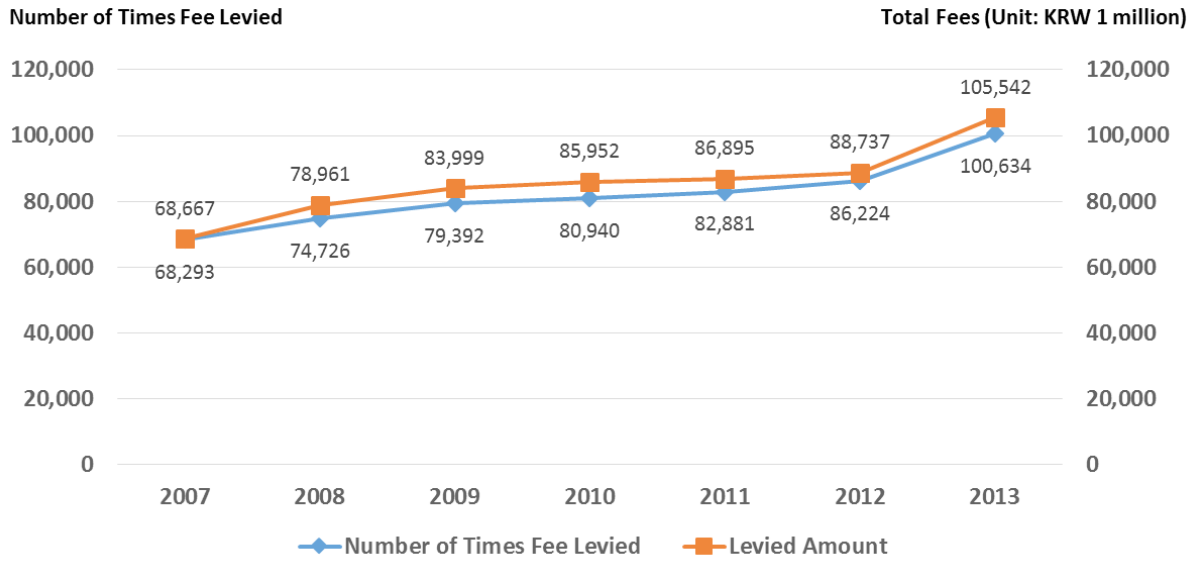
The legal basis for the congestion impact fee is in the Urban Traffic Readjustment Promotion Act revised on January 13, 1990. Pursuant to the Act, the target area is a city of 300,000 or more in population, or a city with 100,000 or more people that has obtained approval from the mayor or the provincial governor. The fees collected are to be deposited into a dedicated account for the local city transportation program and used to improve urban transportation facilities and infrastructure such as the center bus lane.

The City of Seoul fundamentally follows the enforcement rules concerning the impact fee as prescribed in the Urban Traffic Readjustment Promotion Act, but it also set up its own ways to levy the fees, which are calculated by multiplying total floor area of the facilities, the unit congestion impact fee, and the congestion coefficient. The unit congestion impact fee is 350 or 700 Korean won per ㎡ of floor area; the congestion coefficient varies by location and use of the facilities – from 9.83 for a department store to 0.47 for a factory. The congestion impact fee is levied on owners of facilities with a total floor area of 1,000 ㎡ or more. In the event a facility is owned by multiple entities, each pays in accordance with their share of ownership.

Implementation

In Seoul, the number of facilities paying the congestion impact fee and the amount collected grow every year, with data on collected fees kept since 2007. As can be seen in Figure 2 below, the number of times the fee was levied reached 100,634 times in 2013, and equaled approximately KRW 105.542 billion.

Figure 1 - Congestion Impact Fees Levied in Seoul



Source: The Korea Transport Institute (2014)

Transportation Demand Management Policy for Companies

Background

To further drive the congestion impact fee system and encourage companies to get on board, the City of Seoul introduced a TDM system for companies, designed to get them involved in reducing traffic volume on a voluntary basis. This allows companies to participate in traffic volume reduction programs, the outcome of which determines the discount on (or even exemption from) the congestion impact fee for which the business is responsible. In the early days of introducing the program in 1995, companies were required to impose parking fees on cars using their parking facilities, but this mandatory requirement was soon abolished in 1999. It became easier to participate in the program, and the participation rate rose. This TDM for companies is positive for individual residents, as it targets the facilities and companies that create large traffic volumes.

Summary

The TDM policy for companies stems from Regulation 15, adopted as part of Southern California's Clean Air Act. The major difference is that California imposes penalties on non-complying companies but Seoul offers discounts instead for those that participate.

This system was first proposed in the Study on Transportation Demand Management in Seoul conducted by the Seoul Development Institute (currently The Seoul Institute) in 1993. In 1994, feasibility was tested in preliminary research on 6 companies located in Jongno-gu, and the Ministry of Land, Infrastructure & Transport revised the Urban Traffic Readjustment Promotion Act and officially announced the TDM system for companies. In April of the following year, the Seoul Metropolitan Council enacted the Seoul Ordinances

on the Congestion Impact Fee Discount, Etc., and by August 1, 1995, the TDM policy for companies was launched. This policy targets buildings with a total area of 1,000 ㎡ or more, providing varying discounts (2% - 30% by program) on the congestion impact fee based on participation and performance. If one company participates in multiple programs designed to reduce traffic volume, the discounts are added together. The traffic reduction programs that companies can choose include mandatory parking fees, voluntary road space rationing, and commuter buses.

Table 1 - Congestion Impact Fee Discounts by Traffic Volume Reduction Activity

Activity	Target	Conditions	Discount(Unit: %)
Voluntary Road Space Rationing	Facility employees; users	1-10 system	10
		5-day system	20
		Odd-even system	30
		Weekly no-driving day system	20
Mandatory Parking Fees	Facility employees; users	Operating at least 9 hours on weekdays	10
Commuter Bus	Facility employees	At commuting hours; based on the number of seats provided	10
			15
			20
Subsidy	Facility employees	Transport cards/ticket worth KRW 30,000 per month	10
Phased Commuting Hours	Facility employees	Standard: 09:00 Phased by hour	5
Car Sharing	Facility employees	Always	5
			10
			15
Bicycles	Facility employees	Always	5
			10
Public Transit Days	Facility employees	1 – 2 times a month	2
		3 or more times a month	4

Source: Summary of the Seoul Ordinances on the Congestion Impact Fee Discount, Etc.

Implementation

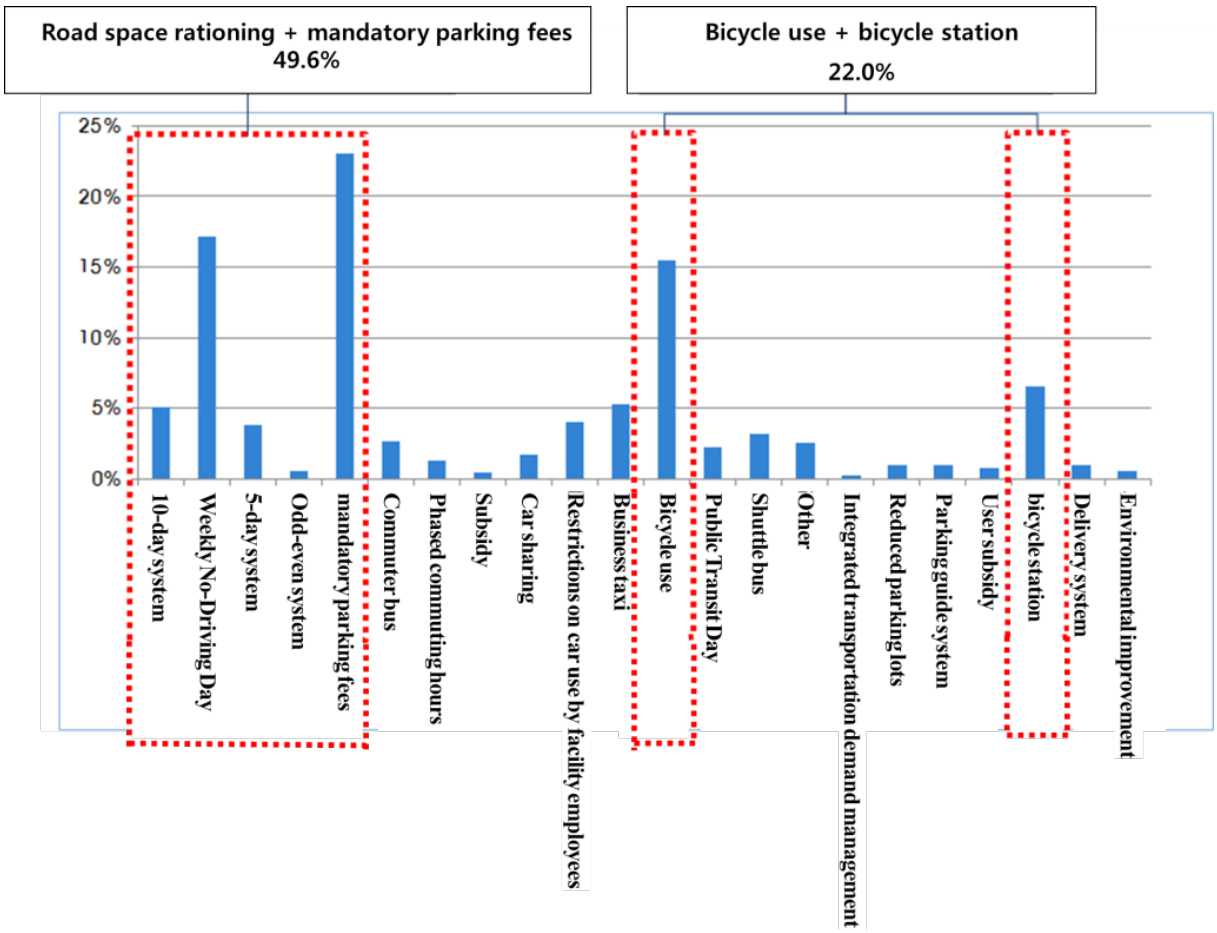
First introduced in 1995, the TDM system for companies offered highly attractive incentives, and the number of participating companies and the total discount are growing steadily. As of 2013, some 22% of the facilities subject to the TDM program for companies are involved.

Figure 3 - Companies Participating in the TDM Program

Source: Internal data, Seoul Metropolitan Government.

The demand management programs for personal cars (e.g., such as the Weekly No-Driving Day Program, 1-10 Road Space Rationing, and mandatory parking fees) and programs to encourage the use of bicycle (such as installation of bicycle stations) account for 70% of all programs. These programs are easier than others for companies to participate in, so participation is high. On the other hand, phased commuting hours or restrictions on the use of cars by target facility employees may not be applicable due to specific business circumstances. Commuter/shuttle buses and parking guide system cost money to operate/install so participation is low.

Figure 4 - Companies Participating in the TDM Program (2013)



Source: Internal data, Seoul Metropolitan Government

Congestion Charge at Namsan Tunnel 1 & 3

Background

The first city to adopt the congestion charge was Singapore. Soon, others like London, Rome, and Stockholm followed suit. In Seoul, discussions began in the late 1980s, but it was not introduced for circumstantial reasons. With the explosive growth in automobile use in the 1990s came a great need to contain the use of personal cars, so the charge was introduced for Namsan Tunnel 1 and 3 in November 1996.

Summary

According to the Urban Traffic Readjustment Promotion Act, a congestion charge is to be levied on road segments according to travel speed and average delay. Targets are arterial roads or adjacent zones under the influence of such roads where the average travel speed is less than 21 km/h (for 4 lanes or more each way) or 15 km/h (for 3 lanes or fewer each way) on weekdays only (excluding weekends and holidays) during 3 or more time periods per day. The charge may also be imposed on intersections or adjacent zones under the influence of such intersections where the average control delay time is 100 seconds or more (at signaled intersections) or 50 seconds or more (at unsignaled intersections) for 3 or more times a day. By this standard, most major roads in Seoul at the time when the charge was being discussed were subject to the congestion charge. Knowing that the sudden introduction of the charge in most or all of Seoul would likely meet severe opposition, the city aimed to phase in the system.

At Namsan Tunnel 1 and 3, the city began with a levy of KRW 2,000 for both directions from 7:00 – 21:00 Monday to Friday and 7:00 – 15:00 on Saturday, excluding Sundays and public holidays, based on the City of Seoul Ordinance (no charge on Saturday currently). The charge is levied against vehicles with only 1 or 2 occupants, while vehicles used by people with disabilities or for public purposes (ambulances etc.) are exempt.

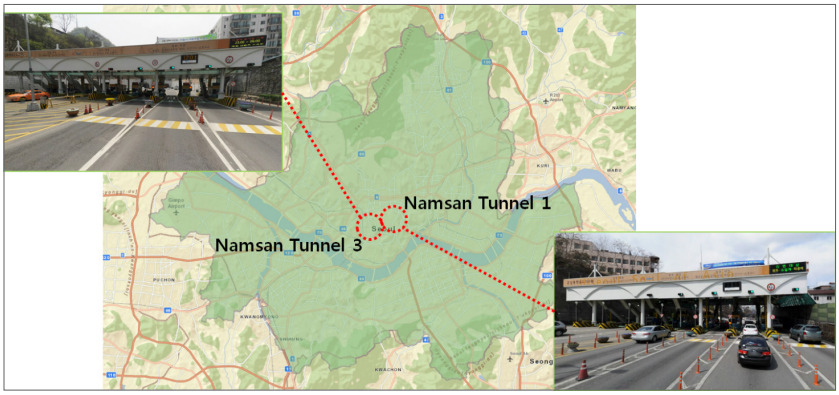
Implementation & Benefits

According to studies by The Seoul Institute (2012), traffic volume on roads linked to Namsan Tunnel 1 and 3 dropped by 24.2% a month after the charge was introduced. Beyond that, the rate of decrease slowed; a year later (in November 1997), the decrease rate was 13.6%. Until August 1998, the daily average traffic volume was 77,000 vehicles, and the decrease rate stood at 14% on average. In the meantime, the volume of private cars at peak hours fell by 30% a year after introduction, with cars occupied by 1 or 2 people dropping substantially by 40.2%. Four roads near Namsan Tunnel 1 and 3 can be used as detours, and there had been concerns that the congestion charge would simply cause congestion in other areas as cars moved to the detour roads. According to a year-long study after introduction, traffic volumes on the detour roads rose by only 5.7%. At the same time, average travel speed increased by 11.8%, from 24.5 km/h to 28.3 km/h.

One of the most important outcomes from the congestion charge was that cars with only 1 or 2 occupants stayed away from the tunnels, began carrying more people, or the occupants began using more public

transport such as buses or taxis. Studies by The Seoul Institute (2012) indicate that private vehicles passing through Namsan Tunnel 1 and 3 dropped by 25.8% while buses increased by 4.7% in 2010. At peak commuting hours, the share of buses and taxis soared from 3.3% and 7.8% to 8.0% and 26.4% respectively.

Figure 5 - Levying the Congestion Charge at Namsan Tunnel



Source: Street view, Naver.

Parking Lot Restrictions for Facilities in Certain Areas (Parking Threshold)

Background

Before 1990, Seoul's parking policy was keen on supplying more parking spaces to accommodate the increasing number of cars. However, such policies began to change with the growing importance of TDM in the 1990s. In line with the policy trend, South Korea adopted a system of restricting the creation of parking lots (also called the parking threshold) for facilities in congested areas to curb the parking demand. Seoul set up its own parking threshold system for implementation to incorporate the unique circumstances of the city in restricting parking lots pursuant to the Parking Lot Act. With Seoul's parking threshold regulations in place, parking lots for department stores and other commercial and business facilities in congested areas were limited to 50% of the parking lots located in non-congested areas.

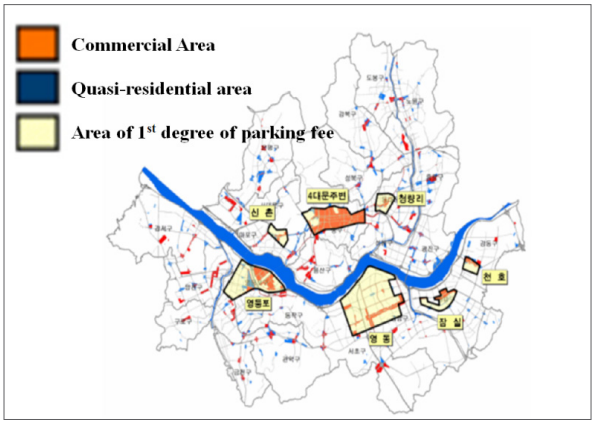
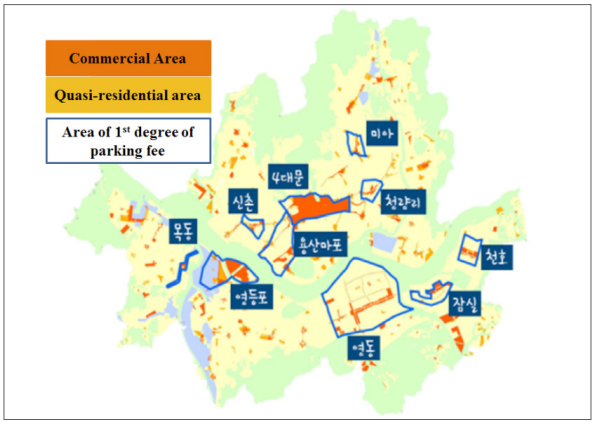
Summary

Through the Parking Lot Act, the City of Seoul came up with parking threshold regulations via the City of Seoul Ordinance on the Installation & Management of Parking Lots. In Seoul, "areas that are congested with automobile traffic", as stipulated in the Parking Lot Act, are categorized as "Class 1 areas as defined in the public parking fee table". The City of Seoul Ordinance also sets different standards for the installation of parking lots based on the type of facility.

Seoul's parking threshold program was first launched on January 15, 1997, was extensively revised on March 18, 2009 and is in effect to this day. In the beginning, there were seven Class 1 target areas (commercial only) as defined in the public parking fee table, but this number grew to 10 (and included quasi-residential areas) in

the course of revising the Ordinance in 2009. With the parking threshold program in effect, the City of Seoul achieved some success with its TDM in suppressing transportation demand.

Figure 6 - Parking Threshold Zones in Seoul

Beginning (1997 – 2008)	Now (2009 –)
· Seven Class 1 commercial areas as defined in the public parking fee table	· Ten Class 1 commercial and quasi-residential areas as defined in the public parking fee table · Special congestion management zone where public transport is easily accessible
	
13.8 km² · 2.3% of the total area of Seoul · 60% of the total commercial area in Seoul	**16.2 km²** · 2.7% of the total area of Seoul · 58.7% of the total commercial area in Seoul

Source: The Seoul Institute (2014).

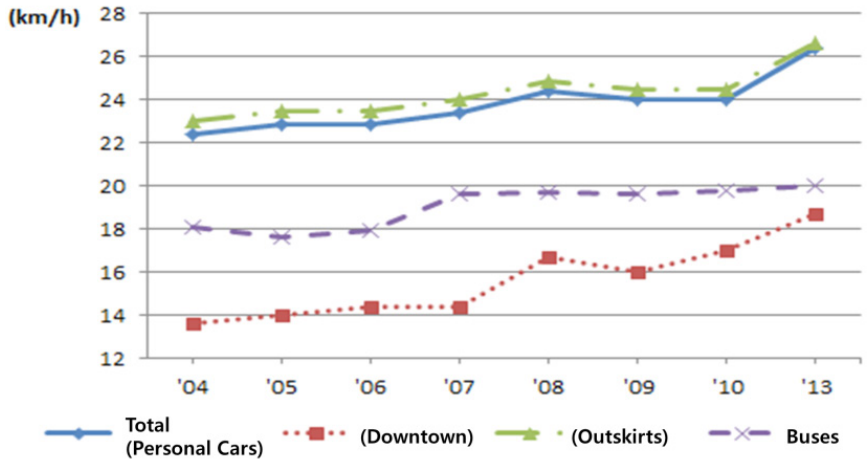
Achievements of Seoul's TDM Policy

Improved Transportation Environment due to Reduced Transport Share of Personal Cars & Increased Share of Public Transport

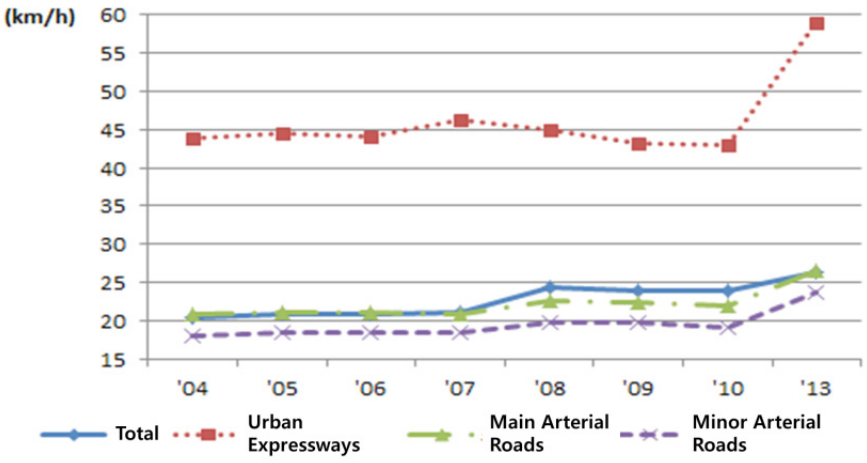
Implemented in various ways since the 1990s, the TDM policy contributed to lowering the transport share of personal cars in Seoul. Meanwhile, the share of public transport has steadily risen from 61% in 2004 to 66% in 2012. Naturally, the average travel speed on major and downtown roads is also increasing. In the early 2000s, the average downtown travel speed in Seoul was 22.4 km/h, rising 4km/h to 26.4 km/h in 2013. A similar phenomenon has been observed in the outskirts of Seoul and on major arterials roads.

Figure 8 - Changes in Average Travel Speed in Seoul

(a) > Changes in Average Travel Speed in Seoul



(b) > Changes in Average Travel Speed in Seoul (by Road Type)

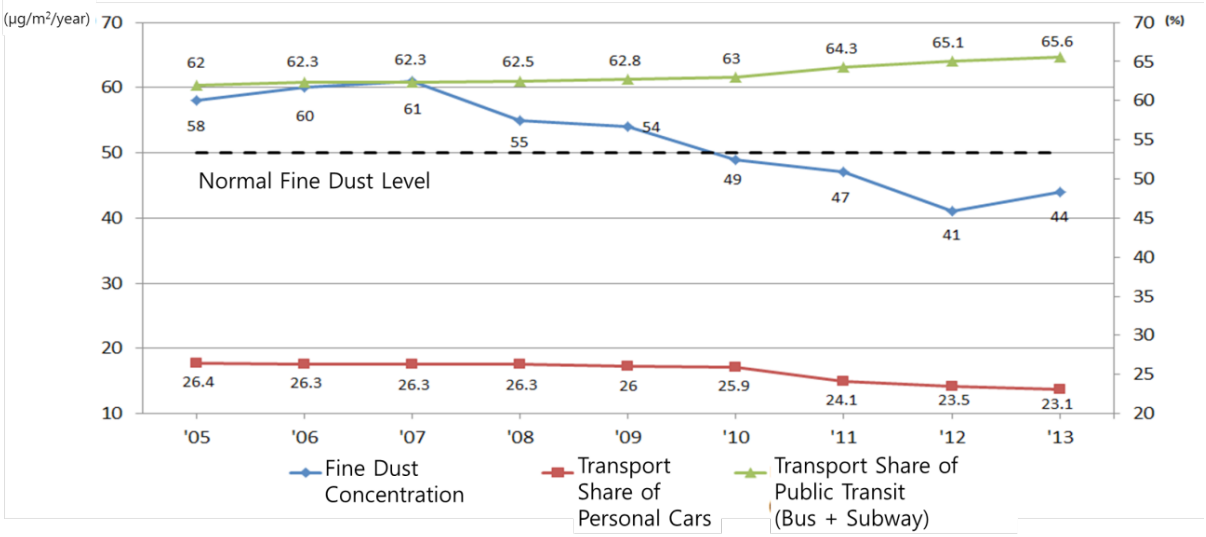


Source: Seoul Statistics

Contribution to Improved Air Quality

Seoul's air quality has also improved thanks to the increased average travel speed, decreased transport share of personal cars, and increased share of public transport. The concentration of fine dust – a cause of respiratory diseases and a hotly debated social issue – was 60μg/㎥ in 2004, 50μg/㎥ higher than Seoul's normal level. However, the decrease in passenger cars and other elements helped reduce the concentration each year, and by 2013 it had fallen to 44μg/㎥.

Figure 9 - Changes in Fine Dust Concentration & Share of Transport



Source: Seoul Statistics

Priority on Pedestrians in Urban Transportation Policy

As the TDM policy encouraged drivers to switch to public transport or walk, the city also began to shift its focus from cars to pedestrians. In line with this trend, Seoul created a "Walk-Friendly Seoul" by reducing the 4-lane Gwangjingyo Road to 2 lanes in 2007 and expanding the pedestrian walkway. In January 2014, the city created its first transit mall on Yonsei-ro. Many zones busy with pedestrians on weekends (e.g., Cheonggye Stream, Hongik University) were turned into pedestrian-only areas. The TDM policy has significantly helped Seoul become a more walking-friendly city.

Limitations & Needs for Improvement

Differentiation of the Congestion Coefficient

The congestion impact fee system has attempted on many occasions to differentiate the congestion coefficient by city size and facility. However, regional characteristics or facility locations were not reflected, and the impact fee was unnecessarily imposed on areas where congestion is minimal or not an issue. On the contrary, the fee is too low in significant traffic-generating areas or where congestion is severe, making the system virtually impractical according to critics. It is therefore critical to differentiate the congestion coefficient in light of the level of congestion and regional characteristics. Now, the coefficient can be upwardly adjusted by autonomous districts within the 100% range prescribed in the Urban Traffic Promotion Act, but the terms of the Urban Traffic Readjustment Promotion Act should be revised to allow coefficients to exceed 100% for those facilities located in heavily congested areas. As for those areas without sufficient public transit, the coefficient should be lowered, even if the facilities generate large traffic volumes.

Usefulness of Congestion Impact Fee System

Launched in the 1990s, the congestion impact fee has become one of Seoul's major transportation policies over the past 20 years, but there are still doubts as to its usefulness. The unit fee has been fixed for 22 years despite rising prices, and the total levied impact fees account for only 1% of all costs arising from congestion in Seoul. The City of Seoul is seeking to revise the relevant Ordinances and raise the unit congestion impact fee to a more suitable level, thereby putting pressure on companies not yet participating in TDM programs to do so, while providing more and better incentives to participants.

Improvement of the Parking Threshold System

Currently, Seoul's parking threshold is the same regardless of the intended use of the land, buildings, and surrounding areas. This runs counter to the fundamental purpose of the system and is inefficient and illogical to some extent. Many large buildings allow parking outside or find parking spaces that get around the parking threshold. Opinions on the parking threshold vary greatly by facility type. For improved operational efficiency, the system needs more specifics in its design.

Improvement of the Congestion Charge Rate & Method at Namsan Tunnel 1 & 3

As part of the TDM policy designed to decrease the number of vehicles entering the city center and therefore

mitigate congestion, the City of Seoul began to levy the congestion charge on 10-person vehicles and smaller if they are carrying only 1 or 2 people (including the driver) at Namsan Tunnel 1 and 3 from November 1996. However, the effect of the congestion charge in reducing traffic has gradually slowed, probably because the congestion charge is the same during peak and off-peak hours and has never been adjusted upward. Meanwhile, discount benefits were increased for compact cars in 2003 and for Weekly No-Driving Day Program participants in 2004. Considering how overall prices and other transport costs have risen, the congestion charge should also be adjusted to a more suitable level and be differentiated by time of day to have the desired effect on traffic volume.

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3. Transportation Demand anagement Program Based on the Causer-Pays Principle: the Congestion Impact Fee System in Seoul

Writer : Seoul Institute Dr. Joon-Ho Ko

Policy Area: Transportation

Introduction to the Congestion Impact Fee System

Economic development in South Korea has continued to attract many people to the capital and its vicinity, but especially to Seoul. In the city center and downtown areas, high-rise buildings have been erected one after another. The floating population downtown has grown, and severe traffic congestion has increased along with the number of vehicles. The increased national income in the 1980s and 1990s in particular led to an explosive demand for automobiles and transportation systems, overloading the transportation infrastructure and facilities and greatly exacerbating the existing traffic problems.

Large buildings, wedding halls, department stores, and similar specific-purpose facilities choke the roads in and around the downtown areas and contribute to socioeconomic loss. In discussions that followed, demands arose to require such large facilities responsible for the congestion to compensate the area for this loss. Out of these discussions came a proposal for a "congestion impact fee" for such facilities.

Enforcing the congestion impact fee, as defined by the Urban Traffic Readjustment Promotion Act, resulted in facility owners paying a fee in accordance with the "causer-pays" principle so as to indirectly rein in the concentration of facilities that cause congestion in the city and to secure funds for improvement of the city traffic situation. While some facility owners have objected to this additional financial burden, general public consensus was reached on the necessity of a system designed to reduce the negative impact of traffic congestion and provide quality transportation services to the public. This congestion impact fee enacted by the government was then adopted by the City of Seoul as the "City of Seoul Ordinance on the Reduction of the Congestion Impact Fee, Etc.", specifying the target facilities, exemptions, methods for calculation, etc. The system was first implemented in 1990 in Seoul; since then the impact fee has been imposed on facilities once each year.

Two of the main purposes for adopting the system in Seoul were to provide a means of additional funding for expanding and improving the transportation infrastructure and to encourage large congestion-causing facilities to relocate to the city outskirts.

The Congestion Impact Fee System: A Summary

Basis for Levying the Congestion Impact Fee

1) Revision of the Impact Fee System and the Basis for Levy

The legal basis for the congestion impact fee is in the Urban Traffic Readjustment Promotion Act revised and promulgated on January 13, 1990. The specific conditions for levying the impact fee are set out in the Enforcement Decree to the Urban Traffic Readjustment Promotion Act, which were revised and promulgated on September 25 of the same year. The congestion impact fee came into effect on July 1, 1990. The target areas

were cities with populations of 300,000 or more, or with 100,000 or more and approval from the city mayor or provincial governor. The levied fees were deposited in a special account for the local city transportation program, to be used to improve transportation systems and facilities (e.g., introduction of bus-only lanes).

With the City of Seoul Ordinance on Fees to Reduce Impact of Congestion, Etc. in place, Seoul also had a basis upon which it could levy a congestion impact fee on select facilities. The impact fee is calculated by multiplying the total floor area of the facility by the unit congestion impact fee, and then again by the congestion coefficient. The unit congestion impact fee is 350 or 700 Korean won per m^2 of the floor area; the congestion coefficient varies by location and use of the facility – from 9.83 for a department store in downtown Seoul to 0.47 for a factory on the outskirts of a city directly controlled by the central government. The congestion impact fee is levied on owners of facilities with a total floor area of 1,000 m^2 or more. For facilities with multiple owners, each owner pays an amount proportionate to his/her share of ownership.

2) Unit Congestion Impact Fee

In principle, the Enforcement Decree to the Urban Traffic Readjustment Promotion Act determines Seoul's unit congestion impact fee, but the city also has its own congestion impact fee ordinance, which dictates this fee. The unit congestion impact fee is KRW 350 for facilities with less than 3,000㎡ in floor area, or those with 3,000㎡ or more in floor area but with parking for fewer than 10 cars; and KRW 700 for facilities that are 3,000 ㎡ or larger in floor area and have 10 or more parking spots. The unit congestion impact fee is more specific than what is set out in the Urban Traffic Readjustment Promotion Act, with the unit fee higher for facilities that occupy a large area. Fees are higher than in the City of Incheon or the Gyeonggi Province because Seoul is more crowded and sees higher levels of traffic and congestion due to large facilities.

Table 1 - Unit Congestion Impact Fee by Local Governments in the Seoul Metropolitan Area

Urban Traffic Readjustment Promotion Act	· KRW 350 per ㎡ for facilities with a floor area of 1,000 ㎡ or more
City of Seoul	· KRW 350: Facilities with less than 3,000 ㎡ in floor area, or 3,000 ㎡ or more but with fewer than 10 parking spaces · KRW 700: Facilities with 3,000 ㎡ or more in floor area and 10 or more parking spaces
City of Incheon	· KRW 350: Facilities with less than 3,000 ㎡ in total area or with fewer than 10 parking spaces · KRW 500: Facilities with a total area of 3,000 m^2 or greater and with 10 or more parking spaces
Gyeonggi Province	· KRW 350: Facilities with less than 3,000 ㎡ in total area · KRW 500: Facilities with a total area of 3,000 m^2 or more

Sources: Article 19 of the Urban Traffic Readjustment Promotion Act, the ordinances of local governments on the congestion

impact fee (Seoul/Incheon/Gyeonggi).

3) Congestion Coefficient

The congestion coefficient refers to the level of congestion caused by the targeted facilities. The coefficient is fundamentally dictated by Article 19 of the Urban Traffic Readjustment Promotion Act (refer to Table 1 above), and is higher for large retail facilities that cause relatively higher levels of traffic such as department stores and shopping centers (5.46) and for transport facilities such as passenger and freight train stations (4.13 – 5.56). Based on the congestion coefficient set forth in the Enforcement Decree to the Urban Traffic Readjustment Promotion Act, local governments are allowed to introduce their own ordinances and double the coefficient if they wish. The City of Seoul uses the basic coefficient in the Urban Traffic Readjustment Promotion Act, while city ordinances adjust it as necessary, after the city has inspected the facilities that cause congestion and come up with higher coefficients for facilities related to sales, recreation, amusement, sports, and business as identified in Table 2 below.

