ISSUE 03

KOTI Knowledge Sharing Report

Korea's Best Practices in the Transport Sector

Lessons from Transition in Urban Transport Policy

Edited by Sang-kyu Hwang, Ph.D

THE KOREA TRANSPORT INSTITUTE

Korea's Best Practices in the Transport Sector

Lessons from Transition in Urban Transport Policy

The Korea Transport Institute (KOTI):

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

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Preface

The transport sector has been playing an enormous role as a stimulator during Korean economic development by facilitating trades of goods and services, cultures, and technologies. As the Korean economic development accelerated, the need for transport demand increased dramatically. To respond to the transport demand, the Korean government developed subsequent transport infrastructures. However, the time gap in balancing demand and supply of the transport caused traffic congestion and air pollution.

The Low Carbon·Green Growth policy is one of the important policies intended to prevent global warming in Korea, and the green transportation policy pursuing through promoting public transportation is one of the primary policy measures in the Korean transport sector. Over a few decades, the consumer demands for transport quantity have shifted toward transport quality. However, with limited land and citizen's demand for more green and healthy environment, expanding more physical transport infrastructure has been constrained. To relax constraints, the transport authorities introduced various demand control measures to limit traffic demand which showed only minimal efficacies.

In the meantime, the city of Seoul reformed bus system which resulted in tremendous improvement on quality of bus services and other relevant public transport systems. As the nation witnessed the tremendous effects of the reform such as improvements on traffic speed and public transport ridership, the regional transport authorities tried to benchmark the Seoul's reform. One of the important success factors of the Seoul's reform is that it was adopted in the holistic approach combining physical, operational, and administrative factors. Thus, the public transport could leverage the combination of BRT, inter-modal transfer centers, BIS, economic incentives for customers, and efficient administrative bodies.

A systematic approach is needed to encourage public transit use as shown in the Seoul's reform. In other words, it is important to form transit oriented urban

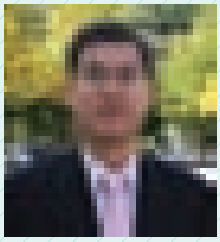
spaces by harmonizing urban transport planning at the policy development stage. Also, transport networks should be designed in a integrated manner that considers all different modes together for convenient transfer to each other for users, and integrated fair system should be implemented among adjacent municipal authorities. Eventually technical integration is necessary to realize integration of public transportation.

With various innovative transport technologies and policies implemented, the quality of Korean public transport systems have been improved radically. As one of the series publication of KOTI Knowledge Sharing Report, this report introduces best practices for urban public transport system developments achieved by Korea and summarizes directions and criteria for developing master plans for urban public transport system which may give insights for the developing countries. In particular, it suggests visions and policy tasks for the future urban transport systems with the hope to contribute to economic development.

With praise-worthy efforts of the Korean delegates from Ministry of Strategy and Finance and Ministry of Foreign Affairs and Trade, some of the best practices for transportation policies were introduced in the report for G-20 leaders' summit in Mexico, 2012. The Korea Transport Institute as a representative transport research entity, was greatly honored to have the opportunity to support the delegates to share the knowledge of Korean transport development technologies and policies. Also, as the president of the Korea Transport Institute, I thank for all the authors and a research assistant, Sun A Cho, who put their efforts in this publication.

Gyeng Chul Kim
President
The Korea Transport Institute

Short Biography of Authors



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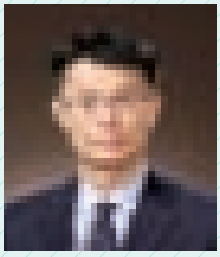

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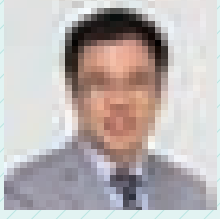

Contents

List of **Tables**

List of Figures

Lessons from Transition in Urban Transport Policy

Chapter 01

Introduction

1 Introduction

Sang-kyu Hwang / Senior Research Fellow

1. Urbanization and Transport Problems

Urbanization is one of the global phenomena that will continue to grow further. According to a report by World Bank[1] , the world urban population is expected to grow by 2.8 billion between 2010 and 2050. Further, 96 percent of this urban population will be located in low or middle-income countries.

The gravity of urban areas not only attracts population but also industries, cultures, politics, and other social elements. This phenomenon is a natural consequence that arises on the path of economic development since the concentration of these elements within a certain range of space could act as a stimulator for further growth by maximizing their synergy effects.

Even though the urbanization has positive effects on economic prosperity,

1. Cities at a Crossroads: Unlocking the Potential for Green Urban Transport 2012

it does have negative effects on social welfare. The negative side effects stem from time lags between growth speed for urban elements and adequate facility developments that could absorb overflows of populations, traffic demands, and energy consumptions on time.

Among the urban sectors, the transportation sector has been playing a crucial role in economic development for facilitating economic activities. Without efficient transport, the economy would have difficulties in trading goods and services. Without efficient transport, the city could have difficulties on communicating with exteriors and accepting various cultures and technologies to make improvements. Without efficient transport, human beings could have difficulties on traveling and attaining necessities. However, the time lags for balancing the traffic demand and supply of the adequate infrastructure caused traffic congestions and environmental harms.

In the era of economic development in Korea, the problems of traffic congestion had been emphasized due to its direct effects on economic efficiencies. In the Korean urban transportation scene, several policy measures were introduced to mitigate traffic congestions discretely and spontaneously. However, the mitigation measures on one side could not provide ultimate solutions, rather they caused congestions on the other side. When the Korean economy was in underdeveloped state, new infrastructure constructions made robust improvements for Korean economy. Along with the expanding transport infrastructures and economic development, the quantity of registered vehicles increased and the quality of citizen's wellbeing improved as well. However, when the economic growth had reached a certain state, the development speed for each transport sector has started to be unbalanced. The roads and registered vehicles had reached their saturation state while public transportation had lost consumers especially for the bus transportation. Major reasons for the passenger loss for bus services might be due to the lower punctuality, the inadequate transport capacity during the peak hours, and the appearance of the competitors such as private passenger vehicles. As traffic demand for private passenger

vehicles increased, the air quality and traffic congestions have exacerbated.

To tackle these problems, the city of Seoul implemented several policy measures for example. The measures include charging congestion fees on vehicles that enter the Namsan Tunnel gate toward the center of Seoul and exclusive bus lane system on major arterials. These policies showed some effect on controlling traffic demands, however it was not until when Seoul reformed public transportation system as a whole in 2004 that the policies showed robust effects on traffic congestion.

2. Environmental Issus on Urban Transport and the Low-Carbon Green Growth Policy

Recently, the urban problems have shaded new lights on the side of global warming and climate change. As the city is congested with human, more houses, vehicles, and energies are needed to sustain the city. As the city consumes more resources, there arise environmental problems such as pollution, traffic congestion, and shortage of the green and energy. These environmental Bads harm not only the health of human beings but also the economy as well. To tackle these problems, a holistic approach is needed that binds economic and social sectors within regions and neighboring countries to maximize mitigation effects. In other words, the environmental Bads affect not only on the city they stem from but also on neighboring cities and countries, and not only on the person who causes the Bads but also on neighbors.

With the notion of minimizing environmental Bads while maximizing synergy effects of urbanization for economic growth, the Korean government suggested the Low·Carbon Green Growth policy. The goal of the policy is to deliver economic paradigm shift from economy centered growth to convergence of economic growth and environmental preservation so that it could improve overall social welfare. Also in the transportation sector, the green transportation

policy was suggested to comply with the low-carbon green growth policy. Through promoting green transportation such as efficient public transport, non-motorized transport, and non-fossil fuel transport, the Korean government aims to reduce GHG emissions by 33-37% comparing BAU and 20-24% comparing the volume of 2005 in the transport sector by 2020.

In effort to collaborate with international environmental movement at the government level, the Korean government is aggressively participating in the activities of international non-profit organization such as GGGI (the Global Green Growth Institute). The GGGI is pursuing both of economic growth and environmental sustainability in collaboration with various participants from local and national governments, NGOs, private institutes, and academia. In pursuant to Green Growth Policy, the Korean government strongly supports the GGGI by providing finance, logistics and intellectuals, and hosted the head quarter office in Seoul.

3. Brief Reviews of Transition in Urban Transport Policy

The first public transport launched in Korea was the tram system back in 1899. The tram was a model project in conjunction with the electricity network development in Seoul. After having endured the chaos of Korean contemporary history, the tram stopped its operation in 1968 and the bus transportation had become the major public mode until the first subway opened in 1974.

As the economic development plan started in 1962 and the influx of labors congested in Seoul, the bus services could not meet the demand in a stable and pleasant manner. Therefore, the city expanded transport infrastructure in 1974 by opening the first subway system to meet the overflow of public transport demand. While the subway system had gradually extended their service areas, the buses had lost ridership due to unstable and lack of punctuality. Also, as the economic growth affirmed the consumer confidence, private ownership for

passenger vehicle accelerated in the mid-1980. Once the ownership reached one million in 1988, the numbers showed exponential growth for a decade until the economy being hit by the financial crisis in 1997. As a result, the increased private passenger vehicle ownership affected traffic congestion, car accidents, and reduction on bus ridership.

Furthermore, as the economy and population grew, the urban sprawl started to happen forming metropolitan area by developing new cities in the periphery of Seoul territory. One of the results of urban sprawl in transportation sector was increased demand for inter-city transport. Related city municipalities competed with each other to provide public transport and the administrative boundaries became a constraint in delivering convenient intercity transport. Therefore, the need for a new institution that would coordinate regional transportation plan had grown. Following the reform of Seoul public transportation in 2004, the Metropolitan Transportation Authority was founded to coordinate discussions of inter-city transportation plan in Seoul Metropolitan area.

The Cheonggeycheon restoration project with the transportation reform was an iconic urban planning that pursued sustainable development, which required harmonization of environment-friendly urban and transport planning to foster livable urban atmosphere. The success of the Gheonggeycheon restoration in conjunction with public transport reform was due to the integration of organizational measure, innovative technology, infrastructure development, and transport operation.

4. Best Practices for Urban Transport in Korea

Transit Oriented Development (TOD)

The Transit oriented development (TOD) is putting transport planning in priority for designing urban space. Setting transport network in priority considering

overall space structure is crucial for sustainable development. The goal of the TOD strategy in urban planning is to ameliorate adverse urban conditions with the traffic congestion, urban sprawl, and shortage of housings. The features of the TOD strategy are high-density and mixed-use development of residential and commercial areas along the public transport network for accessibility improvement, and provide convenient and pleasant pedestrian spaces. With these features, the expected results are an increase in transit ridership, mitigation on traffic congestion, and reduction on pollution that will eventually lead the urban space into a sustainable space.

The Korean government adopted TOD strategy as a formal method in planning new cities. Unjeong new town plan was the first TOD urban project adopted. The project consisted of two construction phases starting in 2003 and expecting to be completed in 2017. Two major public transport networks, BRT lines and regional railway, developed with other TOD facilities such as inter-modal transit centers and pedestrian and bicycle oriented roads.

Bus Rapid Transit System (BRT)

Bus Rapid Transit (BRT) system and Bicycle Rapid Transit (BiRT) systems were given priorities with exclusive lanes in planning Sejong city, which will become the administrative capital in Korea. The goal of the transportation plan for Sejong city was to provide sustainable transport system with Green Transportation modes. The BRT system is not a new concept in Korea since it was initially adapted to the Seoul public transport system. With limited budget, BRT could provide revolutionary improvements on the quality of bus services with exclusive lanes, priority traffic signals, and inter-modal transfer centers. The BRT system adopted to Sejong City on the circular arterial designed to be accessed from any point in the city within 20 minutes. Also considered bus vehicle types are greener vehicles such as Electric Bus, Online Electric Bus, and Bi-modal trams.

M-Bus System

The M-Bus systems were developed to encourage private automobile commuters to shift to public transit for inter-regional transport in Seoul Metropolitan Area. Therefore the M-Buses were devised to serve the high-end customers who used private passenger vehicles. The features that M-Buses have adopted are nearly direct and express routes with a handful of stops, and standee passengers are not allowed on board. To deliver the program, the Korean government had to coordinate three regional authorities to converge on an agreement due to their different bus operating systems. The survey results conducted by the Korea Transport Institute showed that an average ridership for popular routes reached about four to five thousand per day and 76 percent of the respondents were satisfied with the M-Bus system. Therefore, the government is planning to add more routes.

Transfer Centers for Intercity Buses at Service Area

The Transfer Center on express highways for inter-regional bus lines is evaluated as an innovative program that improves convenience for transfer passengers. Further this program is expected to contribute to increaseing inter-regional bus ridership by providing passengers with transfer connections. To develop Express Highway Transfer Centers, the government managed several interest groups to converge on an agreement to take part in delivering the program. The inter-regional bus lines have their own financial plans and serve customers with non-stop routes. Therefore, the bus operators should have devised new fare systems for transfer customers. Also, the rest area operators should have taken the responsibility to operate ticketing facilities. Currently, four pilot projects are in operation and intermediary results showed positive signals such as an increase in route utilization by 140.9%, average travel time reduction by 49 minutes, and average fare reduction by 1,566 won.

Intermodal Transfer Center in Downtown Area

Another type of transfer center is the inter-modal transfer center in urban area. When the city of Seoul reformed public transport system, several inter-modal transfer centers were installed. Among them, the one at the Seoul Station is evaluated as an exemplary. The aim of the transfer center at the Seoul Station is to develop a pedestrian-friendly facility to improve public transit ridership. Various transport modes are converged into the Seoul Station including KTX, train, subway lines, taxis, and hundreds of bus lines. Therefore, passengers were easily confused in finding right directions for transferring. In conjunction with the transfer center, several pedestrian facilities are installed such as crosswalks and a direct pathway connecting subways and bus depots. According to a survey, 76.8% of respondents were satisfied with the center for a transfer convenience.

Quasi-Public Bus Operation System

Quasi-Public Bus Operation System is one of Public-Private Partnerships in managing bus system, and it is devised to manage bus operators to improve quality of bus services by separating the bus operation entity and the financial entity. While private bus companies operate the bus lines, the regional authorities control the financial parts with advanced tendering technology and relevant subsidies on shortfalls of operation costs. This system is evaluated to increase level of service quality which increased ridership. After the city of Seoul adapted Quasi-Public Bus Operation System to the package of transportation reform measures, authorities of other cities benchmarked the system to reform their bus transport system.

Applications of Intelligent Transport Systems (ITS) in Public Transport

The Intelligent Transport Systems (ITS) has adapted to manage some of transportation problems with advanced information technology rather than

merely expand expensive transport infrastructures in response to increasing transport demand. The government designed ITS master plan and seven service areas are included. Five out of seven services are implemented in the Korean transport sector including advanced traffic management, advanced public transport, electronic toll collection and payment, advanced traveler information, and intelligent vehicle and highway systems.

Bus Information and Management System (BIS) is to provide real-time bus information so that passengers could opt for other itinerary options. Combined with electronic payment system, the BIS are benefiting the operators, transport authorities, researchers, and the customers by providing accurate tendering data, passenger itinerary tracking data, and accurate and real time bus information. A survey result showed that a high level of satisfaction on average of 60 to 70% with BIS services and a field study showed 15% of ridership increase.

Innovative Bike System

After the Korean government witnessed the possibility of Bike sharing program in Changwon city as one of the major transport modes, they decided to include bicycle facilities to Sejong city with an improved form. Especially, BiRT system is expected to become an iconic feature in Sejong city with its tube shaped bicycle lane that the adverse weather conditions would not hinder bicycle rides. Mostly, bike lanes are considered more for leisure and short distance mobility. However, BiRT will provide long distance mobility so that it could become a major non-motorized transport mode.

With BRT and BiRT system, the Sejong city is expecting public transport ridership to reach up to 70% of total traffic demand by 2030.

Electric Vehicle for Low Carbon · Green Growth

The last example is the Electric Vehicle policy. EVs will be an important mode of Green Transportation in terms of its efficacies of reduction on GHG emissions

and energy savings. Especially, EV buses and EV Car-sharing program could be a maximal shape for public transport. To provide convenience for EV users, the Korean government agencies are supporting various EV related projects financially and administratively. The Ministry of Land, Transport, and Maritime Affairs amended law to allow NEVs to run on conventional road where maximum speed is 60km/h. Also, the Ministry of Environment has been granting various financial supports to run pilot EV projects in nationwide. Finally the Ministry of Knowledge Economy has been granting for technology development projects. Although the results have not been shown enough to stimulate the EV market activities, the government expects EVs will eventually be deployed throughout Korea and will contribute to reducing GHG emissions.

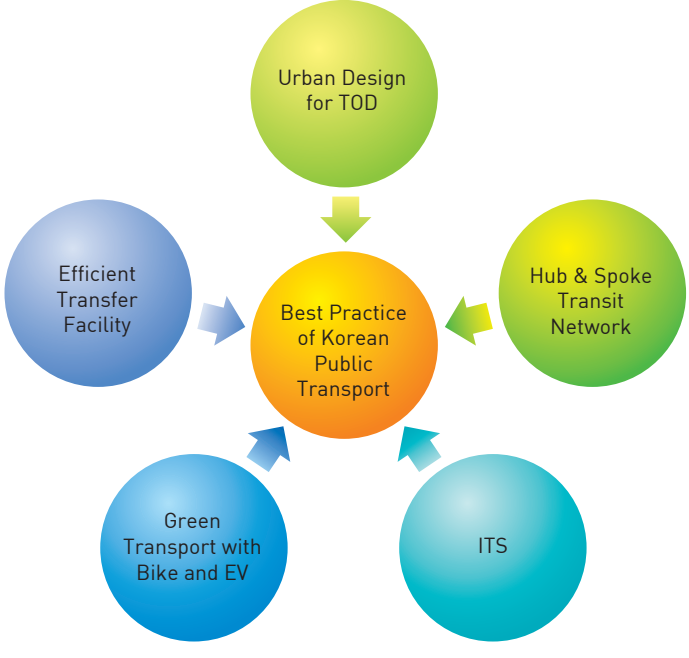

Figure 1. Best Practice of Korean Urban Transport

5. Effects of Best Practices on Urban Transport Service

These examples are only discretely presented. However, a holistic adoption of relevant projects could result in dramatic changes on urban characteristics and even some changes on life-styles for urban residents. For example, the BRT system combined with BIS and intermodal transfer centers has changed urban characters. With Quasi-Public Bus Operation System, the citizens could enjoy reliable bus services regardless of their physical and socio-economic status. The BIS provides residents with real-time transportation information through smartphones so that they could attain itinerary ahead. In some suburbs, exclusive bike lanes and bike-sharing program allowed residents to commute with bikes habitually. Furthermore, some researches on TOD showed value improvements for properties along the BRT lanes. However, some of the projects only showed moderate effects since the project features might require longer period of time to draw visible results or they might require complementary systems such as electric bus and charging infrastructures. As shown in the table below, the Seoul bus transport reform project that was delivered with the holistic manner achieved dramatic quality improvements and passenger satisfaction.

Table 1. Effects of the Seoul Bus System Reform

		2003	2004	2005
Number of Bus Stops		5,175	-	5,818
Bus Service Area(number/km2)		14.6	16.35	-
Total Length of the Routes(km)		14.973	15.493	-
Changes in Punctuality		-	0.537(October)	0.37(March)
Changes in Ridership for (million)	**Bus**	1,760	1,919	-
	Subways	2,272	2,277	-

Source: The Korea Transport Institute, ¨Bus System Reform in Korea", 2012

Also, when delivering a public transportation project, it is critical to manage conflicts properly for the success of the project. Due to the various interest groups involved in transport projects, there arise conflicts among them. In some cases, the government played a role as a mediator when the conflicts aroused among different regional authorities. In other cases, conflicts were managed at the initial level of the projects by forming governance consisted of the government, citizens, and other interest groups such as Seoul transportation reform project. Furthermore, in some cases, the government should play a leading role to deliver projects with disadvantageous characteristics for private players and projects that have features of public goods and should be combined with various systems. For example, to deploy EVs, the government should play a leading role to foster EV technologies and to stimulate EV markets by reducing production costs. Another case is delivering the ITS systems that have characteristics of public goods. Also, ITS should be combined with different systems such as BIS which combined with Bus system, tendering system, telecommunication system, and information technologies.

Therefore, a systematic approach is needed to stimulate green transportation in public sector that had been slowed down due to comparative disadvantages. In other words, it is important to form a transit oriented urban spaces through harmonizing urban and transport planning at a policy development stage. Also, transport networks should be systemically designed in the integrated manner that considers all different modes together for convenient inter-modal transfer and fair system should be integrated among adjacent municipal authorities. Eventually technical integration is necessary to realize integration of public transportation.

This report introduces best practices for transport system developments achieved by Korea[2] and summarizes directions and criteria for developing the urban public transport systems that may give insights for other countries. In particular, it suggests policy toolkits for designing the future urban transport systems.

Source: Website of G20 Summit 2012 Maxico

2. Recently, some of the best practices were introduced at the G-20 summit meeting held at Mexico in 2012 (see appendix).

Box 1

Effects of Public Transport on Environment, Safety, and Health

The efficiency of public transportation is higher than private passenger vehicles. While 65% of the vehicles on the road in Seoul consist with private automobiles, their modal share rates are only accounted for 15%. However, compard to private passenger vehicles, transportation efficiency of the bus is approximately 10 times higher and the subway is approximately 20 times higher.

The public transportation is a type of modes that consumes less energy than private automobiles. According to statistics provided by the U.S. energy department, energy consumption rates (BTU/passenger. Mile) by each transportation mode represent as 4,063 for the passenger vehicles, 3,711 for the buses, 3,397 for the conventional rails, and 3,102 for the commuting rails. These numbers show that the private passenger vehicle is a type of transport modes that over consume energy resources.

The negative effects on air quality are lower for public transportation than private automobiles. Particularly, CO_2 emitted by vehicles has enormous effects on climate change and it is the most serious environmental issue that may have positive relation to accrued strong typhoons, floods, draught, and raising sea levels.

