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

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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.





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.

Form of Pub- lic 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

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

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.

References

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