Table 2 - Congestion Coefficients by Type of Facility

General Category of Facility	Specific Type of Facility	City Population (Unit: Number of People)				Seoul
		1 million or more	500,000 – 1 million	300,000 – 500,000	100,000 – 300,000	
Neighbor-hood	Supermarkets, Retail Stores for Daily Necessities	1.68	1.66	1.64	1.12	1.68
	General Restaurants	2.56	2.48	1.59	1.48	2.56
	Driving Ranges	5.00	4.80	2.40	2.12	5.00
	Gyms, Bowling Centers, Table Tennis Businesses, etc.	1.80	1.46	1.32	1.06	1.68
	Other Neighborhood Facilities	1.44	1.16	1.02	1.02	1.44
Medical	General Hospitals	1.28	1.04	0.93	0.93	2.56
	Private Hospitals, Clinics, Care Centers, Doctors' Offices	1.34	1.08	0.88	0.72	1.34
Education & Research	Education Centers, Research Centers, Private Schools, etc.	1.42	1.16	1.00	0.78	1.42
	Libraries, Research Centers, etc.	0.90	0.82	0.74	0.74	0.90
Sports	Stadiums	1.12	1.04	0.96	0.96	1.68
Business	General Business Facilities	1.20	1.00	0.82	0.82	1.80
Accommoda-tion	Tourism & Accommodation	2.62	2.23	1.81	0.77	2.62
	General Accommodation	1.16	0.87	0.79	0.77	1.16
Sales	Wholesale Markets	1.81	1.77	1.63	0.94	1.81
	Department Stores, Shopping Centers, Discount Stores, etc.	5.46	4.48	2.67	2.67	9.83
	Retail Markets, Stores	1.68	1.66	1.64	1.12	1.81
Recreation & Amusement	Bars	2.56	2.48	1.40	1.16	3.84
	Public Bath House	1.44	1.16	1.02	1.02	2.16

Performance, Assembly	Performance Halls, Theaters, Cinemas, etc.	3.55	2.38	1.94	1.12	3.55
	Assembly Halls, Conference Halls, Wedding Halls, etc.	4.16	3.43	2.39	1.49	4.16
	Sports Stadiums, Horse Race Tracks, etc.	3.55	2.38	1.94	1.12	3.55
Exhibition	Museums, Art Galleries, Memorial Halls, etc.	3.55	2.42	2.16	2.03	3.55
	Zoos, Botanical Gardens, Aquariums, etc.	0.72	0.62	0.55	0.55	0.72
Factory		0.47	0.43	0.31	0.24	0.47
Storage	Storage, Loading Facilities	0.61	0.50	0.37	0.30	0.61
Transport	Passenger Vehicle Terminals, Freight Terminals	5.56	4.34	3.92	2.76	5.56
	Railroad Station	4.13	3.76	3.11	2.46	4.13
	Airports, Sea Ports	1.81	1.14	1.14	1.14	1.81
Automobile	Sales, Auto Repair Shops, Car Washes, etc.	1.49	1.18	1.04	1.04	1.49
	Driving Schools, Repair Schools	0.88	0.86	0.67	0.20	0.88
Broadcasting & Communications	Broadcasting Stations, Filming Sets	1.89	1.20	1.18	1.00	1.89
	Telecommunication Stations	1.00	0.82	0.67	0.67	1.00
Tourism	Parks, Amusement Parks, etc.	3.10	2.68	2.14	1.71	3.10
Other	-	1.20	1.00	0.82	0.71	1.20

Source: Article 19 of the Urban Traffic Readjustment Promotion Act, the Seoul Ordinance on the Congestion Impact Fee.

Exemption from the Congestion Impact Fee

The Urban Traffic Readjustment Promotion Act does not charge facilities that do not significantly increase traffic or those that are for public interest as well as facilities used for registered non-profit organizations. Specifically, these include: foreign embassies and international organizations; facilities owned by foreign volunteer organizations; residential buildings; shared community facilities for the New Town Program; facilities owned by political parties; religious facilities; kindergartens, primary/middle/high schools, and other educational facilities; museums and art galleries; and libraries.

Use of Funds from Levied Impact Fees

Pursuant to the Urban Traffic Readjustment Promotion Act, funds collected through the congestion impact fee system and funds from other transportation-related programs (parking fees, congestion fee, etc.) are to

be invested in transportation-related programs, specifically designed to: expand transportation facilities and infrastructure and improve their operation; conduct city transportation-related research and studies; improve public transit services and the management of public transit operation (screening doors in subway stations, subsidies for the integrated transfer discount system, construction of bicycle trails, etc.); facilitate management of and measures to enhance transportation demand; improve roads and transportation safety facilities/infrastructure (surveillance cameras, improved pedestrian environment, etc.); and promote good parking demand management and orderly parking (construction of parking lots and transfer centers, enforcement of illegal stopping, parking controls, etc.).

Stronger Regulation of Transportation Demand in Collaboration with Transportation Demand Management Programs by Private Companies

To promote the congestion impact fee system and encourage companies to voluntarily control transportation demand, the City of Seoul adopted a transportation demand management system for companies. It allows companies to voluntarily implement a traffic volume reduction program, with the authority to reduce the congestion impact fee by 1% to 100% based on the outcomes. The percentage of the impact fee reduction by activity is as follows:

Table 3 - Impact Fee Reduction by Activity

Activities to Reduce Traffic Volume	Requirements	Fee Reduction (%)
Voluntary Road Space Rationing for Passenger Cars	1-10; 5; odd-even; 7-day	10/20/30/20
Charging for Parking	9 hours or more on week days	10
Providing Commuter Bus	Morning and evening commute hours; based on the number of seats provided	10/15/20
Providing Transportation Subsidy	Transport cards or tickets worth KRW 30,000/month	10
Phased Commuting Hour	Standard: 9 a.m.; 1 hour more	5
Car Pooling	Anytime	5/10/15
Riding Bicycles	Anytime	5/10
Creation of a Company Public Transit Day	Once or twice a month; /3+ times a month	2/4

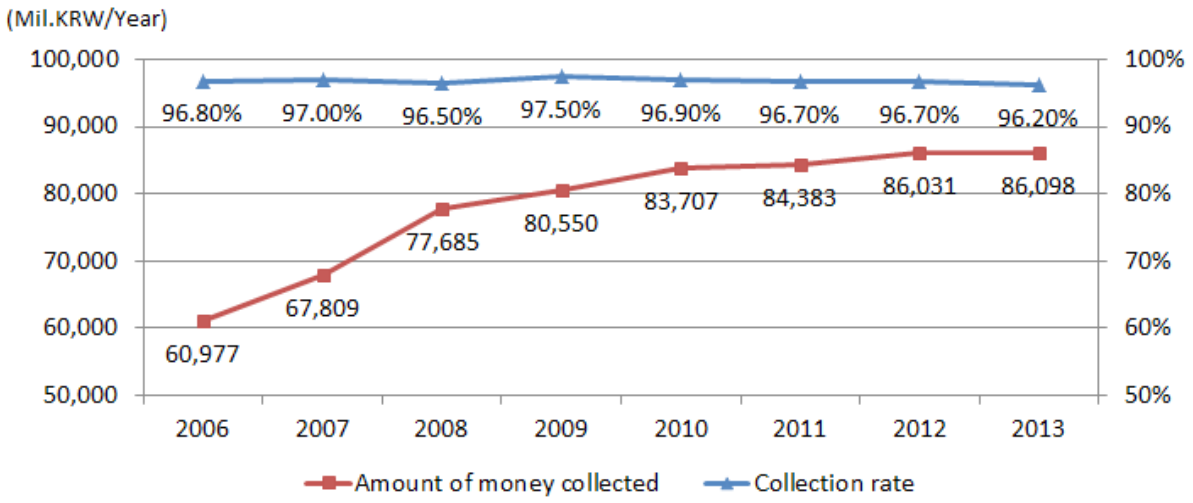
Source: Adapted from the City of Seoul Ordinance on Fees to Reduce Impact of Congestion, Etc.

Success in the Transportation Demand Management Program

More Facilities Participating in the Congestion Impact Fee System and Greater Investment in Transportation Programs

In Seoul, the congestion impact fee system began in 1990, and the number of participating facilities has gradually grown. As of 2013, a total of KRW 105.542 billion has been collected from 100,634 facilities across Seoul; the actual collected amount, after applying the reductions and subtracting unpaid fees, was approximately KRW 86 billion. Statistics since 2006 (when data first became available) show more than 95% of applicable facilities have paid the fees that have been levied against them, and that the monetary total for impact fees in Seoul is on the rise.

Figure 1 - Collection of the Congestion Impact Fee in Seoul



Source: Internal data from the City of Seoul.

As seen above, Seoul levies congestion impact fees based on facility type and total area. Consequently, as shown in Table 4, the number of levies against large facilities (which have a high impact) is relatively low but the fees collected from these facilities account for a large portion of the total. As of 2013, the number of total impact fees levied on facilities 10,000 ㎡ or larger represents only 1.5% of the total, but by monetary amount these facilities pay approximately KRW 48.4 billion, about 45.9% of the total amount paid by all facilities.

Table 4 - Congestion Impact Fees for Facilities in Seoul (2013)

Category		All	Less than 1,000 m^2	Less than 3,000 m^2	Less than 10,000 m^2	Less than 30,000 m^2	30,000 m^2 or more
Number of Levies	Number of Times	100,634	73,099	21,255	4,763	1,105	412
	Percentage	100.0%	72.6%	21.1%	4.7%	1.1%	0.4%
Amount of Fee	Amount (KRW 1 million)	105,542	15,072	18,559	43,441	20,453	28,018
	Percentage	100.0%	14.3%	17.6%	41.2%	19.4%	26.5%

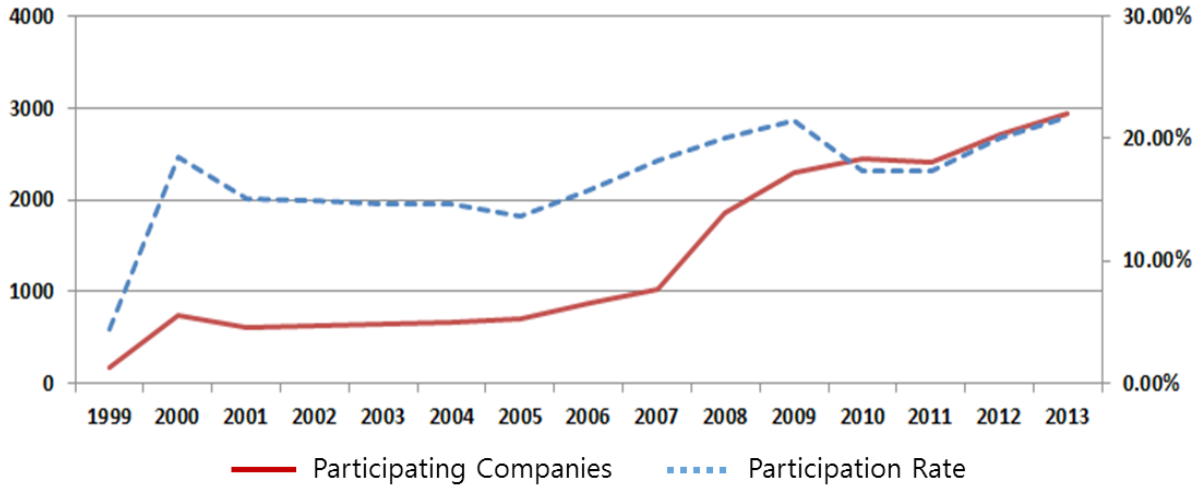
Source: The Korea Transport Institute (2014), Study on Improving the Congestion Coefficient.

Incentive for Companies to Participate in the Transportation Demand Management Program

The congestion impact fee can be burdensome for companies. However, participation in the Transportation Demand Management Program allows them to benefit from the incentives provided, and the number of program participants has gradually increased. As of 2013, 22% of the program target facilities were involved.

Figure 2 - Participation of Companies in the Transportation Demand Management Program (by Year)

(Units: No. of Companies, %)



Source: Internal data from the City of Seoul.

Limitations & Needed Improvements

Doubts about the Effect of the Impact Fee (Need for the Unit Impact Fee to Be More Realistic)

The congestion impact fee, adopted in 1990, is now over 20 years old and constitutes a major transportation policy in Seoul. However, questions have recently been raised about its effectiveness. Despite rising prices, the unit congestion impact fee has been fixed at the same level for 22 years. The total impact fees account for only 1% of all costs arising from congestion in Seoul. As of 2011, actual participation rate in the transportation demand management system for companies was barely 18%. One of the reasons, according to experts, is that impact fees have been kept at the same level for 2 decades while the size and population of the city has continued to grow and the number of registered vehicles more than quintupled. The City of Seoul is now working to revise the relevant ordinances and give the fees greater influence by applying pressure on companies that do not participate in the transportation demand management program and providing attractive incentives to those that do.

A Need to Improve the System and Use the Fee to Invest in Transportation

Seoul collects some KRW 100 billion annually through the congestion impact fee system, but this is insignificant to effectively reduce traffic volumes. For example, subway construction costs KRW 120 – 150 billion per km in Seoul; the impact fees presently collected cannot even finance a kilometer of subway construction. Up to 30% of the fee is granted to local districts, but since there is presently no requirement that the grant be used for transportation programs, relevant regulations are needed.

A Need for More Specific Congestion Coefficients

The congestion impact fee system has long attempted to differentiate the congestion coefficients by city size and facility to make them more realistic. However, the fees are unnecessarily levied on some areas where congestion is insignificant because the characteristics or specific conditions of the locations have not been taken into account. On the other hand, it has been suggested that the impact fee has little effect on heavily congested areas. The congestion coefficients need to be differentiated in multiple steps and reflect the level of congestion and the unique characteristics of the region. For instance, upward adjustment of the congestion coefficient must remain within the 100% range of the coefficient set out in the Urban Traffic Readjustment Promotion Act; this needs to be revised so that upward adjustment can go beyond 100% for those facilities that significantly add to traffic congestion of an area. For those areas where public transit is inadequate, the coefficient should be lowered, even if the congestion increases due to certain facilities.

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4. The Freeway Traffic Management System (FTMS)

Writer : Seoul Institute Dr. Joon-Ho Ko

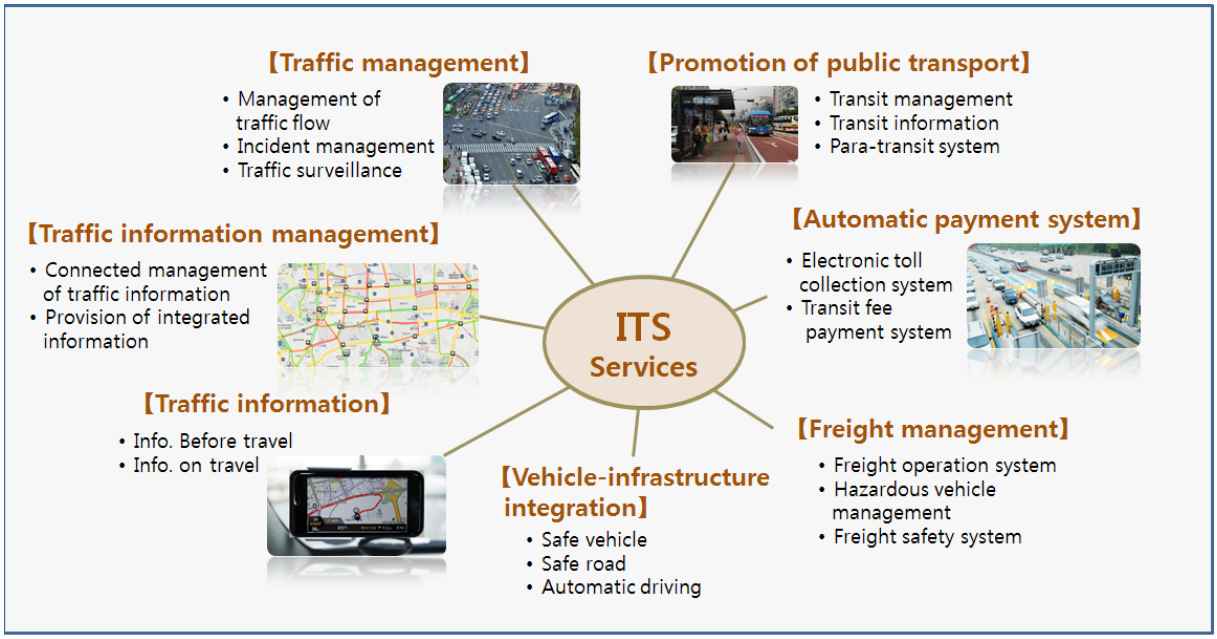
Policy Area: Transportation

Introduction of the ITS Program & Installation of the FTMS in Seoul

As the number of vehicles grew rapidly in the 1990s, prohibitive social costs were incurred by such results as road congestion and traffic accidents in the City of Seoul. Accordingly, decision makers were compelled to seek a new path, through transportation policy, away from the old, supply-oriented approach and towards investment. At the time, other countries were actively involved in studies on the Intelligent Transportation System (ITS) – the application of cutting-edge technology to transportation facilities and infrastructure. The ITS efficiently manages traffic flow at a more affordable cost than building additional infrastructure such as new roads, and major cities around the world were increasingly adopting this system. Seoul also adopted advanced ITS from overseas and sought to localize it.

The ITS efficiently manages traffic flow through a combination of technologies, both "hardware" (road construction, transportation, communications, electricity, electronics, automobiles, etc.) and "software" (operating methods, information processing techniques, etc.). The principal purpose of the ITS is to ensure travel convenience and safety by providing information on optimal routes to individual travelers and to maximize overall efficiency of the transportation system. South Korea pursued various ITS research and development programs and pilots in the 1990s. The ITS that was introduced to Korea included such elements as a traffic control system that controls traffic flow on highways and arterial road networks; and various subsystems such as the transportation information system that provides road information in advance or in real time.

Figure 1 -Types of ITS Services & their Roles: South Korea



In the early days of the ITS, Seoul seriously pursued the Freeway Traffic Management System (FTMS) program. The FTMS is one of the ITS programs that upgraded the efficiency of urban expressways in Seoul. With introduction of the FTMS, it became easier to manage traffic on urban expressways in real time and allowed automatic collection of information, significantly revamping the existing manually operated traffic system to make it more efficient. It also enabled immediate response to various situations on the road.

Implementation of the FTMS

The Olympic Expressway: First in Seoul to Be Managed by the FTMS

The first urban expressway in Seoul to embrace the FTMS was the Olympic Expressway, providing a wealth of transportation information towards improving the traffic flow as well as to detect and respond to traffic incidents rapidly, thereby enhancing the transportation environment and driver convenience. The Olympic Expressway FTMS was first designed by the Seoul Development Institute in August 1995, and implemented in July 1997. The pilot project was in operation from August 1997 to January 1998, with full service beginning in February 1998, now covering an 18 km leg (from Yeouido to Jamsil) of the 41 km long Olympic Expressway. This first FTMS collected data through a video detection system and analyzed traffic flow, all in real time. Data was interpreted and delivered to drivers and system operators through various media such as screens over the roads, ARS, fax messages, and the internet.

Figure 2 - View of the Olympic Expressway

Source: The Academy of Korean Studies, The Electronic Encyclopedia of the Korean Culture

Establishment of a Comprehensive ITS Plan for Seoul, Including Expansion of the FTMS

Beginning with the Olympic Expressway FTMS, Seoul steadily expanded the ITS, but each program was pursued independent of each other, thereby lacking in systematic structure and consistent directionality. To rectify this, the City of Seoul established a "Comprehensive ITS Plan for Seoul" to create a more systematic structure and consistent directionality while preventing redundant investment and creating a platform for more aggressive investment. In this Plan, the city set out its mid to long-term strategies for the ITS program and plans for phased construction of 15 systems in 5 areas, including the FTMS, a comprehensive traffic information center, and the bus guidance system. With a goal to introduce a data-based transportation management system for its major arterial roads and urban expressways, the city developed detailed action plans. The purpose and expectations for the FTMS in the Comprehensive ITS Plan for Seoul are as follows:

- Identify traffic and road situations on urban expressways in real time, analyze the causes for congestion and improvements to be made, and ensure overall efficiency of the transportation management system;
- Shorten travel time on urban expressways;
- Reduce transportation system costs by automatically detecting and rapidly responding to unexpected incidents; and
- Provide information on roads and traffic flow to drivers and create a more convenient transportation environment.

Phased Expansion of the FTMS in Seoul

After introducing the FTMS to the Olympic Expressway, Seoul expanded the system in phases.

Phase 1: Naebu Inner Beltway

The FTMS was introduced to the 40.1 km stretch of the Naebu Inner Beltway. The program began in May 2000, with a pilot program in place from November 2001 to June 2002. The FTMS enabled real-time management of traffic flow, keeping it at a reasonable speed. It also enabled rapid response to unexpected incidents and greatly contributed to enhancing user safety.

Phase 2 Zone 1: Remaining Segment of Gangbyeon Riverside Expressway & Bukbu Northern Arterial Road

The program for Zone 1 of Phase 2, began in November 2001 and completed in June 2004, expanded the scope of management by the transportation management system from the existing segments (Naebu Inner Beltway and Olympic Expressway) to include the 21.7 km segment of the Gangbyeon Riverside Expressway and the Bukbu Northern Arterial Road. This increased the number of messages displayed on electronic screens above the roads, and screen displays were modified as a result to include graphics to aid readability; helping drivers better understand the information and overcoming existing information display limitations. Additional host computers and databases were added to facilitate the increased data processing. An intrusion

detection system was added to the existing firewall to enhance system security and respond more effectively to hacking and other types of intrusion.

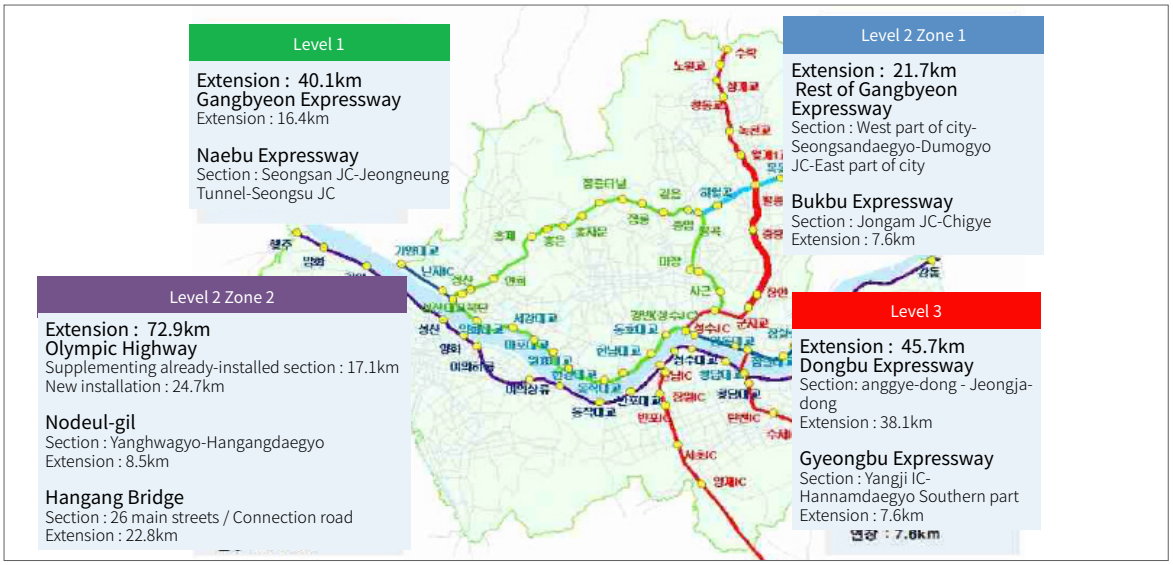
Phase 2 Zone 2: Olympic Expressway, Nodeul Road, & Han River Bridge

In Zone 2 of Phase 2, the transportation information system was implemented for the 49.3 km segment of the Olympic Expressway, Nodeul Road, and the bridge. Beginning in October 2003 and finishing in September 2005, the system began offering traffic information on urban expressways via mobile phone and PDAs, in line with the development of wireless communications infrastructure and the increasing use of wireless devices. Moreover, the Road Weather Information System (RWIS) was introduced, which collects weather data from humidity and temperature sensors installed on road surfaces and weather devices at roadside. Drivers can receive information on sudden and localized weather changes, as well as road use in real time, significantly improving traffic flow and driver safety.

Phase 3: Dongbu Eastern Arterial Road & Gyeongbu Expressway (Managed by the City of Seoul)

In Phase 3, the FTMS was installed on the 45.7 km of Dongbu Eastern Arterial Road and Gyeongbu Expressway (managed by the City of Seoul). Beginning in April 2005 and finishing in April 2007, this phase included response plans for the flood-prone Dongbu Eastern Arterial Road and the urban expressways near the Han River. Data was provided upon a rise in water level; strategies were set up to prevent vehicles from entering the flooded roads; and operational plans were developed to limit entry to all segments of the road. Furthermore, roadside electronic message displays were changed to ensure that information on unexpected incidents were given priority and automatically shown in affected areas.

Figure 3 -The FTMS in Seoul



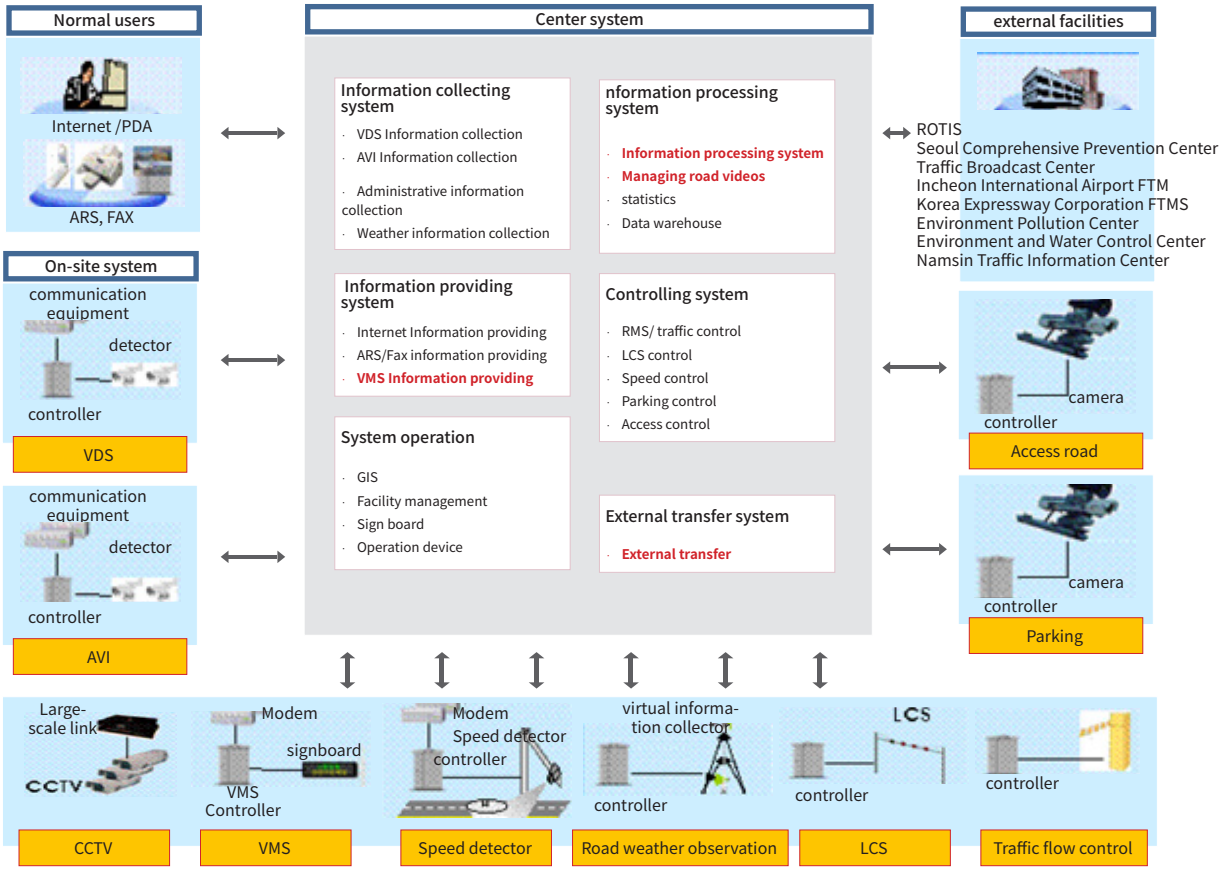
Source: Seoul Metropolitan Government (2007)

Establishment of the Urban Expressway Traffic Control Center & External Data Connection

In December 2000, the City of Seoul developed an "Urban Expressway Traffic Control Center Plan" which specified the name of the center and operation methodology. In March 2001, detailed action plans were set up for operation, and the necessary manpower was assigned to build the center. In April 2001, while the transportation management system for the Naebu Inner Beltway was underway, the FTMS Operation Plan was developed, describing organizational structure, operation and management plans, and an expressway patrol. By March 2002, the Urban Expressway Traffic Control Center was in operation.

The Urban Expressway Traffic Control Center is comprised of i) a local system for collection and provision of traffic information; ii) a traffic information processing and analysis system; and iii) a center system that oversees system operation and links to external entities. The system was built to share traffic data and weather information collected from the detection system, CCTV (closed-circuit television), and RWIS with other institutions such as the Korea Expressway Corporation, the Seoul Metropolitan Police Agency, and the Seoul Emergency Operations Center.

Figure 4 - The FTMS Concept



Source: Seoul Metropolitan Government (2013)

As of 2013, the number of local system facilities installed for data collection, provision, and control of information on urban expressways stood at 1,193 (Vehicle Detection System (VDS): 1,047; CCTV: 144; RWIS: 2), the facilities for information provision and traffic flow control stood at 325 (Variable Message Signs (VMS): 260; Ramp Metering System (RMS): 30; Lane Control System (LCS): 33; Interruption 2), in addition to websites and notification through ARS or fax.

Table 1 -The FTMS on Urban Expressways in Seoul

Category	Data Collection					Information Provision					
	VDS		AVI	CCTV	RWIS	VMS	RMS	LCS	Inter-rup-tion	Inter-net	Oth-er
	Video	Loop									
Phase 1	215	24	-	38	-	62	12	-	-	Web-site	ARS/ FAX
Phase 2	120	2	-	21	-	43	-	-	-		
	217	124	Removed	40	2	81	-	19	-		
Phase 3	194	10	-	36	-	61	18	14	2		
Namsan Zone	-	141	Removed	9	-	13	-	-	-		
Phase 4	Underway										
Phase 5	To be implemented										

Source: Seoul Metropolitan Government (2013)

Table 2 - External Links to the FTMS

Category		Information Details	Frequency	Use of the Information
From	Seoul Metropolitan Police Agency	Traffic flow at a fixed point (1 min interval), traffic flow at a fixed segment (1 min interval), unexpected incidents	1 min	-
		CCTV feed	-	-
	Korea Expressway Corporation	Traffic flow at a fixed segment (1 min interval)	5 min	-
	Traffic Broadcasting Station (TBS)	CCTV feed	-	-
	Seoul Transport Operation & Information Service (TOPIS)	Traffic flow at a fixed segment (1 min interval)	5 min	-
		CCTV feed	-	-
	Expressway to Incheon International Airport	Traffic flow at a fixed segment (1 min interval), unexpected incidents	5 min	-
To	Expressway to Incheon International Airport	Traffic flow on the Incheon Airport Expressway (Bukno JC – Airport)	10 min	Traffic information provided online
	Korea Expressway Corporation	Traffic flow on the Gyeongbu Expressway (Hannam – Shingal), Oegwak Outer Beltway (Toegyewon – Ilsan)	5 min	Traffic information provided online, displayed on operation devices and online maps
	Seoul Metropolitan Fire & Disaster Headquarters (Seoul Emergency Operations Center)	Weather data	1 min	Weather information provided online
		Data on dams, Han River level, and precipitation	-	Operation devices
	Namsan Zone Traffic Data	Traffic flow at a fixed segment (1 min interval)	1 min	Traffic information on the Namsan Zone via VMS

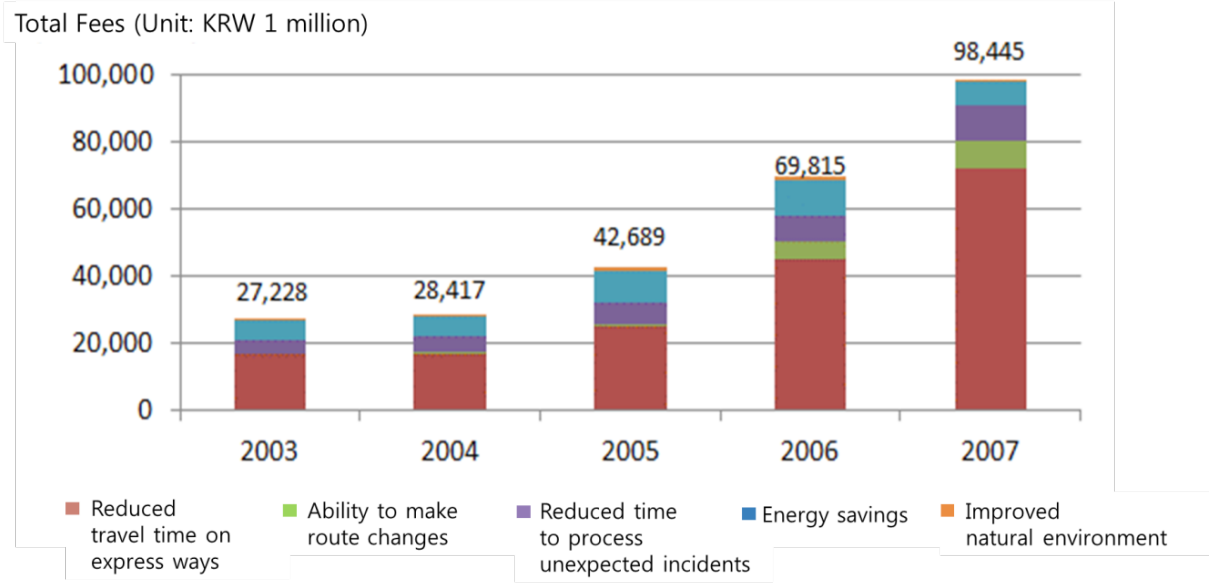
Source: Seoul Metropolitan Government (2013).

Major Achievements

Socioeconomic Benefits from the FTMS

According to a 2007 report by the Seoul Metropolitan Government, the FTMS has resulted in several benefits: reduced travel time on main roads; improved ability in making effective route changes; reduced time in processing unexpected incidents; energy savings; and improvement of the driving environment. As Phase 1 transitioned into Phase 2, the FTMS gradually expanded, thereby adding socioeconomic benefit as shown in Figure 5. Of these, reduced travel time on the main urban expressways was the greatest, followed by energy savings, reduced time to process unexpected incidents, improved ability to make effective route changes, and improved the driving environment.