In terms of transport safety, public transportation is much safer than automobiles. Since higher traffic volume by vehicles would raise the risk of accidents for pedestrians and bikers overall, increase in public transport volume would lower the number of vehicles on the street and so does the risks of overall accidents. Therefore, it could contribute to passenger safety than automobiles.

Furthermore, there are health improvements for those of who shifted to public transport, bicycles, and walking for commute from automobiles. WHO suggested research results that one who walks or bikes for 30 minutes every day would reduce the risk of getting cardiovascular disease, diabetes, over weights, and higher blood pressure. Specifically, some studies showed that 50% reduction in the risk of cardiovascular disease particularly related to coronary arteries, adult diabetes, and overweight as well as reduction in 10/8 mm Hg of blood pressure for hypertension patients. Also, a research in Korea showed that effects of health improvement in monetary term estimated as more than 38 billion won, if 10% of automobile commuters were shifted to the green transportation, in particular, for thos who lack in physical activities.

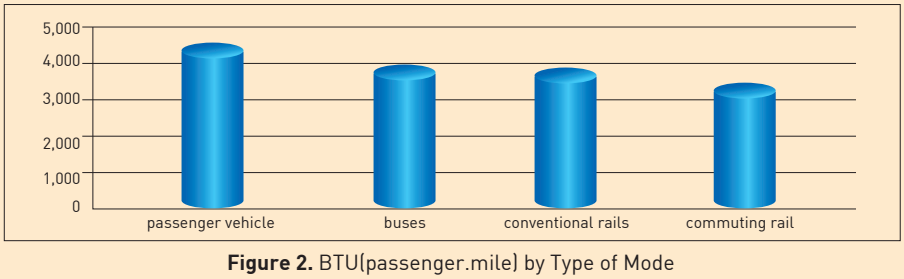

Figure 2. BTU(passenger.mile) by Type of Mode

Lessons from Transition in Urban Transport Policy

Chapter 02

Historical Review on Urban Transport and Best Practices in Public Transport

1 Towards Sustainable Transport Development: Achievements and Challenges

Youngkook Kim / Associate Research Fellow

1. Introduction

The development of urban transport in Korea can be summarized as follows. Firstly, urban transport systems have focused on establishing countermeasures to accommodate traffic demand caused by concentration of population in cities along with industrial development. Secondly, economic growth and income increase caused the skyrocketing ownership of private cars, which, in turn, induced heavy travel demand. Therefore, the Korean government has focused on setting up a transport system to serve high traffic demand and mitigate congestion. Thirdly, as the boundaries of cities sprawled, the establishment of intercity transport systems has been considered as the main issue of urban transport policy. Lastly, the paradigm of transport policy was shifted from mobility and efficiency to human-centered, eco-friendliness, and equity improvement. In this regard, urban transport policy has also included people

and environment oriented policy tools, such as consideration of pedestrian safety and convenience, removal of overpasses, restoration of natural assets, and introduction of transit mall and walkable pathways in urban regions.

Historically, the appearance of trams in 1899 marked the start of the modern urban transport in Korea. As the economic development of Korea began in the 1960s, city buses played an important role as a daily mode of transport in dealing with increasing travel demand. Transport policy in the 1980s had put more focus on the public transport system. The continuously growing number of car owners, however, worsened traffic congestion, especially for the Seoul metropolitan area. The transport policy in the 1990s was designed mainly to promote the public transport system and restrain private car use. City buses were developed as the core mode of transport and subway systems were introduced to meet rising travel demand. Since the highest use of buses in 1990, the volume of bus passengers gradually decreased. After the reform of Seoul bus system in 2004, the number of bus passengers started to increase. Seoul opened her first subway line in 1974, and currently, 9 subway lines and 7 inter-regional railways are in operation. Such urban railway systems play an important part in public transport to serve the massive traffic demand. Since the ownership of private vehicles has been so popular, it was very difficult for supply-centered policies, such as the construction and expansion of roads, to handle the increased traffic demand. Therefore, Transportation Demand Management (TDM) programs, such as congestion fees, garage certification, and parking management, were introduced to reduce the demand and ease traffic congestion in the city center. As housing demand increased, the Korean government promoted the construction of new towns around the Seoul metropolitan area and other major cities. The development of new towns induced large inter-city traffic demand, resulting in traffic jams on arterial roads. Intercity buses operate to manage traffic demand between cities, and the bus rapid transit (BRT) system has been introduced on trunk roads. As of 2011, a total extension of BRT lanes, 157 km on 13 corridors, is in service.

Bus and Subway, the major modes of public transport, need to be a win-win relationship through seamless transfer systems rather than competing with each other. Before the public transport reform in 2004, bus and subway systems were not smoothly connected, so there were limitations to encourage the use of public transport in Seoul. In terms of fares, the incentives for making transfers between the two modes were so small that it was difficult to attract people to use public transport. Stagnant or decreased public transport demand resulted in operating at a loss and aggravating the quality of service. This, in turn, caused the decrease of public transport demand, which created a vicious cycle as a result. The 2004 transport reforms introduced a semi-public operating system for bus companies. The new system gives the right to coordinate the arrangement of bus routes to the public authority and financial support to privately operating companies. This system laid the foundation for efficient public transport by connecting bus and subway services. Such a connection system stimulated the use of public transport and increased the number of passengers transferring between the two modes. However, the financial burden for subsidizing operation losses and transfer discounts increased rapidly and the Seoul city government suffered from financial difficulties.

2. Development of Urban Transport in Korea

Advent of Modern Transport Modes

Korea's modern urban transport is said to start with the operation of trams in 1899. Entering into the 1960s, city buses were being operated on major streets and the use of trams decreased gradually. In addition, the tram lines caused traffic congestion because of slow speeds, spoiled the appearance of streets, and the risk of accidents increased. The investment of tram cars was required also, but the fares for trams were frozen, with little room left for improvement. In 1966, Seoul city decided to establish a subway system in the long term to

accommodate the large travel demand and alleviate traffic congestion. Thus, the government removed the tram lines and the tram service stopped completely on Nov. 30, 1968. Since the first subway line started operating in 1974, the bus system substituted the role of the urban public transport service. However, the increasing volume of auto aggravated traffic conditions had negative effects on the punctuality of bus services. In addition, diesel-powered buses aggravated air quality in urban regions.

City Buses: Key of Urban Transport

The bus transport business started in 1912, providing intercity service only, and city bus services commenced in 1928. Along with the invigoration of the bus service, related laws and regulations were established. The Automobile Transport Service Act and the Road Transport Vehicle Act were enacted in 1961. The Motor Vehicle Compensation Guarantee Act was established in 1963, and the Automobile Regular Inspection System was introduced in 1967. These laws and regulations played as an institutional framework to improve bus transport services. Due to the provisions of the legal system, the business of private bus company was promoted. In 1966, Seoul city issued a municipal ordinance for setting up a transport office and operated buses directly in the remote areas where private companies were reluctant to serve because of small fare revenue. The number of municipal buses ran by Seoul city was 17 and then increased to 200. In 1968 the Ministry of Transportation held an open license policy temporarily, so the number of operating buses increased to almost double, creating fierce competition in bus routes. Consequently, the most of companies operated high-yielding routes only and avoided routes with a small number of passengers.

The increase of passenger car use exacerbated the traffic congestion. The users of buses had experienced longer travelling time than before and the bus service was not punctual any more. Therefore, bus users moved to the subway

which guaranteed on time service. The increase of private cars resulted in the decrease of public transport demand, and also subway-centered policy was another factor that lowered the share of bus service. In the 2000s, the lines of subway systems had been completed and the Seoul city government had no room to bear financial burden for construction of new subway lines. Therefore, the government had to reform the public transport system especially for the city bus system.

In Seoul, the public transport reforms increased the number of bus passengers. Continuously declining bus transport volume from 1990 started to increase in 2004 when the bus reform project was implemented. The semi-public operating system helped in redesigning the bus network reasonably, providing the government with much flexibility on route coordination. Also, according to the agreements signed at the time of introduction of the system, the bus companies were granted revenue guarantees on the condition that they provide a certain level of quality public bus service.

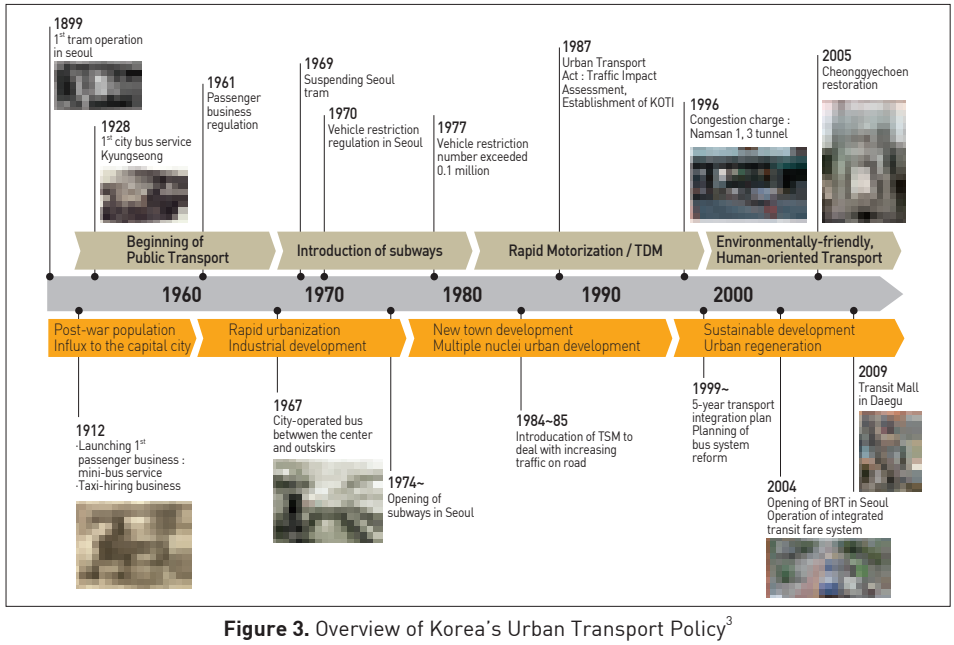

Figure 3. Overview of Korea's Urban Transport Policy[3]

3.Park, Kyounga(2012), revised by the author

Therefore, there was no need to compete fiercely to take more bus passengers. Other benefits of the bus reforms included a decline in bus-related accidents.

Subway: Becoming a Major Mode of Public Transport

Seoul's population increased from 101 million in the 1950s to 433 million in the late 1960s. That was the time when rapid population growth started. Seoul city extended bus routes to serve increased travel demand, but faced limitations in increasing transport capacity. As a solution to solve this problem, subway construction was developed. The first subway line was 9km long from Seoul Station under Jongno street to Cheongyangni. The construction cost was paid by the central government and Seoul city together, and a financial loan was also acquired. In 1970, the city government officially established the "Seoul Metropolitan Government Office of Subway Construction". The subway construction office was leading to create a master plan of subway construction for the metropolitan and neighboring areas together with experts from the Japanese Association for Railway Technical Survey. In March of 1971, subway line 1 received approval from the Ministry of Construction and began to be constructed in 15 sections step by step, commencing its commercial operation in 1974. At the time of opening, the daily frequency of service was only 210 runs, which later then increased to 526 runs in 1978. The Seoul government shifted its development direction for urban structure from single-nucleus to multi-nuclei. Based on the new direction, a ‘Seoul Master Plan' was re-established. According to the master plan, subway line 2 was revised to have a circular line connecting 3 nuclei of Seoul.

The city failed to acquire foreign loans, and used up to 100 million dollars of foreign capital in government hands. The rest of the investment was filled with subway construction bonds, municipal budget, central government financing, national subsidy, etc. In the case of subway line 2, the project cost was funded by only domestic capital without any foreign loans. Subway line 2 circulated the northern and southern parts of Seoul and there were technical difficulties

in crossing the Han river. This served as a momentum to develop a variety of techniques for subway construction. Subway lines 3 and 4 started construction in Feb. 1980. The network formed an "X" shape, crisscrossing the center of Seoul, because it was considered that the existing line 1 and circular line 2 were not enough to solve traffic congestion caused by increased traffic demand. Also, Seoul city aimed to seek for balanced development along the north-south and west-east axes, and to establish the backbone of public transport with subway lines. In Aug. 1981, Seoul Metro Subway Corporation was established and was responsible for building subway lines 3 and 4.

The introduction of the subway was essential to solve the traffic problems in the city. However, local governments, which promoted the construction of subway lines beyond their financial capabilities, suffered from financial deficit. Even when the subway, which was constructed with a huge amount of investment, had fewer passengers than estimated, the operating deficit could exacerbate the financial situation. Recently, LRT (Light Rail Transit) and BRT are considered reasonable transit modes because they require less investment; however these modes carry less passengers than a subway. Currently, one LRT line is operating in Busan, and several BRT lines are running on major arterial roads and expanding their routes to adjacent regions.

Private Passenger Car Becoming Popular

In 1970, the number of cars was 128,000. After the mid-1980s, the increase of national income made private car ownership popular. In 1985, the number of registered cars exceeded one million, and hit two million in 1988 at the time of the Seoul Olympics. Following this, the number of cars increased by one million every year, with three million recorded in 1990, five million in 1992, and ten million at the end of 1997. The annual average growth in the number of cars from 1980 to 1990 was 20.5 percent, an unprecedented record in the world. In 2008, the number of registered cars reached 16.8 million. Among them, 74%, 12.5million, were private passenger cars, which is one vehicle per 3.9 people.

The skyrocketing increase of cars was attributed to the successful implementation of economic development plans from 1962 to 1991, which resulted in a ten-time increase in national income and the large scale expansion of road facilities. Also, the other factors for the car increase were the development of the car industry and the government's policy to promote car sales to boost the domestic economy. A subsidy for the driving of private cars was given to public officials, resulting in an encouragement to purchase cars. Popular car ownership, along with the development of the car industry and the modernization of the transport system, has caused the development of other industries. It has even influenced people's lifestyles and the increase of car ownership and improvement of transport system enabled the whole nation to access within one day. The increased number of cars caused severe traffic congestion on the road not only in the metropolitan areas but also in rural cities. As of 2005, the traffic congestion cost in seven major cities was $14.5 billion dollars and of that, Seoul made up of $6.2 billion dollars. Together with traffic congestion, parking problems were also serious as illegal parking was common in residential areas as well as in commercial areas. The lack of parking spaces led to illegal parking in residential areas, which blocked emergency vehicle access.

As car dependency increased, the use of public transport decreased. Also mobility-oriented transport policy has limitations in securing a safe environment for walking and cycling in cities. Even people who made short-distance trips tend to use private cars, and it is very common to use private cars for short shopping and individual trips. Due to the high car-dependency and unsafe walking and cycling environment, Korea had the highest number of traffic accidents among OECD countries. The total number of accidents in 2008 was 215,822, including 5,870 deaths and 338,962 injuries. In 2008, the comprehensive cost of traffic accidents, considering human casualty cost, property damage, administrative expenses, and social cost such as pain, grief and suffering, reached $9.1 billion dollars, or 1.1% percent of the GDP. Automobiles

provide fast and comfortable travel, but also induce socio-economic costs in various aspects. The continuous increase in income level will obviously result in the increase of the traffic demand of private cars. Therefore, it is expected, without restraint on traffic demand quality of life and national competitiveness would deteriorate.

3. City Sprawl and Intercity Transport Plan

Suburbanization and Intercity Transport Problems

Since the 1960s, people flocked to Seoul, which experienced extensive suburbanization and sprawl after the 1990s. Urban transport is usually focused on managing traffic volume which is generated within the administrative boundaries of the city. However, as the widespread ownership of private cars facilitated intercity trips, the government started to develop new towns around the Seoul metropolitan area. The purpose of the new town projects were to slow down the population concentration in Seoul and to provide housing. The central government developed five areas in phase 1 including Bundang, Ilsan, Pyungchon, Joongdong, and Sanbon. Phase 2 included several areas around the metropolitan area such as Pangyo, Paju, Gimpo, Dongtan, etc, for the purpose of housing supply and price stabilization. However, phase 2 was evaluated to have more focus on increasing housing stock in the short term, rather than stabilizing home prices. As new towns were developed outside the green belt area, intercity traffic volume increased, resulting in the increase of travel distance. Because the newly developed towns had low self-sufficiency and functioned as bed towns, intercity traffic naturally increased. At the time of new town development, the excessive supply of road infrastructure and the lack of public transport service exacerbated intercity transport problems. Also reckless small-scale land development around the new towns, which were free from any restraints, merely aggravated the situation.

The government established the "Special Act on the Management of Intercity Transport in Metropolitan Areas" in 1997 and made a compulsory intercity transport plan. The intercity plan is for the metropolitan city and has marks the attributes between an "urban transport plan" at a municipal level and a "plan for the key national traffic network" at a national level. In 1999, the first five-year intercity transport plan was set up, followed by the second plan for five local cities in 2000. In 2001, the guidelines on improvement measures for public transport were made for large-scale development in metropolitan cities. Additionally the Special Act was revised to formulate a 20-year master plan and a five-year implementation plan. Accordingly, Seoul and other metropolitan cities set up master plans (2007~2026) and implementation plans (2007~2011).

Intercity Transport Service Expansion

In the past, buses running in Seoul's neighboring areas turned back at city boundaries or sub-centers because of bus-related regulations and conflicting interests among bus companies. So people who wanted to go to the city center, needed to transfer to get to the destination, thus causing them much inconvenience. Also because it took a long time to construct and operate intercity railways, it was necessary to have an intercity bus service before the railway service. In this regard, the intercity bus service connecting the center of Seoul and Bundang commenced in 1998 as a pilot program. Intercity buses were differentiated from other buses in that they operated routes directly to the center of Seoul. They passed through the major parts of Seoul but minimized stops as less as possible, serving as a rapid transport service between the city center and new towns. Differentiated intercity bus services were considered a success, and extended to Ilsan and other new towns.

Since the 1970s, Seoul city and other municipalities have constructed and operated urban railways continuously to combat traffic congestion. The intercity railway network had its start in 1972 through the railway electrification of the Gyeongin line (Seoul ~ Incheon). The electrification was expanded to the

Gyeongbu line and the Gyeongwon line. The electrified lines absorbed a certain amount of traffic demand, which contributed toward alleviating traffic problems and dispersing the population of Seoul to other areas. However, as the costly operation of heavy railway transit incurred increasing deficits, LRT and BRT came to the fore as alternative modes of transport in the 2000s.

Local governments as well as the central government competitively consider planning and promoting the introduction of such modes. LRT and BRT have strong points in that they serve the mid-level demand between subway and bus, and require less cost than heavy rail in operation and construction. The comparative advantages of the two modes were discussed in terms of traffic attraction effect and flexible route coordination. LRT has high traffic attraction effects and low flexibility in route control, and vice versa for BRT. It is necessary to choose the mode of transport best suited to the conditions of different areas considering road expansion and land availability as well as pros and cons about the alternative modes.

4. Eco-Friendly and Human-Centered Transport System

Cheonggye Stream Restoration[4]

The restoration of Cheonggye stream, measuring 5.84km in length, started in 2003 and was completed in 2005 with the removal of the overpass and the improvement of waterways. The reason why this project attracted so much attention both at home and abroad was that it was the first large-scale project that introduced a new paradigm of “From Development to the Environment.” Behind the implementation of this restoration project there were three major reasons: Firstly, a safety analysis of the structure concluded that repair works to the overpass would have cost about USD 88 million, and during the repairing

4. Seoul Metropolitan Government and Seoul Development Institute (2006)

period the overpass would be closed to traffic. Even after that, the repairs would have to be made continuously. Secondly, the overpass located in the center of Seoul blocked the redevelopment around the Cheonggye stream. This acted as a major obstacle to urban growth. Thirdly, there was the recognition that a major reason for the imbalance in the economy, housing, education, culture, etc. between northern and southern Seoul was the difference in urban structures, which were not eco-friendly on the north side of the Han River, such as the overpasses densely located in northern Seoul. The restoration project thus became a milestone in a paradigm shift in urban planning and transport. Previous policies were focused on cars and the supply of transport facilities, but the new paradigm put emphasis on environment and traffic management for public transport and walking. Thus it was possible to introduce a variety of projects that could not be implemented under the previous car-centered policy, such as drastic bus reforms, improvement of the traffic circulation system in front of Seoul city hall, overpass removal, etc.

Environmental benefits resulting from the Cheonggye stream restoration, led to the initiation of other restoration projects for Seongbuk stream and Jeongneung stream. Also feasibility studies for restoring other streams were promoted and major cities including Busan are currently in the process of waterway improvement and restoration. Also it influenced o ther international projects like Tokyo's Sibuya stream restoration and the Osaka Water City project.

(a) Before Restoration

(b) After Restoration

Figure 4. Before and After Restoration of Cheonggye Stream

Public Transit Renovation

The aim of Seoul's bus renovation project is to revitalize the bus system through improving regulation, providing BRT, and enhancing operation of bus services. The renovation introduced the new forms of governance in the bus transport industry. Additionally, the reform also introduced reorganized route networks, new monitoring methods, and a new incentives framework for bus drivers and operators, leading to improved transit service quality. To achieve these goals, several projects were prepared and implemented. All these projects were integrated and implemented as the package of projects in order to effectively address the complex issues faced by the bus transport industry in Seoul.

Prior to the reform, the Seoul Metropolitan Government (SMG) had experienced difficulties restructuring bus routes. Routes were operated in an inefficient and uncoordinated manner. The lack of coordination in the assignment of bus routes led to ineffective competition among bus companies, resulting in the rapid deterioration of the quality of service offered to

consumers. To address these shortcomings, the SMG decided to regain control over the assignment of bus routes, the determination of bus schedules, and the evolution of fares. The Government established a 'semi-public operation system' to manage and assign bus routes, and determine the bus schedules. A Bus System Reform Citizen Committee (BSRCC) was established in August 2003. BSRCC consists of stakeholders of the bus system such as Seoul Department of Transportation, Municipal Council, and Association of Bus Company, transportation professionals, and lawyers etc. Since the members of BSRCC consisted of government officials and private parties, the committee was named as a semi-public system. BSRCC is taking charge of decisions on various issues, such as bus routes, fares, and operating systems.