Figure 5 - Socioeconomic Benefits from the FTMS: By Year

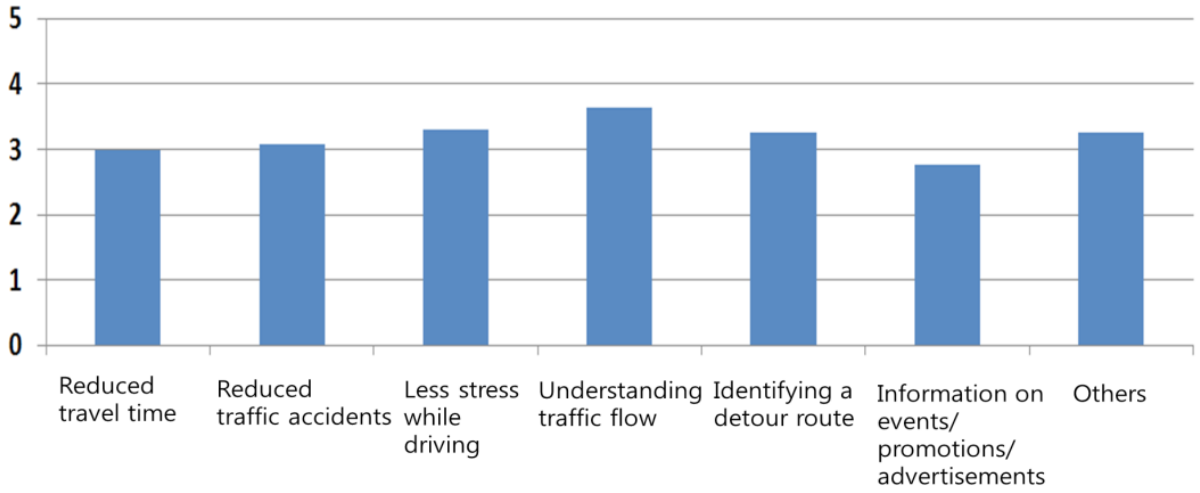


Source: Seoul Metropolitan Government (2007).

FTMS Reliability & High Degree of Public Satisfaction

According to 2007 data provided by the Seoul Metropolitan Government, the FTMS traffic information system helped expressway users with their trips. In a survey, many drivers responded that VMS information was helpful in the use of their vehicles on the road. Specifically, the system was most helpful in understanding traffic situation (3.65 points), followed by finding less stress (3.3 points).

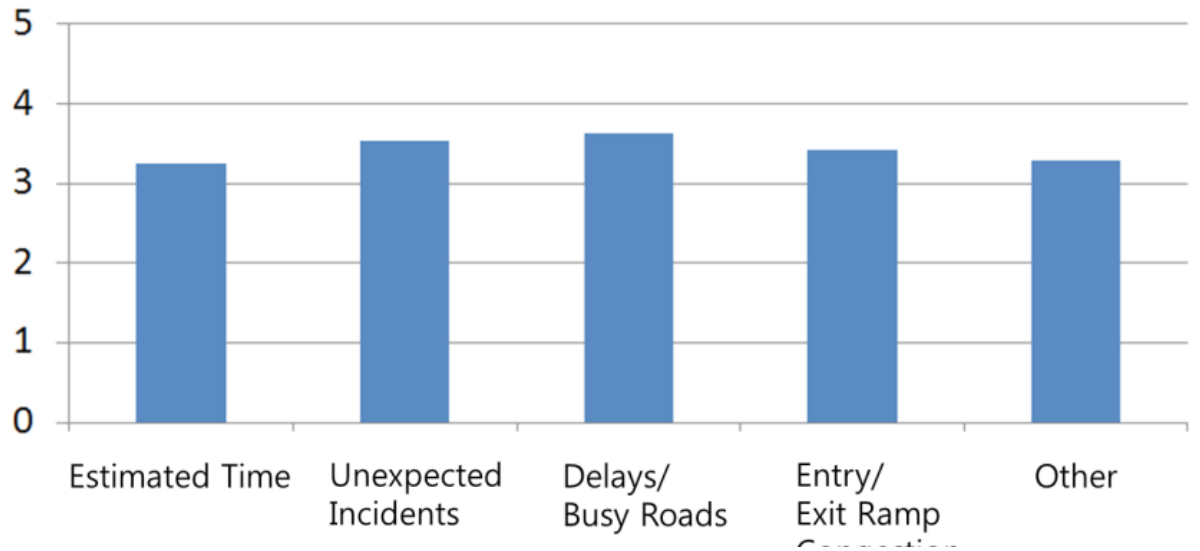
Figure 6 - Ways VMS Information Assists Drivers



Source: Seoul Metropolitan Government (2007).

In a survey on reliability of the estimated travel time data displayed on the VMS, respondents generally found it dependable, with expected delays and busy road information most reliable (3.64 points), followed by information on unexpected incidents (3.54 points).

Figure 7 - Reliability of VMS Information (By Type)



Source: Seoul Metropolitan Government (2007).

Increasing Use of the FTMS

More drivers are using information generated by the FTMS. According to the 2013 FTMS Operation Report by the city of Seoul, the number of information users in 2003 – during the early phase of analysis – was approximately 2.2 million but jumped 520% to 11.7 million by 2013. Use of the website to find needed information was especially high. Reflecting the rapidly increasing number of smart phone users, mobile device access instances amounted to 5.8 million in 2013. Access via social networking sites is also expected to grow in the future.

Table 3 - Access to FTMS Traffic Information by Media

(Unit: No. of accesses/year)

Category	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total No. of Access Instances	2,256 ,940	2,780 ,286	3,026 ,974	4,276 ,123	4,593 ,626	4,862 ,232	5,930 ,403	10,449 ,609	18,117 ,411	13,612 ,320	11,777 ,260
Internet (excluding Twitter)	2,025 ,411	2,584 ,203	2,822 ,365	3,932 ,823	4,059 ,065	4,294 ,350	5,337 ,458	9,904 ,212	17,759 ,764	13,364 ,052	5,726 ,604
Mobile Phones	No Records										5,811 ,771
ARS/FAX	222 ,342	185 ,664	192 ,151	321 ,624	501 ,039	528 ,204	545 ,110	491 ,263	316 ,693	178 ,101	122 ,922
Phone Communication	9,187	10,419	12,458	16,742	16,493	14,335	12,955	10,077	7,709	6,226	4,972
Feature Phones, PDAs	-	-	518	4,934	17,029	25,343	34,880	44,057	25,155	54,753	7,794
Twitter	-	-	-	-	-	-	-	-	8,090	9,188	9,584

Source: Seoul Metropolitan Government (2013).

Future Direction

The City of Seoul has so far invested much of its human and financial resources into building the FTMS and continual expansion of the system. However, limitations were found in the process, with indications that the systems collecting traffic data should be improved due to the delays in delivering data to users or failing to repair devices that did not meet performance requirements. The following are ways to enhance FTMS performance and ensure continued development.

Reduce Delays in Display of Commercial Data (e.g., Traffic Volume, Speed, Occupancy Rate)

Accuracy, immediate response and convenience are keys to optimizing reliability and use of the FTMS traffic information, all of which can be enabled by a system that minimizes the time required to collect, deliver, process, and provide traffic data. The current FTMS detects data from vehicle detection sensors at various locations and uses it as commercial data or displays it on an electronic map released by the traffic information center. This process takes time, and for some road segments, the information may not be in real time. Server capacity needs to be increased, server loads dispersed, and renewal intervals reduced to see improvements to the system.

Building a "Smart Highway"

The FTMS generates traffic information through detectors and data collecting equipment to manage the urban expressways in Seoul, but this is undermined by some limitations with the collected data. The Ministry of Land, Transport & Maritime Affairs is now pursuing the "Smart Highway" program to place more advanced technology on expressways to correct the above-mentioned limitations. This program includes the development of "smart" technologies to improve mobility and safety through: "smart" toll booths that offer various automatic payment methods; automatic detection of all situations on an expressway using real-time panoramic video; and the WAVE system which uses high-speed wireless communication technology installed on a fast-moving car to send and receive all data on the expressways and adjacent roads. In the long-term, Seoul will be better equipped to combine cutting-edge information technology with the FTMS to build a safer, smarter, and more reliable expressway management system.

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5. Shared Transport: Car Sharing in Seoul (Nanum-Car)

Writer : Seoul Institute Dr. Joon-Ho Ko

Policy Area: Transportation

Background

As people depend more heavily on automobiles and increasingly drive their own vehicles, there are related societal costs such as air pollution, higher demand for fuel, and heavy congestion. The City of Seoul has responded through various policies to reduce the traffic volume created by private vehicles. Since the mid-1990s, these policies include: a transportation demand management system for companies (1995); the congestion fee on Namsan Tunnels 1 and 3 (1996); the parking threshold program (1997); and the 7-day road space rationing (2003). The city has adjusted policy implementation and adopted new measures to reflect changes in the transportation environment.

Recently, the global trend has been toward policies on effective use of vehicles, with one of the best known being car sharing. Car sharing is an arrangement where non-owners can use a car and is common in Europe and North America. In South Korea, public awareness on car ownership is changing, and advanced wireless communications (such as smart phones) have made it much more convenient to book and hire cars, opening new possibilities for the car sharing program. With the shifting opinion of car ownership, the City of Seoul has made plans to offer a car sharing service as part of its transportation demand management policy, curtailing vehicle ownership when it is not required and providing the service to those people who are otherwise unlikely to have access to private cars.

Process

In September 2012, the Mayor of Seoul declared the beginning of the "Seoul: A Sharing City" campaign, which focuses on bringing back a tradition of sharing, which has a long history in Korea, to resolve socioeconomic issues in the city. Officially referred to as the "car sharing service", car sharing was particularly touted as one of the most important programs in making Seoul a "sharing city". For this program, the City of Seoul publicly recruited contestants; reviewed operating plans and services for citizens, and strategies to promote public interest; and signed a partnership agreement with 2 private companies. In a public contest held in February 2013, the program was named "Nanum-Car". In an effort to encourage the use of eco-friendly cars, Seoul also initiated an electric car sharing service in May 2012 before the general car sharing service began, but due to delays in making an agreement with the program entities as well as construction of the appropriate infrastructure and system integration, the program officially began in May 2013, 3 months after the official introduction of the gasoline-driven car sharing service.

Starting the Car Sharing Program (Nanum-Car) in Seoul: An Overview

- September 2012: "Seoul: A Sharing City" campaign initiated.

- October 2012: Opened bidding for operators of the car sharing program (requirements such as dedication to the public interest announced).

Bidding parties (Program Entities): Submitted proposals on plans for operation, services, and strategies to promote the public interest.

- January 3, 2013: Partnership agreement signed with Green Point Consortium and Socar.

Selection and agreement: Committee created to choose partners, verify ability to perform the program, and sign the agreement.

- January 21, 2013 – February 3, 2013: Citizens invited to enter a naming contest for the car sharing program.
- February 20, 2013: Membership drive for Nanum-Car; Service begun.

Starting the Electric Car Sharing Program in Seoul: An Overview

- May 2012: Plan developed for pilot electric car sharing program.
- July 2012: Agreement signed with program entities.
- August 2012: Council created with 4 electric car sharing program entities (184 cars).
- August 2012 – March 2013: Infrastructure built & system integrated for electric car sharing program; 212 charging stations built (including 28 "Express" stations).
- April 2013: Citizen testers program launched for electric cars.
- May 2013: Electric car sharing service initiated.
- July 2013: Program transferred to Seoul City Transportation Headquarters (from the Seoul City Climate Headquarters).

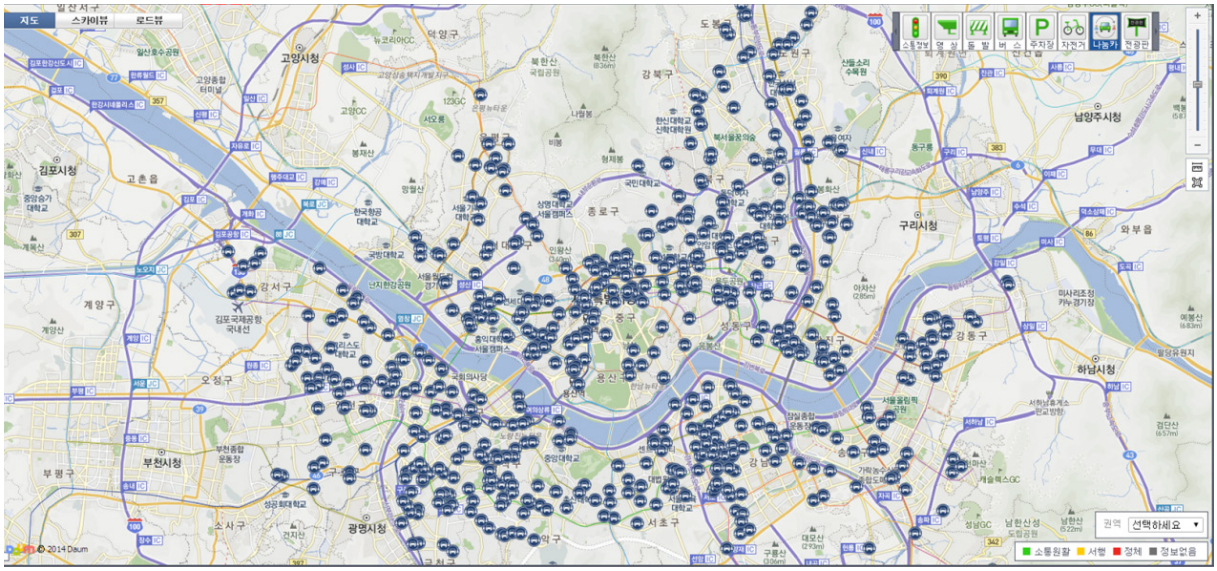
Table 1 - Program Entities in the Car Sharing Program (Nanum-Car) in Seoul

Category	Program Entity		Brand Name
Gasoline-driven Cars	green car 대한민국 No.1 카셰어링	Green Point Co., Ltd. (Consortium)	Green Car
	SOCAR	Socar Co. Ltd.	Socar
Electric Cars	citycar	LG CNS Co., Ltd. (Consortium)	Citycar
	(주)한국카쉐어링	HanCar Co., Ltd. (Consortium)	HanCar
	kt 금호 렌터카 카셰어링	KT Rental Co., Ltd. (Consortium)	-
	YOUCAR	Korail Networks Co., Ltd. (Consortium)	YouCar

Operation

The car sharing service started with 292 outlets and 492 cars in February 2013 and had grown to 850 outlets and 1,816 cars as of November 2014. The outlets are located near public parking lots run by the local administrative districts of Seoul or by public institutions, and car rentals are possible at anytime all over the city (refer to Figure 1). The plans for the electric car sharing service are to build additional infrastructure such as dedicated parking spaces for electric cars and the installation of electric chargers.

Figure 1 - Car Sharing Service Outlets in Seoul



Source: Seoul Transport Operation & Information Service (TOPIS).

Figure 2 - Parking Spaces for the Car Sharing Program

(a) Parking for Gasoline-Driven Cars

(b) Parking for Electric Cars

(c) Signs for Car Sharing Program Parking

Characteristics

Membership-based or Hourly Services

Unlike the predominant type of car rental system, the car sharing service rents program cars, stationed across the city, to people who have applied for and received membership and booked a car online (via mobile phone or ARS) for their desired length of time before they arrive. This can be seen in Table 2. With regular rental services, a customer rents a car by the day, while with the car sharing service members can rent by the hour, significantly reducing the fixed cost for people wishing to use a car for a shorter period of time. Because the same car can be used by several people each day, the operational efficiency is higher than regular car rental services. Outlets located across the city and insurance coverage included in rental cost makes the program convenient for users.

Table 2 - Car Sharing Vs. Car Rental: A Comparison

	Car Sharing (Nanum-Car)	Car Rental
Users	Members	Anyone
Rental Time Segments	30 minutes (available 24 hours/day)	1 day (available only within business hours)
Outlets	All across the city	Designated branches
Payment	After use	Before use
Contract Type	Upon first applying for membership	New contract each time
Pick-up & Drop off Process	Automated	Personnel required
Insurance	Included	Additional

Source: Car Sharing page on the Seoul Metropolitan Government website (http://traffic.seoul.go.kr/archives/9344).

Easy Rental through Advanced Information Technology

Members are able to preview the cars available and the associated outlets through many media forms such as the internet, mobile devices or ARS. A smart key[1] embedded in their membership card or smart phone application can be used, making pick-up and drop-off simple and convenient.

Figure 3 - Picking Up/Returning Cars with Smart Key or Membership Card

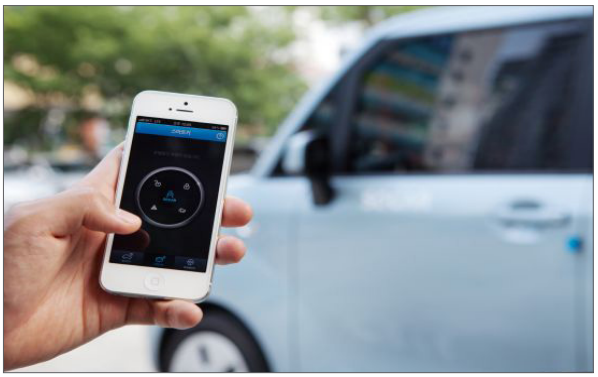
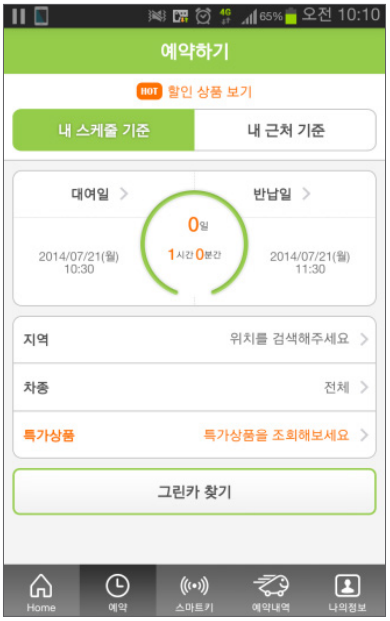
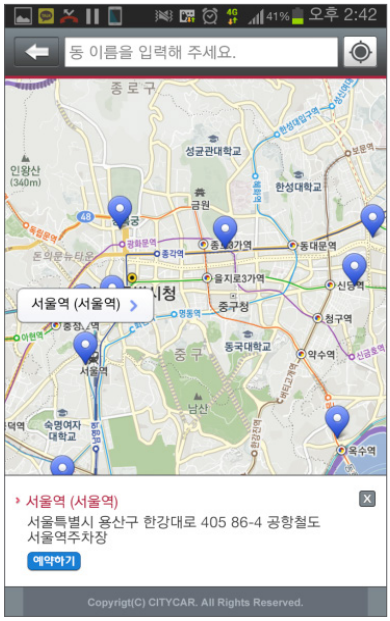


Figure 4 - Using a Smart Phone Application to Book a Car



(a) Booking a Car Using the Smart Phone Application



(b) Map of Outlet Locations

1. A smart phone application can be used instead of the smart key to lock and unlock the car.

Platform to Encourage the Use of Electric Cars

The car sharing service includes electric cars as well, with an aim to boost the electric car market in Korea and take action to address climate change by reducing pollutants and greenhouse gas emissions. Seoul's electric car sharing program uses the Kia Ray and Renault Samsung Sm3 ZE, both developed in Korea. Korean cars were selected to boost the domestic market, but the service will offer other types of electric cars that include international models to offer a wider range of choice.

The City of Seoul signed agreements with 4 private companies (such as Citycar): Seoul provides benefits such as access to public parking lots, while the partnership companies provide the electric car sharing service. In addition to the normal-speed chargers at the electric car sharing outlets, "Express" chargers were installed at 32 outlets for those wanting a faster charge.

Figure 5 - Express Charging Stations

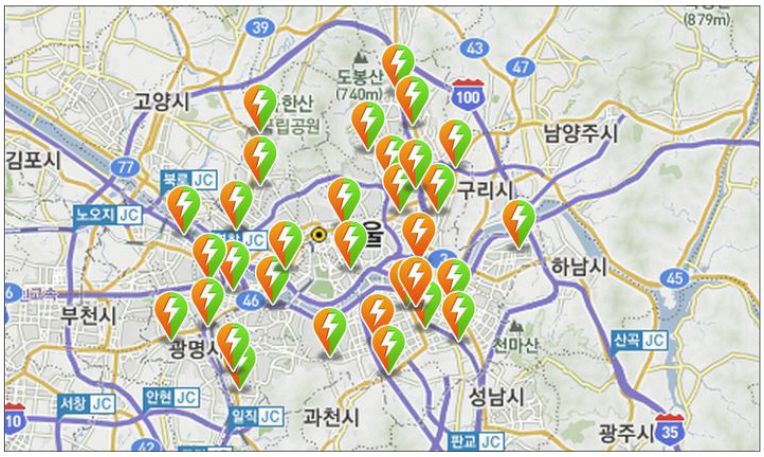


Figure 5 - Using the Electric Charger

Source: City Car website.

Seoul's Policy on Assistance for the Nanum-Car Program

Purchase Subsidies for Program Entities & Discounts for Users

The City of Seoul provides different assistance programs to benefit the car sharing program. Car sharing service providers are given a 50% discount for parking in public parking lots (as of October 1, 2013, a discount of KRW 5.3 million has been given for the 93 Nanum-Car vehicles); electric car sharing service providers receive a subsidy on the purchase of the electric cars (KRW 15 million per car from the city; KRW 15 million from the national government) and free installation of normal-speed chargers. Seoul provides more benefits as part of the integrated transfer discount scheme: members using public transit to get to the car sharing outlet within a travel time of 30 minutes receive an average discount of KRW 300 – 1,000 per use.

Integrated Information & Service Management System

The City of Seoul built a user-friendly system by integrating various individually-run services that were independent of each other, resulting in user inconvenience. This integrated system allows members to access services provided by multiple entities with a "multi-card", while in the past membership with each provider was necessary. The system also includes an integrated gasoline-driven/electric car information service: the outlet/car search feature is now integrated into the TOPIS website, which previously had been provided by each car sharing service provider.

Seoul also created a service management system to address complaints and issues raised by users, such as additional fees charged to a previous user in the event the next user complains about the cleanliness of the car, or in the event a user fails to report any incidents or accidents in which the car is involved.

Major Achievements

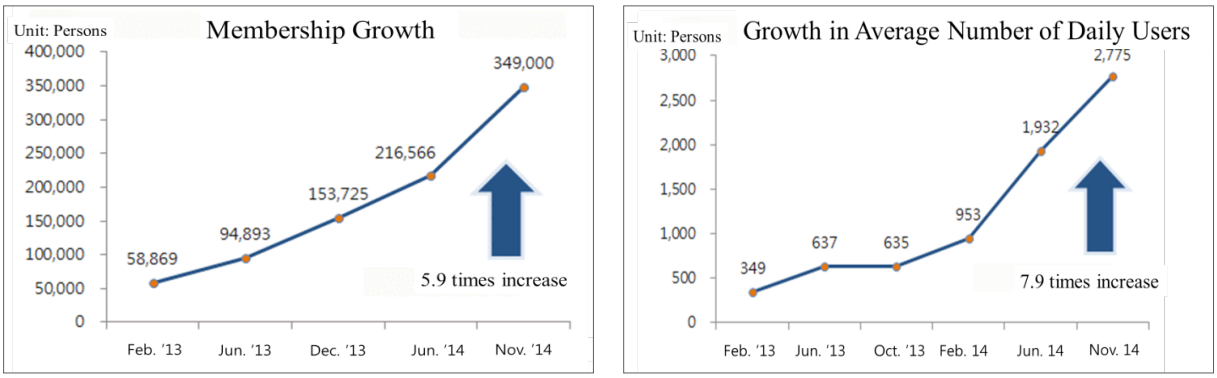
Continuous Growth in Membership & Users

The car sharing program allows non-owners access to cars, attracting some 60,000 members when the service was first launched in February 2013. Membership growth slowed due to inadequacy of the operating system, the small number of outlets, and insufficient promotion, but this changed as services were improved, more outlets appeared, and promotion became more common. As seen in Figure 7, the number of members for the car sharing service had reached 350,000 by November 2014.

The average number of users per day has also steadily increased. Growth has been particularly high since 2014. In November, an average of 2,775 members used the service each day, with an average time per use of 4 hours and 7 minutes: 4 hours and 20 minutes (70 km) per use for gasoline-driven cars and 3 hours and

54 minutes (64 km) per use for electric cars.

Figure 7 - Growing Car Sharing Service Members & Users Per Day

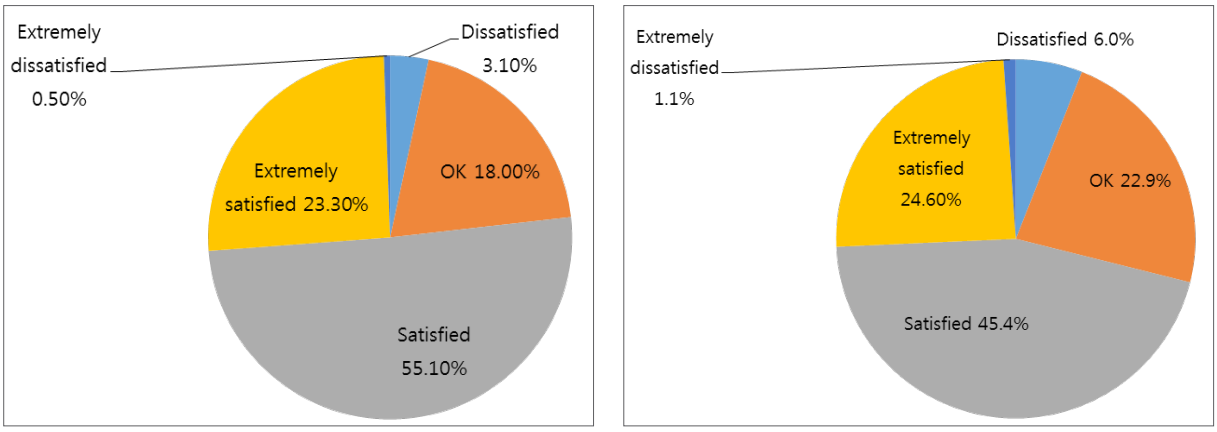


Source: Internal data, Seoul Metropolitan Government

High Satisfaction Rate

In the early days, complaints were directed towards the inconveniences of the car sharing service. Thanks to continued improvement, users are highly satisfied with the service now, according to a survey conducted by the City of Seoul in November 2013. Of 5,950 respondents, most were satisfied: 23.3% said they were "very satisfied" while 55.1% were "satisfied". While satisfaction was high in terms of the rental system and use, it was lower in terms of car condition, number of outlets, number of cars, and fees. According to the results of a survey conducted via the "Policy e-Poll" on the city website, the car sharing service ranked as the 5th most important program in Seoul in the first half of 2013, after the program to phase out a nuclear power generator (1st), night bus (2nd), the Clean Apartment project (3rd), and the program for Patient-friendly Hospitals & Clinics (4th). However, many members requested that the program be expanded and allow one-way trips. A study by the city on the electric car sharing service in 2013 also revealed that many were satisfied: 24.6% were "very satisfied" while 45.4% were "satisfied". The aspects of the service that they were satisfied with were: positive contribution to preserving the environment; vehicles (noise levels, speed, drivability, maintenance, cleanliness); reduced transportation costs; and ease of booking. On the other hand, the instances where members were not satisfied with included time of use, location, and fees. Many complaints were also given regarding charging the electric cars: problems with the charging facilities and the limitations on distances that could be travelled on a single charge.

Figure 8 - Satisfaction with Car Sharing Service (Survey Results)



(a) Gasoline-Driven Cars (b) Electric Cars

Source: (a) Internal data, Seoul Metropolitan Government, (b) Seoul Metropolitan Government (2013).

Reduced Household Expenses

According to the study by the City of Seoul, the car sharing service allows users to avoid the cost of vehicle depreciation, long-term insurance, and vehicle maintenance, with annual savings depending on the number of times a member uses the service. For example, annual cost for car owners who drive twice a week is KRW 4.26 million in total (KRW 1.86 million in depreciation, KRW 850,000 in fixed expenses, and KRW 1.55 million to run the vehicle). However, a twice-weekly user of the car sharing service spends KRW 1.7 million in total – an annual membership of KRW 30,000 and KRW 1,674,400 – about KRW 2.56 million less than car owners. Based on 5-days-a-week use, a car owner spends KRW 6.3 million while a car sharing service user spends KRW 4.18 million: KRW 2.08 million less a year.

Limitations & Needed Improvements

Potentially Ineffective for Transportation Demand Management

Analysis of car sharing service user patterns shows that a majority of users (83.8%) are in their 20s and 30s – the age group that usually uses public transit as they are less able to afford a car purchase – and this may actually work against the policy designed to curtail the use of individual cars. It is also estimated that the shared cars are highly likely to be used on weekends; the percentage of weekend users was 37.5%. In other words, the effectiveness of the car sharing service in terms of managing transportation demand is rather limited, considering how relatively low the use of shared cars is and that people in their 20s and 30s who are less likely to own a car account for the majority (83.8%) of all shared car users. In the long term however, the steadily growing number of users, especially in the young adult group, may discourage people from owning a car in the future. It is therefore necessary to wait and see the effectiveness of this program rather than only focusing on the immediate negative aspects.

Figure 3 - Percentage of Car Sharing Service Users by Age Group (2014)

Category	20s	30s	40s	50s	60s or older	Total
User Percentage	44.2%	42.2%	10.0%	3.5%	0.1%	100.0%

Source: Internal Data, Seoul Metropolitan Government.

Limited Ability to Make One-way Trips

One common request made is to allow one-way trips so that users do not have to return to the outlet where they rented the car, but can instead return the car to an outlet more convenient for them. Currently, one-way trips are possible on a very limited scope, but return trips are mostly required due to the likely imbalance between number of cars at rental points and the number at return points. At this point in time, the one-way trip option is not likely to be expanded when the demand for the service is limited. However more widespread use of the service and expansion of the infrastructure will make this more of a possibility.

Implications

The major difference between the car sharing services provided in 60 countries around the world and that offered in Seoul is who provides the service. Most services in other countries are provided by the private sector. In Seoul, the service is provided by the private sector as well but the program itself was implemented by the City of Seoul. The service in Seoul is different as it grew rapidly, boosted by policy support (subsidized use of public parking lots, subsidies for the purchase of electric cars, etc.) by the city.

Before launching the car sharing service, Seoul sought and assessed proposals to find suitable providers before signing an agreement with those who could provide quality service. To come up with the basic policy directions and minimum service requirements, meetings were held with experts, policymakers, and industry leaders to collect ideas and expertise, after which the city adopted a policy. To support the private-sector providers, the city revised its ordinance on parking lots and decided to allow these providers to use public parking lots at a discount. The service is provided by the private sector, but the brand was named by the city. The city also selected the providers and maintains service quality. The car sharing service in Seoul is a partnership between the public sector and the private sector.

Despite the limitations mentioned earlier, the car sharing service is geared for success considering the growing number of users and increasing demand. In order to meet the originally-intended goals in terms of transportation demand management, the following policy considerations are necessary:

First, the car sharing service needs to be more self-sufficient and requires a platform on which it can expand. For the service to be sustainable, it needs more users to the point where profitability can happen, which will require effective advertisement and promotion strategies by the city and the providers. Operation of the service will need to be more proactive and reasonable, responding immediately to user needs and relocating outlets to meet user demand.

Second, the extent of program expansion should be reviewed in order to ensure service quality. To do this, the role of the service in Seoul's transportation environment needs to be defined, also in consideration of the roles of other modes of transport (buses, taxis, etc.). The service should not be competing with other modes of transport, but rather should make up for the shortcomings of the other modes. This will significantly enhance mobility for the public.

Third, the public nature of the car sharing service should be emphasized. Shared cars may be used to enhance the transportation experience for groups of people who do not have much access to passenger cars (e.g., low-income families, people with disabilities) or certain regions (e.g., traditional markets, community-building project areas, regions not reached by public transit). In terms of transportation demand management, the service also needs policies such as different fees for peak or non-peak hours or discounts to people who have sold their cars. In addition, eco-friendly cars should make up a higher percentage of cars offered and those chosen by users, to ensure that the service becomes greener.

Fourth, a model for safe operation and management is necessary. Transportation safety-related institutions

can help analyze the types and causes of accidents and incidents, based on which a relevant safety manual can be prepared and distributed for users of shared cars.

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6. Removal of Overpasses in Seoul to Improve the Cityscape & Transportation Environment

Writer : Seoul Institute Dr. Joon-Ho Ko

Policy Area: Transportation

Background to Removal of Overpasses

Into the 1970s, South Korea achieved dramatic economic growth. With it, the automobile industry also grew. One of the most important transportation policies of the time was to facilitate traffic flow, and overpasses were built in support of this policy. These structures were built mostly in the old downtown area because, at the time, traffic flowed into the city center, within the boundaries of the four old city gates. The urban expressways (e.g., Gangbyeon Riverside Expressway, Olympic Expressway, Oegwak Outer Beltway, Naebu Inner Beltway) did not exist, and all arterial roads headed toward the city center. In the 1970s and 1980s, most overpasses were built in the old town center in Gangbuk where traffic bottlenecks occurred. Eighty-six overpasses were built in Seoul during this time of constant construction.

Three to four decades later, in the 2000s, overpasses began to lose their originally intended function due to more balanced urban development as well as changes in road networks and the overall traffic system. As highly functional roads such as urban expressways were built one after another, traffic dispersed and urban concentration also eased. More than anything, the old town within the four old city gates declined and the new Gangnam areas prospered. This shift in urban concentration and "relocation" of the bottlenecks from old to new areas brought the excessive investment on overpasses to light. For instance, Ahyeon Overpass was empty except during commuting hours and its numerous sharp bends resulted in speed-related accidents. Overpasses such as this, where users were hit with a "congestion charge" to discourage them from bringing their cars into the city center, were no longer the symbol of smooth flowing traffic. The transportation policy paradigm was also changing, and more emphasis was placed on pedestrians and public transit than on vehicles.

Residents argued that overpasses blighted the cityscape, caused regional isolation, and undermined regional development. Accordingly, the argument for removing overpasses became more and more logical, which the City of Seoul began to review. Subsequently, the city decided to remove some of them, starting with the Cheonggye Overpass connecting east and west in 2003. The removal of this first overpass resulted in a better cityscape and traffic congestion was not as severe as had been expected. Since then, the city decided to consider removal of other old, ugly overpasses that undermined the cityscape.

Figure 1 - Removal of Cheonggye Overpass: Before & After

Source: Internal data, Seoul Metropolitan Government.

Another reason for this was that overpasses interfered with another program in Seoul – introduction of the center bus lane system. To install center bus lanes, a minimum of 2 additional lanes were necessary; most overpasses began at the center of roads that were 4 lanes (both ways) or narrower. Center bus lanes could not be built on roads over which overpasses occupied. On the stretch of roads where overpasses begin, congestion is frequent as cars and buses change lanes to get on their desired path. The local environment was also an element. Most areas with overpasses saw their commercial districts fade away due to the support columns, some areas even becoming slums. Many of these supports have been removed for a myriad of other reasons (deterioration, disruption of traffic flow, interference with subway construction, blighting the cityscape, etc.). More will follow suit.

Summary & Process

Studies by experts show that there were approximately 40 deteriorating overpasses of 30 years of age or older, and that were not as functional as they were intended to be. Although removal of the overpasses would potentially nearly double the traffic volume, this would be compensated by better public transit service, leaving the road's capacity for cars unchanged. In 2002, Seoul started with Tteokjeon Overpass in Jeonnong-dong and phased out overpasses that were not safe or lacked economic or environmental value, seeking to change public awareness of the changing city, improve the cityscape and urban environment, revitalize affected regions and their commerce, and enhance traffic flow and safety.

One of the best examples of an overpass that outlived its effectiveness in terms of traffic flow is the previously-mentioned Cheonggye Overpass. Built to absorb the explosive traffic inflow in the 1960s, Cheonggye Overpass was removed as part of the Cheonggye Stream Restoration project in 2003. The 5 km stretch was replaced with a one-way 2-lane road with a center bus lane. Before demolition, some worried about severe congestion due to the reduced road capacity, but the current condition near the stream is not severe. Ac-

cording to expert evaluation, changes to the city center traffic pattern, new city center development, and especially the increasing number of cars no longer entering the city center assisted policies to make the city more oriented towards public transit. Due to the success of the removal of Cheonggye Overpass and transportation improvement plans, Seoul moved onto other overpasses. The city government paid extra attention to residents who consistently demanded removal because of the blighted cityscape and hindered regional development. Comprehensive plans were established, with the overpasses removed in phases. Table 1 provides a summary of this overpass removal in Seoul.

Table 1 - Overpass Removal (by Year)

Name	Built in	Removed in	Reason for Demolition
Samgakji Rotary Overpass	1967	Nov.1994	Interference with subway (line 6) construction
Tteokjeon Overpass	1977	Feb.2002	Deterioration, improvement of urban environment
Noryangjin Reserve Overpass	1969	Feb.2003	Interference with subway (line 6) construction
Wonnam Overpass	1969	May 2003	Rearrangement of traffic system for the Cheonggye Stream Restoration project
Cheonggye Overpass	1969	Sep.2003	Cheonggye Stream Restoration project
Samil Overpass	1970	Oct.2003	Removal of the connecting Cheonggye Overpass
Miah Overpass	1978	Feb.2004	Improvement of traffic flow, installation of center bus lane
Seoul Station Overpass	1970	Feb.2004	Safety, beautification of the city
Hyehwa Overpass	1971	Aug.2008	Isolated and cut-off center bus lane
Gwanghee Overpass	1967	Nov.2008	Deterioration, improvement of traffic flow
Hoehyeon Overpass	1977	Sep.2009	Interference with view of Nam Mountain, improvement of traffic flow
Hangang Bridge Overpass (North)	1968	Sep.2009	Improvement of Han River view, disrupted traffic flow
Mullae Overpass	1979	Aug.2010	Isolated and cut-off center bus lane, disrupted traffic flow
Hwayang Overpass	1979	Feb.2011	Deterioration, disrupted traffic flow
Noryangjin Overpass	1981	Mar.2011	Improvement of cityscape
Hongje Overpass	1977	Feb.2012	Isolated and cut-off center bus lane, disrupted traffic flow
Ahyeon Overpass	1968	Mar.2014	Isolated and cut-off center bus lane, disrupted traffic flow
Yaksu Overpass	1984	Jul.2014	Beautification of the city

Removal Process

First, the City of Seoul identifies problems with traffic control and management that may arise from removal and comes up with solutions. Items to be reviewed are then determined (location and function of the intersection, traffic flow, maintenance costs, suitability with plans for surroundings, etc.) and evaluated to consider feasibility and priorities.

Figure 2-The Removal Process

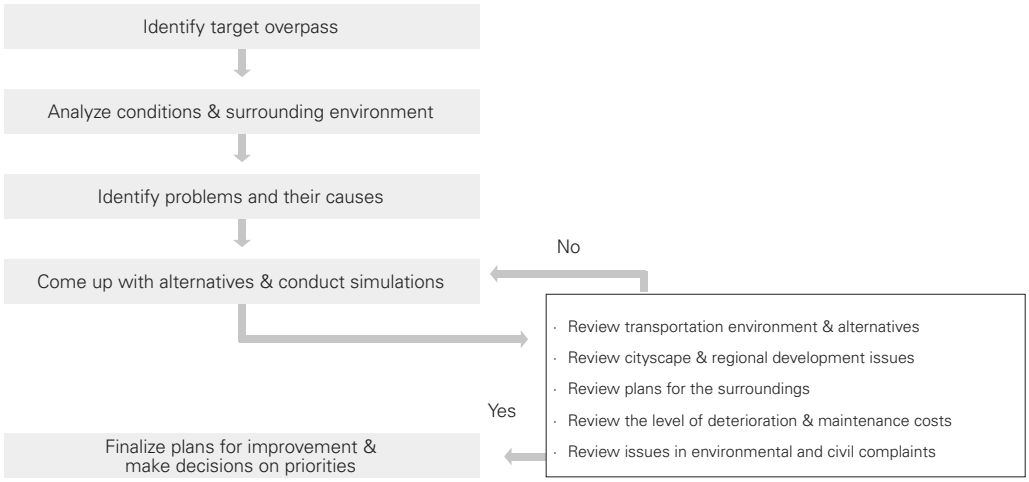


Table 2 - Items for Review Prior to Removal

Items		Review
Category	Subcategory	
Transportation Environment & Alternatives	Location & Functional Characteristics	Review feasibility; consider connection with major roads and functional characteristics (gaps, traverse, street traffic).
	Mobility & Accessibility	Consider effects of change in optimal plans before and after removal, such as congestion, speed, waiting line, etc.
Cityscape & Regional Development	Cityscape	Consider improvements to the cityscape and slum areas.
	Regional Development	Consider the possibilities of development and revitalization of nearby areas.
Plans for Surroundings	Development Plans for Adjacent Land	Ensure balance with existing land use plans, and facilities and land development programs.
	Adjacent Road Plans	Ensure balance with roads and railroads.
Deterioration & Maintenance Costs	Deterioration	Consider deterioration over time.
	Maintenance Costs	Consider annual maintenance costs.
Environmental & Civil Complaints	Environment	Consider noise, air quality, etc.
	Civil Complaints	Consider potential complaints related to overpass removal.

Examples of Removal & Consequent Measures

Removals in 2010 & 2011

In 2010 and 2011, the City of Seoul removed 6 overpasses deemed to have minor traffic impact. In 2010, the Hwayang, Noryangjin, and Mullae were removed; in 2011, the Ahyeon, Seodaemun, and Hongje – linked to the installation of center bus lanes – were demolished. Of these, the Hwayang, Noryangjin, and Mullae had been frequent subjects of complaints as their entry/exit points created bottlenecks and undermined regional development. Removal of these overpasses did not have any significant effect on adjacent roads but did improve the cityscape. In particular, the removal of the Mullae Overpass enhanced connection to the isolated center bus lane, making it easier for people to use public transit. The Ahyeon, Seodaemun, and Hongje Overpasses were removed in 2011 when the center bus lane was opened on the Shinchon-ro and Toingil-Euiju-ro road, materially improving the cityscape and regional development.

Major Preventive Measures

To mitigate congestion from the removal of the overpasses, the City of Seoul came up with various preventive measures, such as improving signal operation at adjacent intersections, securing additional lanes, enhancing connection of the center bus lane, and modifying bus routes. Details can be seen in Table 3 below.

Table 3 - Overpass Removal: Major Congestion-Prevention Measures

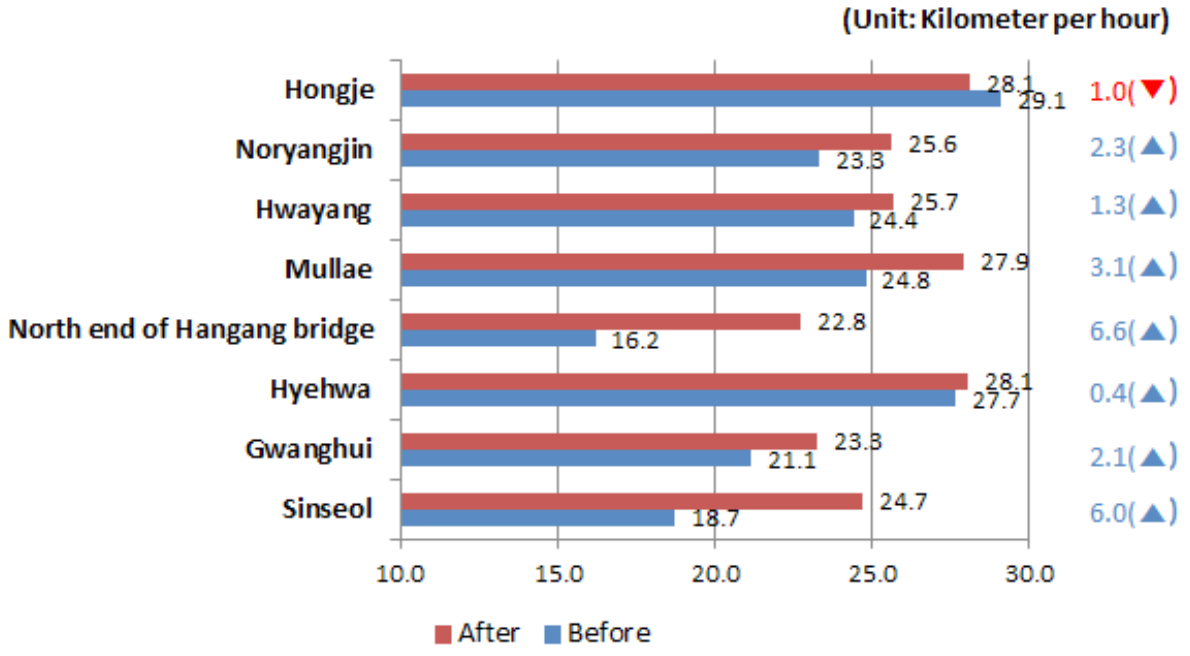
Demolished Overpass	Preventive Measures
Hwayang Overpass	Modified signal operations at adjacent intersections to facilitate linear traffic flow. (From simultaneous straight/left signals to differently timed left signals)
Noryangjin Overpass	Added extra straight/left-turn lanes.
Mullae Overpass	Improved connection to center bus lane; enhanced side lanes for cars making a U-turn where the overpass used to be; secured detour routes.
Ahyeon Overpass	Extended center bus lane after overpass removal; added extra left-turn lanes, and adjusted community bus routes.
Seodaemun Overpass	Removed double intersection, U-turns used.
Hongje Overpass	Removed left-turn lane, added detour bridge, improved side lanes, and secured detour routes to augment intersection capacity.

Major Achievements

Improved Traffic Flow

On many occasions, overpass removal improved traffic flow in the vicinity. Analysis of morning traffic flow before and after removal of Wonnam, Miah, and Hyehwa Overpasses shows that average speed increased in these areas except for the Hongje Overpass area. There was a tendency for a reduction in travel speed on roads immediately after the removal, but speed returned to normal levels or increased within a year or two. This improvement was due not only to overpass removal, but also i) physical changes (e.g., increased capacity of intersections due to expanded access; geometric improvement of intersections previously limited by overpass support columns; channelization of turn lanes); and ii) systemic changes (e.g., improvement of signal operations and route management; control of turns at intersections).

Figure 3 - Changes in Average Travel Speed after Overpass Removal



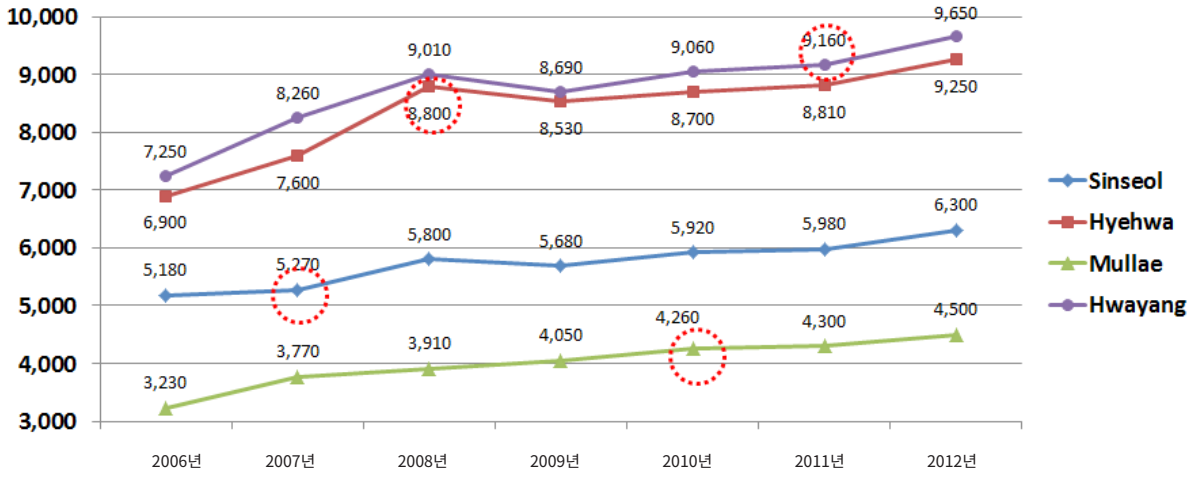
Financial Effect: Greater Revenues for Adjacent Businesses & Increased Housing Prices

In many cases, housing prices go up when an overpass is removed. The City of Seoul compared officially-assessed land prices in the vicinity of the overpasses and found that the land prices increased faster near the removed overpass than in nearby regions. Figure 4 shows the official real estate prices in adjacent areas after removing 4 overpasses in Seoul; growth rate is high immediately before and after demolition. When the

Tteokjeon Overpass was removed in 2002, prices of real estate in the surrounding area rose by 18% in 2003 and 2004 whereas the average growth rate in all of Dongdaemun-gu (where the overpass had been) was only 5.09% during the same period. Prices of land near the Miah Overpass, removed in 2004, rose by 16% in 2005 and 2006 – about 10% higher than the 6% growth rate of Seongbuk-gu and Gangbuk-gu.

Figure 4 - Changes in Real Estate Prices in Immediate Vicinities after Overpass Removal

Note: Red circle denotes year overpass was removed.
Source: Internal data, Seoul Metropolitan Government.

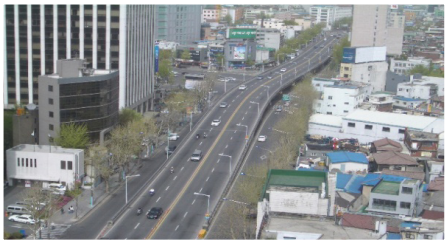
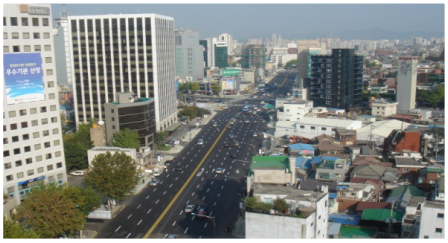
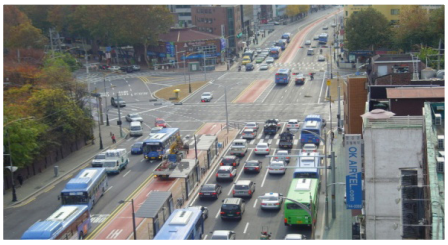
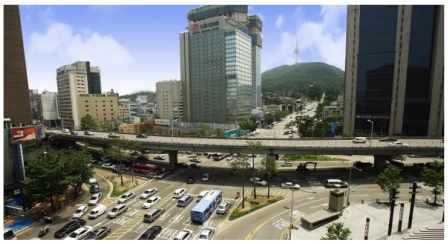


Greater Value to the Surrounding Landscape

In terms of landscape, the view of the intersections is more open and sweeping after an overpass is removed, as seen in Figure 5. It is expected that people who enter the region are more satisfied with the view.

Figure 5 - Before and After Overpass Removal

Category	Before	After
Tteokjeon Overpass (2004)		

Miah Overpass (2004)		
Shinseol Overpass (2007)		
Gwanghee Overpass (2008)		
Hyehwa Overpass (2008)		
Hoehyeon Overpass (2009)		
Hangang Bridge Overpass (North) (2009)		

Source: Internal data, Seoul Metropolitan Government.

Limitations & Needed Improvements

Removing old overpasses that undermine the cityscape and regional development brings positive results to local residents and others passing through, but there are still experts and residents who believe that the removal is less ideal in terms of traffic flow, partly due to a lack of studies that clarify the socioeconomic effects of the removal. It is therefore necessary to continue monitoring and analyzing the effects, the results of which can be used later to set the course for future direction.

Indeed, removal is positive in many ways, such as traffic flow and cityscape, but resultant losses should not be ignored. As the paradigm of transportation policy continues to change to accommodate pedestrians and public transit, the removal of overpasses is a reasonable change that suits this paradigm shift, but cannot be an excuse for a "one-size-fits-all" approach: that demolition can resolve anything. Economic loss due to slower traffic may be as great as the benefits from boosted commerce and improved landscape. On the other hand, the High Line in Manhattan, New York shows an old overpass that has been transformed into an urban park, significantly increasing the value of nearby businesses and real estate, and has become one of the most visited tourist attractions in the city. At times, rehabilitation should be considered before demolition, as can be seen in this case from New York.

Experts who are concerned over demolition-oriented policies insist that the negative aspects of demolition should not be ignored. According to data from the City of Seoul, business arcades near the 5 removed overpasses had a 10% increase in revenue but underground arcades experienced a severe drop in their revenues. Previously, pedestrians had to go underground to cross the road, but after removal of the overpass, they could use the new crosswalk and rarely went underground. It is imperative that a balance should be struck between demolition and preservation (utilization), with keen consideration for the improvement of environments, businesses, and regional development.

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7. Development Program for Yonsei-ro Transit Mall

Writer : Seoul Institute Dr. Joon-Ho Ko

Policy Area: Transportation

Background to the Program

In the past, South Korea pursued industrialization and urbanization for economic growth and built a transportation system that was automobile-oriented. However, urbanization brought with it some severe traffic congestion and other social costs as side effects, such as increased travel time, air pollution, higher accident rates, and resentment. It has in recent years become very important to shift from an automobile-centered urban paradigm to a perspective that prioritizes pedestrian rights and road use efficiency. In 2006, the Ministry of Land, Transport & Maritime Affairs announced the First Basic Plan for Public Transport and opened discussions on the introduction of a "transit mall" as part of the measures to strengthen transportation demand management in congested areas of the city. The Second Basic Plan in 2011 proposed expansion of the transit mall.

In line with this trend, the City of Seoul modified the public transit system and worked to build a pedestrian-friendly climate putting people and public transit first, thereby creating a sustainable urban environment. By June 2012, the city came up with a new vision called, "Walk-Friendly Seoul", with a transit mall suiting the transportation policies of Seoul, but because it had never been tried in the city, various research institutes, including The Seoul Institute, decided to review the idea through academic studies. Outside Korea, transit malls have been utilized since the 1960s and 1970s in European and North American cities where automobile transportation was concentrated. In Korea, the first location of a transit mall was on Jungang Road in Daegu in December 2009. Recently, Busan also announced plans to create a transit mall on Dongcheon Road.

In 2012, the City of Seoul developed its Seoul Comprehensive Plan for Transit Malls and selected 10 candidate areas, carefully reviewing land use, floating population, public transit access, number of public transit users, characteristics of the business districts, and symbolic significance. The transit mall would potentially be resisted by local residents, business owners, and pedestrians as it would limit the number of vehicles in the area, and many different elements therefore had to be carefully analyzed. Of the 10 candidate locations, the Yonsei-ro district was chosen as Seoul's pilot program in July 2012. The city actively communicated with interested parties to address any potential complaints and conflicts: community meetings were hosted, discussions were held to revitalize business districts in Shinchon, and the Seoul Metropolitan Police Agency conducted a deliberation. A year and a half later (in January 2014), the transit mall in Yonsei-ro was finally opened.

Concept of "Transit Mall" & Examples

Concept & Purpose

Generally, "transit mall" refers to a district reserved for public transit (trams, light rail, buses, etc.) and pedestrians, with passenger cars and other vehicles prohibited. It is different from pedestrian-only zones as public transit is allowed. A transit mall has 4 purposes – transportation demand management, city revitalization, enhancement of the public transit experience, and improvement of the pedestrian environment. These purposes are organically connected, as programs in which a transit mall is designated result in improved public transit and pedestrian experience, Furthermore transit malls contribute to reducing future demand for transportation and encouraging local as well as regional development. The following are more details on these purposes:

- Transportation demand management: As set forth in the Basic Plan for Public Transport, the fundamental purpose of a transit mall is to reduce the demand for passenger car use.
- City revitalization: A transit mall is sometimes created as part of transportation demand management to influence land use. The zone should therefore be designed in consideration of transportation quality (convenient, safe, and comfortable). It cannot compromise accessibility nor can it be far from the reach of public transport. In terms of safety, a transit mall cannot be effective if located in any zone where traffic speeds are excessively high (or where mobility is important or where the zone serves as a transportation hub) or in areas prone to crimes and/or accidents. As far as convenience is concerned, a transit mall cannot be located in areas that can only be accessed by driving (such as hospital areas).
- Enhancement of the public transit experience: Transit malls limit the use of passenger cars and enhance the timeliness, speed, and frequency of public transit. They can be located in areas where various types of public transit are concentrated. After a zone is selected, routes and frequencies can be increased for user convenience as well as for better profitability of the public transit companies.
- Improvement of the pedestrian environment: The presence of vehicles can pose a potential threat to pedestrians, and a transit mall can help improve their safety. It can also insert various elements of urban design (art, benches, trees, etc.) in the zone to attract more pedestrians.

Legal Basis

In Korea, there are still no laws that stipulate specific details on the definition and creation of a transit mall. Nonetheless, the Urban Traffic Readjustment Promotion Act and its Enforcement Decree allows city mayors to designate and operate transit malls as part of transportation demand management to facilitate urban transportation. In addition, the Road Traffic Act under the "Prohibition Against & Limitations on Travel" article sets forth that the head of a local police agency may prohibit or limit the passage of vehicles. Lastly, the Act on the Support & Promotion of Utilization of the Mass Transit System and its Enforcement Decree prescribes under "Recipients of Financial Assistance" that the state or a local government organization may provide part or all of the required funds, as a subsidy or loan, to another local government organization or a public transport

service provider for the operation of specific programs.

Examples At Home & Abroad

Outside Korea, many transit malls were designated across regions in Europe and North America in the 1960s and 1970s. Since then, some have been modified or removed, but many are still in operation. In Japan, there are many transit malls, but they are either at the stage of social experimentation, except in some regions, or insufficient to be called a transit mall.
In Korea, the first transit mall was designated on Jungang Road in Daegu in December 2009. Another transit mall is underway on Dongcheon Road in Busan. The city of Incheon is also reviewing the introduction of a transit mall (on Sijang Street), as are many other local governments.

Process

Selection of Transit Mall Candidate Areas in Seoul

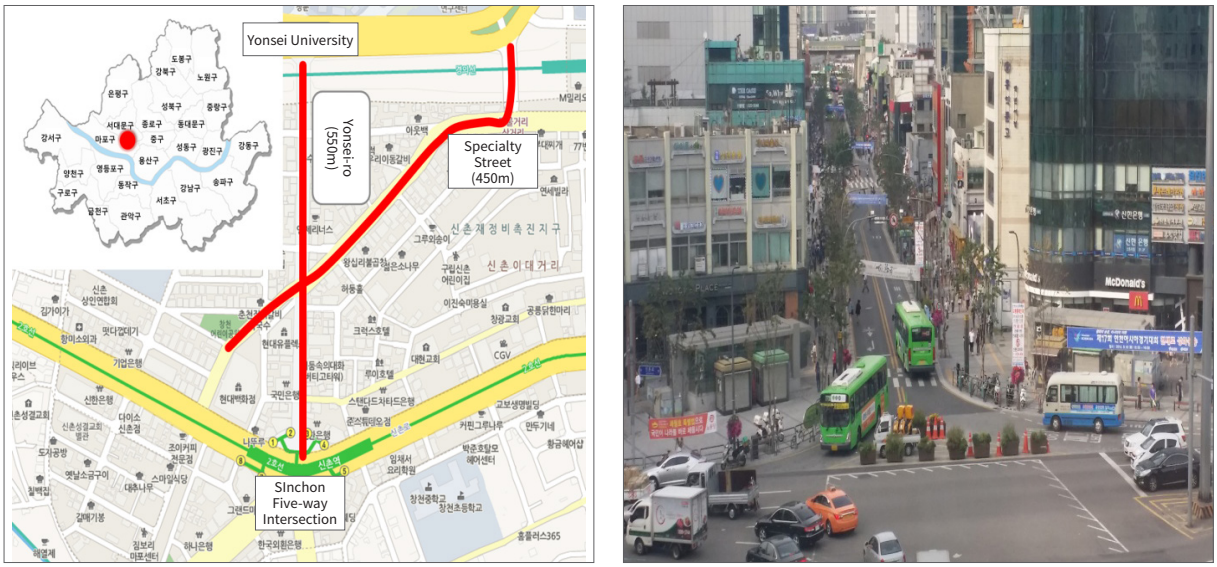
As part of its transportation policy, Seoul aimed to create an urban environment where people and public transit come first and reviewed the introduction of a transit mall beginning in late 2011. To select suitable candidate locations, the City worked with The Seoul Institute to develop its "Criteria for the Selection of Transit Mall Candidate Locations for Seoul" and selected 10 areas based on land use, floating population, access to public transit, number of public transit users, extension of the target road, continuity of road, presence of entry to/exit from parking facilities, presence of access-controlled facilities during vehicle access control, characteristics of business districts, and symbolic significance. In the initial review, 82 public transit nodes with high floating populations were selected. They were then narrowed down to 32 which had subway stations within walking distance, a high number of subway users and a large floating population, and other relevant aspects. The list was then narrowed down to 10 final candidate locations.

Selection & Progress

Of the 10 candidate location finalists, the City of Seoul chose Yonsei-ro for its pilot program after considering the surrounding conditions. Overall and detailed designs were initiated while a program committee was organized to communicate with local residents and interested parties. Public hearings and resident orientations were also frequently hosted. With input from residents, the program finally began construction in September 2013. In January of the following year, the transit mall was opened. The scope of the program was the 550m segment on Yonsei-ro (Shinchon Rotary to Yonsei University) and the 450m segment of Myeongmul (Attrac-

tion) Street (Hyundai Department Store to Yonsei Severance Hospital) in Shinchon-dong, Seodaemun-gu. The total program cost was KRW 7.915 billion, with KRW 1.35 billion coming from the national government. Construction was for a period of nearly 2 years, from March 2012 to December 2013.

Figure 1 - Yonsei-ro Transit Mall: Location & View from the Air



(a) Yonsei-ro Transit Mall Location

(b) Yonsei-ro Transit Mall View

Source: Press release by Seoul Metropolitan Government (2013).

Program Summary

Detour Traffic Control due to Transit Mall Construction

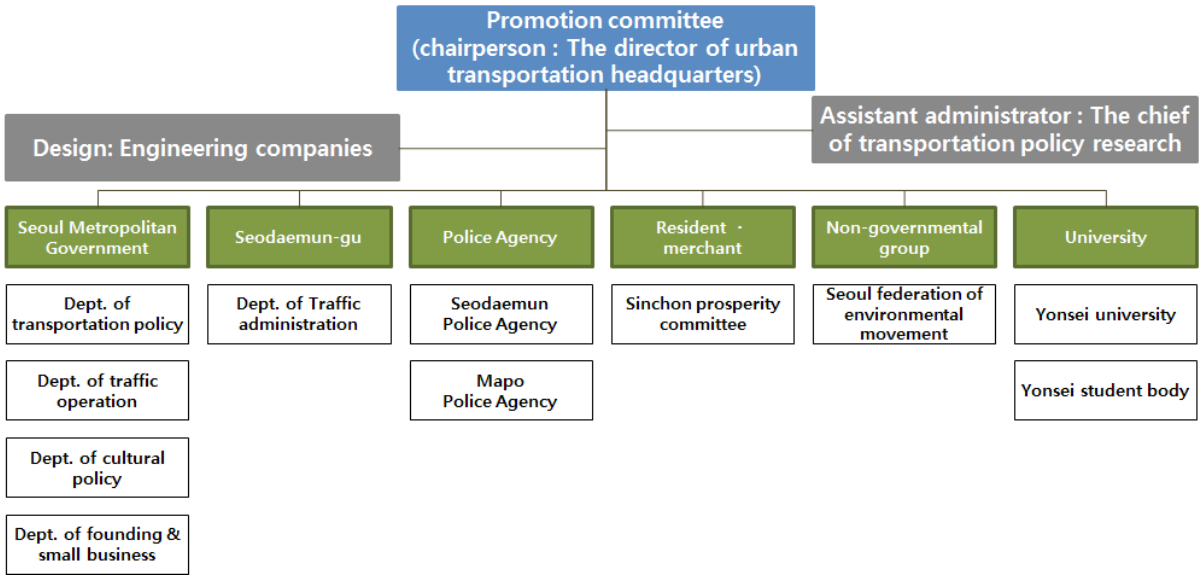
Construction of a transit mall on Yonsei-ro meant that measures to process detour traffic were needed. There were traffic congestion concerns for adjacent roads due to the detour, and discussions were held to minimize the congestion. First of all, a new intersection was installed at the north entry to Yonsei-ro to accommodate the detour traffic and the signal system was improved in the adjacent intersections. One-way signs were added to the nearby roads to facilitate the traffic flow. In areas where a large number of pedestrians were expected, crosswalks were added.

Management of Conflict between Interested Parties

Due to vehicles being prohibited in the area, a transit mall program may lead to inconvenience in travel, reduced revenues, and a slowdown in business activities, giving rise to conflict between interested parties.

In an effort to encourage such parties to participate in the program and reach agreement, the City of Seoul organized a program committee, comprised of 6 institutions – the city, the local gu district, the police, a local merchants' association, a civic group, and the university – and of 3 subcommittees – transportation, design/construction, and promotion. Resident hearings and orientations were frequently held for local inhabitants, and discussions were held on improving the transportation system and revitalizing local business. The program, with a great emphasis on communication, also convinced residents and the relevant administrative organizations through clear legal and administrative logics. These series of actions, designed with clarification in mind, led to successful introduction of the program in a short period of time. In 2013, the program was selected as a role model for conflict management in Seoul, eligible for the joint government assessment program.

Figure 2 - Yonsei-ro Transit Mall Program Committee



Source: Kim Sang-shin, Lee Su-jin (2014).

Table 1 - Major Points of Conflict & Resolution by Local Residents & the Relevant Administrative Authorities

Parties Involved	Conflicts	Resolution (Discussion Points)
Local Residents & Merchants	· Reduced business due to controlled vehicle access · Congested nearby road networks due to detour · Demand for large public parking facilities	· 80% of vehicles passing through cause congestion, rather than by vehicles trying to access the area · Explained positive effect of increased pedestrian numbers on business based on actual examples from home and abroad · Explained ways to attract visitors (e.g., cultural events) · Established effective transportation plans (e.g., detour, new intersection) · Explained traffic simulation results · Explained extra parking capacity after investigating parking facilities in the Shinchon area · Agreement signed with Hyundai Department Store and night time discounts offered to merchants
Hyundai Department Store	· Reduced revenues due to access control · Demand for a new intersection in front of Hyundai Department Store on Yanghwa-ro	· Explained the issues surrounding installation of a new intersection · Left turns to be allowed at existing intersection as additional access route
Seoul Metropolitan Police Agency	· Concerns of traffic congestion from the extra crosswalk in front of Yonsei University and a new intersection in front of Severance Hospital	· Simplify and link the signals by removing the straight-ahead/left-turn signals for vehicles leaving Yonsei University · Sensor proposed that would deter lines of tailgating cars entering the intersection during red signal · Merchants' association can participate in review of traffic safety facilities to convince the authorities of the necessity of the program
KEPCO	· Moving of 40 power distribution equipment units to be financed by the city	· Legal advisors showed that existing law made it appropriate for KEPCO to finance the move
Street Vendors	· Demand to stay in current locations even after the transit mall opens · Demand for a new intersection	· Proposed moving to an alternative location · A council comprised of the gu district office, the merchant's association, and street vendors to develop a protocol that specifies the locations, numbers, sales methods, etc.

Source: Kim Sang-shin, Lee Su-jin (2014).

Transit Mall for a More Relaxed, Easier Way to Walk & Travel

Yonsei-ro suffered from poor pedestrian safety and persistent congestion. According to city research on the floating population in 2009, pedestrian volume on Yonsei-ro was 2,000 - 3,000 people per hour, approximately 30,000 per day. The pedestrian path along Yonsei-ro was 3 to 4m in width, enough to accommodate pedestrians, but facilities such as KEPCO's power distribution equipment and street vendor stalls constricted the path, reducing this width to between 1 and 2m in reality. One of the greatest goals became to secure space for pedestrians to enjoy the walk. The power distribution equipment and street stalls were moved or removed, and the 2 driving lanes (in both directions) were reduced to a single lane in each direction. The points where pedestrians congregate or travel were identified and the pedestrian walk was expanded up to 8m, depending on the location in connection to the major routes. As a result, chicanes were naturally formed, slowing down traffic speed.

Figure 3 - Yonsei-ro Transit Mall

Pedestrians Come First in the Transit Mall

To ensure the safety of pedestrians, the speed limit on all vehicles in the Yonsei-ro transit mall is limited to 30km/h or less, allowing vans carrying 16 or more, vehicles for emergency use, and bicycles at all times. To prevent congestion, taxis are only allowed between the hours of midnight and 4:00 AM when public transit

is not available. Those vehicles that are necessary for business must obtain a permit, and are allowed access only from 10:00 – 11:00 AM and 3:00 – 4:00 PM. All other vehicles are prohibited from travelling or stopping/parking on the road. Violations result in a fine of KRW 40,000 for passenger vehicles and KRW 50,000 for vans. From 2:00 PM Saturday to 10:00 PM on Sunday, all buses passing Yonsei-ro detour around the area to keep the space solely for pedestrians.

Transit Mall as a Cultural & Living Space for People

From the start, the transit mall program has been discussed in relation to long-term regional development. Restricted vehicle access resulted in no-throughway roads on either side of the intersection, and this space is used to hold various art and cultural events, such as Open Art Theater (May – October, every Saturday), B-boy battles, Seoul festivals, and many more. The space can also be used by anyone for an impromptu performance, without going through the complicated process of obtaining approval. Such free use of the space is the driver behind creativity and new cultural expression unique to Shinchon, and a place to enjoy culture for visitors. Other events and possibilities that are under review include installation of a fountain on Attraction Street as well as public artwork by citizens, local artists, and university students.

Major Benefits

According to a press release by the Seoul City Transportation Headquarters in July 2014, positive effects from the new transit mall included: traffic accidents reduced by 34% in 6 months compared to the same period of the previous year; people satisfied with the changes; increased number of city bus users; and increased revenues and more visitors to Shinchon businesses.