The renovated transit system unified and coordinated the fare structure to integrate both bus and subway services. The previous fare system imposed a higher fare on the bus riders travelling shorter distances because the fare system was based on a single trip based payment. The new fare system varied by mode of transportation and total distance traveled. The single fare for bus service started at 800 Korean Won for the first 10 km and 100 Korean Won was added in increments of 5 km. The base fare also includes free-transfers for up to 4 times applicable within 30 minutes after the first trip to both bus and subway, regardless of which mode was chosen first. Users have an option of payment with their smart card or with cash, but cash paying users do not have free-transfer privileges and must also pay a surcharge of 100 won regardless of transportation mode. A distance-based fare system replaced the flat-fare system. The effectiveness of free transfers between buses and subway modes substantially increased the ridership of bus and subway. The introduction of the smart card eased payment methods and also attracted users through its multiple benefits. Transportation expenses generally decreased because of reduced costs for each trip ($0.67→$0.63) and popularization of monthly subway commuting tickets.

Table 2. Main Content of Public Transit Reforms in Seoul

Category	Content	
Bus-centered public transport system establishment	Bus route system reforms	· Shift of bus network to a hub-and-spoke network · Bus type and operating practice reform by function · Bus numbering system reform
	Bus operating support system reforms	· Median bus lane installation · Curb-side bus lane improvements · BMS(Bus Management System) establishment and operation management
	Bus company operation system reforms	· Quasi-public operation introduction · Bus company operation system reforms · Service quality assessment, personnel welfare improvement
Integrated fare system establishment	Reasonable fare structure reforms	
	Smart card payment system (T-Money)	
Public transport infrastructure expansion	Urban railway service expansion	
	Transit center construction	

The network of bus routes was entirely re-designed to integrate all bus routes in the Seoul Metropolitan area. All bus services are now grouped into four types and color-code made them easily distinguishable. The red long-distance intercity buses connect outlying suburbs with each other and the city center. The blue trunk buses operate between sub-cores and along major arterial corridors in Seoul. The green feeder buses including community buses provide local services to feed subway stations and express bus stops, and the yellow circular buses provide local services within the city's center. The route number was also reconstructed in order to provide passengers with easy identification of users' start and end zone.

Before the introduction of the new transit system, previous exclusive bus lanes were installed along the curb side. This had little improvement on traffic congestion, especially at intersections where turning cars continued to interfere with buses. Instead of this inefficient curb side system, median bus lanes replaced the curb side lanes. The new BRT system includes state-of-the-art bus services such as exclusive median bus lanes, high-quality median bus stops, priority traffic signals at intersections, real-time information for passengers and system operators. The combined effects of these new services have

resulted in the significant success of the new public transit service. Substantial improvements have been observed in bus speed and carrying capacity. Specifically, the overall average bus speed has increased up to 20%. By early 2005, there was already 75 km of BRT services over 6 different corridors, and other BRT routes will be continued to expand rapidly.

Figure 5. Public Transit Transfer Center and BRT Line near Cheongnyangni Station, Seoul, Korea

5. Achievements and Challenges

A well-designed public transit system helps cities become sustainable and livable by relieving congestion, saving energy, introducing environmental advantages, and enhancing the mobility of economic minorities. Seoul faced demographic and economic changes that created new transportation demands and these changes in transportation patterns increased private car use. Once, the bus was the most widely used transit mode, but increased private car use and traffic congestion aggravated the level of public bus service.

The traditional method of piecemeal reforms for the bus system no longer worked. Innovative and extensive reorganization strategies were necessary rather than fragmented approaches. The Public Transportation Reform in Seoul was a major step towards sustainable mobility. The key of its success lies in its integrated approach combining organisational measures, innovative technology, infrastructure development, and transport operation.

Since the Cheonggye Stream restoration had to be accompanied with highway deconstruction, road capacity reduction in the central business district (CBD) of Seoul was inevitable. Therefore, a well-organized public transit system needed to be provided to accommodate diverted traffic demand in advance. Citizens can choose transport modes at their discretion to deal with the road capacity reduction. Strengthening the public transit system is a prerequisite policy tool for the successful implementation of urban renewal programs with road capacity reduction. The Cheonggye Stream Restoration began in 2003 and finished in 2005. During the restoration period, the reforms of the public transit system, including the BRT system, hub and spoke bus route structure, and free transfers between bus and subway, were completed. As a result, the frequent connection of bus routes and subway lines in downtown Seoul helped accommodate diverted travel demand, leading to relieve traffic congestion after the deconstruction of the Cheonggyecheon highway. The renovation of transit systems encouraged citizens to use the buses and the subway. As reviewed, the restoration of the Cheonggye Stream and the renovation of the public transit system have been closely correlated, it is necessary to introduce these two projects simultaneously. Preferably, the renovation or strengthening of transit system needs to be implemented in advance.

Recent planning theories, such as New Urbanism and Smart Growth, have strongly suggested avoiding unnecessary sprawl and regenerating the declining CBD. The principles of the new planning paradigm are summarized as follows: regeneration of urban core, introduction of environmentally friendly transport modes, such as walking, biking, and public transit, good connectivity among

various transport modes, compact and mixed land use, and close cooperation between local government and stakeholders. The combination of the Cheonggye Stream Restoration and Public Transit Renovation implemented in Seoul could be considered appropriately combined projects to establish these principles, leading to make the city of Seoul environmentally sustainable, socially equitable and economically viable.

In the context of the joint implementation of public transit reform and the Cheonggye Stream restoration confirmed the importance of leadership, civic participation, and efficient management. As the deconstruction of an urban highway and investment in the public transit system affect diverse interests and raise public concerns, leadership plays an important role to implement these two innovative urban policies. For successful implementation of these two projects, a clear vision should be shared with citizens. The vision needs to be formed based on the consultation of experienced experts. In addition, civil participation also plays an essential role in completing these projects. The increased participation of citizens and open discussion would minimize conflicts among stakeholders and help officials develop consensus for diverse opinions during the planning and construction periods. As reviewed in the case of the Cheonggye Stream Restoration and Public Transit Renovation in Seoul, the regeneration of the declining CBD and the reformation of a sustainable transport system should not be implemented in isolation.

Identifying additional and alternative financing sources for public transit is a major concern of local and central governments. The subsidy ratio of public transport in Seoul has been increased since the 2004 public transit reform. Due to the scarcity of public funds, however, it is important to discover new financial sources, such as charges for property development, road pricing, congestion fees and parking fee revenues, which can be used for transit renovation projects or bus subsidies.

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2 Transit-Oriented Development in Unjeong New Town: Integration of Urban and Transport Planning

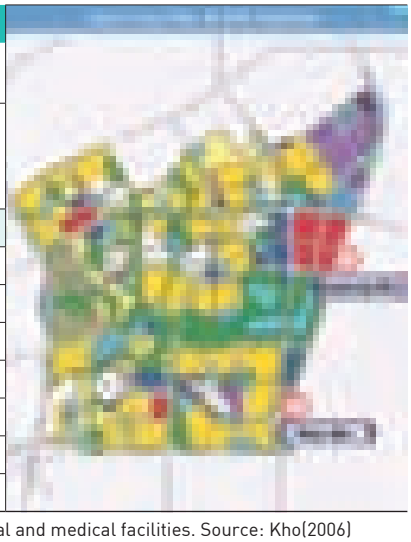
Hyungun Sung / Research Fellow

1. Introduction

Unjeong New Town, located away 30 to 40km from the center of the Seoul city to the northwest, was planned to accommodate 46,256 households (almost 124,898 persons) in an area of 9.4㎢ with a development density of 133 individuals per hectare. The new town development project approved by the Ministry of Land, Transport and Maritime Affairs in December, 2004, will be completed at the end of 2008 for the first step of the project. Its initial plan in 2003 was a housing development scheme in an area of 4.7㎢. However, such external pressures as the location decision of the LG-Philips LCD factory and concerns about housing-oriented development enforced the central government to revise its initial plan to a transit-oriented bigger urban development project (Kim, 2006). Table 1 briefly indicates the time span, developer and land use plan of Unjeong new town development project in the city of Paju.

Table 3. Introduction of Unjeong New Town Development Project in the city of Paju

Time Span	2004.12~2009.12	
Developer	Korea National Housing Corporation Paju City	
Development Outline	Area: 9,407,766㎡ Population: 124,898 persons (46,256 households) Density: 133 persons/ha	
Land Use Plan	Area	Ratio
Total	9,407,766㎡	100.0%
Residential	3,248,327㎡	34.6%
Park& Green	2,851,160㎡	30.3%
Road	1,446,830㎡	15.3%
School	488,002㎡	5.2%
Commercial	411,502㎡	4.4%
Others	1,264,274㎡	13.4%

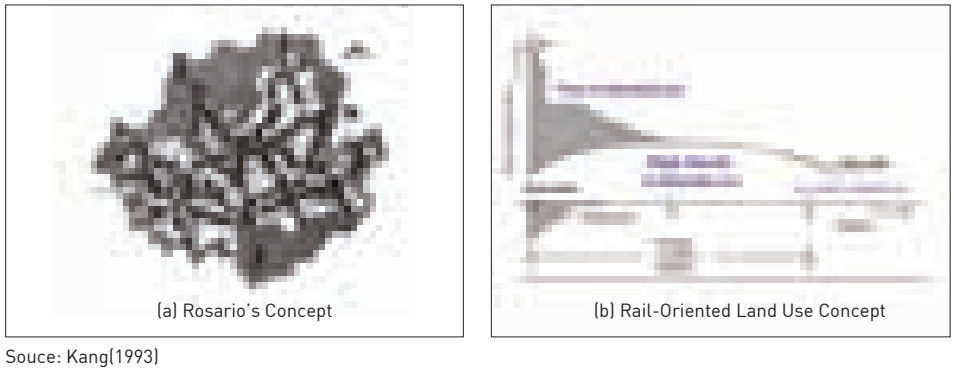


Note: Others include supporting facilities, public facilities, cultural and medical facilities. Source: Kho(2006)

2. Unjeong TOD Project

The plan of transit –oriented development in the Unjeong new town project is a first TOD desiring for sustainable new town development to overcome limitations of the car-oriented development in Korea. However, the TOD concept was not new in Korea. Late Byunggi Kang addressed Rosario's Concept to supply new housings within the 1 km radius areas of rail stations in the city of Seoul. At that time, he estimated additional 10 million people living in the city by 2000. In this regard, he asserted that housing supply policy was closely coordinated with the rail construction plan to build additional 4 rail lines in the city. His concept, as shown in Figure 6, designates both residential and non-residential urban development expected in the future into rail station areas, differentiating development density and land use within a walkable distance from it. Both density and non-residential use of land decrease as it is away from rail stations. Although his concept was reflected in the rail construction plan as well as urban comprehensive plan in the 1980s, it was not materialized in real

world since the Korean government began to invest additional housing supply outside the city of Seoul in order to decentralize the population and economy concentrated in the city. In this regard, the Unjeong TOD plan can be said to be the first plan containing the transportation infrastructure environment for a new town using a TOD concept.



(a) Rosario's Concept

(b) Rail-Oriented Land Use Concept

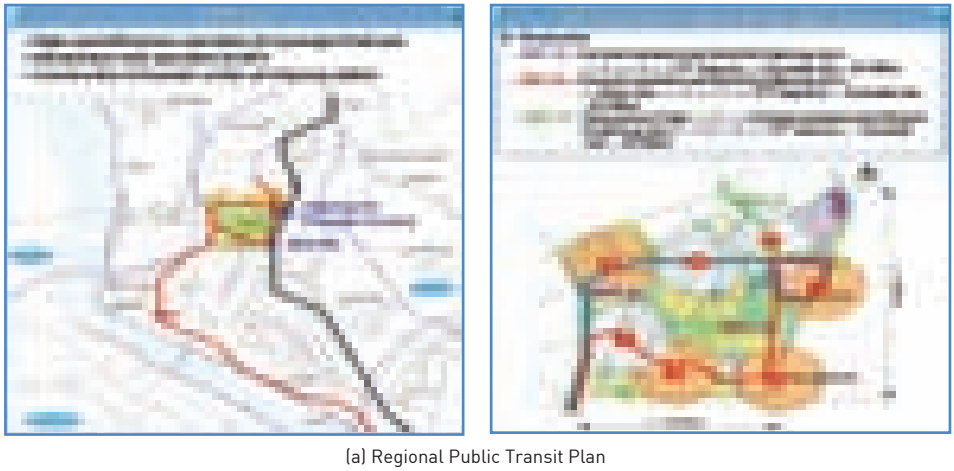
Souce: Kang(1993)

Figure 6. Rosario Concept and TOD

The Unjeong TOD plan was initiated as a measure plan to improve the regional transportation system expected to worsen by the time of the new town construction. Its concept contains an extended TOD, an inter-modal transit center, ITS for TOD and pedestrian-oriented and high density development. The extended TOD indicates that the area of the Unjeong TOD (approximately 4.0km by 2.5km) exceeds the traditional TOD area (approximately 0.5km by 0.5km), requiring a large scale TOD plan due to the size of the development area. The large-scale new town comprises of 6 neighborhood TODs and an urban TOD, as shown in Figure 7(a). The last one has the function of a town center which is located near the Unjeong rail station. It is planned to be the central commercial area conceptualizing a pedestrian-oriented high density district. Within the TOD, an inter-modal transfer transit center has been designed as part of the Unjeong rail station since the new town was located near the Gyeongui railway which had been planned to electrify and double the tracks operating from Munsan in Gyunggi to

Youngsan in Seoul. The transit center, Figure 7(b), is planned to approximately cover a public transit demand of 56,000 persons per day in 2029. It is supposed to be a comprehensive transit center since it comprises of such diverse transfer facilities such as bus stops, park & ride facility, and bicycle parks.

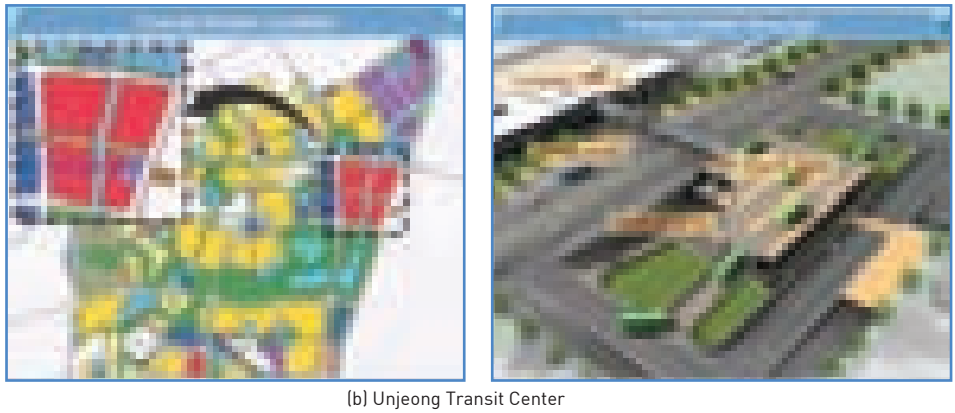
In the Unjeong TOD plan, there are two major regional transit systems covering 134,000 external trips per day in the new town: Gyeongui railway and regional BRT route on motorway. The Gyeongui line passing through Unjeong new town with 2 stops, Unjeong station and another new station is anticipated to be 35~45 minutes from the two stations to the city of Seoul. These two rail stations will take an important role in encouraging the new town residents to take public transit, rather than driving, to travel to the city of Goyang, Ilsan and the city of Seoul. Another regional public transit system is BRT lines operating on the motorway, “the Second Freeway,” which is newly planned to deal with potential traffic congestion driven by the new town, if they would not be timely constructed. These BRT lines are also planned along inside-town arterial roads, for convenience of either transferring travelers to rail stations or directly moving to Goyang city, Ilsan and the city of Seoul.



(a) Regional Public Transit Plan

Travel Demand by Mode in Unjeong Station (Yr 2029) (Unit: Persons/Day)

	Unjeong Rail Station	Transfer Travel Modes					
		Walking	Bus	Cars		Taxi	Bicycle
				Park & Ride	Kiss & Ride		
Getting-On	28,043	16,981	9,316	437	1,181	84	44
Getting-Off	28,139	17,039	9,940	439		677	44



(b) Unjeong Transit Center

Source: Kho(2006)

Figure 7. Unjeong TOD's Concepts

3. Policy Implications and Lessons

Under changing planning paradigm in the 21st Century, the Seoul metropolitan area has begun to take countermeasures to relieve traffic congestion and reduce greenhouse gas emissions resulting from inordinate dependence on road transport for travel. There are many countermeasures which can be taken to deal with such problems. Especially, the President of South Korea, Mr. Myung-Bak Lee, addressed Low Carbon · Green Growth as a new growth engine in the 21st Century to lead the economy in August, 2008. The Ministry of Land, Transport and Maritime Affairs which is responsible for urban development and transport policies addressed Low Carbon · Green Growth Strategies. They can be divided into two categories: Green Development and Green Transport. The former contains both pursuing transit-oriented development and restructuring national

and urban spatial structure toward low-carbon emission and green growth. The latter includes both encouraging the use of non-motorized and transit transport modes and developing green vehicles for low-carbon green growth. Among diverse policies in these two strategies, the research is more focused on planning and policies such as transited-oriented development, bus rapid transit investment and smart operation policy of public transit when it is focused on the Seoul metropolitan area.

In the Seoul metropolitan area, the Unjeong TOD project can be considered a comprehensive approach to coordinate between green development and green transport in newly developing areas to reduce traffic congestion, inordinate use of fossil fuel for travel, and environment degradation. It gives us policy implications on how to hunt two rabbits simultaneously: both accommodating a rapidly increasing population and reducing the negative impacts on travel, energy and environment. The potential benefits resulting from the project can be a successful benchmarking case to developing countries which are experiencing more and more worsening traffic congestion resulting from rapid economic growth, especially in the mega-city regions.

Figure 8. Current View of Unjeong City and Unjeon Train Station

Source: Website of OhmyNews(August, 2012)

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3 BRT System Running Circular Road for the New Administrative City (Sejong)

Byung-Jung Park / Associate Research Fellow

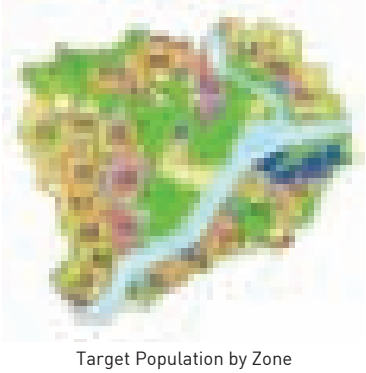
1. Introduction

The Sejong City project, the construction of a new administrative capital in the Yeongi County and Gongju areas in South Chungcheong province is underway in order to alleviate the overcrowding of Seoul metropolitan area as well as to achieve balanced regional development. It is located 120km (74.5 mi) south of Seoul and the site area is about 72.91km^2. It is planned that the central administrative organizations including 16 ministries and agencies and 20 government offices will be relocated in stages, beginning from 2012 and completed by 2014. A total of 10,452 public officials are expected to move from Seoul to the new multi-functional administrative city – Sejong City. The construction will be completed by 2030, and the city is expected to be self-sufficient by accommodating a population of 500,000.

Table 4. Summary of the Project

Project Title	Multi-functional Administrative City Construction		
Location	Yeongi County and Gongju areas in South Chungcheong province		
Developer	The Korea Land & Housing Corporation (LH)		
Time Span	2005 ~ 2030		
Land Use Plan	Total Area	72,908,221㎡	100%
	Residential	15,451,590㎡	21.2%
	Commercial	1,479,087㎡	2.0%
	Industrial	855,513㎡	1.2%
	Park & Green	38,264,732㎡	52.5%
	Facilities	16,105,017㎡	22.1%
	Reserved	752,282㎡	1.0%
Target Population	Total Population	500,000	
	Single Housing	32,990	
	Public Housing	452,010	
	Commercial	15,000	
Target Households	Total Households	200,000	
	Single Housing	13,196	
	Public Housing	180,804	
	Commercial	6,000	

Land Use Plan



Target Population by Zone

One of the key features of the new City is to provide the city dwellers with a sustainable transportation system by promoting transit-oriented development. The objectives of its public transportation plan are to provide a faster, more comfortable, and more convenient public transportation network than automobiles, to build a transit-oriented orbital road which makes it possible to reach any point in the city within 20 minutes, and to provide a seamless transfer between public transportation and other modes. The city expects that the public

transportation mode share will be increased up to 70% by 2030 by networking buses, bicycles, and pedestrian facilities with its transit-oriented orbital road.

Table 5. Expected Future Mode Share (%)

Year	Auto	Taxi	Public Transport	Walking and others	Sum
2013	33.00	9.24	31.11	26.69	100.00
2015	32.19	8.31	32.33	27.28	100.00
2020	30.66	7.04	34.44	27.86	100.00
2030	30.00	6.41	35.67	27.92	100.00

2. BRT Construction Plan

Among many public transportation options, a bus rapid transit (BRT) system has been adopted in Sejong City after considering many factors in terms of traffic, economic, environment, and social impacts. The BRT system can provide the service quality of rail transit while still enjoying the cost savings and flexibility of bus transit. The cost of a BRT system is typically 4 to 20 times less than a tram or light rail transit (LRT) system and 10 to 100 times less than a metro system. The heart of the plan is to construct the transit-oriented orbital road with the exclusive median bus lanes and to operate the newly developed BRT vehicles with priority traffic signals. This can ensure the access to any point in the city within 20 minutes.