Traffic Accidents Reduced

From January to June 2013, there were a total of 29 traffic accidents on Yonsei-ro. During the same period in 2014, this number was down to 19 (34.5% less than the previous year). Also of note is that accidents on side roads near Yonsei-ro dropped by 22% and from Shinchon Station to the Yonsei University main gate, by 54.5%. Concerns had been raised regarding pedestrian safety since there would be many more of them crossing the roads without traffic signals after the transit mall was built, but with a speed limit of 30km/h and a reduced traffic volume, the number of accidents fell.

Table 2 - Number of Traffic Accidents On & Near Yonsei-ro

	Total	Jan. – Jun. 2013	Jan. – Jun. 2014	Change (%)
Total	48	29	19	-34.5
Yonsei-ro	16	11	5	-54.5
Side Roads	32	18	14	-22.2

Source: Press release by Seoul Metropolitan Government (2014).

Increased Satisfaction & Number of Bus Users

The City of Seoul conducted a survey on 300 visitors to Yonsei-ro and 1,000 residents which compared their satisfaction before and after construction of the transit mall. The survey revealed that 70% were satisfied, 58 percentage points higher than those who were more satisfied before the changes (12%). Upon closer look, it can be seen that a majority of respondents were satisfied with safety over the situation in the past, where people and vehicles shared narrow, crowded roads. Others felt positively about the improved convenience and cityscape.

Another survey on 10 bus routes showed that some 54,000 people visited Yonsei-ro via bus from January to May 2013; during the same period in 2014, the number was 61,000, up by 11.1%. This is because Yonsei-ro, where the year before cars had been reduced to 3 – 4 km/h due to the heavy congestion (both weekdays and weekends), was significantly easier to visit by bus in a timely manner after introduction of the transit mall.

Table 3 - Average Number of Daily Bus Passengers on Yonsei-ro

Average Number of Daily Bus Pas-sengers	Total	Jan.	Feb.	Mar.	Apr.	May
2013	54,974	10,799	10,665	11,278	10,937	11,295
2014	61,089	10,751	12,013	12,992	12,312	13,021
Change (%)	+11.1	-0.4	+12.6	+15.2	+12.6	+15.3

Source: Press release by Seoul Metropolitan Government (2014).

Increased Revenues & More Visitors to Shinchon Businesses

After the transit mall was built, business in Shinchon improved. In the first 5 months of 2014, the number of visitors to Shinchon stores increased 28.9% over the same period in 2013, while the number of transactions grew by 10.6% and revenues by 4.2%.

Table 4 - Revenues, Visitors & Transactions at Shinchon Businesses

(Units: KRW 1 million/1,000 people/1,000 transactions)

	2013					2014				
	Jan.	Feb.	Mar.	Apr.	May	Jan.	Feb.	Mar.	Apr.	May
Total Revenue	16,840	16,292	17,633	16,714	17,782	17,692	16,096	18,654	18,063	18,315
Total Number of Visitors	198	192	211	211	220	245	244	274	276	290
Total Number of Revenue-Generating Transactions	564	494	609	598	651	592	550	687	680	717

Note: Based on analysis of data from 1,000 BC Credit Card-affiliated stores in the Yonsei-ro transit mall.
Source: Press release by Seoul Metropolitan Government (2014).

Limitations & Needed Improvements

Better Enforcement of Vehicle Restrictions

All cars, with the exception of approved vehicles, are prohibited from driving in the transit mall, but motorcycles and other vehicles continue to violate this restriction. Manned or unmanned equipment is needed to better manage this situation.

Pursuant to the Road Traffic Act, the city or the gu district office has the authority to manage violations related to stopping, parking, bus lanes, and emergency lanes. However, the transit mall is under the jurisdiction of policy pursuant to Article 6 of the Road Traffic Act. The transit mall thus needs full police supervision, but this is difficult due to a chronic shortage of manpower. Automated equipment can be used, but while the police can deal with traffic signal and speeding violations via cameras etc., there are no specific regulations on access violations. The installation of additional equipment by the police is therefore not an option. Consequently, the City of Seoul has installed 24-hour surveillance cameras to observe unauthorized vehicles entering Yonsei-ro, in operation since midnight Monday, March 3, 2014. There are 4 CCTVs; images of unauthorized cars are sent to the police to impose fines, but this divided system wastes time and manpower for both the city and the police. Operational efficiency will be enhanced if the authority to control and regulate violations in the transit mall could be transferred to the city or the gu district, as are other traffic violations prescribed in the Urban Traffic Readjustment Promotion Act.

Another option is to use unmanned equipment to regulate and photograph vehicle violations, but prior to any such steps, full and voluntary cooperation by visitors and citizens is necessary. This is not an issue that can be addressed and resolved in a short period of time. The relevant authorities will need to continue promoting the necessity of the transit mall and increase public awareness.

Carelessness by Pedestrians While Crossing Roads

After introduction of the transit mall, traffic accidents on Yonsei-ro decreased. However, it is now easier to cross the roads than before, exposing pedestrians to potential accidents. In fact, many pedestrians cross the road where there is no crosswalk. When visibility is significantly reduced at nighttime, accidents involving vehicles and people are more likely to occur. It is imperative that the risk of accidents involving pedestrians is minimized through preventive measures such as brightening the streetlights, better control of vehicle speeds, and raising awareness on the dangers of jaywalking.

Implications

The Yonsei-ro transit mall is meaningful in that it is the first of its kind in Seoul. In the past, the city attempted to introduce this concept as well as pedestrians-only zones, but plans never came to fruition due to conflicts between interested parties and poor cooperation from the relevant authorities in gu district offices. The Yonsei-ro transit mall program however was implemented over a short period of time, thanks to effective management of communication and conflict between the interested parties. The program is touted as one of the most successful examples of conflict management.

Unlike the transit mall on Jungang-ro in Daegu, the Yonsei-ro transit mall removed the elevation between the pedestrian walkway and the road for vehicles. On the weekends, Yonsei-ro is transformed into a pedestrians-only zone. This is one step further from other existing transit malls, creating a better pedestrian environment.

Seoul's first transit mall has been a success, and the city is also considering plans to transform this zone into a full pedestrian-only zone later. It is one of the best examples of Seoul's efforts to achieve its vision of putting people and public transit first and creating a sustainable urban environment. Based on this success, Seoul has plans for a second transit mall in a selected area.

Suitable target areas are essential to expanding the transit mall program. Because the Yonsei-ro transit mall is in its infancy, the surrounding environment – ancillary facilities, trees, landscaping, etc. – is still insufficient. More problems may surface over time. Instead of hastening to expand the program, it would be wiser to identify and resolve the problems and shortcomings in the first program before moving on to the next target.

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8. Weekly No-Driving Day: A Voluntary Program to Reduce Traffic Volume in Seoul

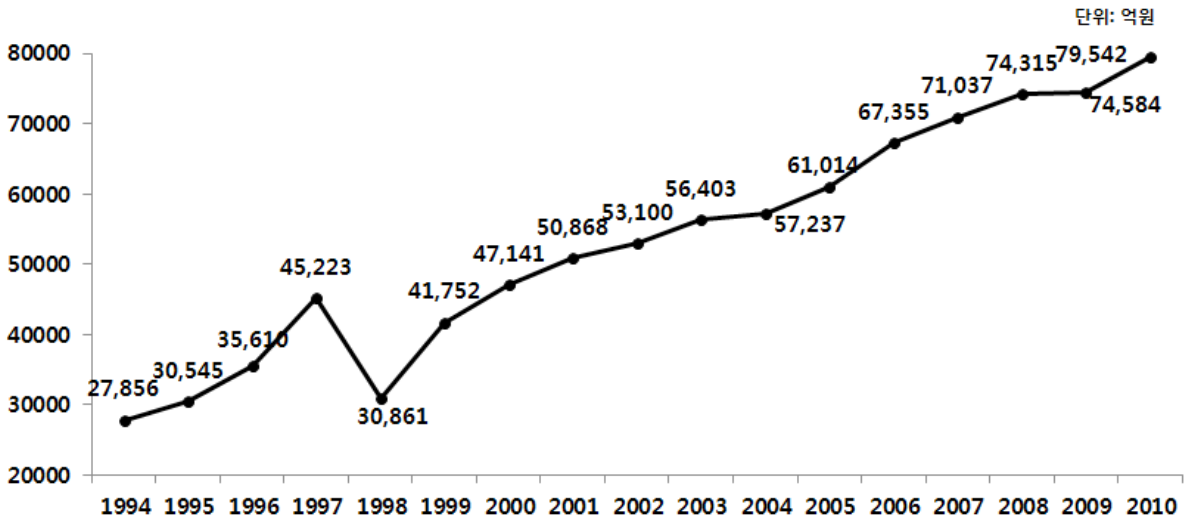
Writer : Seoul Institute Dr. Joon-Ho Ko

Policy Area: Transportation

Background to the Weekly No-Driving Day Program

In South Korea, per-capita petrol consumption is 16.2 barrels as of 2006 – the 5th largest in the world, after Saudi Arabia, USA, Canada, etc. National oil consumption is 2.2 million barrels a day, ranking 9th in the world and making the nation one of the largest energy guzzlers (IEA, 2006). As of 2008, transportation ranked second after non-industry (household) in terms of energy consumption in all of Seoul; in transportation, 80% or more was used to fuel individual passenger cars. The number of cars owned in Seoul rose from 200,000 in the 1980s to nearly 3 million in 2010 – about 15 times larger in only 30 years, approximately a car to each household. This unmanaged growth of passenger car use has driven the city's congestion-related costs up to KRW 8 trillion, a phenomenal loss in money and energy.

Figure 1 - Estimated Costs from Traffic Congestion in Seoul



Source: the Korea Transport Institute (2010)

As more individuals drive and depend on their cars more heavily than before, concerns are rising over air quality, fuel consumption, traffic congestion, and the increase in overall social costs. To address this worrying situation, the City of Seoul has introduced various policies to provide transportation facilities and ease congestion. However, these policies are now faced with numerous difficulties – lack of space, environmental regulations, financing issues, and civil complaints regarding the protection of property rights. The city responded by adopting transportation demand management policies (e.g., congestion charges, bus-only lanes, the congestion impact fee); in 2003, it introduced the Weekly No-Driving Day program, which encourages citizens to choose one day from Monday to Friday to leave the car at home, thereby saving energy, helping to ease traffic congestion and reducing air pollution.

Program Implementation

As of 2003, the total number of registered vehicles in Seoul exceeded 3 million; of these, more than 2 million were passenger cars. The increasing number of vehicles further aggravates the traffic in the city, and pollutants produced on the road account for 78.2% of the total air pollutant emissions in Seoul. The voluntary Weekly No-Driving Day program in July 2003 was one of the plans the city came up with to manage transportation demand and relieve congestion, borne out of the high public participation in the odd-even road rationing program during World Cup 2002. This program encouraged residents not to drive one out of five weekdays. Under existing road rationing systems (e.g., 5-day rationing), car owners are asked not to drive their cars with license plates ending with a certain number on a corresponding day, regardless of the owner's schedule or circumstances. With the Weekly No-Driving Day program, drivers can choose this day. This transportation demand management policy is more people-oriented, allowing people to adjust the off day according to their individual needs and lifestyle patterns.

When the Weekly No-Driving Day program was in its infancy in 2003, the City of Seoul decided to provide a discount on the congestion impact fee for those companies participating in the program. Based on the "causer-pays" approach, the congestion impact fee was levied on facilities negatively impacting traffic congestion. Buildings that participated in the Weekly No-Driving Day program received a 30% discount on the congestion impact fee. People who participated in the program were given a 20% discount on fees at public parking lots, while from 2004, drivers participating in the program paid only 50% of the congestion charge when using Namsan Tunnel 1 and 3. From 2005, participating vehicles were conditionally exempt from the car tax, based on the number of compliance days for a year. In 2010, the city signed a business agreement with 13 insurance companies, who in turn offered an 8.7% discount on car insurance premiums for participating drivers to encourage more vehicle owners to take part.

The most important change since the implementation of the Weekly No-Driving Day program was the launch of an RFID[2]-based operating system for the first time in the world. RFID readers installed throughout Seoul read RFID tags placed on vehicles by program participants to verify participation in the program. In 2007, paper stickers were abandoned and replaced with RFID tags to identify participants. However, the number of citizens who did not use the tags increased as they wanted to drive their cars on the designated "rest" day. In 2012, the city implemented the Electronic Tag Compliance system, which was designed to stop tax cuts and other participation benefits for participants caught 3 or more times a year for non-compliance.

2. RFID (Radio-Frequency Identification): Technology that identifies data via radio frequency from a long distance.

Table 1 - History of the Weekly No-Driving Day Program

Year	Month	Description
2003	July	Launched as "Voluntary 7-day Road Rationing".
	September	Discount on congestion impact fee (30% for facilities that adopt the program)
	October	Mandatory introduction to parking lots at public institutions under City of Seoul jurisdiction
	November	20% discount on parking at public parking lots in Seoul
2004	July	50% discount on congestion charge (Namsan Tunnel 1 and 3)
2005	June	Conditional discount on car tax (Ministry of Government Administration & Home Affairs)
2006	January	RFID system launch (Electronic tags to be attached for the Weekly No-Driving Day program)
		5% discount on car tax
		Discount car insurance program launched (Meritz Fire & Marine Insurance)
	June	Program mandatory for all public institutions in Korea (Ministry of Trade, Industry & Energy)
	December	Phase 2 RFID system built (14 locations)
2007	July	Paper stickers abandoned, electronic tag introduced for all
2008	October	Weekly No-Driving Day program card launched
2010	May	Agreement with 13 insurance companies (discount of 8.7% on premiums)
2012	July	Electronic Tag Compliance system launched

Source: Seoul Metropolitan Government (2014).

Program Summary

Participation Incentives

To encourage more people to take part in and comply with the Weekly No-Driving Day program, the City of Seoul decided to offer various benefits such as parking fee discounts at public parking facilities. Those who comply faithfully with the off day receive a 5% discount on car tax. These incentives can be divided into public and private sector as shown in Table 2. The benefits provided by the public sector include toll discounts and those by the private sector include discounts on petrol, carwashes, and car maintenance. Each year, the city spends KRW 10 billion to offer such incentives.

Table 2 - Incentives for the Weekly No-Driving Day Program

		Description
Public (City of Seoul)	Congestion Charge	50% discount (KRW 2,000 → KRW 1,000)
	Public Parking Lots	20~30% discount on parking fees
	Resident-Priority Parking Zones	Bonus points upon selection
	Congestion Impact Fee	20% discount
	Car Tax	5% discount
Private	Fuel	KRW 10 – 40 discount per liter
	Carwash	Maximum 10% discount
	Car Servicing	Maximum 10% discount
	Car Insurance Premiums	8.7% discount for attaching a device that allows verifica-tion of participation with program

Source: Seoul Metropolitan Government website.

Table 3 - Cost of Incentives for the Weekly No-Driving Day Program

(Unit: KRW 1 million)

Year	Car Tax 5% Discount	Tolls for Namsan Tunnel 1 & 3 50% discount	Public Parking Lot 30% discount on fees	Total
2009	7,338	925	2	8,265
2010	10,050	846	146	11,042
2011	9,744	730	159	10,633
2012	9,110	693	173	9,976

Source: Seoul Metropolitan Government (2014).

Verifying Participation via RFID (Radio Frequency IDentification)

The City of Seoul introduced the RFID wireless system to prevent paying incentives to those who do not actually comply with the off day requirement. RFID technology is similar to a barcode: it is a contactless identification of data stored in the IC chip on the electronic tag via radio frequency. Program participants are required to attach the RFID tags that carry their identification number and their car's chosen off day on the front window. The data is recognized by RFID tag readers (19 locations, 52 readers) installed throughout the city. When the system was first introduced, there were concerns over privacy violations, but the tags only contain the off day code and that the vehicle is owned by a program participant. The RFID system only confirms that the vehicle is in compliance with the off day requirement; it cannot track the car's route or history. It does not contain the license plate number or personal history, and therefore does not constitute a violation of privacy.

Figure 2 - Electronic Tags for the Weekly No-Driving Day Program

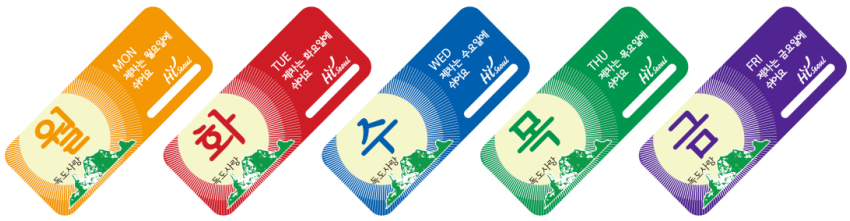
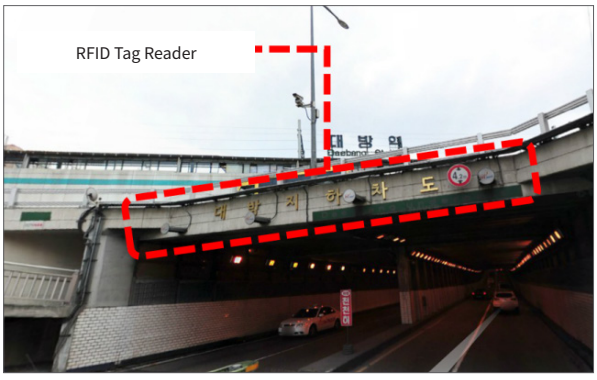


Figure 3 - RFID Tag Reader at the Underground Pass near Daebang Station



Source: Street view, Naver.

Table 4 - Vehicle with an RFID Tag

Source: The Weekly No-Driving Day Program Page, Seoul Metropolitan Government Website.

Compliance System to Ensure the Attachment of Electronic Tags

Because the Weekly No-Driving Day program is voluntary in nature, the city cannot guarantee that all participants abide by the rules. It was found that some participants do not attach the tags properly or at all and still drive. When the city issues the tags, participants need to attach them to the vehicle, take a photograph, and have it verified through the website or smart phone application. The system was modified to give benefits only to those who have had their tags verified by a photograph.

Program Information on the Website & Smart Phone Application

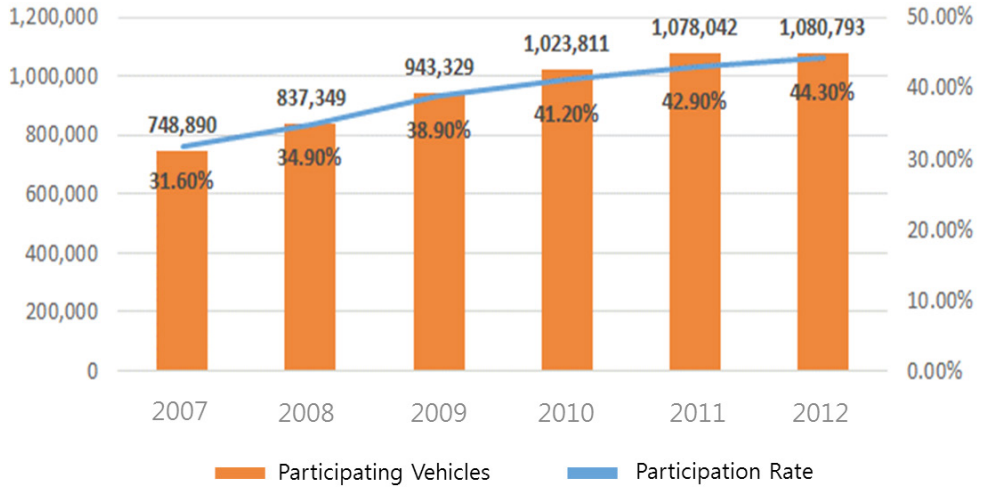
The City of Seoul created a program website and smart phone application to allow participants easy access to information on the program and its incentives. This has made it easier to participate in the program, verify to the city that the tag has been attached, locate affiliated businesses on maps, and calculate the potential benefits should someone choose to participate in the program.

Major Achievements

Steady Increase in the Number of Program Participants

Launched in 2003, the Weekly No-Driving Day program was welcomed by citizens from the beginning. Thanks to the city's encouragement and incentives, participation grew steadily until 2012. As of 2012, the rate was 44.3% - nearly half of all passenger cars in Seoul are in the program.

Figure 5 - Participation in the Weekly No-Driving Day Program



Source: Seoul Metropolitan Government (2014).

Reduced Traffic Volume & Cleaner Air

According to research by the City of Seoul in 2014, the Weekly No-Driving Day program has helped reduce Seoul's traffic volume by 1.1%. This number refers to the actual volume of reduction caused by the program, based on participation rate, compliance rate, and car use patterns. While 1.1% is lower than expected, it is not small considering the cost-effectiveness of running this program.

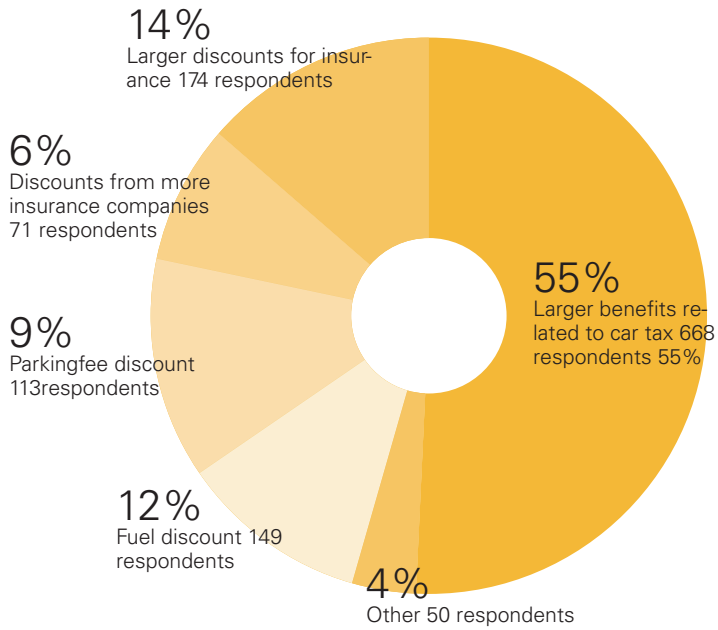
This 1.1% reduction can be translated into some 180 million fewer kilometers traveled by passenger cars a year, and an annual reduction of 36,000 tons of CO_2 emissions (accounting for 0.36% of total emissions by the transportation sector in all of Seoul). The program is also considered responsible for the annual reduction of 295.8 tons of CO, 108.4 tons of NOx, and 35.2 tons of HC. In financial terms, reduced travel and enhanced air quality are worth KRW 144.4 billion per year.

Limitations & Needed Improvements

While the Weekly No-Driving Day program is significant in that it is voluntary, this voluntary nature is what has caused some of the problems. As of 2012, some 1.1 million of the 2.5 million registered passenger cars in Seoul are in the program – a participation rate of 44%. However, traffic volume has been reduced a rather measly 1.1%. One of the reasons for this is that only 45.7% of the participants attach the tags, while only 57.1% of the participants comply with the off day. Such poor rates of actual participation and compliance are what prevent the program from progressing further. Research must be conducted to find a viable way of encouraging more real participation voluntarily.

A survey by Seoul on 1,200 residents in 2014 found that a majority of respondents thought "more incentives" were needed to improve effectiveness of the program. This indicates that the current program incentives (car tax cuts, insurance discounts, etc.) are not sufficient in the minds of individuals. Another complaint was the lack of flexibility – once the off day is set, the participant cannot drive on that day no matter what. This rigidity is something that needs to be addressed as well.

Table 5 - Citizen Survey: Program Benefits Needing Improvement



Source: Seoul Metropolitan Government (2014).

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03

Metro

1. Construction of the Seoul Metro – the Driver behind Sustainable Urban Growth & Change

Writer : Seoul Institute Dr. Seung-Jun Kim

Policy Area: Metro

Background

In the early 20th century, Seoul began to accept the culture and institutions of Japan and the Western world. With these came the tramway (the first tram in Seoul was operated as part of the electricity supply project), which expanded as the city grew. The tramway network was built along the axis of urban development in the last years of the Joseon Dynasty: alongside the new streets and roads paved according to urban plans of the time. The tram routes were quite similar to today's metro routes, as the metro began construction to fill the need in areas no longer serviced when the trams were discontinued.

Until the tram completely disappeared in 1968, Seoul's public transport needs were shouldered by trams and buses. As trams required the onerous work of laying tracks, they began to decline as more automobiles appeared in the late 1950s. Buses became more common as it was easier to change routes and get around the city, making them the easiest way to provide relief to the burgeoning urban traffic need. In other major cities around the world, areas around rail stations were built up first, whereas in Seoul, this began in areas near the city center that were connected by the more mobile bus system. However, population growth and concentration did not only cause a surge in traffic volume but also an increase in the distance traveled. As more people began using automobiles, roads and bus services had to be expanded. This cycle repeated itself again and again. As bus routes inevitably concentrated at the city center, they met the reality of space limitations for buses and bus stops. The need for a mass transit metro system arose.

The population of Seoul was approximately 200,000 in the last years of the Joseon Dynasty. By 1936, due to urban expansion, it exceeded 700,000. After liberation from Japanese colonial rule, many Koreans returned home from overseas, and the population passed 1 million. In the 1960s, industrialization began as part of the economic development strategies, and industrial complexes were built near the city center and along the Gyeongin axis connecting the capital to Incheon. The central and Seoul governments worked together in building the industrial complexes, with the former in charge of building the infrastructure required for industrialization while the latter worked on securing the area to accommodate the growing population and the related activities. As a result, the city's population reached 2.5 million by 1960 and the number of daily commuter trips exceeded 5 million. Consequently, the introduction of a metro system – a fast, convenient mode of transport – was reviewed as an effective solution to the city's traffic issues.

Figure 1 - Tram Map (1946)

Figure 2 - Tram in Operation (1960s)

Source: City History Compilation Committee of Seoul (2000).

History of Construction

Establishment of the Metro Construction Plan

In 1961, the Korean National Railroad reviewed the shortest route between Seoul and Cheongnyangni stations. This route was a part of Japan's loan program, included in the first 5-year economic development plan. Since that time, various urban development plans considered metro plans, such as the subway construction plan from Seoul's 10-year plan in 1965 and the Line 1 – 4 plan from the Basic Seoul Urban Plan. In 1970, President Park Jeong-hee issued a directive to Seoul to develop a mass transit construction plan to resolve its traffic issues. This was when the metro construction plan, reviewed by the local government in the 1960s, became a national agenda. The central government held ministerial meetings with Japan on a regular basis to secure financing and technical support while the Seoul city government reorganized to better pursue the plan. The South Korean Minister for Transportation, the Mayor of Seoul, and experts visited Japan and held discussions with working-level experts to review the feasibility of a Korean metro system. Japan dispatched a group of rail transportation experts to review technical support and loans they would need to provide. The group prepared a report which sparked construction of the Seoul metro: it proposed 5 radiating routes as the structure that would be most appropriate for Seoul a decade later. However, its premise was that the old city center was the only CBD in Seoul. This proposed map is quite different from today's metro network.

Construction of Phase 1 & 2: Completion of the Arterial Metro Network

Construction of Line 1 began in 1971 with plans that included surveys and design. Building a metro line required technical expertise in various fields such as civil engineering, construction, rail tracks, signaling, electrical systems, communications, automotives, and operation. Thankfully, many technical experts had been

trained as part of the economic development plans begun in the 1960s, and construction was able to proceed with mostly local technicians, except for some areas. Materials needed for civil engineering, except those for rail tracks, electrical systems, and metro cars, were sourced locally as well: Line 1 was mostly a domestic effort with domestic technologies. In plans for Line 1, various elements were taken into account to allow for connection to other lines and to introduce a system that would be optimal for the future. Some examples of this include plans to share the Line 1 car depot with Line 2 when it was built, use of a unified track gauge and signaling systems to allow direct connection of Line 1 with the Gyeongin and Gyeongwon lines, shared use of tracks with freight trains, and installation of sidetracks for express lines.

The route for Line 2 was shaped by the new urban plan framework. At the time, 72% of the Seoul population (4.5 million) resided in the Gangbuk area near the city center. Any resultant urban concentration and traffic congestion were to be resolved by plans that proposed dividing the city's spatial structure into 3 nuclei: the old city center would still assume the central role, with Yeongdeungpo the business district and Gangnam a residential district. The Gangbuk segment of Line 2 would inherit the same route segment of the existing east-west route while the Gangnam segment would be restructured into a circulatory network passing through the new central area to be built.

Line 3 and 4 were highlights of the city's efforts to build a city-wide metro network and enhance the public transit service. At the time, Line 1 passed through the old city center and was already in operation, while Line 2 was under construction. Line 3 and 4 were designed to encourage more people to use Line 1 and 2 while providing for the main axis of transit that would stretch out from the center of Seoul to the outskirts. With most funding going into construction of Line 2, Line 3 and 4 were delayed. The city studied private investment projects overseas to review the potential for construction involving private capital, and as this private investment began here, the central government approved the private sector establishment of the Seoul Subway Construction Headquarters, although this organization was ultimately dissolved by the City of Seoul in 1981 due to its poor performance. Instead, the Seoul Metro Subway Corporation was established, the first local public corporation fully financed by the city, to take over the project. Lines 3 and 4 began operation in 1985 and were equipped with new technologies and a systematic guidance system. For instance, the safer and more reliable ATC (Automatic Train Control) system was chosen over the ATS (Automatic Train Stop). To improve overall commuter access, automatic ticket machines, turnstiles, and payment devices were installed, along with surveillance cameras.

The completion of Lines 3 and 4 in 1985 finalized the first phase of metro construction. Debt exceeded KRW 2 trillion, an amount so huge that it could not be serviced, let alone the principal be repaid. Due to the increasing population and number of new housing units, use of the metro grew 10 – 16% each year; by the late 1980s, capacity had been reached. The need for additional metro lines was widely felt by the public, but the huge debt prevented detailed action plans from being developed. In 1988, Seoul announced a plan to build 5 more metro routes connecting to the main line and arterial lines, on the assumption that the central government would subsidize the project, but without financial support it never came to fruition.

In 1989, the Korea Research Institute for Human Settlements came up with a metro plan for the second phase that included arterial lines passing through the city, unlike the City of Seoul's plan, which centered on connecting to the main line. The KRIHS plan focused on minimizing the area not covered by the metro service by ensuring rapid transportation and expanding the station coverage areas. Phase 2 also assigned unique characteristics to each metro line. For instance, Line 5 was designed as a core arterial line to complete Seoul's metro network, connecting Gimpo International Airport, Yeouido business center, and the city center. Quite different from Phase 1, the construction of Line 5 in Phase 2 involved building the first underwater tunnel across the Han River. Line 6 was planned to avoid the concentrated old city center and provided metro service to previously uncovered areas in Gangbuk. Most of the travel would involve other lines via transfers. Line 7 would connect the Sanggye district, formed in the 1980s, to Gangnam. Originally developed as a residential area, Gangnam grew to be more than just a sub-center, becoming THE center of Seoul's business and commerce. Yet the only metro line that passed through Gangnam was the circular Line 2. Line 7 was built to decrease the crowded nature of the metro in Gangnam and enhance its connectivity to Seoul's residential northeast. Line 8 connects Seoul's east to Seongnam, a satellite city that received the inflow of Seoul residents whose homes were demolished in the 1970s. As plans for development of Bundang, a large residential area in the south of Seongnam, came into focus, they served as a catalyst for Phase 2 construction plans.

Phase 3: Wider Metro Coverage

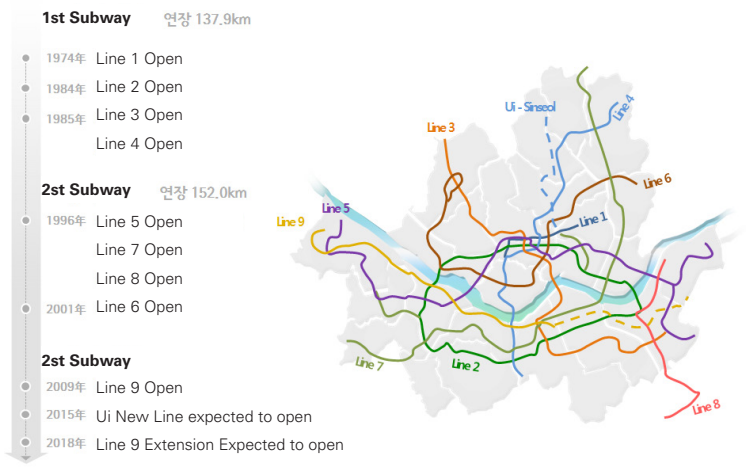
As Phase 2 construction got on track, recommendations for additional lines were suggested within the Seoul city government, as a way to connect areas still unserviced after Phase 2, increase the metro's share of public transport to 75% and reduce heavy road traffic. This Phase 3 metro construction plan, proposed alongside plans for construction of an underground highway to resolve the city's traffic issues, was opposed by many who argued that as Phase 1 resulted in unmanageable debts and Phase 2 had financing issues, planning to build another 'racing lump of debt' was irresponsible. Particular criticism came because the plans were announced only a month after the mayor issued his directive, without any effort to listen to other opinions or conduct feasibility tests.

Moreover, it was in late 1997 when the Gangnam segment of Line 9 was in the design process in accordance with Phase 3 of the metro construction plans; that year, South Korea's foreign currency reserves were low and the nation had to request assistance from the International Monetary Fund to survive its national financial crisis. Many large-scale projects could no longer be pursued. In May 1998, the Ministry of Planning & Budget requested a review of the Phase 3 metro plan, which was ordered the following month by the city mayor, along with orders to adjust the plan so that wider areas would be covered, utilizing the existing metro network of the capital area as much as possible. The relevant authorities, including the Subway Construction Headquarters, conducted the review and decided to cancel, not postpone, the construction of Lines 10, 11, and 12 as part of Phase 3 (Line 9 remained). In September 1998, the changed plan was announced. From the

metro routes planned for Phase 3, the Ogeum segment (Line 3) and Line 9 would be pursued as planned, but Line 11 would be shortened into the New Bundang Line; as for the rest, they would include light rail, small monorail, and arterial lines connecting to the Phase 1 & 2 metro lines. A feasibility test was conducted and approved for Line 9 of which the detail design was completed. It was approved as a Build-Transfer-Operate project, scheduled to start in 2001. The Suseo-Ogeum segment (Line 3) was determined feasible in 2002 and construction began in 2004.

In October 2001, Seoul decided to involve the private sector in a 25.5 km segment (Gimpo International Airport – Banpo) for Phase 1 of Line 9 based on research by the Seoul Development Institute. It was worth KRW 850 billion, and a private operator would be allowed to run Line 9 for at least 30 years after completion. The framework plan for private investment was approved, and the decision made to use private capital to purchase metro cars, install systems and car depots, etc., while land and compensation were excluded. Local companies were not the only ones that were interested: Bombardier (Canada), Alstom (France), Siemens (Germany), Macquarie (Australia), National Bank of France, and Daiwa Securities (Japan) also showed interest in getting involved in Line 9. In the end, a number of companies formed a consortium and took on the project.

Figure 3 - Phase 1 & 2 Metro Construction



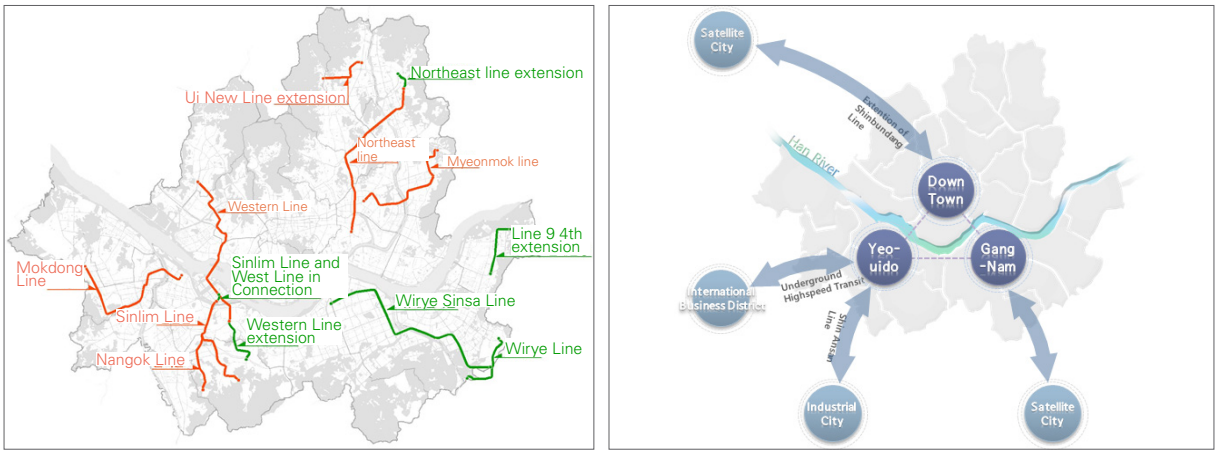
Seoul's 10-year Plan for Balanced Urban Development & Sustainable Metro Construction

One of the goals in the Seoul Traffic Vision 2030 is to make Seoul a city where people do not need to drive or even own cars, where traffic is designed to place people before vehicles and where priority is placed on car sharing and consideration for the environment. In line with the Vision, the City of Seoul desired to transform its public transit system to one that was metro-centric, setting the basic city metro policy directions accordingly. In other words, the city aims to build a metro network, placing a focus on unserviced areas, so

that residents can walk to a metro station within 10 minutes, thereby ensuring that walking and use of the metro become the principal modes of transport in Seoul. The city also seeks to provide bus connections to the metro network in those areas where a metro station cannot be reached within 10 minutes. For hard-to-service areas, Seoul decided to introduce a light rail transit (LRT) that would accommodate up to 10,000 persons/day per kilometer, instead of expanding the costly and issue-prone metro lines. With the LRT, areas not accessed by the city metro would be connected to arterial lines in the existing rail network. A high-speed arterial rail network would also be built to connect the major points within Seoul, making it more convenient for commuters travelling between Seoul and adjacent areas.

Seoul did not wish to repeat the issues of the private-led construction of Line 9 in the future. However, it would not be able to provide the metro service in a timely manner if the project were to be solely financed by the city. The basic principle would be that the LRT construction project would be private sector-led but with more effective management and supervision. This plan involved the City of Seoul developing a standard concession agreement on private sector-led metro construction as a way to minimize potential issues during the project. According to the standard agreement, there would be an organization and experts required during the agreement process as well as during construction and operation to facilitate the project in accordance with the terms and conditions and resolve any issues or conflict. While securing the funding from the private sector, Seoul would be enabled by this system to adjust the agreement terms in consideration of profits, financing conditions, etc. to meet changes in the financial picture in the future.

Figure 4 - Planned Routes in Seoul's 10-year Plan for the City Metro



(a) LRT (b) High-Speed Rail Network

Source: Seoul Metropolitan Government (2013), Comprehensive Development Measures for Seoul's 10-year Plan for the City Metro.

Introducing the Policy

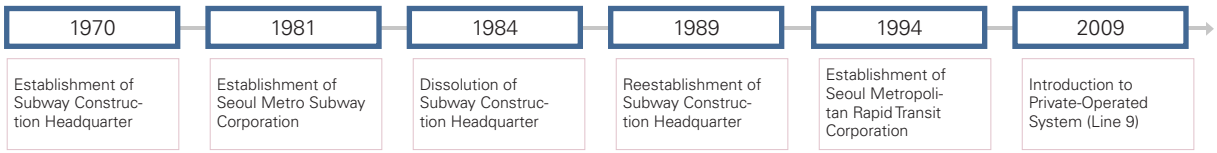
Operational Organization for Sustainable Metro Construction & Efficient Operation

In 1970, the City of Seoul established the Subway Construction Headquarters, comprised of 6 civil engineering and construction experts, under the Urban Planning Bureau. Expertise in civil engineering, rail track, electrical systems, communications, and signaling systems was critical to building the first metro line, but it was near impossible to find such experts due to the circumstances of the time. In an effort to have quick access to such expertise, the Headquarters worked with local research centers and universities to collect and analyze technical trends overseas. The Headquarters also prepared to seek financial and technical assistance from Japan while sending relevant experts overseas to study and train. The responsibilities of the Headquarters were expanded to include not just study and design but also construction and operation after the construction of Line 1 began. By 1974, the organization included 963 people. Based on the construction and operational experience gained from Line 1, the Headquarters took on process and operation planning, and design and construction management for Line 2. At the time, construction and operation was divided between the Headquarters and the Metro Subway Corporation, and a decision was made to integrate the two organizations. After Line 2 was opened, the Subway Construction Headquarters was dissolved. With the leading organization of the metro construction project gone, Seoul re-launched the Subway Construction Headquarters, made up of 157 experienced experts and seconded experts from the Corporation, for construction of Phase 2. The Headquarters was in charge of the first phase metro extension and construction of Lines 5, 6, 7, and 8. It expanded to 604 persons, and oversaw the sites that extend over 160 km. In 2008, the Headquarters was integrated with the Construction Safety Headquarters and reorganized into the Urban Infrastructure Headquarters. Currently, it manages facilities (such as roads, bridges, and tunnels) and oversees matters related to the metro and LRT construction.

With Phase 2 in place in 1990, the public grew increasingly interested in who would be responsible for its operation. Some argued that it was necessary to enhance operational efficiency by encouraging competition with the Subway Corporation that was in charge of the first phase; others supported establishment of an organization independent from the Corporation, which was burdened by debt, so as to provide a more stable environment for Phase 2. Based on popular surveys, public hearings, and expert research, the Seoul Metropolitan Rapid Transit (SMRT) Corporation, completely independent of the Subway Corporation, was founded in 1994. This organization has since been in charge of Phase 2.

Figure 5 - Changes in Operational Organization of the Seoul Metro

History of Related Organizations



Phase 1 (High Percentage of Loans)

Phase 2 (Low Debt Ratio due to Central Government Assistance)

The City of Seoul only had access to KRW 10 billion for the construction of Line 1. For the rest, the city had to rely on loans or the central government. For materials, metro cars and technical services, the city had to borrow money. Construction of an 8.7 km segment for Line 1 required KRW 33 billion: 48% was financed by liability reserve and 39.5% with a loan from Japan. Only 1% came from the national coffers, resulting in excessive debt on the city. KRW 877.1 billion was spent to build Line 2, and it had many financing issues. The construction of Line 3 and 4, which started during the construction of Line 2, was led by the private sector, demonstrating the seriousness of the city's financial situation, which depended heavily on debt. The debt ratio for Line 1 was 55%, and jumped to 63% for Line 2 and to 87% for Line 3 and 4. Repayment of the principal and even servicing the debt soon became an issue, and the debt continued to grow over time, putting an enormous strain on the city and the operating organizations.

When the Phase 1 metro opened, the number of users fell far short of expectations, further widening the debt hole and preventing discussions on new projects. Criticism mounted. However, the number of metro users began to grow steadily (9 – 16% p.a.), and the metro cars filled up to nearly 300% of capacity, and the public demanded expansion of the metro. Knowing that Seoul alone could not pursue such a large-scale project, the central government created an organization led by the Prime Minister to review possible action. As a result, support from the central government was 22% higher in Phase 2 than in Phase 1, while the city was responsible for more of the financing (11%), which served to bring down the ratio of liability. Financing stabilized in Phase 2 because a more sustainable, relatively long-term perspective was taken, as opposed to the reality of Phase 1, during which multiple lines were built.

Conflict between Private & Public Sectors over City Metro Construction

There were frequent changes before Line 2, which was planned to connect east to west, was finalized as a circle route. Back in the 1970s when the general understanding of the metro system was low, plans for the route to pass through a new, high-end residential area were strongly opposed by residents of that community. To minimize any damage from the construction at ground level, the City of Seoul decided to employ small-scale blasting and no-vibration methods in building a tunnel. The city also explained to the residents the

need for the city metro and the accompanying difficulties. Seoul decided to exert more energy in promotional activities and assisting the relevant organizations in helping residents understand that the city metro would help resolve the congestion.

In the meantime, the extended segment of Line 3 induced friction over the route between area residents. A line had to be built and pass through both areas, causing inefficiency. For instance, depots are crucial to keep and maintain the metro cars but are disliked for generating noise, among other reasons. Residents would protest against the construction of a depot in their area, with some holding protests on the tracks.

The LRT system was also planned based on expert analysis of development size, demand, and cost, but some would insist that a heavy rail transit had to be built, mostly due to a lack of understanding of the LRT and a desire to maximize the potential gains to be had from such infrastructure. This ultimately divided public opinion and delayed the project.

Elements of Success

There were many elements that led to the success of the Phase 1 metro construction, but it is desirable to look at the key elements here. First, the major decision-makers (the President of the Republic of Korea, the National Assembly, the mayor) were very much interested in transportation, issuing directives to ease traffic issues. Second, the level of local civil engineering was accurately identified during the construction of Line 1, and it was understood where domestic technologies sufficed and where they did not. Third, the project was completed in a short period of time because the entire nation was strongly motivated to overcome the metal and oil crises of the early days and escape national economic crisis. It was noticeable that the issue of rising prices and labor costs, easily found in developing countries, was overcome with much endeavor. Fourth, no administrative assistance was spared to cut construction costs and shorten the schedule. For example, all vehicles except for buses were banned from in the busy arterial road of Euljiro during the construction. Lastly, bold decisions on facility investment were made. If necessary, plans were revised based on future projections. Today, Seoul's city metro is one of the best in the world in terms of size and performance because plans for size were revised during the construction stage to introduce a larger-scale system that could accommodate 10-car trains on 210m-long platforms.

Outcome & Benefits

Rapid Completion of the Arterial Metro Network

In 1985, only 11 years after Line 1 opened, Line 3 and 4 were finished. Seoul now had an extensive metro network in only a short period of time. Phase 1 of the metro system, spanning 116.5 km in total length and stopping at 113 stations, came to have 1,944 cars and significantly contributed to resolving traffic problems and ensuring balanced development of multiple nuclei in Seoul. In Phase 2, Seoul's metro network grew in both quantitative and qualitative terms, reaching major areas that were not included in Phase 1 as well as the traditionally forgotten and unserviced districts, creating an environment for more people to access the metro system easily. Because of Phase 2, Seoul's metro network became one of the world's best, ranking 5th in terms of serviceable length and 2nd in transportation performance. With the new Line 9 in the 2000s, the network was 327 km in total length, providing a platform for sustainable growth and balanced urban development.

After 40 Years, Seoul Metro Accounts for 36% of Transport Share

Soon after Line 1 was opened in 1974, its share of the public transport sector was only minimal. Most people still used buses, and the metro did not play a significant role in easing congestion. However, the number of users doubled from 270,000 in 1976 to 540,000 in 1980. After Lines 2, 3, and 4 were opened, the Phase 1 metro system moved 3.4 million people – 21% of all travelers – by 1991. Despite this growth, the increase in the absolute number of travelers continued to aggravate road traffic. Congestion slowly eased in the mid-1990s when Phase 2 of the metro was opened in different stages, but the share of transport grew even more, hovering over 30%. In the meantime, the role of buses was greatly diminished; their share of the public transport sector dropped from 80% in 1976 to 29% in 1999.

Table 1 - Changes in Subway Use as % of Public Transport Share (%)

Form of Public Transit	1974	1980	1985	1991	1995	2010
Bus	81	66	58	41	37	28
Metro	1	7	14	21	30	36
Taxi	17	19	17	13	11	7
Private Vehicle	1	8	12	25	23	24

Source: Seoul Statistics.

Implications

As dramatic economic growth accelerated population growth, the bus-centered urban transit system could not properly respond to congestion. When the population reached 3 million, construction of a metro network was prepared in phases with the first metro system completed when the population had passed 6 million. With determination to make the necessary decisions and with the public strongly motivated, the City of Seoul built a network over 300 km in total length at an unprecedented speed, transitioning its public transit system into one that was centered on the subway in response to the traffic issues. Seoul's investment in its metro system not only improved chronic road congestion but also reduced accidents and fuel costs, and enhanced user convenience, all of which aided national economic growth.

Construction costs for a subway system are prohibitive. While pursued at the national level, construction is normally undertaken by local governments in order to process urban traffic. The demand for funds could never be matched by existing tax revenues and such construction usually depends on liability reserve, which is bound to create a serious financial burden even after the service is opened. It is therefore vital that various avenues for financing (assistance from the national government, funding from overseas, private capital, etc.) are carefully reviewed and appropriate steps taken to properly manage demand and fees to avoid operational deficits. Today, the metro is more than a simple mode of transport; it has increasingly become a basis for economic and cultural activity. This trend could be helpful in taking aggressive steps to develop the stations and utilize the surrounding land to secure new sources of income. The metro project is accompanied by various risks – overestimation of users, changes in construction costs, schedule delays, as well as the afore-mentioned operational deficits. Much deliberation is required when it comes to prioritizing the metro or other such projects requiring investment on a grand scale to improve urban functions. To overcome various issues and distribute resources in an effective manner, much thought should be given to the institutional systems and organizations that are capable of managing project plans, feasibility analysis, design, and construction.

The recent environmental, energy, and resource issues have created growing interest in the city metro as the urban mode of transport. Every city is different in its circumstances and there is no one-size-fits-all answer as to what kind and size of metro system is needed by a city and at what timing. It is however widely agreed that such systems bring about positive social and economic change. Large cities in developing countries where overpopulation is accelerated may need to consider various elements from a long-term perspective as they make careful public transit plans centered on a city metro network.

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

Written by: Seoul Institute Dr. Seung-Jun Kim & Dr. Joon-Ho Ko

Policy Area: Urban Railway (Metro)

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 subway[1] 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

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.

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.

Timeline for Subway Line 9 Construction Project

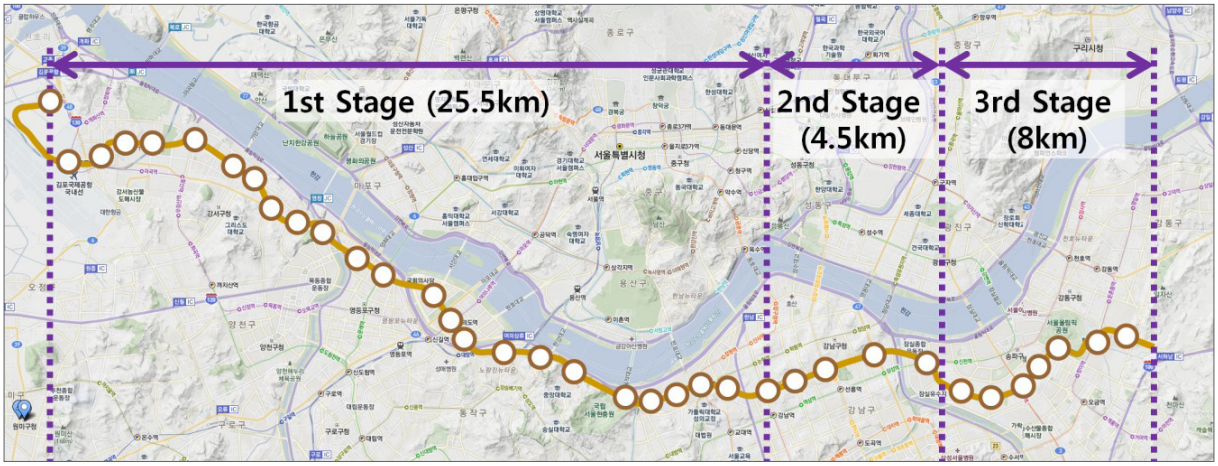
History of Construction of the Subway Line 9

- 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

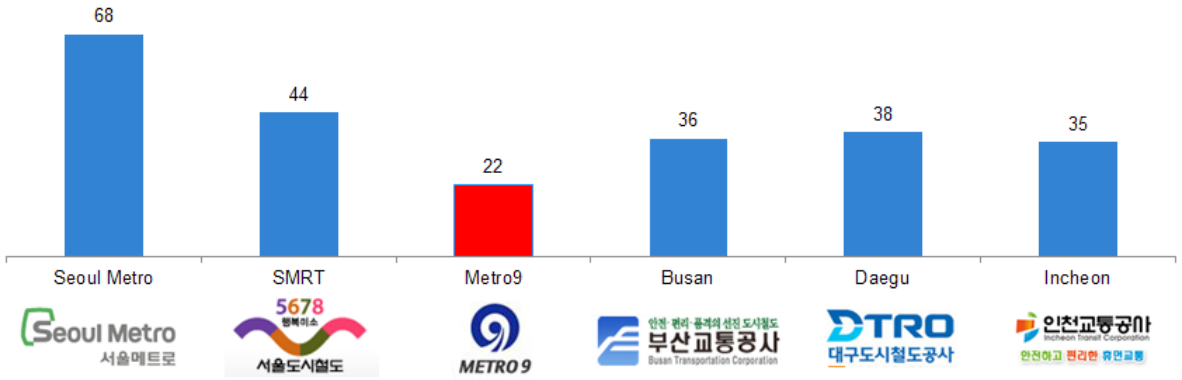
Classification	Normal (N)	Express (E)	(N-E)/E×100%
Gimpo Int'l Airport ~Yeo-uido	26min. 25sec.	15min. 50 sec.	41%
Gimpo Int'l Airport ~ Sin-nonhyeon	47min. 30sec.	30min. 00 sec.	37%

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
· 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	· 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
Unchangeable Basic Fare (KRW)	1,264	1,307	1,352	1,398	1,446	1,495	1,546	1,599
Fare IncreaseRate (%)	3.41	3.41	3.41	3.41	3.41	3.41	3.41	3.41
Operation Year	'17	'18	'19	'20	'21	'22	'23	'24~38
Unchangeable Basic Fare (KRW)	1,653	1,710	1,735	1,761	1,787	1,814	1,840	1,840
Fare Increase Rate (%)	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%

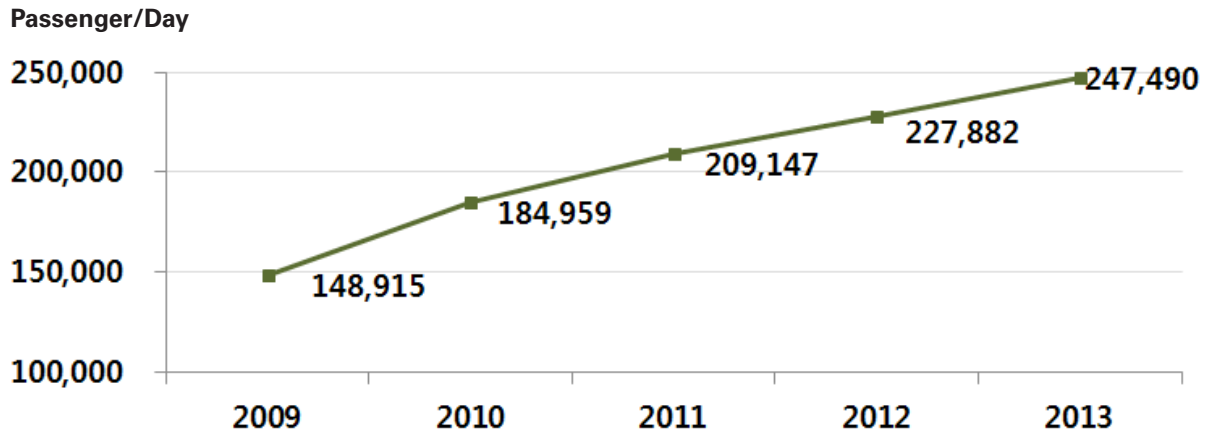
Source: Press Release of the Seoul Metropolitan Government (2013)

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

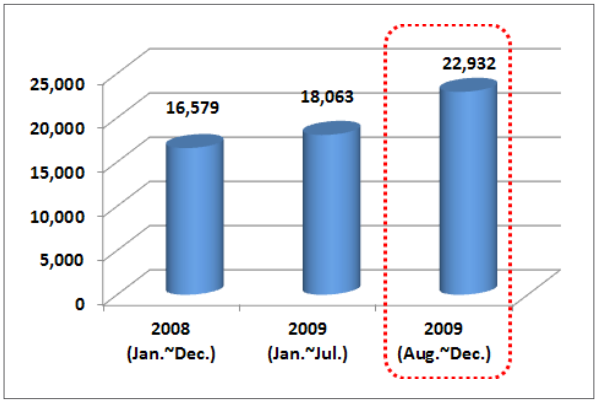
Cut by KRW 100		Cut by KRW 200		Total	
Passengers (Persons)	Reduced Expense (KRW)	Passengers (Persons)	Reduced Expense (KRW)	Passengers (Persons)	Reduced Expense (KRW)
39,936,110	3,993,611,000	807,015	161,403,000	40,743,125	4,155,014,000

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

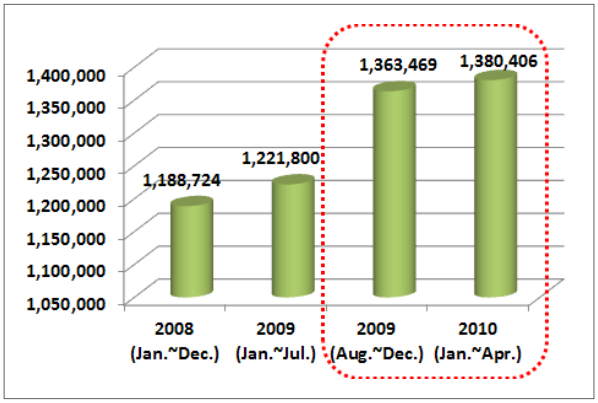
Strengthened Connection to Other Public Transportations including Airport Railroad

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 be 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

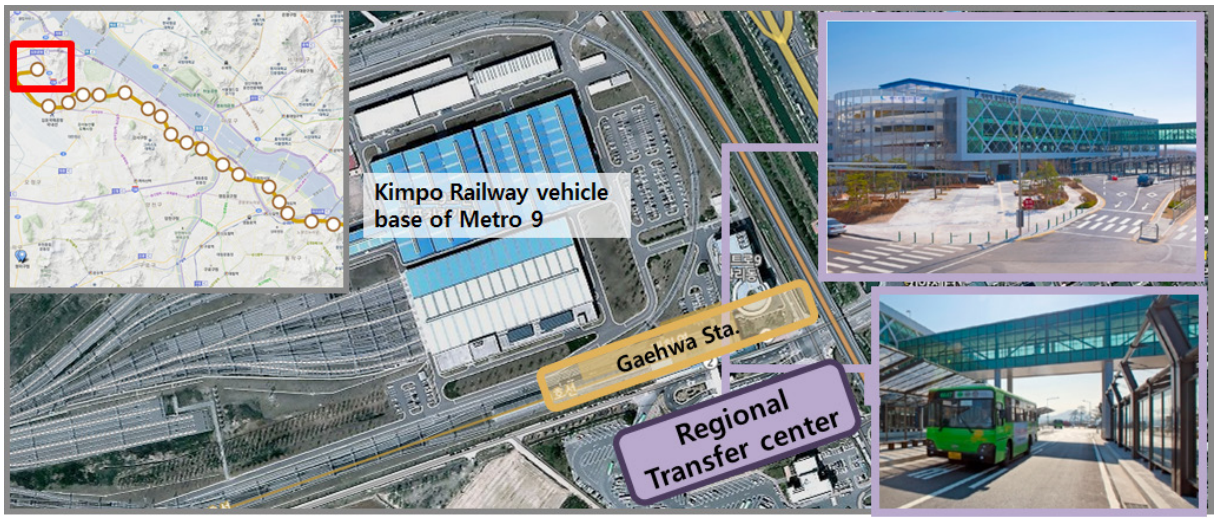
The express trains of subway line 9 connecting the Gangseo region and the Gangnam region of Seoul showed a degree of complexity almost approaching 240% during the rush hour, gaining notoriety as a hell train. It is mainly because the difference of average moving speed between the normal trains and the 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



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3. Seoul's Subway Project for Sustainable Safety

Writer : Seoul Institute Dr. Seung-Jun Kim & Dr. Joon-Ho Ko

Policy Area: Metro

Background to Seoul's Subway Project

With the rapid industrial and social development in the early 1970s, population began to concentrate in urban areas. The urban population density caused traffic congestion and the subway system began construction as part of the measures to cope with the problem. After the opening of 9 subway stations on Line 1 in 1974, the system added Lines 2, 3 and 4 by 1985. By the time the secondary subway lines (5, 6, 7 and 8) were opened, the system was carrying over 6.3 million passengers a day, or 50% of Seoul's population. Each year, Seoul's subway system accounts for 35% of transportation share in the city. The number of passengers has more than doubled, both areas served and the number of subway stations have increased significantly.

Accidents related to safety on station platforms have soared with the dramatic increase of subway lines along with the increase in transportation share. Simple incidents such as engine breakdowns or delays have been replaced by falls from subway platforms, passengers caught in subway doors, collisions, fires, and equipment failures. Besides these, environmental pollution and noise in subway trains and on platforms have also increased. However, safety equipment has been insufficient to keep up with the rapid expansion of the subway system poor management of equipment.

Table 1 - Accidents on the Seoul Subway System (prior to 2003)

	Total	1998	1999	2000	2001	2002	2003
Total	652	85	93	87	92	148	147
Fatalities	296	39	49	34	54	50	70
Injuries	356	46	44	53	38	98	77

Source: Kim Sang-woon et al. (2004)

With increasing awareness of the public regarding subway safety and pollution, the Seoul Metro and Metropolitan Rapid Transit Corporation received KRW 36 billion from the city government in 2005 and began construction of platform screen doors the same year. PSDs (Platform Screen Doors) dramatically improve the environment around subway platforms; they block people from accessing the rail areas, thereby preventing rail-related fatalities, and also improve air quality by helping to contain fine dust. They also decrease noise and train-induced winds and the spread of fire, and save energy. Besides the PSD, Seoul Metro, the Metropolitan Rapid Transit Corporation, and Seoul Metro 9 (the three main Seoul subway operators) provide training and equipment to effectively respond to environmental changes and improve safety as part of subway safety projects.

Subway Safety Systems

PSDs (Platform Screen Doors)

Seoul City injected emergency funds into Seoul Metro and the Metropolitan Rapid Transit Corporation to rush PSD construction due to concerns about subway safety after the Daegu Subway Fire in 2003. As a result, the first PSDs were installed in Sadang Station by the end of 2005, and the city announced plans to install PSDs in every subway station by 2010. However, with ongoing and frequent casualties during the PSD construction period, the city had to accelerate its plans, installing them on 120 Seoul Metro platforms (Lines 1-4), 148 Seoul Metropolitan Rapid Transit platforms (Lines 5-8), and 25 Seoul Metro 9 platforms in 2009.

There are four main benefits to PSD installation: First, passenger safety. With the increase in demand for transportation, the existing platforms were congested and the close proximity between passengers and rail lines created frequent contact with subways or falls as a train approached a station. Such risk, however, can be prevented if PSDs are installed between platform and passengers. In the event of fire in a subway train, the PSDs can be closed to restrict the spread of gases and smoke while allowing passengers to evacuate the train. Second, PSDs facilitate safer operation of the subway trains. Since passenger safety has been secured, the train operator is better able to concentrate on operation of the train, which will help to ensure their own safety. Third, PSDs provide a pleasant station environment, as passengers can know that both contamination and noise levels are reduced. Fourth, PSDs assist energy saving efforts. The doors keep heat generated from the trains out of the platform area and prevent the outflow of cool air from the train into the tunnel, thereby reducing cooling load.

In general, the structural components of PSDs are fixed partitions, doors, driving gears, safety devices, a central control panel, and a display console. Fixed partitions are designed to withstand pressure from both crowds of passengers and from the trains; the design also combines supports and transparent glass to ensure visual openness of the tracks and platforms. Each PSD is a set of two sliding power doors with pressure-resistant transparent glass. The driving gear receives signals from the control panel to open and close the system through automatic interlocking; the initial design also considers maintenance, durability, and precision. Safety devices are designed to set off an alarm and open the doors in the event of safety issues, such as passenger belongings caught in the door while getting on or off the train. The gap between platform and PSD is generally less than 10 cm; however, this gap widens to 10 cm or more at curves in the platform structure, both ends of a platform where the PSD control equipment and monitors are installed, and platforms servicing both passengers and freight.

As shown in Figure 1 below, there are three types of PSD - hermetic, semi-hermetic, and open railing. The hermetic PSD is used at most subway stations: although initial investment and maintenance costs are high this type is most suitable for blocking train and mechanical ventilation noise and maintaining air conditioning efficiency. Semi-hermetic and open railing screen doors are used at ground level stations and carry lower initial investment costs than hermetic PSDs. These types of PSD are used where additional air conditioning

systems are not in operation, and focuses on passenger safety and less on blocking train-induced wind and noise.

Figure 1 - PSD Types

Hermetic PSDs: This system stretches from platform floor to ceiling, completely separating it from the track area. This type of door can dramatically reduce noise, train-induced wind, and dust in the platform area, as well as improve air conditioning efficiency.

Semi-hermetic PSDs: This is also installed at a height of approximately 2m, similar to the hermetic PSD, but with the top open between the track area and platform. While less effective at reducing noise and train-induced wind, it prevents passengers from falling onto the track. Understandably, construction costs are lower than for the hermetic PSD.

Open Railing PSDs: These are about half the height of the hermetic PSD. Installation is cheaper than other PSDs, but it does not provide complete protection for passengers as they can put their heads over the PSD.

CPTED (Crime Prevention Through Environmental Design)

Seoul City endeavors to prevent subway crimes - over 2,000 cases each year - to enhance station comfort and safety. In June 2014, it announced introduction of the CPTED program in five stations on Line 9 (making the line the first place for CPTED application in public transit) and establishment of the Station Crime Prevention Guidelines. Seoul City established safety zones (5m long and 2m wide) in train platforms and is planning to install CCTV (closed-circuit television), emergency phones, emergency alarms, large mirrors, and monitors to discourage crime and respond quickly when it does occur.

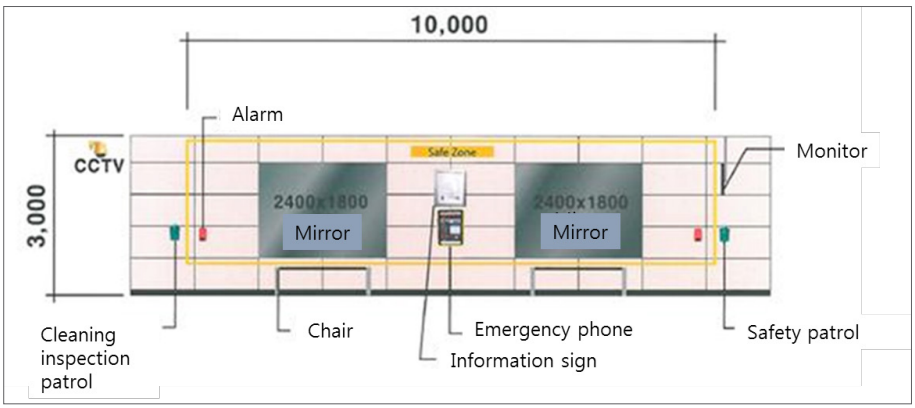
In order to enhance effectiveness of the CPTED program, analysis was done of the correlation between crimes occurring on subway lines 1-8 and 209 stations from 2009 to 2012 and station space, and consulted with experts to identify potential countermeasures. The effectiveness of the CPTED program in preventing crime provides peace of mind to late night/early morning subway travelers. Based on its experience with installing platform safety zones, the city government will apply the CPTED program to Line 9 Phase 3 stations and light railway platforms after establishing subway station crime Prevention Guidelines.

Figure 2 - Crime Prevention through Environmental Design

(a) Before (b) After

Source: Seoul City Press Release (2014)

Figure 3 - Crime Prevention through Environmental Design Proposal



Source: Seoul City press release (2014)

Subway Sheriff System

The Subway Sheriff System is another response to subway crimes and was established by the city to assist with public order, creation of a pleasant subway environment, and help the elderly and the disabled. Sheriffs receive a variety of training, such as countermeasures against crime, firefighting, first aid, and crime and accident prevention. Since 2011, of the 4 subway lines (lines 1-4) operated by Seoul Metro, under the control of Seoul City, approximately 40 subway sheriff have been dispatched to lines 1 and 2. In 2012, the Subway Sheriff System was expanded to the lines run by the Seoul Metropolitan Rapid Transit Corporation, and the number of sheriffs doubled. Seoul Metro 9 also adopted the sheriff system after its opening in 2009. Illegal activity dealt with by subway sheriffs between 2011 to Jan. 2012 include soliciting (6,726 cases), public drunkenness (4,759 cases), newspaper collection (3,854 cases), begging (2,211 cases), and sleeping out in the open (1,997 cases). Any person caught by a subway sheriff for illegal activity will be taken to the Police Task Force and freed after reproof or payment of a fine.

Figure 4 - Subway Sheriffs on Duty

Source: Seoul City Press Release (2011)

Station Safety: Hands-on Experience

Seoul Metropolitan Rapid Transit Corporation is operating a hands-on program for vulnerable transportation users, such as children and the elderly who are frequently exposed to safety issues or inconvenience. The Metro Safety Experience Class provides training on theory and practical experience on subway safety, general use of the subway, fire extinguisher handling, emergency phones, ticket vending machines, and public transportation etiquette. Through visits to urban rail facilities such as stations and depots, participants can increase their understanding of subway operations and safety regulations. Other topics include operation of

the subway emergency doors in the event of fire, and advice on what to do in the event of an actual accident or disaster.