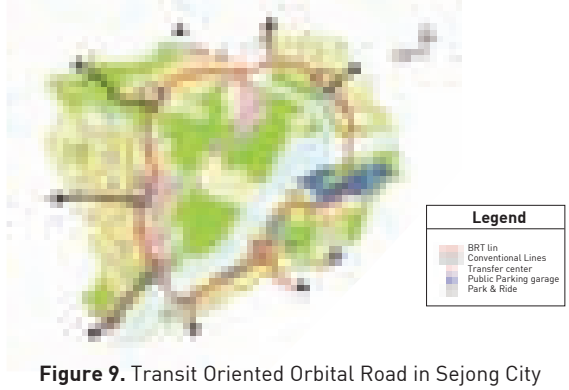


Figure 9. Transit Oriented Orbital Road in Sejong City

Public Transportation Plan

To maximize the efficiency of public transportation the function of the public transportation has been split into two; trunk lines (BRT) and feeder lines (other bus routes). The trunk lines which operate on the transit-oriented orbital road will have two-way two exclusive bus lanes to ensure punctuality and promptness. The feeder lines are linked to the transit-oriented orbital road by connecting it with main living areas and they also cross-connect between adjacent living areas.

The cross-section of the transit-oriented orbital road consists of green spaces in the middle, two lanes for BRT operations and four lanes for general vehicle travelling (Figure 9). Sidewalks, bike paths and street-tree space are also provided separately. The total width is 40m. The green spaces in the middle will be utilized in various ways, including bus passing space, parking spaces, or pedestrian waiting areas. In order to improve the pedestrian walking conditions, the street-tree space will be utilized for installing various obstacles for walking such as poles, streetlights and other support facilities for transport.

The bus stops on the transit-oriented orbital road will be installed at intervals of 400~600m by considering the movement of pedestrians and bicyclists coming from living areas. By securing the overtaking lanes, the bus stops are designed to allow two or more buses to make a stop at the same time. The forms of bus stops will be determined by taking into consideration the way of passenger boarding, fare collection system, and the waiting space. Real-time bus information will be provided at the bus stop to reduce the waiting time for passengers. Advanced public transportation systems such as a bus priority signal system, bus information system, and bus fare management system will be applied to improve public transport punctuality and promptness and to gain public transportation users' confidence.

There are five park-and-ride facilities on the transit-oriented orbital road and two main transfer centers. The park-and-ride facilities are located at the

major entry points from adjacent cities such as Gongju, Deajeon, Chungwon, and Jungan, and encourage the transfer between passenger cars and public transportation. The two transfer centers at the north and the south sides are mainly for transferring between regional BRT lines and the circulating BRT line. They will be also used as terminals for intercity or regional buses.

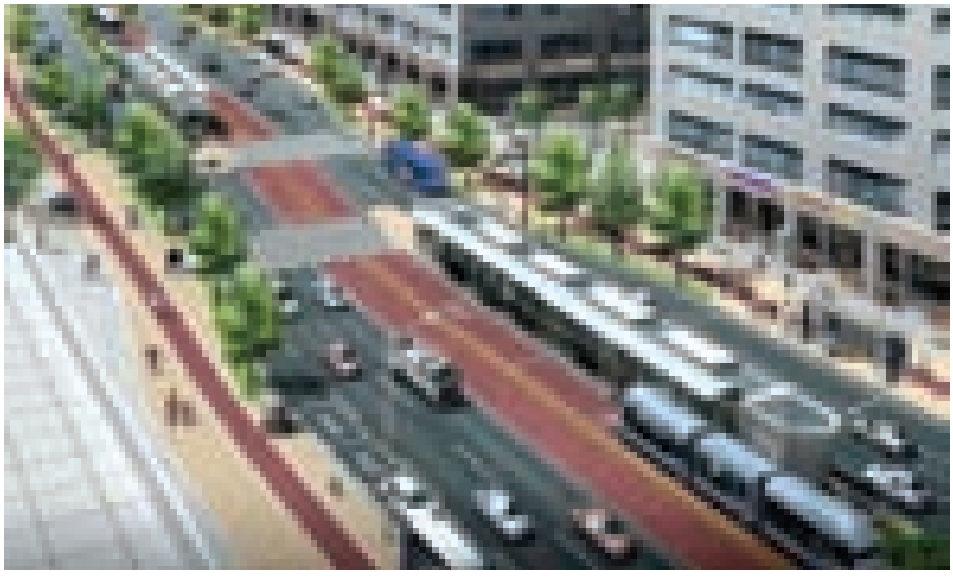


Figure 10. Outlook of BRT System in Sejong City

BRT Route Plan

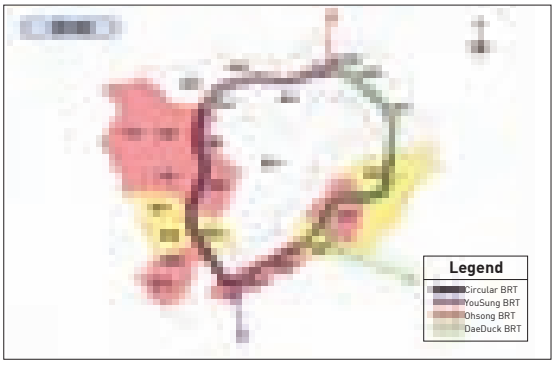
Basically the city will operate four BRT lines including a circulating BRT line within the transit-oriented orbital road and three regional BRT lines which connect the city to its adjacent cities such as Daejeon, Osong, and Yuseong.

- Circulating BRT line: Connects residential areas, new government buildings, commercial area along the transit-oriented orbital road (Length: 22.3km)
- Osong BRT line: Connects directly with the north BRT transfer center at Sejong to Osong KTX station, which improves access to Seoul and other cities (Length: 21.2km)

- Yuseong BRT line: Directly connects the south BRT transfer center at Sejong to Banseok subway station, which improves the access to its adjacent cities such as Yuseong and Doonsan (Length: 27.2km)
- Daedeok BRT line: Provides access to Daedeok Techno Valley (a hi-tech venture complex city) connecting Deajeon, Sejong, and Osong KTX station (Length: 22.4km)

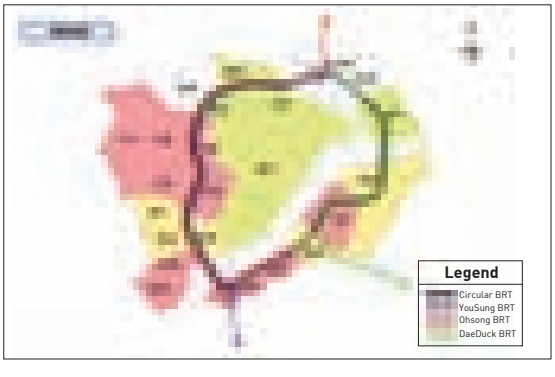
The coverage of BRT lines will be gradually expanded from the year 2013 to 2030 according to the urban development. The type of BRT vehicles and its operators will be determined after consultation with various stakeholders.

Urban-forming period (2013~2015)



* Note: The dotted line indicates a non-stopping section.

Urban-developing period (2016~2020)



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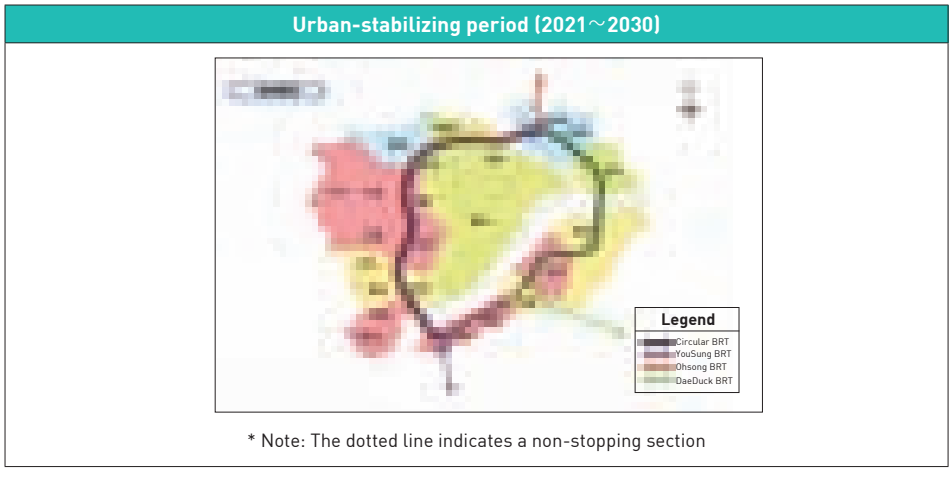


Figure11. Expected Coverage of the BRT Lines by Development Phase

BRT Vehicles

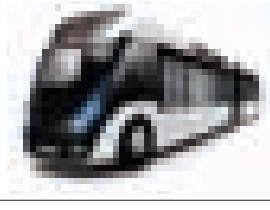
The types of BRT vehicles under consideration so far include bi-modal trams and electric buses from the Hankuk Fiber Group, on-line electric vehicle (OLEV) from KAIST, and electric buses, hydrogen fueled cell buses, and CNG hybrid buses from Hyundai. The best option will be determined after a full consideration of various factors such as safety, the environment, economics, comfortableness, and the image of the city.

The bi-modal tram is one of the public transportation systems with a new and innovative concept. The bi-modal tram, which has been developed by the Korea Railroad Research Institute since 2003, is a rubber tired vehicles with two carriages propelled by CNG hybrid propulsion which can improve fuel efficiency and exhaust emissions. It is designed to have a low floor to provide the elderly and the handicapped with easy access according to Korean physical standards, passenger capacity, and bus and urban railway regulations in Korea. The automated guidance system enables its precise docking to the station at distance of 5 centimeters so that passengers in wheel chairs or with strollers can have easy access without any restrictions.

The electric bus is a plug-in bus and runs purely on electricity. In Korea, the buses have been developed by Hankuk Fiber and Hyundai Heavy Industries and have been formally registered as electric vehicles. There is no doubt that the electric buses are environment-friendly means of public transportation because they do not emit any fine dust particles, smoke or other air pollution agents. They have a maximum speed of 100km/hr and can drive up to 120 kilometers once the lithium batteries are charged. The batteries can be recharged in 20 minutes at nearby bus depots. The Seoul Metropolitan Government already began running these electric buses on Mt. Namsan circular routes in December 2010.

The Online Electric Vehicle (OLEV) is an electric vehicle with a new concept which runs on electric power supplied from an underground electricity line. It has been developed by The Korea Advanced Institute of Science and Technology (KAIST) by overcoming several technical problems encountered by California in the 1990s. Electric power strips are buried 30cm (12 in) deep under the road surface and the pick-up equipment underneath the vehicle then collects power through non-contact magnetic induction which is used either to power the vehicle prime-mover or for battery charging. The OLEV shares many of the benefits of the electric vehicles, but the best thing about it is that it can drive using only one fifth of the battery of a normal electric vehicle because of the ability to recharge itself while on the road. In November 2010, KAIST's non-contact magnetic induction recharging system was selected as Time's the World's 50 Best Inventions of 2010.

Table 6. Options for BRT Vehicle

		
Bi-modal tram	**Electric bus**	**OLEV**

Policy Implications

Since the BRT system is not only favorable in terms of cost-effectiveness compared with other new transport modes, but is also helpful for upgrading the existing public transportation to a higher-quality mode, it is expected that the BRT system will greatly contribute to the improvement of public transportation in Sejong city. Examples from practices abroad have shown that after the implementation of BRT buses ridership has greatly increased (30% in LA, 50% in Miami), and 27 million vehicles in automobile tr affic decreased annually in Curitiba, Brazil.

The BRT system in Sejong city is expected to result in the same positive effects because it can provide the citizens with more reliable travel time by operating in an exclusive median bus lane with faster speed and offering frequent services. The BRT system will also encourage compact, pedestrian and transit-oriented developments by minimizing automobile usage. The BRT system can also help achieve air quality and other environmental goals in Sejong city through the use of clean and alternative fuel vehicles and reduction in automobile traffic and congestion.

Figure 12. BRT Bus in operation and Current View of Sejong City

Source: Website of Sejong City and Wikipedia (Sejong City in Korean)

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4 Metropolitan Express Bus (M-Bus) in Seoul Metropolitan Area

Changhwan Mo / Research Fellow

1. Background of M-Bus: Drastically Increasing Convenience for Residents in the Capital Region

The brainchild of the Korea Transport Institute (KOTI), the metropolitan express bus (M-Bus) service is aimed at resolving traffic problems facing the residents in the capital area. Particularly, it is intended to improve the traffic situation in the region by removing conflicts among related local administrative bodies over bus lines linking Seoul and adjacent new cities as well as the number of buses put in service on the routes.

Conflicts of interest among local governments and their differences in investment priorities had long made it difficult to tackle various problems, one of which was about readjusting the metropolitan bus routes and expanding the supply of facilities. A number of new cities had been built in the region, which naturally led to demand for more bus services between the cities and Seoul.

However, the conflicts among the administrative bodies had kept the relevant authorities from acting flexibly and expeditiously to meet the demand.

At the heart of the problem were different bus operating systems adopted by the local governments. Seoul City, which operates city buses under a quasi-public management system, had focused on maintaining a balance between its financial assistance and the quality of bus service. In contrast, the government of Gyeonggi Province, which runs city buses under a private management system, had pursued profitability for transportation companies.

2. Not Accepting Standing Passengers, Only New Buses Allowed, and a Maximum of 4 Stops Over a 5km Route

KOTI developed the M-Bus idea based on its observation of the failed operation of arterial rapid buses, which had been used to link Seoul and satellite cities in Gyeonggi Province. An enforcement decree for the Transportation Business Law had included a clause allowing the arterial rapid buses to establish additional stations. Exploiting this clause, the bus operators created twisted and excessively long routes which causing a problem that had long been witnessed in the operation of regular/express city buses.

In December 2008, the Ministry of Land, Transport and Maritime Affairs amended the enforcement decree for the Passenger Car Transport Business Law to provide legal grounds for the M-Bus system. The amended decree called for the Minister of Land, Transport and Maritime Affairs to directly issue bus route permits (which meant reduced negotiation procedures), making it easier to ensure direct bus routes, reduced bus travel time, and other customized services. The amended decree stipulated that the metropolitan express buses use mainly expressways and designated bus-only lanes, and stop only at four stations within 5km each from the starting point and the destination, thus ensuring the shortest

travel time and distance. As a measure to ensure high quality services, the buses were also banned from accepting standing passengers. With these features, the M-Bus service was designed to fulfill arterial traffic functions in the capital area.

3. Expected Effects: Travel Time Improved by Average of 15 Minutes Compared to Existing Arterial Rapid Buses

In February 2009, six routes were selected for pilot operation of the M-Bus scheme. The lines were chosen from the four major transportation axes: Yongin - Seoul Station, Bundang - Seoul Station, and Dongtan - Gangnam lines for the southeastern axis; Namyangju - Dongdaemun line for the northeastern axis; Songdo - Gangnam line for the southwestern axis; and Goyang - Seoul Station line for the northwestern axis. The major factors considered in determining the routes were public transport's share of travel, demand for bus use, and new cities under construction. In particular, some political considerations involved in selecting the Namyangju-Dongdaemun and Songdo-Gangnam lines to meet a strong request from local governments arguing a regional equality. The M-Bus service was predicted to cut an average of 15 minutes in travel time compared to the old system of metropolitan buses (arterial rapid buses) on these routes.

- Bundang-City Hall: 11-minute reduction (71→60); Dongtan-Gangnam Station: 15-minute reduction (77→ 62); Songdo-Gangnam: 29-minute reduction (114→85)

The minimum fare for the M-Bus service was planned to set at 2,000 won for the basic travel distance of 30km. However, due to the opposition of Ministry of Strategy and Finance who has an authority for controlling price, it was set at 1,700 won, a same fare of existing arterial rapid buses. Beyond this basic distance, passengers have to pay additional 100 won per every 5km. For

example, a person travelling from Dongtan to Gangnam (41km) by the M-Bus would have to pay 2,300 won, which is a sum of the basic fare of 2,000 won and the additional fare of 300 won. Mainly designed for long-haul commuters, the M-bus system uses luxury buses with 39 or fewer seats, providing improved services that help shorten travel time by 10 to 20 minutes. These features were taken into consideration in deciding the bus fares. To help reduce the burden of transport expenses on the bus users, the M-Bus service was incorporated into the intermodal passenger transfer discount system. So, M-Bus passengers can receive the same transfer discount benefit as those of the existing city-wide buses.

The bus has a distinctive, modern look. Its exterior design has been determined through two customer preference surveys as well as a number of design experts' meetings. The preference surveys were conducted with draft designs prepared by a specialized design company named Design Spoon posted on the home page of the Ministry of Land, Transport and Maritime Affairs as well as in the lobby of the Ministry headquarters.

4. Fair Selection Process of M-Bus Operators through Open Competition

M-Bus operators were selected through open competition based on selection criteria prepared through a number of advisory meetings of experts. Business proposals were evaluated based on ten criteria and twenty specific standards. Also examined were the applicants' financial conditions, readiness to ensure safe and law-abiding operation of vehicles, service promotion measures, and capacity to manage transport-related staff. In March 2009, nineteen applications were received from companies that wanted to join in the M-Bus service. These applications were judged by a panel of private-sector experts, who selected the successful applicants in April.

Table 7. Bus Operation Plans for Selected Companies

Routes (Bus companies)	Number of buses (frequency)	Operation interval (minutes)	Major stations (based on passenger boarding)	
Yongin~City Hall (Gyeonggi Express)	17(112)	8~10	Starting point	①Korea District Heating Corp.~ ②Hyundai Sungwoo Apt.~ ③1st Hyundai Apt.~ ④Meonae
			Destination	⑤Jonggak YMCA ~ ⑥Seoul Station~ ⑦Myeongdong Kookmin Bank~ ⑧Joongang Cinema
Bundang~ City Hall (Dongseong Transport)	16(90)	6~10	Starting point	①Migeum Station~ ②Pureun Village~ ③Hyojachon~ ④Joongang Cinema (Paik Hospital)
			Destination	⑤Jongno 2-ga intersection~ ⑥YMCA~ ⑦Euljiro Ipgu (City Hall)
Dongtan~ Gangnam (Daewon Express)	13(96)	8~15	Starting point	①Shindo Branew Apt.~ ②Daeun Village~ ③Metapolis ~ ④ Hanbit Village
			Destination	⑤Kyobo Tower~ ⑥Gangnam Station~ ⑦Yangjae Station~ ⑧Yangjae Flower Market
Namyangju~ Dongdaemun (Daewon Transport)	13(84)	10~15	Starting point	①Pyeongnae Agricultural Cooperative~ ②Jangnae Village~ ③Geumgok-dong Ex-terminal~ ④Geumgok Station
			Destination	⑤Cheongnyangni Station~ ⑥Jegi-dong Station~ ⑦Sinseol-dong Station~ ⑧Dongdaemun Station
Songdo~ Gangnam (Incheon Seonjin Transport)	15(83)	10~15	Starting point	①Free Economic Zone Authority~ ②2nd, 3rd Poonglim Apt.~ ③Hanjin Haemoro Apt.~ ④Dongmak Station
			Destination	⑤Nambu Terminal~ ⑥Seocho Station~ ⑦Gyodae Station~ ⑧Gangnam Station
Goyang~ Seoul Station (Shinseong Transport, Seoul City license)	20(120)	3~10	Starting point	①Daehwa Station~ ②Gangseon Village~ ③Madu Station
			Destination	④Ganghwamun~ ⑤City Hall~ Seoul Station

Source: Korea Transport Institute. 2009; Mo, 2010

To ensure fairness and objectivity, the selection was made by the 15-member "Metropolitan Bus Project Operators Evaluation Committee" comprising transport experts, lawyers, certified public accountants, and representatives from civic groups. The committee selected Gyeonggi Express for the Yongin - City Hall route, Dongseong Transport for the Bundang - City Hall route, Daewon Express for the Dongtan - Gangnam route, Daewon Transport for the Namyangju - Dongdaemun route, Incheon Seonjin Transport for the Songdo - Gangnam route, and shinseong Transport for the Goyang - Seoul Station route.

The selected bus companies were given a six-year permit for M-Bus operations by the Minister of Land, Transport and Maritime Affairs. This permit can be extended if the companies perform well. They then purchased buses, built garages, installed card reading equipment on the buses, and made other necessary preparations. They launched the M-Bus service on the six routes in August 2009. The pilot operation was scheduled to be followed by a review for possible system changes, establishment of a route expansion plan during the first half of 2010, and full-fledged M-Bus service.

Figure 13. Pilot Project Lines for M-Bus

5. Efficacies of M-Bus Operations

With regard to effectiveness, most passengers of M-Bus showed strong satisfaction of bus services. They also showed positive responses about the operation of M-Bus and the number of users also appears to have shown an increasing trend. Above all, M-Bus contributes to reducing traffic congestion in the capital region because users of private cars have been transferring to M-bus. With regard to efficiency, demands on M-Bus show big differences by region and the gap of profits among bus companies has been enlarged. Except for peak times, few passengers take M-Bus during off-peak times. With regard to social fairness, it is judged that M-Bus has increased social fairness because, due to the expansion of the integrated transfer discount system, the transport cost of passengers has been significantly reduced.

Figure 14. Long-Line of Passengers Waiting for M-Bus

Number of M-Bus Passengers per Day by Route

On May 2010, the average number of passengers per day was 5,020 persons at the route of M4102, 4,925 persons at the route of M4101, 4,771 persons at the route of M7106, and 4,373 persons at the route of M4403. These four routes were successful in attracting passengers. However, M2104 and M6405 route were 1,230 and 1,604 respectively. These routes need to attract more passengers in the future.

As to an analysis of the number of passengers by route, the number of passengers in the initial two hours of the morning towards Seoul from Gyonggi Province and Incheon City was over 50 percent compared with the whole passengers, while the number of passengers in the initial two hours during the afternoon towards Gyeonggi Province and Incheon City was over 30 percent. More than 70% of passengers boarded at the first and the second stop.