CBTC (Communication Based Train Control)

The CBTC of the Seoul subway lines 5-8 operated by Seoul Metropolitan Rapid Transit Corporation was using a fixed block for train detection of the main section. While the method offers excellent stability, it creates a distance loss as much as the track circuit length in terms of absolute position detection of train; thus it is rather inaccurate, causing higher maintenance costs due to the need for more equipment onsite and in the signal machine room. In order to overcome these limitations and actively convert to a new system, the Seoul Metropolitan Rapid Transit Corporation developed a new radio-based train control system and has begun trial operations with it in three areas of Line 8. This new Train Control System consists of a train detection system that can accurately and continuously relay train location and speed, and a system that controls train using information transmitted through radio communication. The system is still in the pilot phase, but once it is developed all train control will become fully-automated and unmanned operation, which is expected to result in improved cost savings, safety, efficiency, maintainability, and passenger convenience over the existing block systems. Continuous developments in railway system engineering are expected to continue effectively decreasing safety problems.

Main Achievements

As a result of a variety of subway safety measures, PSDs have been installed in all subway stations in Seoul, providing a comfortable subway environment for subway users and workers. Starting with Sadang station in 2006, PSDs have been installed on 120 platforms on Lines 1-4 (Seoul Metro), 148 platforms on lines 5-8 (Metropolitan Rapid Transit Corporation), and 25 platforms of Seoul Metro Line 9. As of the end of 2009, PSDs had been installed in all subway stations. Prior to installation, at least 30 people had been injured or killed from suicide attempts or falls from the subway platforms. After installation, however, platforms and tracks are separated and the number of suicides or injuries due to falling on tracks has dramatically decreased.

Table 2 - PSDs in the Seoul Subway System(As of July 2012)

Total stations	Total stations with PSDs	Ground Subway Station		Underground Subway Station	
		Hermetic PSDs	Semi-hermetic PSDs	Hermetic PSDs	Semi-hermetic PSDs
293	293	269	0	22	2

Source: Korea Railroad Corporation (2012)

Table 3 - Accident in the Seoul Subway System

	Total	2009	2010	2011	2012
Total	65	57	8	3	4
Fatalities	31	29	2	1	0
Injuries	34	28	6	2	4

Source: Rail Safety Information System (http://www.railsafety.or.kr)

Figure 4 - Suicides in the Seoul Subway System

Year	2007	2008	2009	2010	2011	2012
Number of Suicides	56	37	44	0	2	0

Source: Korea Railroad Corporation (2012)

Seoul Metro, the Seoul Metropolitan Rapid Transit Corporation, and Seoul Metro 9 have a variety of safety equipment on their trains and platforms and provide guidance and training programs through their websites or Internet blogs. In terms of safety equipment, three portable emergency flashlights are furnished every 25m, fire extinguishers every 20m on platforms and in transit lounges. A total of 334 gas masks are furnished in each station and 792 sprinkler heads in 4.6m intervals of transit lounge ceilings to assist subway users in evacuation during fire or emergency.

Station air quality has improved, as has the station environment through reduction of noise and fine dust. The city also endeavors to monitor air quality by measuring temperature, humidity, and fine dust in real time with sensors installed on platforms and transit lounges. The fine particle readings in Seoul Metro transit lounges was an average of 131.4μg/㎥ before the PSDs were installed, and an average of 80.4μg/㎥ after installation, a decrease of 35.3%. There has also been a reduction of radon each year. The lowest measurements in Seoul subway stations were in 2010, the year after the PSDs were installed, and these levels are still maintained today. The average concentration of radon for the 10 years between 2000 and 2009 was 2.76pCi/L, while measurements taken after installation of the PSDs in 2010 and 2011 showed concentrations of 1.12pCi/L, a reduction of 59.4%. Noise, too, decreased at all stations, although the degree varied by PSD type. Specifically, stations where hermetic PSDs had been installed recorded noise levels an average of 7.3 dB less than before. In Seoul Metro stations, noise levels dropped from 78.3 dB to 72.1 dB (7.9% reduction). Ventilation

and air conditioning costs also decreased by 18% while electricity costs dropped 33% (from KRW 19.447 billion to KRW 13.055 billion).

Limitations & Needed Improvements

The safety of Seoul Subway has reached advanced nation levels thanks to projects promoted by various organizations and increased awareness of the average person regarding safety. However, incidents still occur with the potential to lead to larger events, such as malfunctioning stop signals causing train derailment, passengers setting fires in trains, passengers caught in screen doors, etc. Other problems are also being pointed out besides safety, such as maintenance costs and maintenance work required for the PSDs.

Several important steps need to be taken to prevent recurrence of accidents: First, it is not necessary to build a safety management system that prevents errors and accidents that have been frequent by human (human error), which is an ongoing problem. Enhanced surveillance and alarm systems are needed, particularly remote monitoring and alarm systems for facilities and unmanned machinery rooms in tunnels and bridges, which are difficult for personnel to monitor constantly. Second, aging trains need to be replaced. As of 2013, 600 of the 1,945 vehicles running on lines 1-4 are at least 21 years old, which has been pointed out as a cause for the frequency of recent breakdowns. Trains deemed to be at high risk of causing incidents need to be repaired or replaced, even if they are not past their intended service term. Third, as Seoul's subway system is managed by separate operating entities, an integrated control center is necessary to resolve inadequate safety measures and unsafe operations. Fourth, Golden-time Targeting Program should be introduced for quick safety action in the subway system. A system needs to be designed that will reduce emergency response to five minutes or less to contain situations, protect people, and take other emergency action. This system would also include better training for employees, and standardization of working procedures.

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4. Seoul's Light-Rail Projects Driven by Private Investment for Poorly-Serviced Areas

Writer : Seoul Institute Dr. Seung-Jun Kim & Dr. Joon-Ho Ko

Policy Area: Metro

Background to Light-Rail Projects Driven by Private Investment

In the early 1990s, South Korea's infrastructure (such as roads, railways, ports and airports) was insufficient to its needs. In the 1980s, the Korean government cut spending in the stated interest of encouraging private development and restructuring of the Korean economy, resulting in lackluster investment in social overhead capital. In the 1990s, distribution costs contrast with GDP was increased and it caused serious traffic congestion around several large areas, including Seoul. The government believed there was a limit to providing funds for construction of infrastructure and that it was important to attract the private sector. In August 1994, it began promoting projects driven by private investment with establishment of the Promotion of Private Capital into Social Overhead Capital Investment Act. However, private investment became more difficult after the financial crisis in late 1997. As a means to stimulate the economy after the financial turmoil, the Act on Private Participation in Infrastructure was completely revised to promote private investment projects through various government policies, and the MRG (Minimum Revenue Guarantee) system is one example of the typical government support measures.

The Seoul city government believes that expansion of the public transit network (primarily of the subway system) is necessary even after the completion of 1st and 2nd subway construction and has explored solutions for poorly-serviced areas. The city promoted a multi-nucleic urban structure and balanced development by strengthening the connection between central regions, and supported development of station influence areas to cope with the demands of eastern and western Metropolitan areas. In particular, the need for additional subway track has emerged due to heavy congestion: 30,000 to 40,000 people per hour use the system especially the 25km section from Gimpo Airport to Banpo and the 16km section from Gayang to Banpo. The Asian financial crisis in 1997, however, made it more difficult for the national and local governments to pay for such needed expansion. In 2003, urban railway debt accounted for 81% of Seoul's total debt. The operating deficits of the Seoul Metropolitan Subway Corporation and the Seoul Metropolitan Rapid Transit Corporation have mounted, postponing new subway construction. In response to this problem, Seoul attracted private investment to Seoul Metro Line 9 as a private project that includes the MRG. Due to inaccurate estimation of demand, however, the government's share of the funding increased and reduced the MRG system in 2003. In 2006, the system was abolished in private offering projects, and in 2009 for government-set fixed projects.

Recently, Seoul announced plans for major improvements to still-existing poorly-serviced areas despite the continued expansion of the subway line network. According to analysis conducted in 2014, approximately 38% of Seoul is considered poorly-serviced area, with extensive distribution of the rail lines in the city's northeast, northwest, and southwest regions, causing regional disparity. To address this, and in consideration of requirements for building railway public transport systems, Seoul provided a Railroad Private Project Standard Concession Agreement (proposal). The key details of the improvement measures are to introduce light rail

service to poorly-serviced areas and remedy short comings of the financial support on private projects with MRG.

Figure 1 - Areas in Seoul Poorly-Serviced by Urban Railway

Source: Seoul City (2014)

Main Details of Privately-Invested Light Rail Projects

Review of Urban Railway Routes & Route Selection Process (Seoul's Ten-year Urban Railway Master Plan, 2013)

The 10-Year Urban Railway Master Plan aims at balanced growth and focuses on measures to better serve areas of the city with insufficient rail connection, and was drawn up after an environmental impact and sustainability assessment, consultation with relevant agencies and holding several public hearings to listen to residents. The city also reviewed comprehensive feasibility and route evaluations of both routes outlined in the Master Plan and possible routes in the future. Following is the procedure for selection of the routes outlined in the Urban Railway Master Plan 2013.

1) Selection of target routes for review

A total of 37 routes (the existing 8 urban railway master plans and 29 new routes proposed for review) were selected as target routes for review; some were proposed in the 2008 Urban Railway Master Plan and some have been proposed by local governments and citizen.

2) Selection & evaluation of alternative routes for each target route

Detailed alternative routes are selected for review, with connection between routes, urban spatial structure, land use, social/economy/geographic situations, and the existing urban railway network are all considered. That is, the plan determines whether alternative routes will fit into an economic structure through connection with other relevant plans and transportation infrastructure of the surrounding areas, while ensuring services to isolated areas. The following details are reviewed for each alternative route:

- Possibilities for route expansion, stopovers, depot locations, linking with existing urban railways
- Operating plans (vehicles, formation, and headway train interval) review
- Technical details of regional physical conditions and physical obstructions to the route

3) Route selection of route candidates of the master plan

After reviewing alternative routes, existing routes where technical construction is impossible and routes where demand is deemed to be insignificant due to redundancy are eliminated from the primary candidate list.

4) Routes selected for Master Plan

Demand analysis, project cost calculations, and economic feasibility analyses are done for Master Plan candidate routes. Economically feasible routes are chosen and other routes classified as "optimum alternative candidates", subsequent (candidate) routes and routes for long-term review. A comprehensive review is then begun on indirect effects of route composition.

5) Analysis of master plan routes

The following details are analyzed in accordance with the Urban Railway Master Plan Establishment Guidelines for routes selected for the Master Plan:

- Transportation demand, changes in the public transit modal share, analysis of main road traffic impact
- Establishment of construction and operational plans, linked transportation systems, measures to handle road traffic in construction areas
- Economic / financial feasibility analyses, financial funding measures, annual investment plans
- Pre-environmental review and pre-disaster impact review

Figure 2 - Route Selection for Seoul's Urban Railway Master Plan

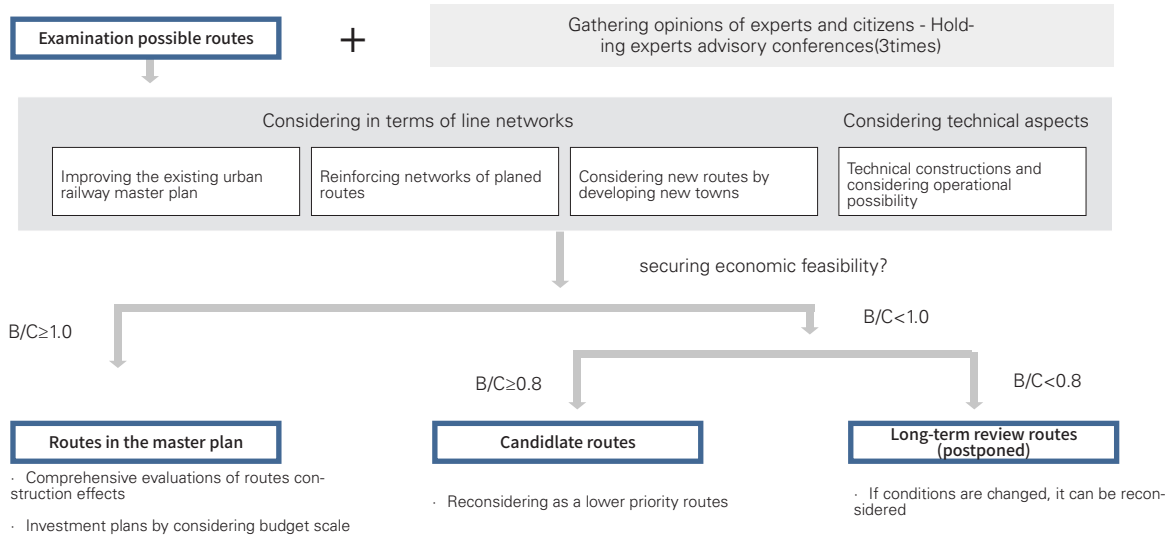
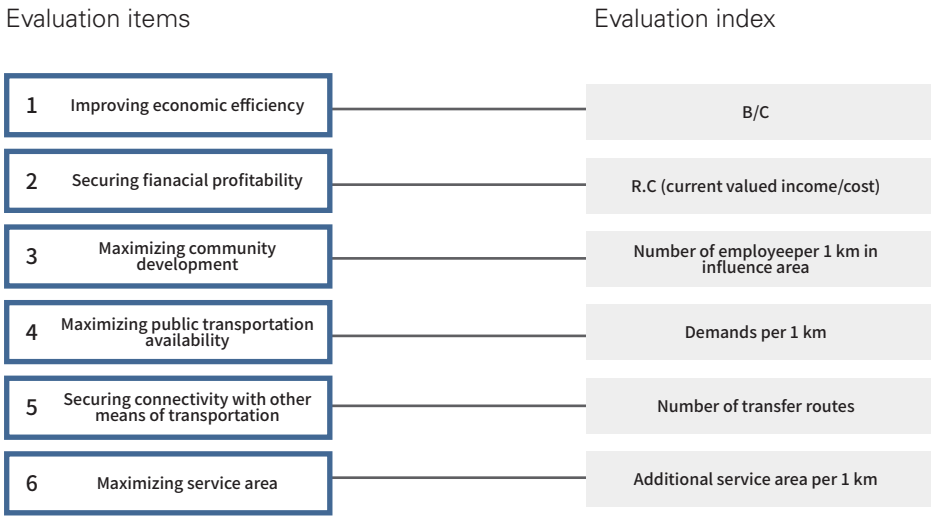


Figure 3 - Comprehensive Review for Routes in Master Plan



Introduction of Light-Rail Service to Poorly-Serviced Areas

To push forward with plans to increase access to rail for poorly-serviced areas, Seoul may create light rail branches (designed to handle 10,000 passengers/km per day) from existing routes instead of the more costly and time-consuming heavy rail tracks. As a result of comparison with routes for review, poorly-serviced areas can be reached by additional construction in UI new extension line, the northeast line, the Myeonmok line for the northeast region, the west line for the northwestern region, the Mokdong line, the Shillim line, and the Nangok line in the southwest region according to Seoul's (2014) report. The routes were, in fact, selected

in the 2008 Urban Railway Master Plan, when they were classified as optimal alternative routes, and there was ongoing demand for construction from residents in poorly-serviced areas. Seoul's light-rail proposal will strengthen integration with the existing urban railway and the Master Plan routes, and includes measures to expand to areas generating massive demand. With these measures, accessibility to urban railway service in poorly-serviced areas will be enhanced, while bus routes will be adjusted to facilitate better connection to the rail system in areas where the proposed light-rail stations will not be within a 10-minute walk.

Figure 4 - LRT Route Planning for Poorly-Serviced Areas

Source: Seoul City (2014)

Additional Financial Support for Existing Private Investment Projects

If Seoul promotes private investment for its light-rail project, various problems are likely, such as operating loss compensation due to excessive demand, and demands are mounting that the project should be financed by the government. On the other hand, state-supported projects often face delays due to budget restrictions. In addition, debate on priority for each route is likely regarding construction period.

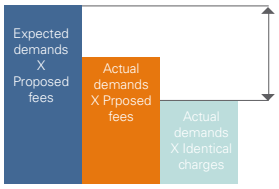
To find a middle ground, Seoul is attracting private investment and strengthening government management of the light-rail projects, including a proposal for consistent standards of process for all projects through a Privately-Funded Railroad Project Standard Concession Agreement of Seoul City. The proposed standard ensures a smooth agreement implementation with private businesses by providing agreement-related organizations and professional manpower throughout the time of agreement, construction and operation. With this, Seoul City was able to secure private funds, including a sound capital structure of which the city can modify agreement details, such as the profit return rate in case of changes in the financial market henceforth.

The supplement of the rate system in the existing private business procedures

The Seoul's2008 Urban Railway Master Plan allows pricing differences. Since private firms that conduct private projects cannot collect huge project expenses, the plan is to allow higher pricing than the current basic transportation rate to help private businesses recover their investment. However, this met with opposition from residents in poorly-serviced areas, so the city decided to follow the existing public transit fare system in Seoul (basic rate, transfer discounts). However, the difference of the rate offered by private businesses and the basic rate is supported by Seoul City, with the scale of support based on actual demand. The amount of financial aid for the northeast line over the last 15 years is expected to be 177.4 billion won. However, under the MRG standard, the cost would have been around 314.6 billion won, which may help Seoul City's finance.

Figure 5 -The concept of Seoul City's financial support in accordance with the same rate system application

Comparlson of Financial Support standard



1. MRG

2. Financial Support based on actual demands = (actual demands) X (basic rate difference)

MRG Guarantee [Based on 2005's MRG master plan]

Paying for 15 years within the following Guarantee linits of '[Expected operating revenue]-[actual operating revenue]'

After the business started, first 5 tear : 80%
6 year ~ 10 year :70%
11 year ~ 15 year : 60%

* MRG abolition : Private suggestion business MRG abolition in 2006 Official business MRG abolition in 2009

Expectancy effects according to Seoul City's light-railway expansion

Effect on Transportation

With light-rail expansion of the subway system, Seoul expects increased public transit modal share and improvement to subway accessibility. The designed light-rail routes will be constructed in poorly-serviced regions, and upon completion, all residents of Seoul will be able to reach a subway station within 10 minutes. Moreover, it is expected that areas with easy subway access (within a 500m radius of subway stations) will increase to 72% from the current 62%, which will reduce average travel time for residents in these light-rail serviced areas by 20%, and by 9% for all residents of Seoul. Lastly, the plan is expected to improve the public transit modal share, while decreasing passenger car modal share and reducing the costs of traffic congestion in the city by 1.2 trillion won annually (as of 2011, total annual traffic congestion costs are approximately 8 trillion won).

Socio-economic Effects

It is difficult in the planning stage to predict the socio-economic effects of Seoul's light-rail projects driven by private investment. However, we can estimate the future effect of Seoul's Light-railway project driven by private investment through urban railway and traffic infrastructure system composition that had been implemented for several years. Urban railway and transport infrastructure projects led by private investment have so far been favorable for private operating agencies, leading to a rise in government financial support and also wasting taxpayers' money. Despite these disadvantages, such projects do tend to begin operations on time, thereby enhancing operational efficiency. From a socio-economic viewpoint, the effect of private investment on Seoul's urban railway and transportation infrastructures are classified into three types:

Growth effect owing to private investment

A large amount of private funds were injected into urban railway and transportation infrastructure, allowing the city to do more in other areas with its own limited financial resources. Since the 1997 Asian financial crisis, private investment projects, promoted as part of an economic stimulus package during the economic recession, have contributed to a booming economy.

Transportation convenience at an earlier stage

With construction of Seoul Metro Line 9, transportation convenience has materialized at an earlier stage, resulting in a return of 1.45 trillion won or 19.4% of the total project expenses. Similarly,14 recent private road projects initiated by Seoul City would have been dramatically delayed if they had been solely dependent on public financing.

Revitalization of regional economies & financial effects

Seoul Metro Line 9 also created additional effects - remigration of the market economy around stations. With the opening of Metro Line 9, accessibility to Gangseo and Yeouido has dramatically improved, where a department store connected to the Express Business Terminal Station (line No. 9) saw their weekend sales up 26.7% year-on-year, up 19.2% compared to the previous weekend, and 9.7% more visitors. Business at restaurants and convenience stores in Metro Line 9 stations has also doubled, resulting in significant revenue.

Limitations & Need for Improvement

Potential exacerbation of Seoul's financial difficulties due to operating deficits

While private investment offers many advantages to the construction of transportation infrastructure (including urban railway projects) such as funding and provision of timely services, there are also disadvantages. Seoul City has experienced many trials and errors in promoting various private projects. One notable problem involving a privately-funded project has been with Seoul Metro Line 9, whose operating entity was offered a Minimum Revenue Guarantee as part of the plans to boost access in Gangseo district to public transit. However, due to the incorrect estimation of demand, the city had problems paying the operating subsidy to Seoul Metro Line 9 management agency as it had become more substantial then expected and increase of fare as the agency had the right to decide fare. If actual revenues fall short of projections stated in the concession agreement, Seoul Metro Line 9 was guaranteed to receive 90% of the minimum operating revenue (the MRG) for up to 5 years from commencement of operations, 80% from 2006 to 2010, and 70% from 2011 to 2015 regardless of actual operational revenue.

Figure 1 - MRG Subsidy for Seoul Metro Line 9

	Total	2009	2010	2011
MRG (100 million won)	838	131	293	414

Source: Seoul City (2014)

The MRG program has been abolished now, and based on failed private-investment projects such as Seoul Metro Line 9, project procedures have been reviewed to ensure the city does not bind itself into unreasonable payments when promoting light-rail projects to private investors. However, the private investment project is also addressed with improvements and limitations. While the fare subsidy had been supported due to accurate estimates in the past, the demand is now estimated based on actual demand, which reduced funding amount of Seoul. However, light-rail construction projects are very likely to require more funding from the city, which already has debts from its existing public transit systems. This means that plans for future light-rail projects need to have sufficient measures to ensure sustainability.

Provision of a management system for private project flexibility

In order to minimize Seoul's financial burden arising from private investment-driven light-rail projects and to ensure sustainability, the city needs to implement flexible plans for effective management and periodical conditions. The light-railway project in schedule may change due to financial realities for the city, including social and economic conditions. Seoul needs to accommodate the needs of subway construction and provide a systematic measure that reflects a variety of fluctuations for activate participation of private investment.

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04

E-Government

1. Process & Achievements: Seoul's e-Government

Writer : Seoul Metropolitan Government Director Ki-Byung Kim

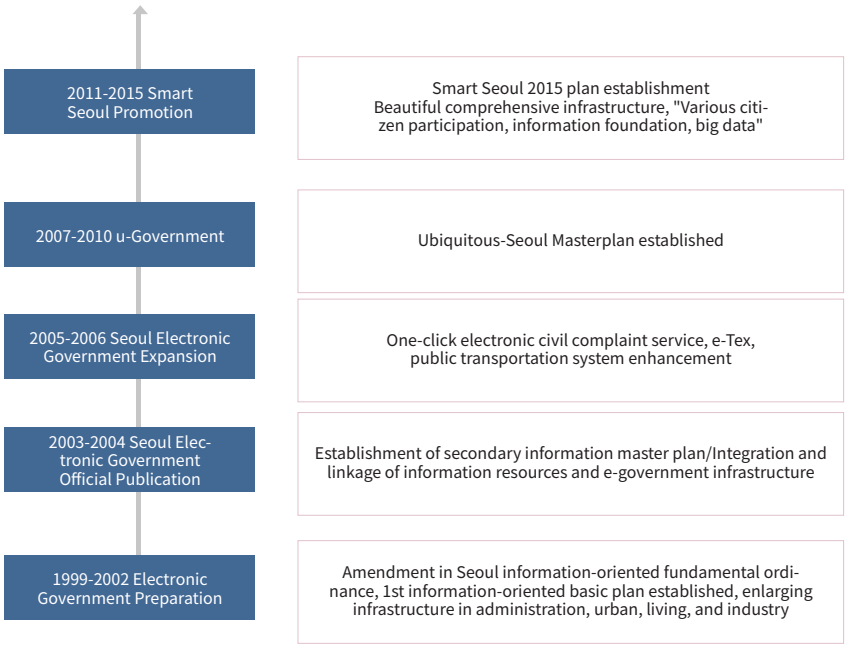
Policy Area: e-Government

Overview

Since the 1990s, Seoul has continually pursued its ICT (Information and Communication Technology) plans to build an efficient, IT-based city government able to provide a convenient information service to the public, systematically manage administrative information, and ensure transparency. Out of these goals, the city's e-Government was born. In the early days, the city's efforts were centered on computerization and automation of administrative duties such as management of taxes, human resources, finances, and geographic information, etc. Automation was further driven by introduction of the electronic signature to assist document control. This move significantly enhanced efficiency in administration, providing a platform on which signed documents could be shared. Of course, prior to that, the Internet made administrative services faster and easier.

In 1999, the City of Seoul Ordinance on Information was passed, forming the legal basis to implement plans and programs to make the city and its administration "smarter". This was a turning point in Seoul's administrative service, a new engine to drive e-Government forward. On March 15, 1999, the Smart Seoul Planning Group was founded to oversee the e-Government program, and an outside expert was invited to be its CIO (Chief Information Officer) and then to head it as a way of giving the system authority. The city now had an environment where its e-Government plan could take flight, embracing a wide spectrum from computerizing administrative duties and providing service to the public, to involving the public in assuring e-democracy. Thanks to the rapidly advancing ICT, Seoul was able to take its first step as an e-Government and strengthen its capabilities for digital administration and digital democracy.

Figure 1 - Progress of Seoul's e-Government



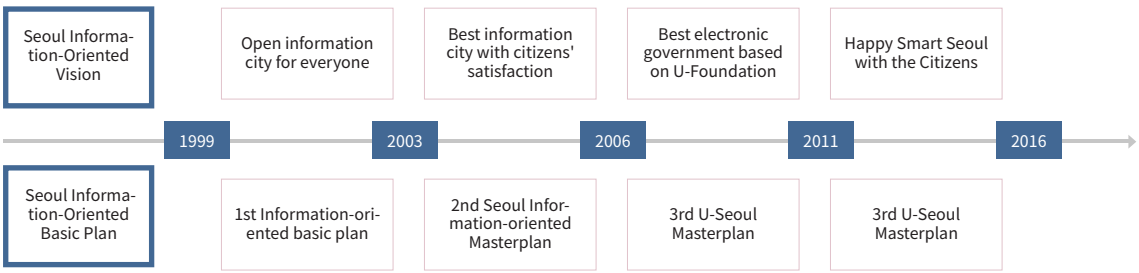
From 1999, Seoul's ICT plan revolved around the 4-Phase Basic Strategic Plan for Informatization of Metropolitan Seoul. Phase 1 (1999 – 2002) was a period of preparation for e-Government, promoting the introduction of ICT in the administration, urban structure, living, and industrial sectors and building the infrastructure for e-Government.

Phase 2 (2003 – 2005) was a period for introduction of e-Government. To keep this introduction systematic, an e-Government roadmap was developed. This included linking and integrating the ever-growing administrative information service and information resources. As a result, Seoul's e-Government began to take its form as a proper electronic framework.

During Phase 3 (2006 – 2010), the u-Seoul Plan was pursued. The city's e-Government was connected to m702 mobile portal to grant people the ability to access and participate from anywhere and at anytime. For u-Seoul, the wireless infrastructure was built on a trial basis. The open Web 2.0 was also introduced to encourage people to participate and share, and GIS (Geographic Information System)-based administrative service and intelligent urban management were incorporated in the plans to build a safer city.

In accordance with Phase 4 (2011 – 2015), Smart Seoul 2015 was undertaken to enable the open e-Government, linked with Seoul City 2.0. Based on the wired and wireless infrastructure, communication and participation was more actively promoted by disclosing public information, providing services tailored to resident needs, and analyzing big data. The public sector worked with the private on big data analysis to address the night bus routes and other urban issues. Documents and content data were disclosed to residents, and Seoul's open, shared data and space information were used by the private sector to develop diverse applications and services.

Figure 2 - Basic Strategic Plan for Informatization of Metropolitan Seoul & Vision

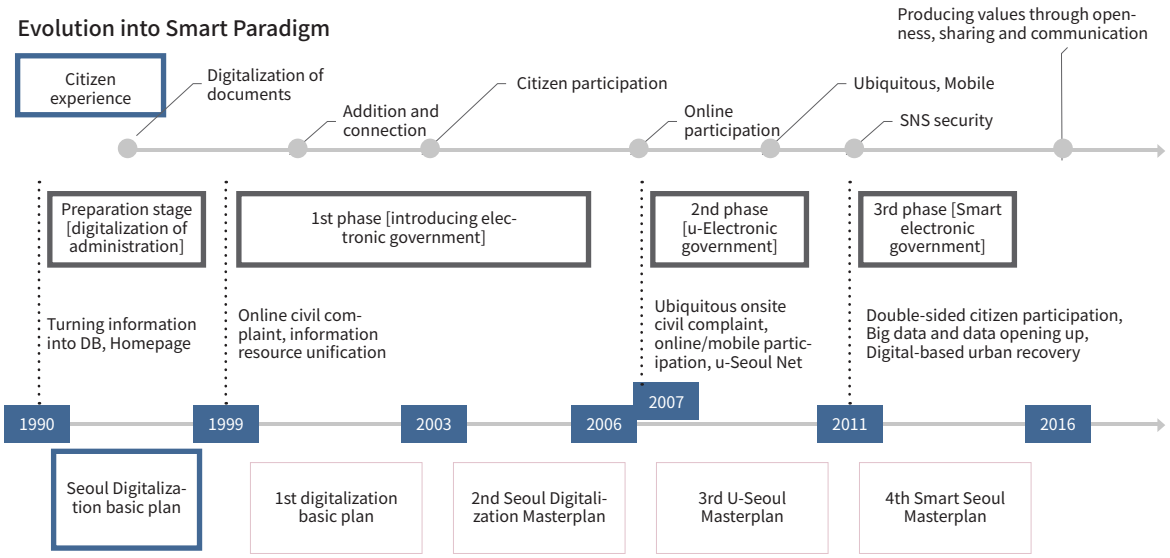


Progress

Seoul's e-Government was launched in earnest in 1999 when the city developed its Basic Strategic Plan for Informatization. The vision for the first Basic Strategic Plan was to create "an open information city at the fingertips". In cooperation with the University of Seoul, the 10-year plan was drafted to advance the 4 sectors of administration, urban infrastructure, living, and industry through information and sharpen the competitive edge of the information system.

With the first Basic Strategic Plan, the administrative information system spread extensively, paving the way toward the launch of e-Government. The public adjusted to the online administrative service system, and attempts were made to initiate a knowledge-based administration. The information system was opened up to advance the infrastructure. An ultra high-speed fiber optics network called e-Seoul Net was constructed and began to reinforce the infrastructure that would enable the shift from a computerized administrative system to an e-Government system.

Figure 3 - Progress of Seoul's e-Government Plan



As a result, Seoul's administrative information services experienced dramatic quantitative growth in 2002. However, this was accompanied by redundant investment in IT resources, inadequate IT service links, and lack of information sharing between the IT systems. To update and improve what had been accomplished during the first Basic Strategic Plan, the Smart Seoul Planning Group tasks were developed in 2003 to establish the second Basic Strategic Plan called the Seoul ICT Master Plan. The Seoul ICT Master Plan was then divided into 2 phases: i) the first phase (2003 – 2004) involving integration of information resources with a vision to create an "information city that people love"; and ii) the second phase (2005 – 2006) involving information service advancement.

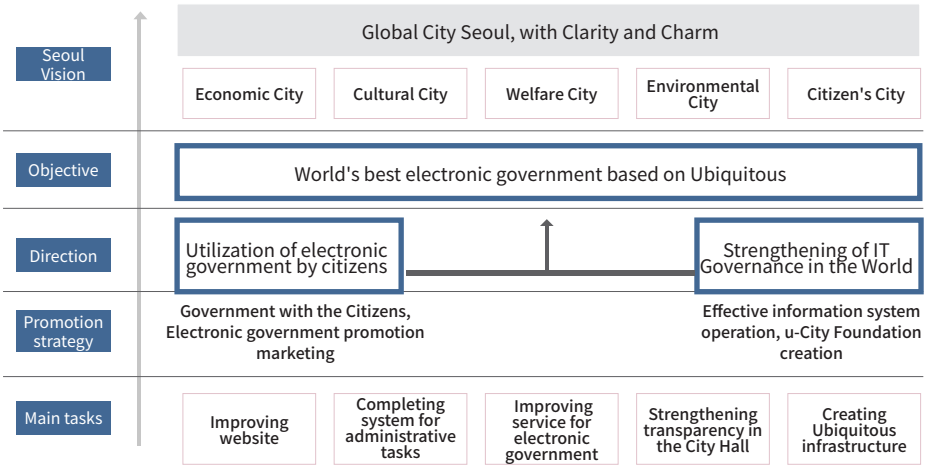
The first phase was about upgrading and integrating the information services and resources that had been individually developed. Many websites were integrated under a single user-friendly interface which was opened on February 24, 2004, and named the Data Center. As for communication infrastructure, Seoul was the first city in the world to have a network such as the e-Seoul Net, which connected the city to 35 major institutions through a 183 km-long high-speed fiber optics cable which allowed e-Government services to be provided without restricting overall network capacity.

Such accomplishments were soon acknowledged: Seoul ranked first of the top 100 performers in the United Nations e-Government Survey conducted by Rutgers University (USA) and Sungkyunkwan University (South Korea) and sponsored by the UN and the American Society for Public Administration, in 2003. It served as an opportunity to export Seoul's e-Government model to other countries.

In 2005 and 2006, the second phase began. Based on the information infrastructure built in the previous phase, policies and procedures were adopted to facilitate the e-Government plan in a more effective and efficient manner. It was also during this period that Seoul's EA (Enterprise Architecture)-based project methodology was completed and an integrated information protection system developed to protect the e-Government infrastructure from security threats. Electronic reporting and meeting systems were introduced for internal administrative work while residents received greater benefit from the e-Government service through introduction of the One-Click Civil Service, e-Tax, upgraded digital administrative services and improvements to the mass transit system.

In 2005, the third Basic Strategic Plan was established, and was a mid- to long-term plan from 2006 to 2010 during which the u-Seoul Master Plan was developed with the aid of ubiquitous technology. With an aim to create the world's best "ubiquitous e-Government", the plan sought to encourage people to make more use of e-Government services and reinforce the IT governance system.

Figure 4 - Vision & Goals for the Third Basic Strategic Plan



In 2007 and 2008, e-Government targeted providing customized and safe services. Open Web 2.0 was introduced as a platform for residents to participate in the development of e-Government, and the One-Click Civil Service was upgraded for user convenience. "Seoul Oasis" (where residents share their ideas on city management), "Cyber Policy Forum", and "Online Policy Voting System" were offered, providing broader opportunities for people to take part online in the decision-making process. In fact, the success of these programs was what helped Seoul win the UN Public Service Awards in 2008. Efforts were also made to expand the foundation for u-City and to build the m702 mobile portal allowing 24/7 access to online information and booking services.