Table 8. Number of Average Passengers per Day

Route	Vehicles/No. of Day Operation	No. of Passengers/ Day
Yongin~Seoul Station(M4101)	22 / 126	4,925
Bundang~Seoul Station(M4102)	16 / 128	5,020
Dongtan~Kangnam(M4403)	18 / 136	4,373
Namyangju~Dongdaemun(M2104)	13 / 84	1,230
Songdo~Kangnam (M6405)	11 / 56	1,604
Ilsan~Seoul Station (M7106)	19 / 133	4,771

Source: Korea Transport Institute, 2010.

Service Satisfaction on M-Bus

As to a result of survey on the satisfaction of bus passengers, 76 percent of them were satisfied but only 2.2 percent of them were not satisfied. On the whole, the satisfaction of passengers was shown to be very high.

Table 9. Satisfaction for M-Bus Services

Classification	No. of Respondent	Rate (%)
Very satisfied	49	21.7
Satisfied	124	54.9
Normal	48	21.2
Dissatisfied	2	0.9
Very dissatisfied	3	1.3
Total	226	100

Source: Korea Transport Institute, 2010.

Saving of Travel Time

Among M-Bus users, office workers are the largest group and 50% of them use it for commuting. Compared with the subway, M-Bus can save about 20 minutes on the same route in the capital region. The most important reason for using M-Bus is to save travel time. It is about ten minutes of total travel time from home to work that passengers of M-bus can save.

Table 10. Changes in M-Bus in Travel time

Classification	Before	After	Increase and Decrease Volume
Access time (min.)	10.62	10.87	0.25
Waiting time (min.)	9.79	8.95	-0.84
Staying time within car(min.)	67.36	57.85	-9.51
Total travel time (min.)	87.77	77.67	-10.10

Source: Korea Transport Institute, 2010.

Modal Shift from Private Car to M-Bus: 8 percent

According to the results of a survey on the past transport modes of M-Bus users, a modal shift happened with a remarkable 8 percent from private cars. About 80 percent of M-Bus passengers came from existing metropolitan buses, such as arterial rapid buses, while about 8.4 percent of them had transferred from subway and urban rail.

Table 11. Transport Mode before Using M-Bus

Classification	No. of Respondents	Rate (%)
Private car	18	8.0
Metropolitan bus	180	79.6
Subway/rail	19	8.4
City bus	2	0.9
Town bus	1	0.4
Miscellaneous	6	2.7
Total	226	100.0

Source: Korea Transport Institute, 2010.

It should be emphasized that M-Bus contributed to reducing traffic congestion and social and economic costs by a significant modal shift from private cars. As M-Bus provides passengers with a high level of services in terms of speed and comfort, it can attract private car users to change their commuting pattern from private car to bus.

Most Important Reason of Using M-Bus

The most important reason to use M-Bus is to save travel time. About 62 percent of respondents answered that they used M-Bus because it could save a significant amount of travel time. The second most important reason to use M-Bus is the comfort that passengers can sit in a seat and the bus does not allow standing passengers. About 24 percent of respondents answered this reason.

Table 12. Primary Reason for Using M-Bus

Classification	No. of Respondent	Rate (%)
Saving travel time	140	61.9
Comfort of taking a seat	53	23.5
New vehicle	8	3.5
Close stops	10	4.4
Low fares	8	3.5
Miscellaneous	7	3.1
Total	226	100.0

Source: Korea Transport Institute, 2010.

6. Lessons Learned from M-Bus Operations

The case of M-Bus shows that medium-distance transport demand for speedy and direct bus services in a metropolitan region exists. This demand can be differentiated from the market of existing city buses that have more than 30 bus stops on a route and are crowded during peak times. As M-Bus has only four stops in each direction, speed is significantly increased compared with the other general city buses. In addition, the buses use exclusive bus lanes or urban expressways, increasing speed further. Therefore, speed is a critical factor in the successful operation of M-Bus. The methods to increase speed are drastically reducing the number of bus stops and using exclusive bus lanes and urban expressways.

In addition to speed, comfort is a key component of the successful operation of M-Bus. Generally, city buses, such as arterial rapid buses and seat buses, do not provide comfort for passengers. During peak times, about 40 people are standing in a bus. Due to the extremely low quality level of city bus services, citizens do not choose buses for their possible alternative method of commuting but instead choose private cars. However, because M-Bus improves the quality level of bus services by not allowing standing passengers on the bus, those of who fortunate enough to take a seat have a high level of comfort from their starting stop to their destination.

This case also shows that only a high standard of bus services can influence the behavior of private car users to use buses for commuting and other social activities. It has been clear that the government's public transit policies have been fruitless in modal shift. According to the M-Bus case, an innovative improvement in bus services, such as speed and comfort, is required to achieve a significant modal shift.

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5 Bus Transfer Centers on Expressways for Intercity Transport

YoungJong Kwon / Research fellow

1. Introduction

One of the purposes of rest areas on express highways is to provide drivers and passengers with a place for refreshment. Recently, a major innovation was suggested by the Korean Transport Institute (KOTI) for these traditional amenities on express highways. KOTI observed the fact that intercity or inter-regional bus lines could take advantage of these rest areas for purpose other than providing refreshments for passengers and brief maintenance for vehicles. Inter-regional buses from all over Korea can stop at certain rest areas on major express highways and then disperse to each destination. Also, inter-regional bus passengers could take advantage of such stops if they could transfer from one line to another at rest areas. KOTI suggested installing transfer centers at rest areas for inter-regional buses as a way to maximize benefits of inter-regional lines.

Currently, six transfer centers at rest areas have been installed and are operating successfully. The results are clear that the service quality of inter-regional bus systems has improved dramatically by maximizing the utilities of bus networks. Thus, the Korean government decided to build more transfer centers at rest areas and is considering installing transfer centers on conventional highways too.

Background and Purpose

Looking into the statistics regarding express and outer-city bus passengers, the numbers for express bus lines have reduced gradually from 70 million in 1991 to 40 million in 2009, and figures for outer-city bus lines have reduced sharply from 700 million in 1991 to 250 million in 2009.

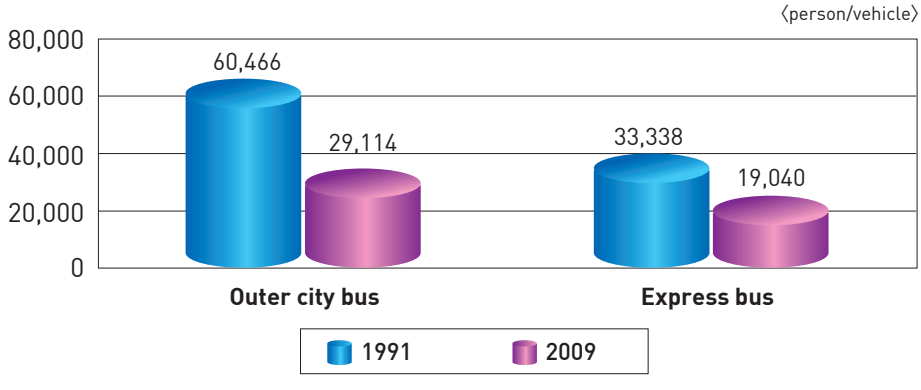
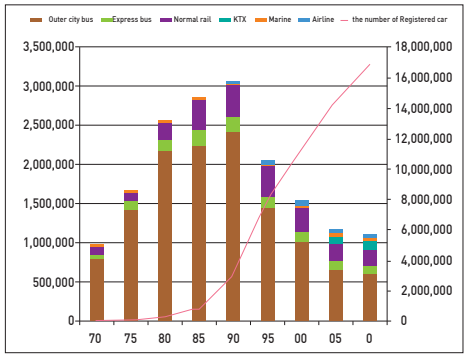


Figure 15. Number of Passengers per Bus by Year

While registered automobile numbers have increased by 4.5 folds, the inter-regional traffic volume by public transport has reduced by 64%. In particular, traffic volume for outer-city line buses has dropped by 74%.

〈Transportation traffic Volume among regions by year〉

〈unit: pass, volume/day〉



〈Pass Volume change by traffic tool〉

〈unit: pass, volume/day〉

Classification	1990	2010	Increase and decrease rate
Outer city bus	2,411,765	618,586	-74%
Express bus	209,602	104,461	-50%
Normal rail	411,164	307,104	-25%
Marine	22,630	39,212	73%
Airline	30,312	55,387	83%
Total	3,085,473	1,124,750	-64%

Figure 16. Changing Trend of Public Transportation Passengers

The most serious problem accrued by the reduced number of passengers is that it became a financial burden for regional governments. As the drastic decrease in the number of passengers per vehicle had worsened profits of bus operators, the amount of financial subsidies by regional governments increased drastically to provide minimum bus services for economic minorities.

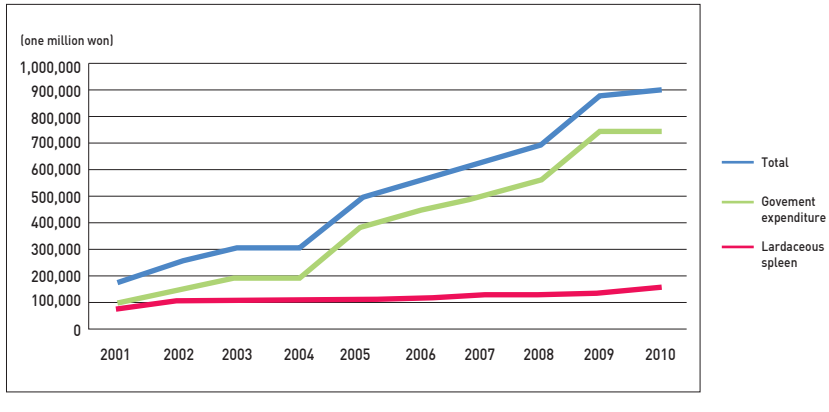


Figure 17. Size of Financial Support by Government

The predominant express bus networks have been built centered in large cities such as Seoul and Busan. Therefore, without direct routes departing from their resident cities, passengers in neighboring smaller cities such as Goyang, Yongin, and Uijeongbu have to be bothered some inconvenience when making inter-regional travels. The passengers have to wait longer for transport or make extra trips to nearby large cities due to the lower frequencies and fewer routes for inter-regional bus lines in the cities that they are living in.

To solve these difficulties, the Korean government (Ministry of Land, Transport, and Maritime Affairs) installed Hub & Spoke transfer systems at the express highway rest areas in November 2009 and launched the pilot project. The purpose of installation was to attract passengers by improving the convenience of outer-city bus lines for the residents of medium and smaller cities.

2. Basic Concept and Major Contents

Express highway transfer centers mean a transport paradigm shift from a hub and spoke system focused on existing large cities to a new sub-hub and spoke system focused on express highway rest areas. Prior to the new system, passengers had to make extra trips to the nearest hub terminals so that they could transfer to their final destinations. With this system, sometimes passengers experience inconveniences and have to pay higher fares for making backward trips from their destinations. However, with express highway transfer centers, passengers could minimize the costs of extra trips to hub terminals while maximizing the utilities of inter-regional bus routes. Rather than travelling backwards, passengers could move directly toward their final destination by making a transfer at sub-hub terminals on transfer centers at rest areas.

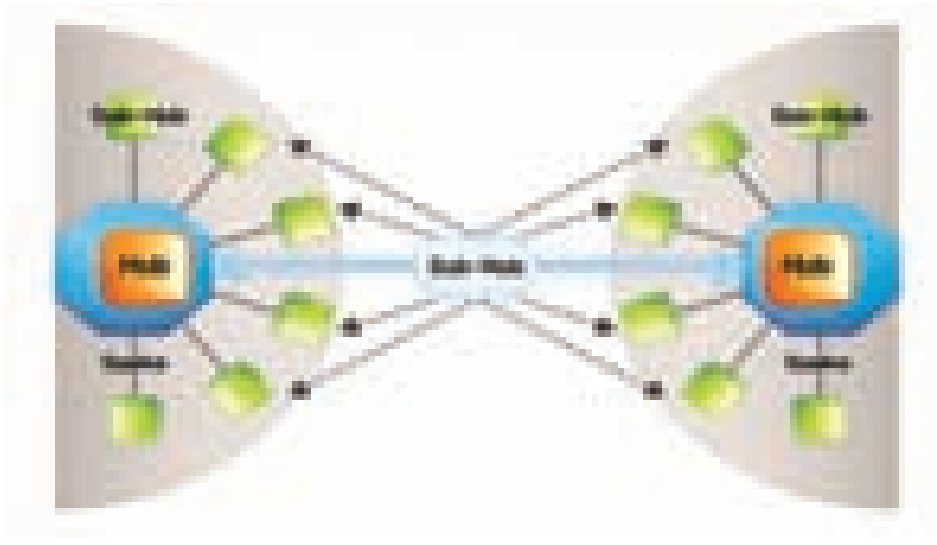


Figure 18. Sub-hub and Spoke System Concept

The most important feature in designing expressway transfer centers is selecting the locations of rest areas for transfer centers. Three selection criteria were adopted such as, areas that provide fewer bus services, traffic frequency of express highways, and the number of parking lots and demand for rest areas.

With these criteria, the government selected six rest areas and transfer centers which are currently in operation. Passengers can purchase tickets to the transfer centers (Jeongan and Hoengseong) at departure terminals, and tickets to the final destinations can be purchased at the transfer centers. Internet (www.kobus.co.kr) and ARS (1588-6900) systems are substitutable means for purchasing tickets in advance of the travel. Also, a plan to develop information and ticketing system for smartphones is underway. With the new ticketing service systems, passengers will be able to reserve tickets on their smartphone while they are on the road. The fare system is similar to that of existing express bus systems in that passengers pay for a whole itinerary at their departure based on travel distance with rates diminishing by distances so that passengers won't be responsible for extra expenses.

Figure 19. Outer and Inner Landscape of Hoengseong ETC

3. Program Execution and Procedures

The government installed four pilot express bus transfer centers at rest areas with 25 lines on both sides of the Honam and Yeongdong express highways in November. The Jeongan rest area on the Honam route facilitates transfer trips for passengers from/to six cities including Seoul, Goyang, Suwon, Seongnam, Uijeongbu, and Yongin which are located in the Seoul metropolitan area and nine small cities including Jeonju, Gunsan, Gimje, Namwon, Iksan, Jeongeup, Gwangju, Mokpo, and Suncheon, which are located in southern part of Korea. The Hoengseong rest area facilitates transfer trips from/to four cities including Seoul, Incheon, Goyang, and Daejeon located in the western part of Korea and four cities including Gangneung, Sokcho, Donghae, and Samcheok located in the eastern part of Korea.

Honam axis	Seoul(Gangnam, East Seoul, Sangbong), Goyang, Suwon, Uijeonbu, Seongnam, Yongin, Ansan, Shiheung, Cheonan, and Ansung	**Jeongan**	Jeonju, Jeongeup, Ilksan, Kimje, Namwon, Kunsan, Kwangju, Mokpo, Suncheon, Yongkwang, Naju, Gangjin, Yeosu, Jindo, Whando, Haenam, Nokdeung, Damyang, Bosung, and Nonsan
Youngdong axis	Seoul(Gangnam, East Seoul), Incheon, Goyang, and Daejeon	**Heongsung**	Gangreung, Sokcho, Donghae, and Samchuk
Honam axis	Seoul(Gangnam, East Seoul, Uijeonbu, Seongnam, Yongin, Incheon, Cheonan, and Cheongju	**Sunsan**	Daegu, Youngcheon, Kyungju, Pohang, Ulsan, Changwon, Masan, and Busan

Figure 20. Service Area for each Route

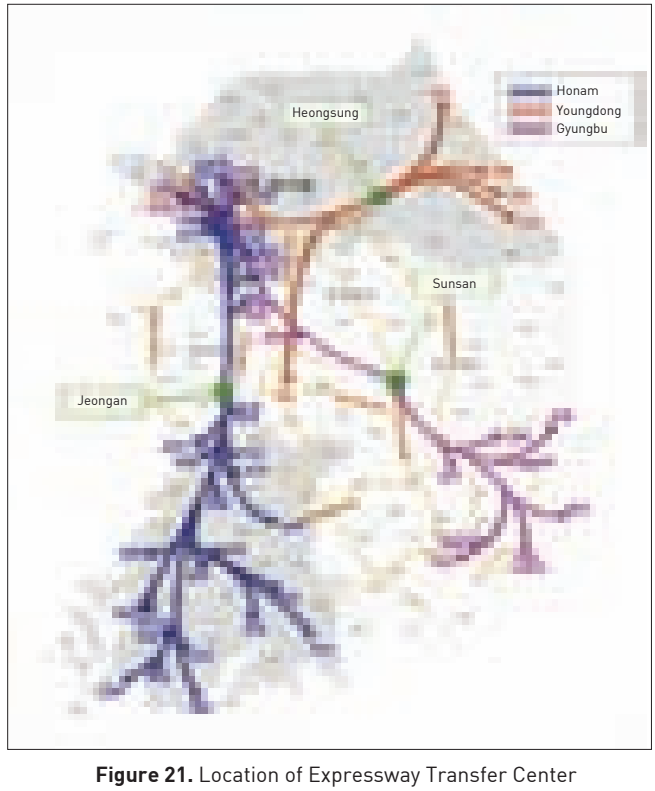


Figure 21. Location of Expressway Transfer Center

The Korean government expects to create 45 additional routes following the operation of the expressway transfer centers. In the case of using express buses in small and medium sized cities, standby hours were expected to be curtailed to an average of 47 minutes, operation distance was expected to be curtailed by about 35km, and fares were expected to be reduced by an average of 2,500 won(standard express 2,000 won, first-class express 3,000 won). On March 2, 2010, a new transfer center was opened at Seonsan rest area on the route of the Gyeongbu line.

Express bus operators and the government cooperated to set up express bus transfer centers. The facilities of the transfer centers were financed by the bus operators while the government provided administrative support. The government amended some rules of the Passenger Transport Service Act so that outer-city bus lines could stop at the expressway transfer centers to allow passengers to transfer to other routes.

4. Efficacies of the Transfer Centers

The express highway transfer center has improved accessibility and mobility between regions remarkably by allowing passengers to transfer to other inter-regional bus routes on express highways. Prior to the transfer center system being implemented, the inter-regional bus systems provided inconvenient mobility without options that directly connects small and medium sized cities. However, the transfer center systems allowed inter-regional bus systems to extend their service range, and passengers could also take advantage of overall time and cost saving.

A survey was carried out on passengers who used the transfer centers at Jeongan, Hoengseong, and Seonsan rest areas on the Honam, Yeongdong, and Gyeongbu highways and an itinerary tracking method was adopted to

analyze the effects. The results showed some effects of the transfer centers on passengers. The number of routes utilized increased from 181 to 436(140.9%). In particular, on the Honam highway, the routes increased by 388.9% from 54 routes to 264 routes. Also, the rate of modal shift from automobiles to inter-regional buses accounted for 25.8%, trains to buses accounted for 9.6%, and air flights to buses accounted for 0.4%. Also, average trip hours decreased by 42 minutes and average expenses decreased by 1,566 won.

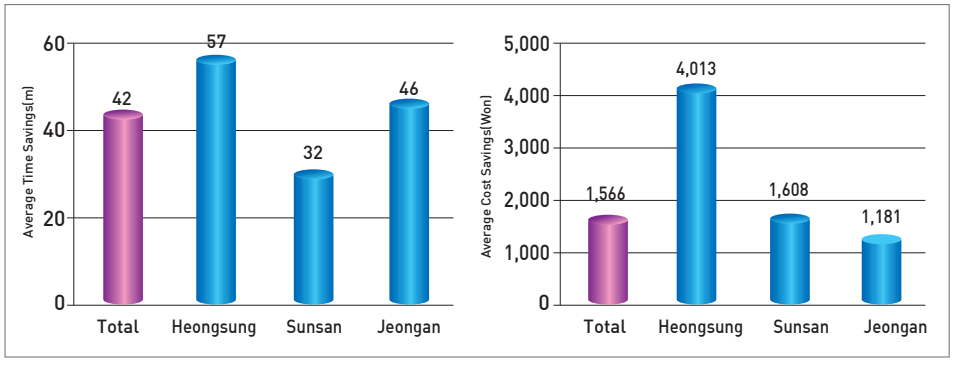


Figure 22. Time and Cost Saving with the Transfer Centers

5. Lessons Learned from Operation of Express Highway Transfer Center

A major shortfall of the express highway transfer center systems is the fact that the centers currently provide inter-regional express bus transfer services. Therefore, it may cause some restrictions on accessibility and mobility for economic minority passengers. Once the conventional outer-line bus systems adapt to transfer center systems, accessibilities and motilities will be extended in much wider ranges. To achieve the goal of expanding the transfer center system, the Korea Transport Institute (KOTI) suggested that the Korean government expand the system to cover all express bus lines as well as conventional outer-city bus lines through amendment of the law and administrative arrangements.

The survey results for passengers' satisfaction of express highway transfer centers showed that 36.9% of passengers were dissatisfied with lack of routes, 20.9% complained about punctuality, and 15.1% claimed longer operation intervals. To cope with the passengers' complaints, more transfer centers should be installed. Specially, the government should expand bus service areas to increase accessibility and mobility for people living in rural areas by installing more transfer centers not only on express high-ways but also on conventional high-ways.

Reference

Korea Transport Institute, *"Maximizing Networking Effects for Regional Bus Operations thru Expressway Transfer Centers"*[in Korean], 2009.

Korea Transport Institute, *"Evaluation of Expressway Transfer Centers and Future Directions"*[in Korean], 2011.

6 Transfer Centers for City Bus Users

YoungJong Kwon / Research Fellow

1. Introduction

It is almost impossible to mitigate traffic congestion in urban areas by expanding road capacities due to the limited land and dense population. Therefore, public transportation may be the only measure that has the capacity to resolve traffic congestion. However, it is inevitable to make transfer trips when using public transportation and this feature becomes a limitation when competing with automobiles which provide door-to-door service.

In urban areas in Korea, only one type of transfer facilities were installed, park and ride areas, which are located near subway stations. However, the park and ride areas could not function as transfer facilities. Rather they have functioned as a type of parking garage. In July, 2004, Seoul authorities started to reform public transport systems and establish bus transfer centers. Currently in Seoul, four major transfer centers have been installed and are functioning

as transfer facilities between trunk and feeder bus lines, as well as among buses and subways. The four transfer centers are located at Seoul station, Cheongnyangni station, Yeouido, and Guro area. In Gyeonggi-do, two transfer centers are in operation, located at Suwon and Ansan stations.

Background and Purpose of the Program

As the city of Seoul formed a metropolitan region through expansion of its economic and social territory toward surrounding regions such as Incheon and Gyeonggi-do, traffic demand increased dramatically, especially for automobiles. Increased traffic demand has also worsened traffic congestion around the borders of Seoul. Furthermore, inconvenient public transportation within Seoul territory increased automobile traffic volumes and exacerbated traffic congestion. At Seoul and Cheongnyangni rail stations in particular, bus depots were located in several locations around the stations. This feature caused inconvenience for transferring passengers and caused traffic problems due to extra time and distance for transferring to bus lines, passenger over-flows at bus depots, and cross-flows of passenger traffic. As a result, these inconveniences and congestions increased automobile traffics which exacerbated urban traffic congestions further.

To resolve these problems of the urban public transportation system, Seoul installed four bus transfer centers as a part of the public transport reform program in July 2004. The purpose of the bus transfer centers was to encourage automobile passengers to shift to public transport by installing convenient transfer systems that could mitigate traffic congestions within Seoul and the Seoul metropolitan area.

2. Basic Concept and Major Contents

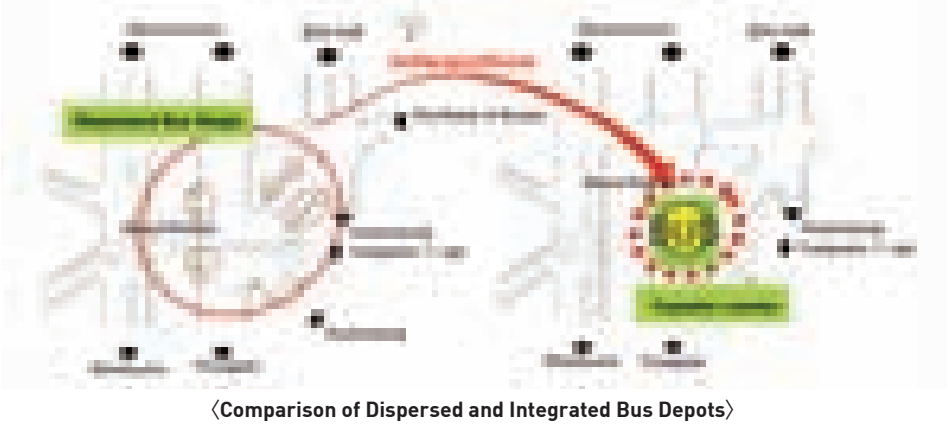
The bus transfer center is one of the basic transport facilities to improve service quality and maximize utilities of public transport systems by providing convenient transfers among public transport modes. Generally, a transfer center is a complex transfer facility combining rail stations, bus depots and terminals, ticketing booths and passenger facilities, transfer paths, and other facilities related to transfers. With transfer centers, passengers are guaranteed transport connectivity at transport nodes where transfer frequencies are higher between modes such as subways, buses, taxis, automobiles, and bicycles.

Table 13. Major Improvement for Bus Transfer Center at Seoul Station

Classification	Content of System Renovation	
Transfer center	Place	· Median lane in front of Seoul station concourse
	Scale	· 5 stops 23 bays (stops width-2 places: 3.5m, 1 place :9.75m, 1 place :3.25m, 1 place :3.0m) · 5 bus only lanes (2 u-turn lanes) · 2 fast lanes
	Direct transfer pass	· Subway line 1, 4 Valid pass width 5.6m · Escalator equipment 1200type(2 person) · Disabled lift equipment, CCTV equipment
	Other facilities	· Pedestrian crossing equipment (Seoul Station ↔ Daewoo building)
Taxi stops		· Taxi stops 2→3 car roads, increase in capacity · Seoul station access road installment additionally
Traffic facilities	Operation	· 2 signals installed only for bus · 1 camera installed for signal violation detection
Traffic system parts		· 1 pedestrian crossing in front of Seoul Station equipment · 2 u-turn lanes only for bus · Center lane installment only for bus near transfer center · Move of pedestrian crossing at Huam-dong street
Miscellaneous		· Closing underground road in front of YTN · 1 Center lane bus stop(4 bus bays) in front of YTN

The purposes of the transfer center at Seoul station are to create eco-friendly and pedestrian priority spaces, and to improve transfer convenience among public transport modes by constructing a transfer system integrating the KTX, buses, and subways, as well as connecting exclusive median bus lanes near

the station. Nine out of twelve depots which were previously dispersed around Seoul Station area were relocated to the median lane near the Seoul station. Therefore, relocated bus depots could provide convenient transfers to subway lines 1 and 4 and the KTX station. A pathway was installed directly connecting subway lines 1 and 4 with bus depots and taxi stands. Additionally, a pedestrian crosswalk was installed in front of the Seoul Station concourse. The influx of bus route patterns has changed and therefore, most buses pass through the transfer center to maximize transferability between modes. At Cheongnyangni Station, the average distance between bus stops and subways has been shortened by 129m. Previously the average distance was 177m and now it is 48m.



〈**Comparison of Dispersed and Integrated Bus Depots**〉

①Kiss&Ride ②Taxi ③Taxi
④Bus(Yongsan, Gimpo Airport direction)
⑤Bus(Southwestern direction)
⑥Bus(Southeastern direction)
⑦Bus(Northwestern,
Northeastern direction)
⑧Bus(Hangangro direction)

〈**Location of Deport of Each Bus Route and Other Modes**〉

Figure 23. Concept of the Transfer Center at Seoul Station

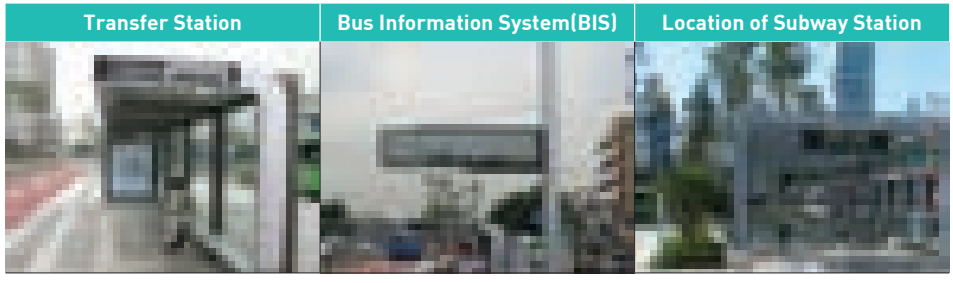


Figure 24. Facilities of the Transfer Center at Seoul Station

3. Pursuing System and Pursuing Process

The bus transfer center installation was scheduled later than the overall Seoul Public Transport reform schedules for almost five years. As a result, at the initial stage of the reform serious problems arose regarding transferring transport modes.

Table 14. Transfer Centers in Seoul and Gyeonggido Province

Transfer Center	Location	Facilities
Guro Station	Seoul	Bus bays, Transfer parking place, Bus information sign, etc.
Seoul Station	Seoul	Bus bays, Taxi bays, BIS(Bus Information System), Bus information sign, etc., Escalator connecting to subway
Yeouido	Seoul	Bus bays, Bus information sign, etc.
Cheongnyangni Station	Seoul	Bus bays, Taxi bays, BIS(Bus Information System), Bus information sign, etc.
Suwon Station	Gyeonggido	Bus bays, Taxi bays, BIS(Bus Information System), Monitoring System for Violation of Parking Regulation (CCTV), Bus information sign, etc.
Ansan Station	Gyeonggido	Bus bays. Taxi bays, BIS(Bus Information System), Elevator for handicapped, Transfer parking place, Monitoring System for Violation of Parking Regulation(CCTV), Bus information sign, etc.

For example, in the case of the transfer center at Seoul Station, the submitted works from a public contest to design a master plan of public transport reform in the Seoul Station area were reviewed in October 2005. In November 2006, a research project was launched to design the master and execution plan for public transport reform of the Seoul Station area. From January to April in 2007, the master plan was drawn up and on July in 2007, the execution plan had been completed. The construction for the transfer center was completed on July in 2009 and opened for service on July 25, 2009.

4. Efficacies of the Program

The transfer center has brought about an effect of reducing transfer distances and increasing accessibility by integrating dispersed bus stops into one place, providing convenient connectivity and transfers between modes. The transfer center also contributed to improving transfer functions by providing real-time arrival information via Bus Information Systems (BIS), developing transfer facilities for handicapped persons, and shortening distance among the stations of each mode via direct pedestrian paths.

A comprehensive evaluation of the Seoul station transfer center is as follows. First, after implementing the Seoul transfer center and the exclusive median bus lane on Namdaemun-ro, the average speed of buses decreased due to the changed routes stopping at the transfer center and the lag time while receiving passengers. However, the average speed for other vehicles outside the median bus lane has increased.

Second, as a result of the reform of bus routes due to the Seoul transfer center, bus traffic between the section of Seoul Station and the crossroads of Seoul station concourse has increased. However, traffic of other vehicles on conventional lanes has decreased. This result can be interpreted that the transfer

center might stimulated public transport ridership and had some effects on overall traffic reduction in Seoul.

Third, it can be plausibly assumed that pedestrians would benefit from the crosswalk connecting Seoul Station Concourse and the Daewoo Building as well as the pathway connecting subways and bus stops underground.

Fourth, according to a survey on passenger satisfaction for the Seoul Station Transfer Center, 76.8% of respondents answered that they were generally satisfied with the center. When asked the reasons, 41.5% answered that it is more convenient to use buses and 39.9% answered that it is convenient to transfer. These results lead to the conclusion that the Seoul Station Transfer Center contributed to some quality improvements for Seoul Public Transportation.

Lastly, after the opening of the center, the average number of passengers for each bay at the transfer center showed a general increase. In particular, the average passenger number at bay four increased the most. Also, comparing the passenger numbers over the period of four weeks after the center opening with the figures of after one month later, there was a 12% increase in the passenger number. The reason for these passenger increases for the Seoul Station Transfer Center could be a result of increased transferability between subways, buses, and KTXs, as well as proper advertising.

5. Lessons Learned from Operation of Urban Transfer Center

The success factors of the Seoul Station Transfer Center are summarized as follows. First is the government's determination to carry out the project. Second is the close cooperation between the local government and the operating organizations. Third is the technology development of a connective transfer system. Fourth is the active participation of transport experts in the connective transfer system.

There are still some parts that need to be improved such as transport safety, amenities, and information. According to the survey, 42.5% of respondents answered that the most dissatisfactory factor for the Seoul Station Transfer Center was its complexness, 22.4% answered lack of amenities, and 20.1% answered traffic congestion. Other suggestions and recommended items included transportation security, convenient facilities and system guidelines.

Table 15. Proposed Improvements for Seoul Transfer Center

Classification	Proposed Improvements
Traffic Safety	· Addition of safe pedestrian pass · Barrier for unlawful crossing of streets
Convenience Facilities	· Improving shelter (Sunshine protection facilities) · Adding a pedestrian pass · Trash cans at the transfer center · Rest area at the transfer center (trees)
Information Systems	· Information for metropolitan buses · Bus route scanner · Bus route information signs
Miscellaneous	· Facilities for the handicapped and the elderly

After the implementation of the Seoul Station Transfer Center and the median bus lane on Namdaemun-ro, the average speed for conventional vehicles improved overall. The policy measures have also had positive effects on the improvement of qualitative factors such as transfer conveniences, pleasantness, and safety. After opening the Seoul Station Transfer Center, it appears that the number of passengers has grown due to route adjustment, appropriate advertising for the transfer center, and the connecting routes. Also, it might be plausible to conclude that improvements in transfer convenience for public transportation and changes in the pedestrian traffic flow have affected passenger growth.

In order to evaluate the effects of the transfer center from a broad viewpoint, it is necessary to develop evaluation criteria for efficacy measurements of transfer convenience as well as various evaluation methods. Further, it is required to review and revise policy measures, and execution timing

appropriateness taking into account above mentioned shortfall and transport environment changes. With regard to the design and installation of transfer centers, more detailed considerations for location selection, accessibility, and passenger safety needs to be taken.

Reference

City of Seoul, *"Comprehensive Plan and Detailed Design for Transportation System Improvement around Seoul Station"* [in Korean], 2008.

City of Seoul, *"Motoring for Seoul Station Transfer Center and NamdaemunRo Median Bus Only Lane"* [in Korean], 2009.

7 Quasi-Public System of Bus Operation

Changhwan Mo / Research Fellow

1. Introduction

As one of the most important transport modes, the bus has been working in great role in various cities throughout Korea for the last 40 years. However, the number of bus passengers in most cities has gradually decreased with the rapid increase of private passenger cars. This phenomenon resulted in unstable provision of bus services for citizens. Private bus companies lowered the level of bus services so that they could maximize their profits. “Many routes were highly circuitous, overlapping and not adequately integrated with metro services and routes of other bus companies. Further, most of the private bus firms sought to maximize profits while disregarding rider safety and comfort. For example, bus drivers would frequently skip stops, recklessly race with other buses to pick up passengers, and deliberately avoid picking up elderly and disabled passengers.” (ESMAP, 2011, p.3) Accordingly, the harder it was for bus

passengers to use buses, the quicker they changed from bus to private passenger cars. To counteract this vicious cycle of private bus system in Korea, the Seoul metropolitan government had radically reformed the operation system of buses in 2004 by changing the private bus system to a quasi-public bus system.

According to this system, the local government has to provide financial subsidies for private bus companies based on the mileage (vehicle·km) of the operating companies. Instead, the local government regains the partial authority to control and change bus lines for the benefit of citizens. Under the private bus system, it does not have the administrative power to change bus routes for the benefit of citizens because private bus companies own bus lines as private property. Like Seoul, other cities, such as Busan, Daejeon, Daegu, Incheon, and Gwangju, have also introduced a quasi-public bus system in order to improve the level of bus services and secure reliable provision of bus services.

In July 2004, the Seoul Metropolitan Government (SMG) implemented a comprehensive reform to improve the public transit system, particularly the bus system. "The reform measures address different aspects of the transit system: a semi-public operation was established, with a tendering scheme to contract out route operation; all bus services are restructured in a functional hierarchy of four groups; a distance-based fare system was introduced allowing free transfers between different modes of public transit, with the aid of a new transportation card system; a Bus Management System (BMS) was set up to provide real-time information on bus operation and to help improve operation efficiency; exclusive median bus lanes were constructed for express bus services." (ESMAP, 2011, p. 1) Among the transit reform measures of Seoul, this study focuses on the subsidy payment mechanism of the quasi-public bus system which was the backbone that allowed the Seoul bus reform to be work.

2. Subsidy Payment Mechanism of Quasi-Public Bus System in Seoul

Government subsidies in the bus transportation industry have been introduced to compensate for the market failure of the business. With competition among companies for maximizing profits in business, seeking to operate only in profitable routes, the 'availability-to-use' has been gradually decreased. The lowering rate of bus transport passengers due to the increase of private passenger cars, and the subsequent profit loss also led to decreasing service in general. In the case of Seoul, the subsidies provided to the private operators are intended to compensate for such losses as maintaining service availability and quality, taking into consideration the characteristics of bus transportation as part of a public service, and how it increases general social welfare as a result.

Subsidies are given aiming for the following social benefits (Cho, 2010):

(a) Increase in availability-to-use of public service: The mass transportation service bears in its nature characteristics of a public good, as it comprises the necessity to offer service regardless of profitability, e.g. establishing new bus routes for connecting remote areas or newly established towns, etc. for the benefit of the citizens. This is explained by the non-exclusiveness characteristics of the public good.

(b) The effect of social equity: In modern society, the provision of mass transportation service by the government is mandatory, as it is perceived as a basic right of the citizens. The cost for improving transportation systems for better use by disabled passengers is believed to save costs on a society level, in comparison with the cost that individual provision of transportation might incur. The provision of subsidies is therefore well sustained and a reasonable means to obtain such support from disadvantaged passengers in terms of transportation use.

(c) Reduction of energy and air pollution: Improvement of bus transportation is expected to absorb private car users into the system thus saving energy and waste.

(d) Lowering the cost of living: Additionally, subsidies for transportation have the effect of lowering the cost of living, as it decreases transportation fares paid by individual citizens, compared to when subsidies are not provided. Thus, it might have an effect on lowering factors of the Consumer Price Index, transportation being one of the major cost components of the CPI. Generally speaking, the demand for bus transportation service is much higher by the lower income class than the middle-upper class that can afford to own an automobile or take taxis. The main source of the subsidies being the city and central government's general taxes, it coul be generally inferred that subsidies to bus transportation fares also have an income transferring effect as one of its benefits.

3. Mechanism of Subsidy Payment

The major characteristics of the Bus Operation System in Seoul consist of the utilization of both (1) selection of contractor by competitive bidding for certain main bus routes, and (2) the revenue common management system (also known as the Quasi-Public Operation System) for the rest of the routes.

The city government calls for a bid to select operating bus companies that can operate ten main routes in city areas during a certain period of time, six years. The rest of the companies operate in routes that can be adjusted according to situational necessities, under the "Quasi-Public Bus Operation System". All revenue generated within this system is managed in a single revenue management account. The government has the power to adjust bus routes and the bus companies obtain compensation from the losses for operation in non-profitable routes.

The mechanism of fare revenue common management works in the following:

a) The transportation smart card company provides the Seoul City Government with information on the fares collected, the length of the operation, and other collected data. The company also transfers the collected revenue to the account of the Revenue Common Management Committee.

b) The Revenue Common Management Committee makes a request to the City Government for permission to withdraw revenue and for payment of due subsidies.

c) The Seoul City Government reviews the request based on the analysis of the data collected from the smart card company and the Bus Management System (BMS) operated by the City Government. The amount of the subsidies is decided by comparing total operation costs to the total revenue generated from the bus operation as a whole. Total operation costs are calculated based on the 'standard operation cost' per vehicle and operation kilometers assessed and agreed on by both parties. Total revenue includes revenues from the operation of buses and bus advertisements. If any discrepancy between the Total Cost and the Total Revenue exists, the City Government makes up for the losses in a form of direct subsidy.

d) Once the transfer of revenue and subsidies is approved, the Committee on Revenue Common Management comprised of Bus Companies transfers due shares to each company, according to their operational costs (bus unit ·km) in their respective routes. Managing all revenues in a single account, the system systematically transfers revenues from profitable route operations to make up for losses in non-profitable ones.

Figure 25. Exclusive Bus Lanes in Seoul

4. Roles of Each Party in the System

The Seoul City Government pays subsidies of operation deficit to bus companies so that they can keep supplying stable bus services for citizens. Between the Seoul City Government and bus companies, both the Committee for Revenue Common Management and Smart Card Company act in a critical role to make the quasi-public bus system function properly.

a) Seoul City Government:
- Makes plan for bus route adjustments, calls for bids, calculates standard operation cost, creates evaluation criteria for revenue distribution, etc.
- Monitors operation services and management of bus companies, evaluates performance of bus companies, provides incentives for superior bus companies, etc.
- Provides subsidy when needed, assesses and evaluates operation results by bus companies

b) Transportation Smart Card Company
- Collects data of revenue made by each mean of transportation such as bus and metro

- Provides operation performance results by individual routes and companies

c) Committee for Revenue Common Management

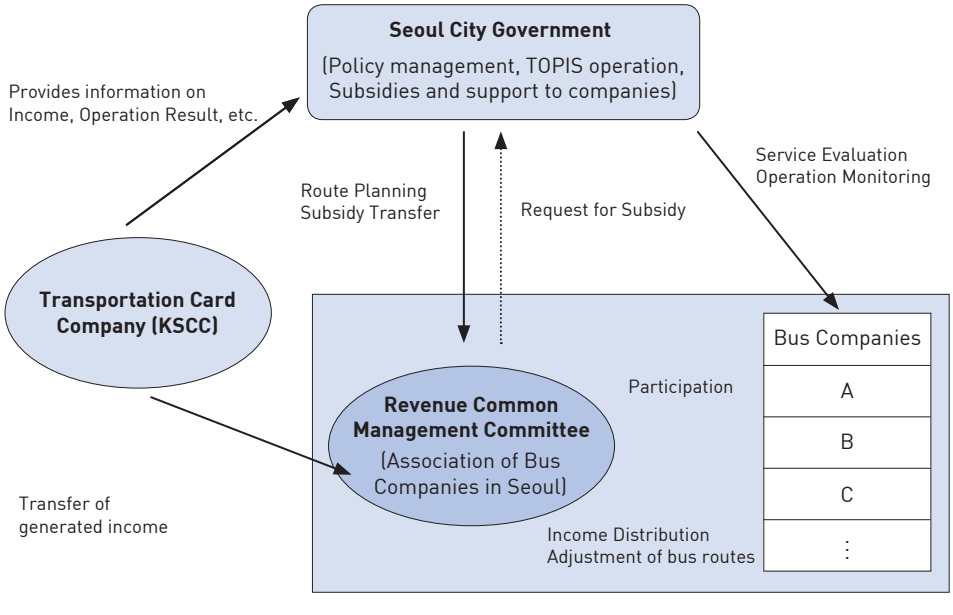
- Manages Operational Revenue account with regard to distribution, calculation, and administrative management
- Negotiates with governmental party when subsidy is required
- Negotiates with bus companies when bus route adjustments are required

d) Individual Bus Company

- Reports the receipt of the distributed revenue
- Reports operation results and provides management data

e) Others: Functional level meeting

- Whenever necessary, functional officers from the city government, transportation card company, and the association of bus companies can join to discuss issues related to the calculation of due payments.