Seoul targeted the e-Government system to make the city a safe place. For this, the accuracy of data warehouse and underground facilities data was improved based on spatial information, and an online road management system was rebuilt. As a way to enhance the safety of the IT infrastructure, an integrated information protection system was built in accordance with international standards for information security management (ISO27001) while fully monitoring access to personal information for increased IT security.

During the period of 2009 and 2010, u-Seoul was initiated in earnest. U-Citizen services were broadened in the u-Seoul plan, and a smart u-Urban Management system was added for environment, traffic, and disaster management. U-Infrastructure and u-Service were scaled up, while u-Healthcare and u-Seoul Safety Zone were piloted, all of which were covered by TIME magazine and on the UN website.

Digital administrative services also took a leap forward. Developed by the Ministry of Public Administration & Security, the Onnara e-document system was improved to start Seoul's unique business process system, which includes systematic document control, sharing, and electronic approvals. The Clean Finance information system was built, and 4 state-assisted institutions adopted the ERP system to make every aspect of financial management as transparent as possible, adding to the pioneering and creative nature of digital administrative services.

To ensure that e-Government remains secure, an integrated security and safety management system was introduced to bring together information security resources scattered among the city and gu district offices. The city also became the first local government to build a security control center, which is linked with the security control centers of the Ministry of Public Administration & Security and the National Intelligence Service. The center dramatically improved its round-the-clock responsiveness to cyber attacks.

Seoul's e-Government also put much effort into global cooperation. Since 2004, the city has continued its global marketing strategies for e-Government while expanding its collaborative network with major global cities. In 2009, the city hosted the World Cities CIO Forum and planned a working-level meeting for the establishment of World e-Government (WeGO). In September 2010, the first assembly of WeGO was held in Seoul, reminding the world of the city's global presence and IT leadership.

In 2010, the Smart Seoul Master Plan – the fourth Basic Strategic Plan (2011 – 2015) – was developed. With a vision of creating a "Smart Seoul" with its residents, the Master Plan set its sights on reforming its information services in accordance with the paradigm shift of administrative services being open and engaging.

In accordance with this, public content and data were opened for improved public access and an enhanced user environment. Seoul also upgraded its mobile services to allow easy access from various types of smart devices. Services were further boosted by the public Wi-Fi and wireless infrastructure.

To make Seoul a Green City, a CCTV integrated control center was installed, providing its service to some 2,500 children from low-income households for the prevention of crimes. In the meantime, the city has been working on integration of the information resources infrastructure.

2012 was the starting year of Seoul's smart e-Government, and the city was the first local government in South Korea to open a "Communication Plaza" and an "Open Data Plaza" for people to access the city's public documents and other data. To further promote access to this data, the city held a contest for smart phone applications and sponsored camps on private/public data use.

People without easy access to information were also engaged so that they could enjoy the associated benefits. The "PC of Love" program was designed for welfare beneficiaries, the disabled, single parents, and multicultural families. Consultations, preventive training and ICT education programs were also offered to minimize any adverse effects from going online.

The ICT plan was also promoted by setting up a governance structure. Based on budgetary feasibility reviews conducted since 2008, ICT program governance was established in 2012 to review all of Seoul's ICT programs for redundancy and budgetary feasibility. When overlapping programs were found, they were integrated or their budgets adjusted to enhance program efficiency. The administrative services were also made smarter by instituting a culture of sharing and collaboration. The ICT plans pursued by different departments were reviewed for feasibility, after which the departments were encouraged to share their work and cooperate if applicable. At the same time, the need for security was emphasized to assure the public of the security and reliability of the information system.

Seoul's e-Government continued to advance. By 2013, Seoul renamed the Smart Seoul Planning Group the "Smart Seoul Group" and shifted its focus from building the e-Government platform to utilizing it. In the meantime, the city continued to stimulate innovation with useful, user-friendly e-Government services.

Thanks to its open platform of big data, mobile, and spatial information as well as its global collaboration through the city network of WeGO, Seoul was able to announce the launch of a fully collaborative e-Government in 2013. Enabled by the open, engaging and sharing City Government 2.0 and the open, sharing, communicative and collaborative City Government 3.0, Seoul's e-Government platform was able to provide a valuable example to other cities around the world.

One example is the Night Owl bus, chosen as the most loved policy in Seoul and used by 2.7 million people annually. It was launched based on big data (including public data) collected from enhanced communication with residents, and aided by private-public collaboration and problem-solving administrative efforts. The data disclosed and used in the process is accessed more than 860,000 times a day and has become one of the most popular city services. The m-Voting mobile service also boosted communication and policy sharing by the city, and has been introduced by the city across many fields, attracting more users over time.

In the meantime, the GIS service engaged people and helped create jobs. It helped the city to chart its policy map and provide a 3D interior space modeling service, a visual guide to policies and their outcomes. It also provided services useful in daily life and enabled a spatial information forum that helped create jobs for young talent. Aimed to make Seoul a safer place, the GIS service won the SAG (Special Achievement in GIS) award from ESRI (USA) in 2011 as well as the Future GOV e-Government grand prize.

In terms of infrastructure development, Seoul upped its responsiveness to cyber threats to make its e-Government a safer institution while working to help its Data Center become greener with the introduction of cloud computing. The Data Center was certified as eco-friendly as it enhanced the efficient use of IT resources and cut energy costs.

Programs by Phase

- Preparation for e-Government (First Basic Strategic Plan, 1999 – 2002)

The City of Seoul Ordinance on Information was enacted and the Smart Seoul Planning Group was founded in 1999. During the period 1999-2002, the focus was on ① providing a user-friendly administrative service; ② enabling the online administrative system; ③ enabling knowledge-based administration; ④ revitalizing the local economy through ICT; and ⑤ building and advancing the information infrastructure. Plans were developed across the 4 sectors of administration, urban infrastructure, living, and industry, and the administrative information system spread rapidly. Introduction of the open system, cyber customer center, and the open online civil service system were successful and these programs were selected as outstanding examples at the International Anti-Corruption Conference and OECD high-level policy seminar.

- Seoul ICT Master Plan (Second Basic Strategic Plan – Phase 1, 2003-2004)

During this period, emphasis was on ① integrating rapidly expanding information resources to maximize efficiency; and ② upgrading the e-Government infrastructure. Integration was conducted from the perspectives of i) the administrative system; ii) service to residents; and iii) IT resources.

Integration of the services to residents was website-based. Websites for each service were brought together into one user-friendly interface. For this job, the One-Click Civil Service was opened and the Cyber Policy Forum began to listen to resident input.

Integration of the administrative information system was initiated through introduction of a new document control system and an integrated city/gu district information system program. Opening of the Data Center on February 4, 2004 coincided with integration of information resources and IT infrastructure, with the Data Center playing a central role. In addition, Seoul's high-speed fiber optics network called e-Seoul Net (183 km) was opened, propelling the e-Government plans without restricting network capacity.

The integration of resources and the involvement of residents were what helped Seoul to rank first in the

United Nations e-Government Survey of the top 100 performers, conducted by Rutgers University (USA) and Sungkyunkwan University e-Government research institute (South Korea) and sponsored by the UN and the American Society for Public Administration, in 2003, and is evidence that Seoul's model has been acknowledged by the world for its excellence.

- Seoul ICT Master Plan – (Second Basic Strategic Plan – Phase 2, 2005 – 2006)

In 2005 and 2006, the information security system was the key to ① encouraging people to use the e-Government service; ② building the e-Government management platform; and ③ ensuring the stability and reliability of e-Government.

To promote use of the e-Government service, a satisfaction survey was conducted to improve service quality, and further projects involved the public in implementation. Besides website integration, content, video, and GIS portals were used to invite more people to access the service. Other ways to involve more people included the assistance to the Cyber Policy Forum and community activities; cyber education to help people become more familiar with ICT and narrow the information gap; and distribution of free computers to the marginalized.

The integrated and efficiently upgraded e-Government infrastructure allowed the city to revamp its policies and procedures to push ahead with its e-Government plans. The EA project methodology was used to introduce electronic reporting and meeting features in the internal work procedure. With increased resident participation, the digital administration became more mature and widespread.

Seoul introduced the integrated system and advanced management methods to protect the e-Government system from outside threats. It obtained BS7799 accreditation, thereby enhancing the stability and reliability of e-Government.

- Customized e-Government (Third Basic Strategic Plan, 2007 – 2008)

This was a stage where the e-Government service was tailored based on the integrated system so that civil services can be accessed by anyone at anytime and from anywhere.

The introduction of Web 2.0 and the upgraded One-Click Civil Service offered better, easier services while the online idea-sharing "Seoul Oasis" and "Cyber Policy Forum" invited more people to participate in running the city. In 2008, their success was what helped Seoul to win the UN Public Service Awards.

The information system continued to expand. The Clean Finance, civil service, automobile and benefits information systems were added to the new system, and a dedicated team was created to support integration.

To build the u-City platform, the m702 mobile portal was built to allow access to online civil, traffic, environment, cultural activities and booking services from computer or mobile phone. Technology was also applied for urban safety, with the u-Children program as a good example. Moreover, GIS-based data warehouse, underground facilities, and road management systems were rebuilt, and mobile GIS platform and business models were identified to reinforce the safety of e-Government.

- u-Seoul (Third Basic Strategic Plan, 2009 – 2010)

For u-Seoul, ① the u-Service and ② the u-Infrastructure were broadened. Wireless infrastructure was built for the city, and Euljiro-2-ga was turned into "Ubiquitous Street". The u-Seoul children's safety system and u-TOPIS were also installed. The u-Safety and u-Healthcare systems (both from u-Seoul) were featured in TIME magazine and on the UN website.

Digital administration continued, and Seoul built its own business processing system, such as the document control and electronic approval systems. Developed by the Ministry Of Public Administration & Security, the Onnara e-document system was improved to take document control and sharing systems to the next level. In addition, the Clean Finance information system was built, and 4 state-assisted institutions adopted the ERP system to make every aspect of financial management transparent, aiding the digital administrative services to become more pioneering and creative.

To ensure that e-Government remains secure, an integrated security and safety management system was introduced to bring together information security resources scattered among the city and gu district offices. The city also became the first local government to build a security control center, which is linked with the security control centers of the Ministry Of Public Administration & Security and the National Intelligence Service. The center dramatically improved round-the-clock responsiveness to cyber attacks. A wireless control system for 119 emergency directives was built, as was the u-Seoul information security system, to continually ensure security of the e-Government system.

Seoul put much effort into global cooperation, sharing its achievements and experience with e-Government with other cities around the world. Based on these efforts, Seoul established WeGO in September 2010 and held the first assembly in Seoul, reminding the world of the city's global presence and IT leadership.

- Launch of "Smart Seoul" (Fourth Basic Strategic Plan, 2011 – 2015)

With a vision to create a "Smart Seoul for and by Everyone", Seoul's new Basic Strategic Plan "Smart Seoul 2015" was launched in 2011. It pursued plans in 4 areas: ① smart, communicative government; ② smart, sustainable living; ③ smart green spaces; and ④ smart, creative global economy. The new plan took Seoul's e-Government one step closer to a smarter paradigm.

For a "smart, communicative government", the city revolutionized its information service in line with the new "open, sharing and engaging" paradigm. Public content and data were open to the public, and resident accessibility was improved to enable full use. The mobile service for smart devices was upgraded, and further boosted by the public Wi-Fi and wireless infrastructure.

In 2012, the "open, sharing and engaging" City Government 2.0 was pursued, enabled by the Communication Plaza and the Open Data Plaza, a city first in South Korea, thereby giving open access to public information and data. It became a strong platform for e-Government, which supports the "communicative, open, engaging and sharing" City Government 2.0 and the "open, sharing, communicative and collaborative" City Government 3.0.

Thanks to its open platform of big data, mobile, and spatial information as well as its global collaboration based on the city network of WeGO, Seoul was able to announce the launch of a fully collaborative e-Government in 2013. The m-Voting-based mobile service boosted communication with residents and sharing of policy. Users of the mobile service, introduced in the early stages in 2012, more than doubled by 2014.

In 2014, the city attempted to enhance communication with residents and resolve administrative issues through the use of big data and public data collected by way of private-public collaboration. One example is the Night Owl bus, chosen as the most loved policy in Seoul and used by 2.7 million people annually. The data disclosed and used in the process is accessed more than 860,000 times a day, making it one of the most popular city services.

Those citizens who do not have easy access to information were also engaged to allow access to the benefits of the city's sustainable welfare programs. The "PC of Love" program was provided to welfare beneficiaries, the disabled, single parents, and families from multicultural backgrounds. ICT education programs were also offered, and in 2012 alone, some 16,371 people completed training courses. Consultations and online safety education were also offered to minimize potential adverse effects from going online, attracting 150,000 people.

To make Seoul a Green City, the CCTV network and CCTV integrated control center were installed, and the u-Seoul Safety service was provided to some 2,500 children from low-income households for the prevention of crime. In the meantime, Seoul Guardian, a mobile safety system, was linked to the 120 complaint service to push disaster and incident alerts and otherwise protect people from danger.

In terms of creativity, budgetary feasibility reviews were utilized to make the digital administrative service smarter and more collaborative. ICT plans pursued by different departments were reviewed for feasibility, after which the departments were encouraged to share their work and cooperate if applicable. At the same time, the need for security was emphasized to assure the public of the security and reliability of the information system.

In terms of infrastructure development, Seoul upped its responsiveness to cyber threats to make its e-Government a more secure institution while working to help its Data Center become greener with the introduction of cloud computing. The Data Center was certified as eco-friendly, as it enhanced efficient use of IT resources and cut energy costs.

Programs were also launched to vitalize the smart industry. Construction of an IT complex is underway, scheduled to be completed in 2016. Other programs include the Seoul App Center and Gaepo Digital Innovation Park. The GIS service was expanded to cover the city's policy map and the 3D interior space modeling service, used to develop major policies and use as performance indicators. Young talented minds took part in GIS development, creating new jobs in the market. It also expanded in scope to be used as a platform to provide services useful in daily life.

Major Achievements

- Integration of Administrative Information Services & Resources, and Seoul's Data Center

As part of the 4-phase Basic Strategic Plan, Seoul now has a strong administrative information system comprised of some 490 different sub-types. Some 78% – 385 types – of the total was developed by the city itself to satisfy specific needs in providing administrative services. Seoul's 144 teams and departments have independent systems optimized to their responsibilities. With these systems in place, they are able to provide civil services in the most effective way and to ensure transparency and efficiency, encouraging more people to take interest.

Since the first Basic Strategic Plan, the administrative information systems have continued to grow and expand. In 2003, information resources that had been scattered across institutions and sectors were brought together as one system. On February 24, 2004, the Data Center was opened and began operating around the clock. In 2014, the Data Center was upgraded for better efficiency and environmental-friendliness and was certified as a "green" center. Thanks to the center, service interruptions were reduced by 76% on monthly average and the services are provided non-stop 24 hours a day all year round. It also allowed for a strong and efficient e-Government platform that ensures quality of the services provided.

While physical resources were integrated by the Data Center, integration of the information systems and applications were completed by Enterprise Architecture.

By ensuring the interactive operability of the information systems comprising 4 layers – technology, data, application, and business – and integrating varied resources, information can be managed in a coherent manner, paving the way for an enterprise-wide IT management system.

- e-Seoul Net and u-Seoul Net

For the first global city, Seoul opened its 183 km-long high-speed fiber optics cable network called e-Seoul Net, connecting itself to 35 major institutions. With this network, Seoul was able to expand e-Government services without restricting network capacity or being limited by budget. When it was first opened in 2003, it was the 2 Gbps backbone network. In 2009, it was upgraded to 20 Gbps, allowing the e-Government system to use and process large data.

In 2011, u-Seoul Net was opened to transmit audio, video and multimedia (e.g., traffic, CCTV data). U-Seoul Net uses fiber optics as well as Wi-Fi, Wibro, USN, and CCTV sensors to allow for diversified service communications, and for people to access useful services related to prevention of disasters, incidents, crime, and even illegal dumping.

Figure 7 - e-Seoul Net Organization

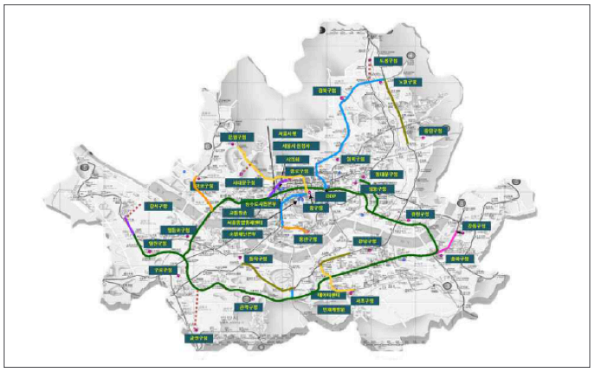
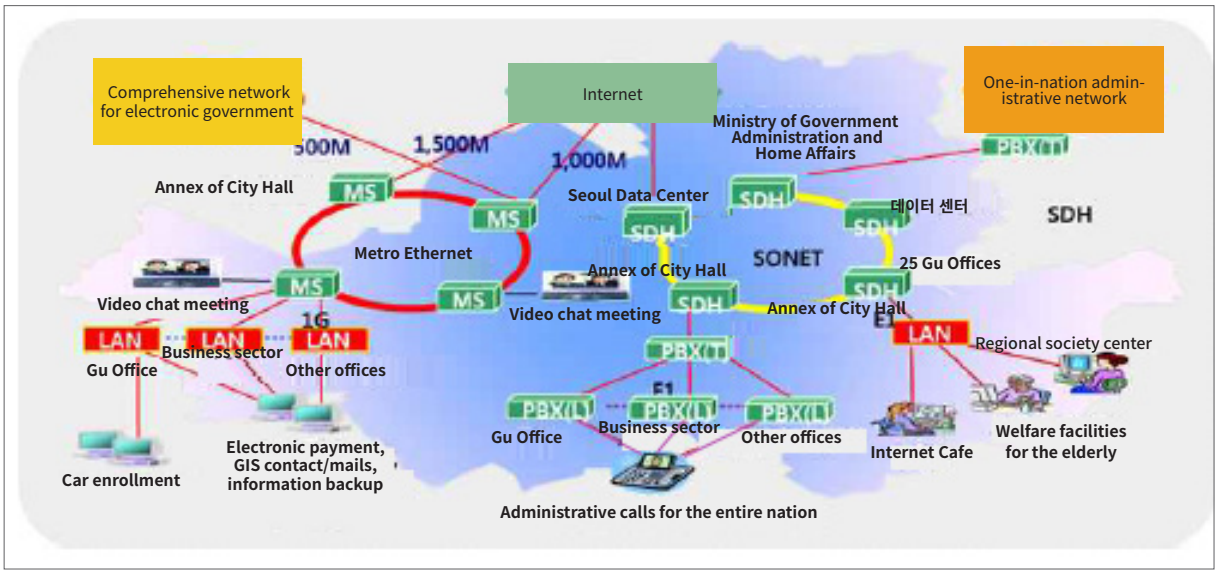


Figure 8 - u-Seoul Net Organization

Figure 9 - e-Seoul Net Organization



- Ranking First in the UN e-Government Survey for 6 Consecutive Years

In 2003, under the sponsorship of the UN and the American Society for Public Administration, Rutgers University (New Jersey, USA) and Sungkyunkwan University (South Korea) conducted the e-Government Survey to identify the top 100 performers. In the first survey, Seoul was selected as the top performer.

In the e-Governance survey by Rutgers University, there are 2 categories – digital governance in the evaluation of the public service and digital democracy in the evaluation of citizen participation. The evaluation considers not only the presence of an e-Government service but also the quality of the service, exploring the aspect of citizen participation and digital democracy. The survey offers a comprehensive view of the quality of the IT, e-Government service, and citizen engagement.

Table 10 - Top 20 cities for electronic government inspection in '13 and '14

Rank	City	Overall	Prhaey	Usability	Content	Services	CS Engage-ment
1	Seoul	85.80	16.30	16.57	17.46	16.72	18.75
2	New York	66.15	13.34	14.38	14.45	15.25	8.75
3	Hong Kong	60.32	13.33	14.07	12.22	12.79	7.92
4	Singapore	59.82	7.41	15.00	13.65	12.30	11.46
5	Yerevan	59.61	3.70	17.82	14.92	12.13	11.04
6	Bratislava	58.31	11.11	16.88	11.43	9.51	9.38
7	Toronto	58.05	8.52	16.57	16.19	11.15	5.63
8	Shanghai	56.02	4.44	15.32	11.27	15.41	9.58
9	Dubai	55.89	13.71	15.47	7.94	13.77	5.00
10	Prague	54.88	14.07	15.63	9.84	9.51	5.83
11	Vilnius	53.82	15.56	11.57	12.23	7.38	7.09
12	Viena	53.40	8.89	15.94	10.16	8.20	10.21
13	Oslo	52.52	14.07	15.00	13.97	6.56	2.92
14	Stockholm	52.25	8.15	11.88	16.19	13.11	2.92
15	London	51.90	11.48	15.00	11.91	7.05	6.46
16	Helsinki	51.27	13.70	12.19	8.26	9.84	7.29
17	Macao	48.69	11.11	14.69	11.43	7.71	3.75
18	Mexico City	47.01	4.44	15.01	13.18	9.18	5.21
19	Kuala Lum-pur	46.16	9.63	13.13	7.94	12.13	3.33
20	Zurich	45.36	7.41	16.57	11.11	5.90	4.38

The first evaluation in 2003 looked at 5 categories – Privacy & Security, Usability, Content, Online Services, and Citizen Participation. Seoul earned a total score of 73.48, much higher than the second-ranking Hong Kong (66.57).

Since 2003, Seoul has ranked first 6 times in the last 11 years (2005, 2007, 2009, 2012, and 2014). The latest evaluation in 2014 showed that Seoul's e-Government was excellent in all categories – Privacy & Security, Usability, Content, Services, and Citizen Participation. In the last category, Seoul's score was more than double that of New York, Hong Kong, and Singapore, demonstrating that Seoul's e-Government is particularly unique in citizen participation. It is a crucial platform that supports the 4-year plan of the city's 6th government elected by popular vote in 2014, as expressed in the motto – "Together, Seoul". It can be seen that the city's administrative services were designed with citizen participation in mind.

- World e-Government (WeGO)

In 2008, Seoul hosted the Seoul World Mayors Forum and proposed creation of the World e-Government. In 2009, the World Cities CIO Forum was hosted in Barcelona in 2009, with working-level negotiations held to establish WeGO.

As a result, representatives from 50 cities around the world assembled in Seoul to officially launch the World e-Governments Organization of Cities & Local Governments, the international council of organization in Seoul, in September 2010. Seoul was selected as the chair city, and its mayor the chairman. After the first meeting in Seoul in 2010, the second meeting was held in Barcelona in 2012, and the third one in Chengdu, China, in 2014. Starting with 50 members, WeGO had 82 members at its third meeting in November 2014, growing as one of the most influential international organizations in the city e-Government sector.

With an aim to improve the quality of life for urban dwellers around the world, WeGO is involved in diverse activities, including: improving public administration using ICT; identifying e-Governance success stories; sharing cases and experience in practical application; providing e-Government tool kits and framework; and connecting cities with the potential to develop an e-Government system.

- Communication & Big Data, Open City Government 2.0

From 2007 to 2011, Seoul reviewed the Night Owl bus program, and by the end of 2012, city buses ran for an extra 2 hours for 19 days. The program was received positively and suggestions made to operate some city bus routes 24 hours a day. In early 2013, a university student sent a proposal via social networking to the mayor of Seoul about the night bus program.

The city began to analyze big data. It signed a business agreement with KT and analyzed 3 billion calls during the night when the buses were in operation and 5 million pieces of data on taxi travel in Seoul. To identify the distribution of floating population across Seoul and verify the demand for travel, Seoul was divided into 1,252 hexagons (with a radius of 500 m), which was the assumed distance to and from a bus stop that people would be willing to walk at night. Seoul then established and analyzed the big data model to identify the floating population and their desired destinations at night. As a result, the locations where bus travelers usually gather as well as their travel patterns were identified, based on which optimized bus routes were charted.

Figure 10 - Big data problem definition

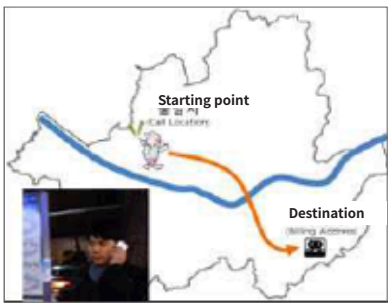


Figure 11 - Modeling

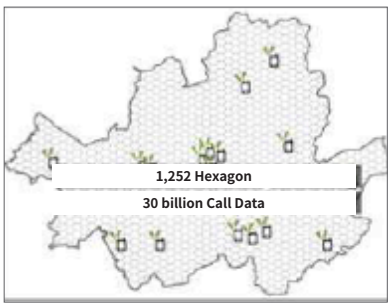


Figure 12 - Floating population

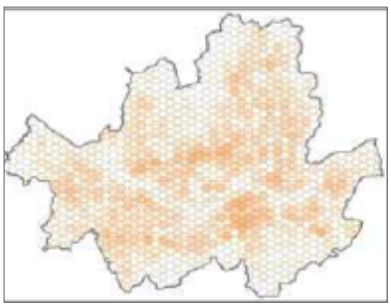


Figure 13 - Night bus routes

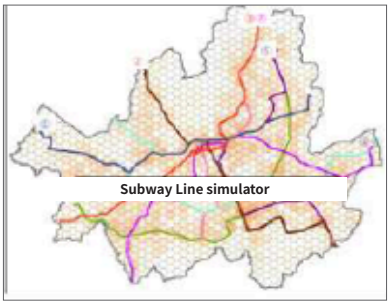


Figure 14 - Routes optimization

Figure 15 - Optimization cases

Considering the nature of a night bus, resources (buses, manpower, etc.) were rather limited. Compared to daytime buses however, the night bus routes optimized by big data analysis were more efficient than was expected:

- Complaints from route changes due to night bus optimization were reduced by data analysis;
- After optimization, the number of passengers increased by up to 10%; and
- Nine night bus routes were able to provide the desired services to 42% of the nighttime bus travelers.
- Other indirect benefits included:
- With the new bus service as an alternative, the rate at which taxis refused to serve customers was reduced by 8.9%;
- The number of women out at night increased by 11.8%; and
- Nighttime safety improved.

With its success with big data analysis, Seoul conducted another analysis in 7 areas related to daily life in 2013 and 2014. Examples include: ① matching analysis of annual travel and empty running data (amounting to some 180 billion pieces of data) of 70,000 taxis in Seoul; ② location optimization analysis for the city's promotional materials; ③ identifying ideal location for the Seoul Seniors Center; ④ identifying ideal locations for senior recreational and welfare facilities; ⑤ analysis of traffic accidents; ⑥ analysis of wait time for call taxis for the disabled; ⑦ analysis of official document issuing machines; and ⑧ analysis of the floating foreign tourist population. With the successful big data analysis cases used to resolve traffic issues and select ideal locations, Seoul applied the methodology in 2015 to resolving issues in 4 major areas of safety, welfare, economy and environment/culture/tourism as well as in the daily issues that residents encounter. Big data analysis is expanding in application; it was also used in commercial district analysis to provide scientifically-proven and effective data-based administrative services.

Towards ensuring an "open, sharing and engaging" paradigm and to enhance communication, in 2012 the city became the first administrative institution in the nation to open its administrative documents and data to the public with an aim to narrow the information gap. As of the end of 2014, residents had access to 3 million documents and 3,600 pieces of data. In 2015, 25 local districts will be ready to disclose their data. The scope of disclosure is steadily growing.

- Interactive Citizen Participation & Digital Democracy

One of the major defining aspects of Seoul's e-Government is that it actively engages citizens in an interactive way. People take an active part in policy development, or propose ideas or offer opinions online, part of the evidence of an improved digital democracy. Cyber Forum, Seoul Oasis, citizen proposals, online communities, electronic voting and other channels are now open to the public. Cyber Forum and Seoul Oasis won the UN Public Service Awards in 2008 and 2009 respectively, proving e-Government excellence in citizen participation.

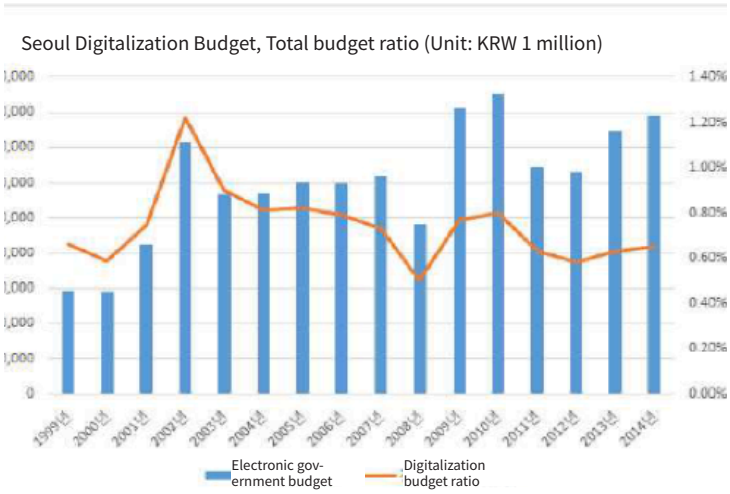
Residents now have more channels of participation. In 2007, the mobile portal called mSeoul702 was built, providing mobile services in traffic, environment, culture and booking, along with an e-poll by which citizens can have their say. Since 2013, people have been able to have a greater part in deciding issues by suggesting specific areas to vote on, thanks to the interactive mobile communication tool called mVoting service. These types of mobile tools encourage more citizens to participate in shaping the city. By 2014, the number of city website users had more than doubled over 2012 levels.

Scheduled to open in 2016, an IT complex is planned in the Sangam DMC, and will be a place where people can share their ideas and where e-Government can be used to test the new ICT and support the ICT industry. Resident participation was designed and instituted by ICT experts and residents through the ICT Committee. Comprised of 30 e-Government experts from companies, research centers, and universities, the Committee developed and reviewed basic plans for e-Government, cementing the governance framework that ensures resident and expert participation in e-Government.

Investment Trends

Pursuant to the Basic Strategic Plan phases, Seoul's ICT budget has been executed in a strategic manner. Since 2002, the ICT budget has accounted for 0.5 – 1% of the city's total budget. The year 2002 was when the first outcome of the first phase was to be revealed, and it can be seen that the size of investment in 2002 (the year of preparation for e-Government), 2009 and 2010 (the years when the results of u-Seoul were out), and 2013 and 2014 (the period of implementing the Smart Seoul 2015) were relatively high.

Figure 16 - Seoul City Digitalization Expected Future



Phase 1 of the Basic Strategic Plan for Informatization pursuant to the City of Seoul Ordinance on Information in 1999, Seoul's ICT budget was KRW 58.4 billion, only 0.66% of the total budget (KRW 8.87 trillion). By 2002, when Phase 1 plans were nearing finalization, investment increased by a significant margin, to KRW 142.9 billion (1.22%) of the total budget (KRW 11.67 trillion). During the introduction of e-Government, the major focus was on tasks designed to enhance government efficiency, such as computerizing all administrative duties, introducing the online civil service system, integrating all computerized resources, and building the Data Center. Through these efforts, the online civil service, integration of information resources, and e-Seoul Net were realized.

From 2003 to 2008, investment remained between KRW 110 billion and 120 billion. Between 2009 and 2010, investment expanded to cover the later part of the u-Seoul plan – Phase 3 of the Basic Strategic Plan. In 2010 alone, KRW 170.4 billion – 0.8% of Seoul's total budget of KRW 21.25 trillion – was invested, establishing the foundation for development of the u-Seoul infrastructure, u-Seoul Net, a ubiquitous onsite civil service system, and the online/mobile infrastructure for citizen participation. The "ubiquitous" infrastructure was particularly helpful in launching urban safety projects such as u-Healthcare and u-Children Safety. It also enabled 24/7 joint cyber threat response and cooperation between all institutions in Seoul and the National Intelligence Service's security control center, significantly expanding the u-Infrastructure platform and enhancing

the response to cyber incidents.

In 2014, during Phase 4 of the Basic Strategic Plan (Smart Seoul Master Plan), Seoul invested KRW 158.2 billion (0.65% of the total budget of KRW 25.4 trillion). The main programs included: resolution of traffic and safety issue with big data and the disclosure of public data, all of which were praised as outstanding examples of digital and scientific administration. In South Korea, Seoul was the first public institution to adopt such a framework. Moreover, the mobile-based interactive communication tool – mVoting service – was also provided. Scheduled to be completed in 2016, the IT Complex in Sangam DMC will be the hub of interactive communication between people and government agencies, boosting the digital-based economy. It will serve as a platform on which a smart, digital government can communicate and share information with residents.

Direction of Development for Seoul's e-Government

Since establishing Phase 1 of the Basic Strategic Plan in 1999, Seoul went on to develop 3 other phases, the fourth Smart Seoul Master Plan as the last, between 2011 and 2015. The city has been able to build the foundation for its e-Government and operate a globally leading e-Government system. In 2015, the Smart Seoul Master Plan developed in 2010 will be completed, with new ones to be established every 5 years pursuant to the City of Seoul Ordinance on Information.

Amidst the rapidly changing and developing ICT environment, the role of digital technology in the public sector has been to provide innovative and pioneering infrastructure across various fields such as economics, industry, culture and society. The importance of an urban digital infrastructure is growing by the day as it helps the city to respond to new technologies and environments (e.g., 3D printers, augmented reality, virtual reality, wearables). By connecting to the digital convergence environment via the Internet of things, cloud, and 4G and 5G wireless networks, the concept and scope of openness, communication and collaboration have broadened even more, as more people remain connected to the things, which in turn are connected to other things. Against this background, digital administration and the digital industry will encourage people to participate more aggressively in the process of policy-making.

The fast-changing digital environment will take South Korea into the era of super-connectivity between 2016 and 2020. During this period, advanced digital technologies will be used to connect people to people, and people to things, while utilizing data-based communication and convergence innovation to provide scientific administrative services and resolve urban issues. To be able to adapt to environmental changes and maintain a leading e-Government system, Seoul will need a new digital urban infrastructure.

Seoul plans to develop ICT plans that will help the city to respond to environmental changes and maintain its digital leadership and presence in the world. Its plans will be diverse, encompassing generation, distribution, storage, analysis, utilization, and safety of the data which constitutes the core of a digital city, aided by de-

tailed and phased strategic and management plans.

In the new Seoul Digital Basic Plan 2020, Seoul will come up with integrated digital governance that will connect both tangible and intangible resources of the city (e.g., citizens, infrastructure, and culture) on a digital foundation. So as to keep its global leadership in the new digital paradigm and respond aggressively to the changing urban environment and the latest ICT, Seoul will endeavor to develop the Plan as a digital blueprint that will include practical application and actionable plans.

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SEOUL METROPOLITAN
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