Source: Mo, Changhwan et al. (2009)

Figure 26. Payment Mechanism of Quasi-Public Bus Operation System

5. Effects of Quasi-Public Bus Operation System in Seoul

The Quasi-public Bus System has brought various positive effects, such as increase of bus passengers, efficient change of bus routes, decrease of bus accidents, and increase of bus users' satisfaction, although the local government has to increase the amount of subsidy for private bus companies. In particular, the new bus operation system has increased the stability of bus provision for bus passengers who are mostly captive users.

In Seoul, the change of the bus operation system in 2004 brought the increase of bus passengers from 4,809,000 trips per day to 5,280,000 trips per day in Seoul. The increase of bus ridership should not be accepted as a pure increase of ridership because transfers also increased after the introduction of an integrated transfer discount system in Seoul. However the Seoul bus reform, not the change of bus operating system, has reversed the previous declining trend of bus ridership and, at least, has stopped the decreasing trend of bus ridership in Seoul (Mo, 2009).

Table 16. Trend of Bus Passengers Transported Before and After Quasi-public Bus System

Classification	Before	After	Change (%)
	July, 2003-June, 2004	July, 2004-June, 2005	
Bus passengers transported in Seoul (1,000 trips/day)	4,809	5,280	9.8

Source: Mo et. al., (2009)

At the same time, the introduction of the Quasi-public Bus Operation System seems to have The effect of decreasing on bus accidents. Bus companies are more likely to comply with traffic regulations strictly, with expectations on stable revenue from the operation system, as the City Government monitors their services including the safety of passengers.

In Seoul, bus accidents in 2008 decreased by 49% less than the number of

accidents in 2003, the year prior to the implementation. The colored shield represents the period of the Quasi-public Bus Operation System that was implemented after 2004.

Table 17. Trend of Bus Accidents in Seoul

Year	Seoul (Cases)
2002	8,246
2003	8,177
2004	7,163
2005	5,643
2006	4,832
2007	4,596
2008	4,173
Changes	-49.0%

Source: Cho, 2010.

In Seoul, bus passengers showed a high satisfaction with services after the introduction of the Quasi-public Bus System in 2004. According to a survey, the satisfaction of bus passengers increased from 22.4 percent to 30.4 percent, while the dissatisfaction of bus users decreased from 41.8 percent to 17.5 percent (Mo et. al, 2009).

Table 18. Change of Users' Satisfaction on Bus Services

Classification		Satisfaction	Dissatisfaction
User Satisfaction on bus services	Before (%)	22.4	41.8
	After (%)	30.4	17.5
	Change (%)	35.7	- 58.1

Source: Mo et. al., 2009.

The Seoul City Government has to increase the amount of subsidies for private bus companies from $84.5 million in 2003 to $193.1 million in 2005. This increasing trend of bus subsidies has continued until 2012. Kim and Kim (2012, 63) argued that "productivity went down in terms of distance traveled" and "productivity as measured in terms of the number of passengers can be

said to have deteriorated as well." They also pointed out that "Increased wage levels for drivers were cited as the most important factor that caused the drop in productivity." (Kim and Kim, 2012: 63) However, it is not clear that the quasi-public bus system is the main cause of the drop in productivity and the increase of bus subsidies because the Seoul City Government has not increased bus fares annually and has provided significant discounts on transfers between transit modes such as bus and the metro.

Table 19. Comparison of City Government Subsidy before and after Quasi-public Bus System

Classification	Before (2003)	After (2005)	Change (%)
Subsidy (US$ million)	84.5	193.1	128.5
Subsidy per vehicle (US$)	10,609	24,696	132.9

Note: 1 US$ = 1,150 Korean Won Source: Mo et. al., 2009

6. Lessons Learned From This Unique Bus Operating System

This unique operation system, quasi-public bus system, can be suggested as a compromising operation system for developing countries whose bus operation system is totally private. In most developed countries, the direction of bus reform is from a public operation to a public-private partnership(PPP), such as a competitive tendering system. In contrast, in many developing countries, since private bus companies provide bus services for citizens either without receiving any government subsidies or only with receiving partial government subsidies, the direction of bus reform is oriented from private to public. If the central and local governments completely rely on market forces to execute a structural reform to change their bus operation system from a private system to PPP, bus users can suffer from unstable bus services during the transition process for a long time. Under the market-based restructuring system, the Seoul City Government could gradually recover the ownership of unprofitable bus routes that private companies gave up operations on and operate them under a

competitive tendering system. This transition process from private operations to PPP would take a long period of time.

With the advantage of smooth and gradual transition alternatives from private operations to PPP, developing countries whose bus system is private can seriously consider this quasi-public bus operation system. However, if developing countries are to adopt this operation system, they are encouraged to pay attention to the uniqueness of the Korean license system for bus routes. In Korea, licensed bus routes are legally protected as the property of private bus companies. Due to this characteristic, the Seoul City Government had to adopt the quasi-public operation system to change bus service arrangements, such as routes and frequency, for the public's interest.

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8 Intelligent Transport Systems (ITS)

Yung-Jun MOON / Research Fellow

1. Background

Since 1990s, Korea's economy has grown rapidly as well as the number of registered vehicles. Due to the rapidly rising demand of traffic, a number of problems have been aroused such as traffic jam, accidents, and air-pollution. The intelligent transport systems (ITS) was introduced to solve the traffic problems with limited fund and restricted policies and to utilize the traffic infrastructure efficiently.

In order to solve the problems caused by rapidly increasing automobiles and demand for transportation, the issues in the past were focused on making a policy and/or on developing construction technology to increase the capabilities of highway and railroad. Under the circumstances where the transportation demand is surpassing the capacity of transportation facilities, an alternative way of efficient transportation management is needed by utilizing advanced

technologies. It is the ITS, which represents an advanced transportation with information and communication technology.

2. ITS Plans

In Korea, ITS have been introduced since the early 1990's. In order to promote the ITS program more efficiently in an organized manner, the government designed the first national ITS master plan in 1997. In 1990, the traffic system improvement act was enacted to ensure the legal and the systematical basis.

The master plan specifies the definition of service, strategies, annual budget, and other details to define the ITS architecture. It is based on the principle which will be implemented through a 20-year period and will have a rolling plan of adjusting and amending through evaluation in every 5 years. It has a medium and long term direction and an implementation plan based on the evaluation of each stage.

In this plan, the national ITS architecture has been specified with the scope of services, strategies, and budgets in detail by defining the hierarchical structure of user services such as 7 service areas, 23 services, and 48 sub-services. The seven main service areas include advanced traffic management, advanced public transport, electronic toll collection and payment, traffic information, traveler information, intelligent vehicle and highway, and freight transportation.

The budget of ITS invested by the planning of mid-term period from 2001 is shown as follows; first stage of 2001 thru 2007 with USD 1,158 million, second stage of 2008 thru 2012 with USD 1,139 million, and third stage of 2013 thru 2020 with USD 1,152 million.

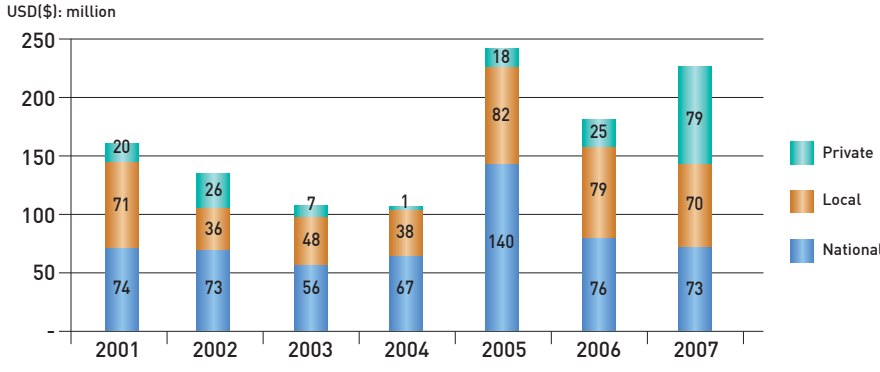


Figure 27. Annual Investment of ITS

Systems Implemented in Korea

● Advanced Traffic Management System

By installing various sensors such as the VDS and CCTVs, transportation status can be collected, processed, and analyzed. It establishes automatic work of controlling signals, managing demand of transportation, recognizing traffic accidents, and managing the overloaded vehicles entering into some specific areas such as bridges. Also, the processed information is distributed to the transportation users in real-time through various media.

● Advanced Public Transport Systems – Bus Information and Management System (BIS)

Based on the information of the public transport operation system, the BIS maximizes the convenience of the users by providing real-time public transport information such as running schedules and transfer information of public transportation.

● Electronic Toll Collection System

The ETCS makes the toll payment automatic for charged roads, thus the inconvenience of payment at the toll gates for the drivers has mitigated by

utilizing a computerized operation system to make payment efficient. Also, the system makes it possible to use one card to pay for buses, subways, and taxis.

● Advanced Traffic and Traveler Information System

By collecting and analyzing various transportation information related to traffic conditions on the roads, the system provides routes guidance and travel time quickly and accurately to drivers through media such as FM radio broadcast devices in vehicles.

● Advanced Vehicle and Highway System

By installing high-tech sensors and automatic control devices which acknowledge traffic situation and obstacles on vehicles and highways, it makes driving semi-automatic in the specific roadway sections, and induces safe driving and intelligence of assistance for drivers.

Model City Deployment Project

In 1994, the Ministry of Construction and Transportation (MOCT)[6] has established the national ITS master plan and enacted "The Transportation Systems Efficient Act" by carrying out ITS related R&D, standard, and pilot projects. In order to activate the ITS business, the ITS Model City Deployment Initiative Project was initiated by MOCT by designating the three types of city; Daejeon city as metropolitan, Jeonju city as mid-size city, and Jeju city as Tourism city.

Project Objectives

- Activating ITS-related industries
- Establishing institutional environments for efficient deployment of ITS business

6. Currently, MOCT became the Ministry of Land, Transportation, and Maritime Affairs: MLTM

- Developing ITS technologies
- Improving transportation systems services

Project Characteristics and Services

- Public-Private Partnership (PPP) Project
- Services systems deployed

System	Daejeon City	Jeonju City	Jeju City
Urban Arterial Traffic Signal Control System	★	★	★
Urban Arterial Traffic Information System	★	★	★
Urban Freeway Traffic Managemnet System	★		★
Urban Arterial Incident Management System	★	★	★
Urban Freeway Incident Management System	★		★
Speed Enforcement System	★	★	
City Bus Information System	※	※	※
Traffic Signal Enforcement System	★		★
Basic Information System	★	※	★
Pre-trip Traveler Information System	★	※	★
City Bus Operation Management System	◦	※	
Urban Highway Tall Collection System	※		
Public Fare Collection System	※	※	
Bus Lane Violation Enforcement System	★	★	
Parking Information System		★	
Car Navigation System (CNS)			※

Note) ★: System by Public Sector ※: System by Private Sector

Figure 28. Characters of ITS Pilot Projects

● Daejeon City

The Daejeon City project has three major outstanding features.

Table 20. Systems Adopted to Deajeon City

System	Scale
VMS (unit)	34
CCTV Camera (unit)	18
Signal Controller (set)	185
Vehicle Detector (unit)	890
Speed Enforcement Equipment (unit)	23
On-Board Equipment (OBE) for Traffic Information (unit)	4,967
Road-Board Equipment (RBE) for Traffic Information (unit)	599
Bus Lane Enforcement Equipment (set)	7
Traffic Signal Enforcement Equipment (set)	7
City Bus Information Terminal (unit)	200 bus stops, 967 buses
Traffic Card	Subways and city buses

It was the biggest system scale among the model cities. About 50% of the total budget was allocated to traffic signal controlling system. Also, the DSRC technology was utilized for the first time in the world to provide traffic and city bus information.

● Jeonju City

In Jeonju city, five out of eleven systems were constructed by the private investors. Also, sharing the same traffic information centers for both of municipal government and the police department of the city ensured more efficient traffic management. Another key factor that the Jeonju city adopted was the traffic card which was devised to be used as a credit card also.

Table 21. Systems Adopted to Jeonju City

System	Scale
VMS (unit)	18
CCTV Camera (unit)	9
Signal Controller (set)	60
Vehicle Detector (unit)	140
Speed Enforcement Equipment (unit)	2
Bus Lane Enforcement Equipment (set)	2
Traffic Signal Enforcement Equipment (set)	7
Parking Enforcement System (set)	7
Traffic Card	all city buses

● Jeju City

Jeju city was selected for its character as the tourists' city and for the fact that it is one of the largest islands in Korea. Therefore adopted services are mostly related to tourism. First, the Car Navigation System (CNS) was adopted for rental vehicles to provide drivers with information on traffic, map, sightseeing, and the weather. Second, the weather information for passing through the mid-slope highways of Mt. Halla was adopted also. Lastly, a special consideration was given for the structural damages by effects of strong winds mixed with salt.

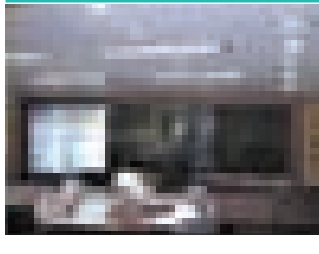
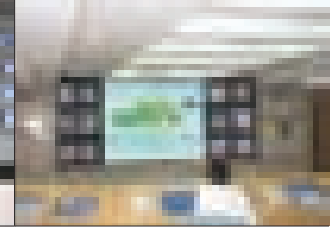
Table 22. Systems Adopted Jeju City

System	Scale
VMS (unit)	14
CCTV Camera (unit)	17
Signal Controller (set)	39
Vehicle Detector (unit)	343
Traffic Signal Enforcement Equipment (unit)	5
City Bus Information Terminal (unit)	200 buses, 150 stops
License Plate Detector (unit)	8
Weather Information Collector (set)	5

● Traffic Information Center (TIC)

The function of the Traffic Information Center is for gathering information from various transport sources, providing information to the drivers and other consumers, and monitoring systems in operation. The various incoming data from CCTV, controllers and roadside equipment are analyzed and interpreted for information. Then the traffic information is provided to the drivers via VMS, internet, kiosks and roadside terminals. Also, the center acts as a troubleshooter by tracking down the operating status of road-side equipment to check for malfunctions.

Table 23. Traffic Information Center

Daejeon TIC	Jeonju TIC	Jeju TIC
		

3. Bus Information Systems (BIS)

Project Overview

- Introduced first at Gwacheon ITS Model City in 1997
- Currently deployed in 61 local cities
- Most popular Service with the highest citizens' satisfaction
- From 2004, BIS inter cities provided by Ministry of land, Transport and Maritime Affairs (MLTM)
- Plan to expand BIS system nationwide
- BIS is operated by the individual BIS center established in each local government
- Provide and share Info with the neighbor local areas

Service Goals

The service goal of the BIS is to provide user-oriented service with information of bus arrival and intermodal transfer time by improving the quality of bus service and keeping the regular bus interval.

For bus users to decrease inconvenience caused by indefinite waiting, the following information is provided: expected bus arrival time, real time bus location, bus route and transfer location, first/last bus, and fare, etc. For bus drivers to improve the service quality by effective bus operation and management the followings are provided: previous/next bus interval, bus arrival, real time status of bus route operation, and traffic accident. For bus companies with improved financial status, the following information is provided; real time bus location and interval, route control and management, scheduling and run-cutting, etc. For administration offices with systematic and highly effective public transportation management, the following are possible functions; scientific bus operation management and provision of high quality of

public transportation and improvement of effectiveness in bus management and administration.

System Architecture

The architecture of the system is consisted with three component including information collection, information processing and analysis, and information provision.

- Information Collection: bus location, events at bus stops & intersection, accidents or incidents by GPS, dedicated short range communications(DSRC), radio frequency (RF) communications , CDMA, Wibro, Wireless LAN, etc.
- Information Processing and Analysis: Bus Operation and Management, Bus Location Tracking, Bus Information Provision, Management of Node & Link, Management of Bus Stop, Intermodal Connection, Equipment Management.
- Information Provision: Internet and/or Web, Mobile Web and App, Bus Information Terminals (BIT), etc.

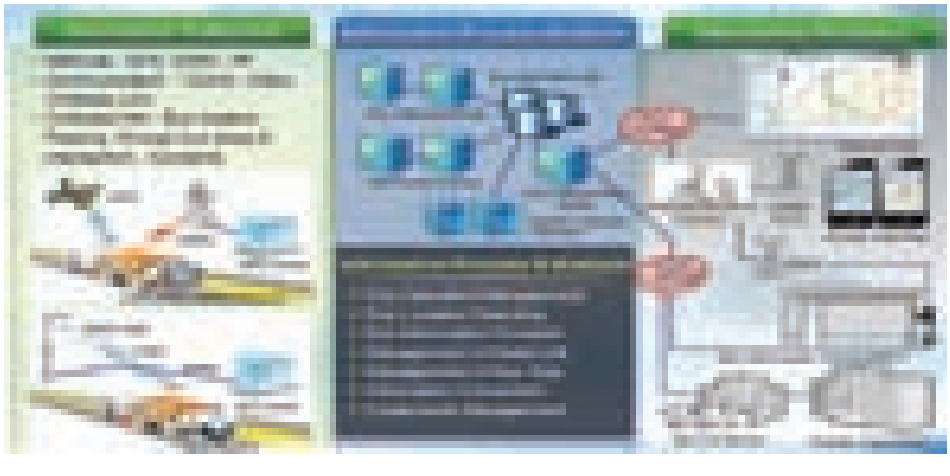


Figure 29. System Architecture

Benefits

Findings by the survey showed that there are high level of satisfaction (average 60~70%) with public BIS service in each local area.

Findings by field operation showed an increased number of passengers and bus riding rate more than 15%.

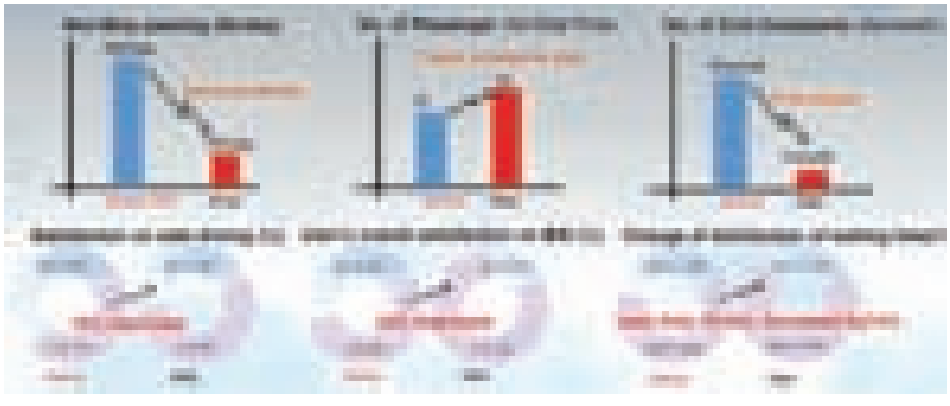


Figure 30. Benefits of BIS

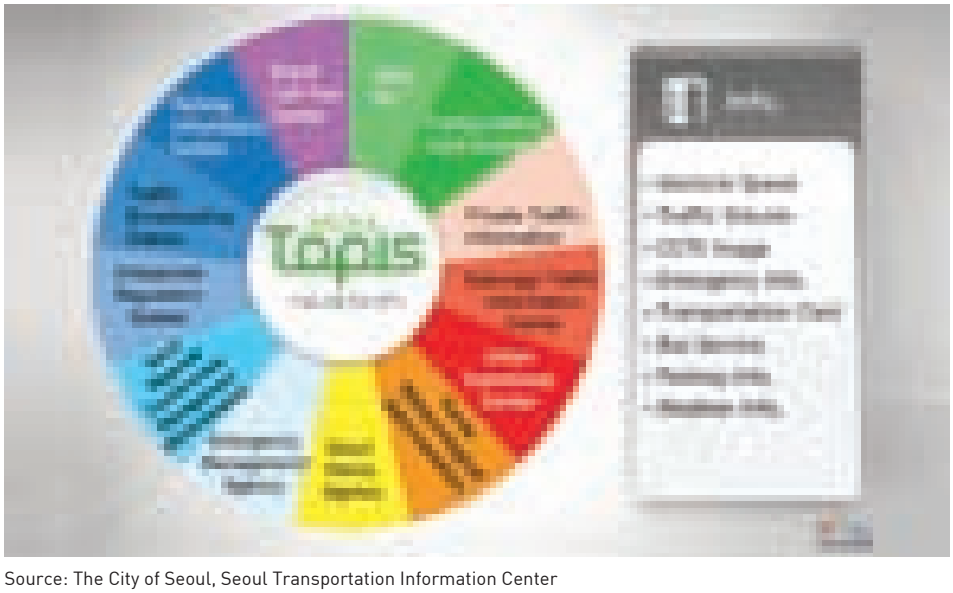
3 Seoul TOPIS

Project Overview

- Transport Operation & Information Service (TOPIS) for integrating a variety of traffic systems in Seoul Metropolitan City
- To Coordinate and reproduce traffic information, conducts scientific operation and provides prompt information as general traffic field service system
- Functions linked with: BIS/BMS, Transportation Card System, Private Traffic Information, Gyeonggi Traffic Information Center, Urban Expressway Center, Seoul Police Agency, Emergency Management Agency, Traffic Broadcasting Station, Parking Information System, Brand Call-Taxi Center,

Unmanned Regulation System, Korea Meteorological Administration, Seoul Regional Construction management Administration

- Information Services: Vehicle Speed, Traffic Volume, CCTV Image, Emergency Information, Transportation Card, Bus Service, Parking Information, and Weather Information



Source: The City of Seoul, Seoul Transportation Information Center

Figure 31. Function of Seoul TOPIS

Service Goals

There are four major goals for the Seoul TOPIS. First is to manage and provide real-time traffic information by monitoring traffic conditions and prompt provision of traffic congestion. Second is to support scientific transportation administration by monitoring bus operations, traffic congestion, and roadway conditions. Third is to manage real-time bus schedule by controlling bus intervals and detour route scheduling. Forth is to operate unmanned regulation system by legislation of exclusive bus lane and parking violation control.

Fifth is to share ideas of up-to-date transportation system by providing transportation information conveniently.

System Architecture

- Data Operation: transportation information process with master data and original data linked with other authorities
- Data Extraction: Converting into a variety of information formats
- Traffic Analysis: Route, Average Speed, Emergency, Traffic Volume, Transportation Card, Route and Administration Area, Days Traffic of the Week, Peak Times and Specific Periods, Accidents/Constructions/Events, BMS Emergency Data
- Public Transportation Card Analysis: Trip and Transit Data (Bus & Subway), Boarding and Alighting, Fare, etc.
- Stakeholders: Policy Decision Maker, System Operator, Associated Agencies
- Urban Traffic Information System

• Bus Operation Management System

• Transportation Card System

Development Plans for TOPIS

The period of development for TOPIS was about 5 years starting in 2005 and completing in 2010. The procedure could be divided into three steps. The first step was integration process (2005-2006). In this period, simple connection system was established such as connection of transportation by authority, and real-time traffic flow monitoring. During the second period, expansion process (2007-2008), an efficient operating system with diversifying information provision media was established, supported development of policy related to Seoul, and provided services for citizens such as BIS, Internet, Mobile, DMB, and TBS. During the last period, which was the completion process (2009-2010), an intelligent integrated operating system with subways and bus operating system was established. Also traffic information hubs on the entire land and parking information system were built.

4. Smart Card System for Public Transportation: T-Money (Data Source: http://www.koreasmartcard.co.kr/)

Project Overview

T-money is a pre-paid RF smartcard embedded with CPU to enable self-calculation. It can be used on every public transportation modes such as bus, subway, and taxi. Since the system was enhanced card security by applying international and national security algorithm, it has been enlarging its service ranges to all parking fees and tunnel fees. Also, T-money is introducing new payment media such as mobile phone, accessory, watch and USB storage, and will keep on increasing various value-added services for the future.

Benefits of T-Money

- Benefit for Citizens: Service Upgrade and Fare Discount
  - Increase in purchasing convenience by expanding transportation services and affiliates (convenience stores, museums, theaters, parking lots, vending machines, and more)
  - Utilizing 24hr-operated convenience stores for immediate recharge and refund service
  - Improvement in security
  - Upgrade in service quality by unifying T-money service center
  - Minimizing civil transportation burden by applying transfer discount policy
  - Applying transportation mileage service

- Benefit for the Government: Efficient Operation and Enhancing Public Interests
  - Efficient and scientific policy making by analyzing Transportation data
  - Operation of feeder/trunk lines
  - Operation of distance-based fare system and semi-public bus operation
  - Clear settlement of fare profits
  - Foundation for high-tech transportation infrastructure like ITS

- Benefit for Transportation Provider: Efficient Management & Increase in Revenue
  - By using scientific T-money data, efficient allocation of bus routes and controlling bus intervals are possible
  - Discount benefit for using T-money makes more people use public transportation

T-Money Service

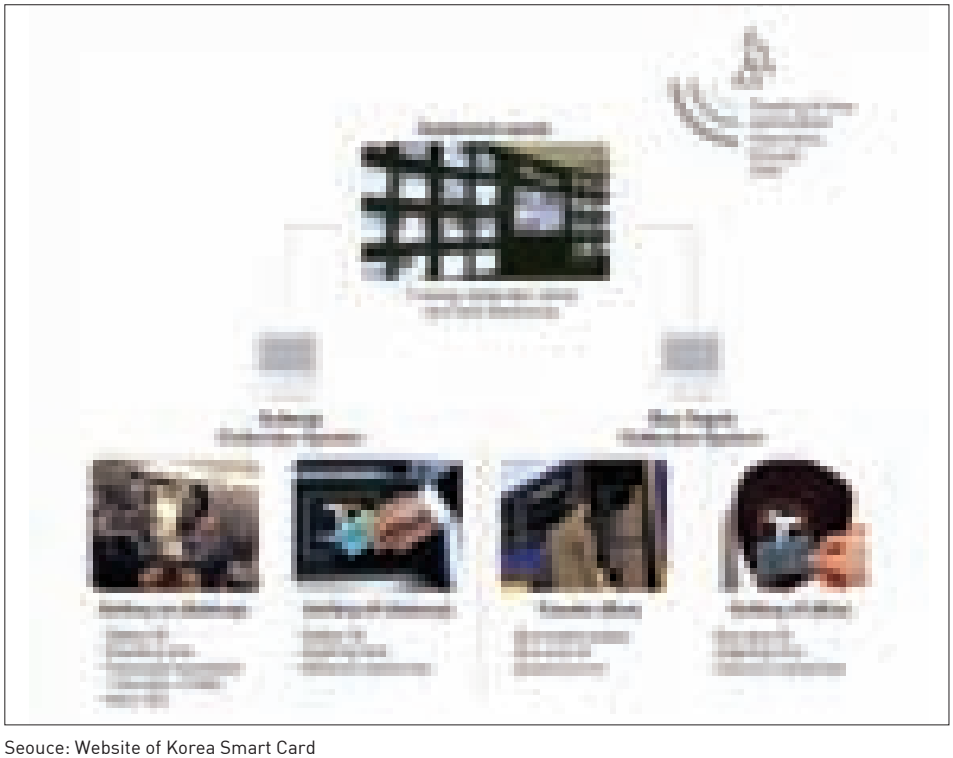
T-money, with the Killer application in the public transport sector, is vastly expanding the service to e-money market, and is providing various beneficial services to customers.

With just one T-money card, one can quickly pay and go at various places without waiting in line for the change, receipt, or signature, since T-money is safe, quick, comfortable, flexible and reliable.

● Transportation Card Function

All the transaction records are transferred and kept for more than one year in the Data Warehouse (DW) which is connected to GIS DB and bus management system DB of Seoul Metro Government.

All the intelligence resources for public transportation management in Seoul are depending on the DW.



Seouce: Website of Korea Smart Card

Figure 32. Concept of T-Money

- E-Money function

Figure 33. e-Money Function

T-Money Card Types

T-money not only provides cards with various functions, but also issue diverse types of accessory type cards for users to easily carry. Especially, Internet T-money, which can be recharged anywhere, is one of the best sellers.

Smart Card Management System

Smart Card Management System (SCMS) manages the whole lifecycle of Smartcard. Also, SCMS provides customers with product management, issuance management, interface with other system (ERP, Customer Services, etc.) and other affiliations.

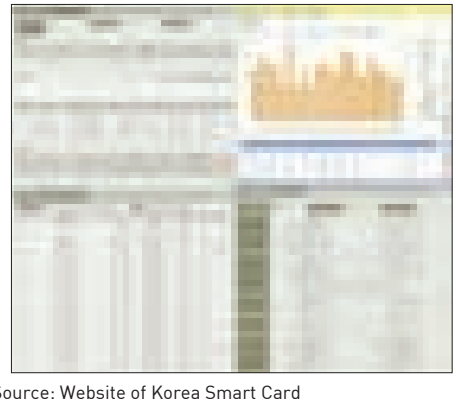
Source: Website of Korea Smart Card

Figure 34. Smart Card Management System

● Public Transportation Solution

Seoul's successful Public Transport Reform Project the would have been impossible without the state-of-the-art IT technology and reliable products. T-money products are high-tech, reliable, secure, and most important, cost-effective.

Special Features



- **Card Issuance Management**
- **Card Lifecycle Management**
- **Card Manufacturing Process and Stock Management**
- **Integrated Quality Control**
- **Secure Key Management**
- **Card Holder Support**

Source: Website of Korea Smart Card

Figure 35. Special Features

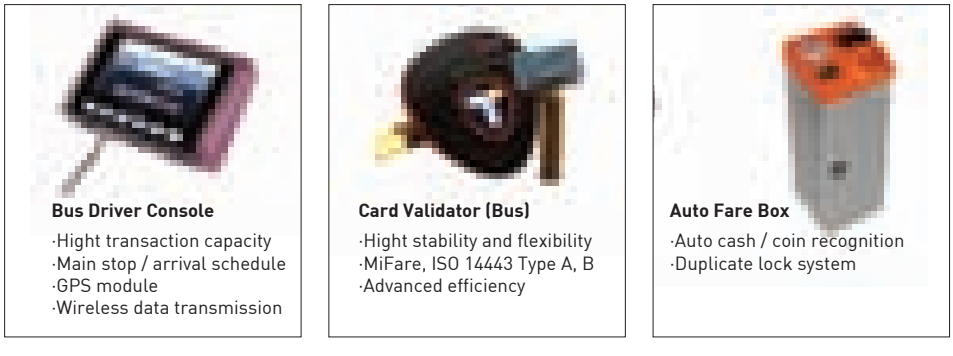
Services provided by Integrated Bus Solution

Source: Website of Korea Smart Card

Figure 36. Business Solutions

● Bus Ticketing System

The benefit of the system is the design of the system for future flexibility and expansion. Unified on-board terminal provides both the bus ticketing and bus management system.

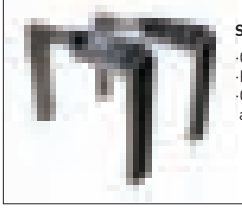


Source: Website of Korea Smart Card

Figure 37. Ticketing System

● Other Solutions in Rail and Taxi Services

Rail Solution



Smart Gate

·Customer-friendly developed as open gate type
·Practical use of enough space between gates
·Contactless card dedicated product with slim and fashionable design

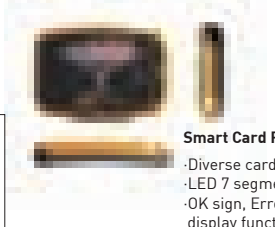
Unified Ticket Vending Machine

·Ticket vending and value reloading
·22-inch Touch Screen LCD
·Auto cash / coin recognition

Taxi Solution

Card Validator (Taxi)

·Integration of card payment, receipt printer, hand-fee, and simultaneous interpreter function
·Navigation function



Smart Card Reader (RF-Pad)

·Diverse card payment
·LED 7 segment
·OK sign, Error sign, fare balance display function

Source: Website of Korea Smart Card

Best Cases in Seoul Metropolitan Area

With over 22 million residents, the Greater Seoul Metropolitan Area depends on the public transport system with 765 bus routes, 9 metro lines and 391 stations. Due to a wide origin-destination spectrum of trip demands, majority of trips can't be completed by a single vehicle or mode.

However, before Seoul Public Transport Reform, metro services and bus routes were not adequately integrated. Fare policy, circuitous bus routes, and extension facilities were not favorable for transfer passengers. It results in the continuing but drastic reduction in bus ridership and sharp increase of passenger

vehicle usage. The rising subsidy needs by bus industry became a grave concern.

In addition to efforts of various aspects, Seoul Public Transport Reform has adopted a new fare policy, allowing free transfer among modes and vehicles. It implies that each passenger may pay distince based fares for the same ride, depending on previous trip records. To execute this policy, an electronic system for unified fare collection and indisputable settlement among operators was essential.

T-money is the name of the system for the solutions. A private company, Korea Smart Card Co., Ltd (KSCC) is the developer and operator of T-money, the smart card application for the mega scale public transportation management.

Chapter 02

9 Innovative Bike Project in Sejong City

Byung-Jung Park / Associate Research Fellow

1. Introduction

According to the Sejong City project, the total bicycle road network will reach up to 354 km when the project is complete. The ratio of the bicycle road length with respect to the area is the highest in Sejong City compared with other cities in Korea. The gentle slope of the terrain makes it easier to use bicycles and the accessibility of the bicycle to the residential and other commercial areas is very high because these areas are located within 1~2km from the transit-oriented orbital road.

Table 24. Comparison of Bicycle Road Length Between Cities in Korea

	Sejong	Seoul	Busan	Daegu	Incheon	Gwangju	Daejeon	Ulsan
Area (km2) A	72.91	605.25	765.64	884.1	1,029.44	501.25	539.94	1,058.95
Bike Road Length (km) B	354	844.74	329.46	548.91	408.63	511	592.7	283.2
Ratio (B/A)	4.85	1.39	0.43	0.62	0.39	1.01	1.09	0.26

In Sejong city, bike parking stations will be designed to match their surroundings and provide shelter from rain or snow, while discouraging theft. Large-scale bike parking stations will be installed to allow systematic management. These bike parking stations will be installed in places where a lot of cyclists visit, such as tourist attractions, parks, intercity bus terminals, department stores, gyms, markets, shops, public places, government offices, schools and so on. In order to ensure safety and convenience of bicycle use, bicycle crossing facilities, traffic lights, signs, and other guiding facilities and amenities are planned to be installed.

Although bicycles are widely considered to be the most viable green transportation alternative, their use has been limited due to weather, lack of exclusive bike lanes, and stop lights that reduce movement speed. These drawbacks require another green transportation system, known as Bike Rapid Transit (BiRT) system.

In this section, the concept, system design, and the benefits of the BiRT system are introduced so that the city of Sejong can take it into consideration as an alternative for promoting bicycle usage in the future. This new green transportation system will help the city achieve the target of public transportation mode share up to 70% by 2030. The contents of this section are based on the study done by the Korea Transport Institute [7].

2. Bike Rapid Transit System Concept

Rapid industrialization and a rising number of automobiles on the road have resulted in the majority of transport programs and policies being focused on cars. Exclusive reliance on high-density development has rendered planners unable to adapt to deteriorating traffic conditions, while exacerbating

7. Hee-cheol Shin and Hunki Lee, A Study on the Bike Rapid Transit System, The Korea Transport Institute, 2008.

environmental pollution. Shift to a new transportation paradigm is required that can provide an alternative to fossil fuel-based vehicle transportation in order to reduce airborne pollution and greenhouse gases. Bike Rapid Transit (BiRT) is a new green transportation alternative. A BiRT system addresses following issues:

- Bicycles are easily affected by adverse weather, and are difficult to ride during summer and winter.
- 'Road dieting' measures reduce existing vehicle lanes, creating additional traffic congestion.
- The majority of bicycle paths in Korea are shared as pedestrian/bicycle lanes, virtually making them impossible for use by bicycles due to collisions with pedestrians and road clutter.
- The lack of a bicycle road network creates reduced speed due to incompatible stop lights.

BiRT can be defined as a transportation mode enabling high speed long-distance travel via a matrix of structures. BiRT is faster than traditional bicycles and public transit at peak times, and allows medium and long distance movement using minimal energy consumption. The BiRT structure is enclosed to be weather-resistant, and the three-dimensional structure with adjustable height allows travel regardless of terrain features. Light and slim construction structure reduces construction and maintenance costs. Video monitoring systems can be employed to track accidents and emergency situations, and existing traffic medians or the surface portion of green dividers can be utilized to maximize space utilizations. Development of an inter-metropolitan (30km radius) transit system can be achieved by utilizing current expressway medians.

Figure 38. Example of BiRT System

3. System Design

System technical issues: Bicycle roads cannot be fully utilized on terrains with gradients exceeding 3%. Due to Korea's hilly terrain, the height of support pillars can be adjusted to create a gradient appropriate for use by bicycles. In regards to technical features for emergency evacuation, the basic features such as emergency exits and ladders as well as CCTV and emergency phone systems must be installed.

Figure 39. Overcoming Terrain By Adjusting Support Pillar Height

Figure 40. Emergency Evacuation System

If two BiRTs intersect, several circular and curved connecting lanes must be created which do not exceed a certain gradient level to create a seamless link between multiple BiRT systems. For improving average speed, several options can be considered: airflow in the direction of travel; adjusting airflow on graded intersections to maintain speed; installing double doors to prevent airflow leakage at entrance and exit portals. To protect from adverse weather conditions, it is necessary to maintain enclosure with transportation barriers. Bicycle traffic signals also need to be installed for preventing collisions and other accidents.

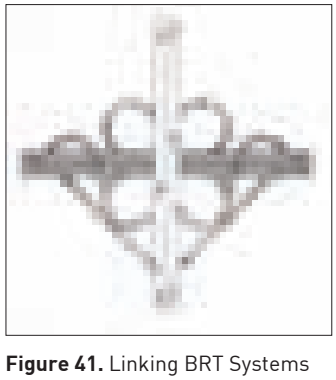


Figure 41. Linking BRT Systems

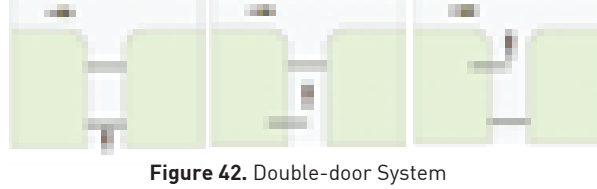


Figure 42. Double-door System

System operation: Initial construction through public financing followed by private operation can ensure low fees. A BTL (Build Transfer Lease) method by using private financing for construction and eliminating fees through public support will increase the number of users. A BTO (Build Transfer Operate) method by using private financing for construction and private operation will create an optimal balance between efficient investment and demand level.

Space utilization design: A BRT system will utilize existing traffic medians or the surface of green dividers, thus requiring no additional land and enhancing urban space utilization. On-ramps and entrance/exits will be installed at a 2nd-story level to increase accessibility, linked with the ground surface via a spiral ramp or mechanical elevator. The tubular tunnels of a BRT system will be installed in pairs when possible, to prevent drag created by bicycles travelling in opposite directions.

Figure 43. Cross Section of a 4-Lane BRT

4. Analysis of Effectiveness

Table 25 shows the comparison of the BiRT system with other systems. Compared to other systems, the BiRT system is low in energy use and has no environmental pollution, lowest management and maintenance costs. It needs small space for construction but provides high capacity. The speed of 25~35km/h compares favorably with other urban transit systems such as buses. It also has

low usage fees and provides significant health benefits.

For energy consumption, the BiRT system has the lowest energy consumption compared to 570kcal/km per person for buses, 80kcal/km per person for subways and new transit systems, and 1,153kcal/km per person for automobiles. There is a significant reduction in air, noise and vibration pollution compared to other transit modes.

In terms of construction costs, it is estimated 5~15 billion won per km which exceeds the construction costs for bus systems (5 billion), but it is lower than that of new transit systems (50~60 billion) or subway systems (100 billion).

Assuming the average speed of 22.9km/h for passenger cars and 17.6km/h for buses and waiting times of 5, 7, 10 and 15 minutes for bicycles, passenger vehicles, buses, and railway respectively, bicycle transportation has competitive advantages of 1~2km distance at average travel speed of 15km/h, 1~5km at speed of 20km/h, and 1~14km at speed of 25km/h.

Since 50% of all vehicle travel in Seoul takes place over distances of less than 10km, a 20% conversion of passenger cars to bicycle traffic for travel distances of less than 10km will create a benefit of saving approximately 700 billion won per year. This saving represents fuel and greenhouse gas reduction calculated by using an average travel distance of 5km for motor vehicle travel of less than 10km per instance, with an average of 8km travel per liter of fuel and CO_2 emissions of 204g per kilometer travelled, and the availability of BiRT systems in the entire Seoul area.

Table 25. Comparison with Other System

		Bike Rapid Transit	Bus	New Transit System	Subway	Automobile (Expressway)
Energy Consumption		22kcal/km per person (Thrust:55,900kcal/h)	570kcal/km per person	80kcal/km per person	80kcal/km per person	1,153kcal/km per person
Environmental Pollution	Air Pollution	None	Significant	Minimal	Minimal	Significant
	Noise	None	Minimal	Minimal	Significant	Minimal
	Vibration	None	Minimal	Minimal	Significant	Minimal
Costs	Construction	5~15 billion per km	5 billion per km (1/20 of subway system)	50~60 billion per km (1/2 of subway)	100 billion per km	25 billion per km (4-lane road)
	Maintenance	Low	Low	High	Low	Very High
	Operating	Low	Low	High	High (Large labor costs)	Very High
Land Use	System	7.6m width / 2m surface width	9m surface width	7.6m width / 2m surface width	Underground	3.5m width (per vehicle lane)
	Garage Facility	1㎡ (1 unit)	16,500㎡ (84 units)	15,000㎡	221,100㎡ (No. 2 Line)	11.5㎡ (1 unit)
	Station Facility	Not Needed	Needed	Needed	Highly Needed	Not Needed
Capacity (unit: persons)		4,000 (4 lanes) (Germany)	10,000~15,000	5,000~30,000	50,000~80,000	7,200 (4 lanes)
Speed		25~35km/h	17.6km/h	30km/h	35km/h	22.9km/h
Construction Duration		-	3~6 months	2 years	7~10 years	3 years
Accidents (Unit: incidence/km per person		-	0.30×10-6	0.004×10-6	0.02×10-6	0.63×10-6
User Fees		Very Low	Low	Low	Low	High
Health Effects		Significant	Minimal	Minimal	Minimal	None

4. Potential Application Sites in Korea

A BiRT is faster than traditional bicycles, is faster than public transit at peak times, and allows medium and long distance movement using minor energy consumption. The BiRT system can be very effective as an alternative to monorails and other transit systems. In this regard, several potential application sites in Korea are suggested here including the city of Sejong.

- The Han Riverside District will become a major transit axis as the optimal site of a BRT system, linking major residential and commercial districts on both sides of the river.

- The planned Yeouido monorail transit system can be replaced by a BiRT linking high-speed bicycle lanes along the Han River park district.
- A BiRT system can be implemented during the planning stages of new cities, such as Sejong, Songdo and Asan, to create an urban transit network linking residential areas in the suburbs with the downtown.
- A BiRT can be a new alternative for linking large metropolitan centers such as Seoul with outlying satellite cities such as Bundang and Ilsan.
- Due to longer distances, these links have traditionally been limited to motor vehicle transportation.
- BRT systems can be used as major arteries to link major cities, relieving chronic congestion on main intercity expressways such as the Seoul-Incheon Expressway.

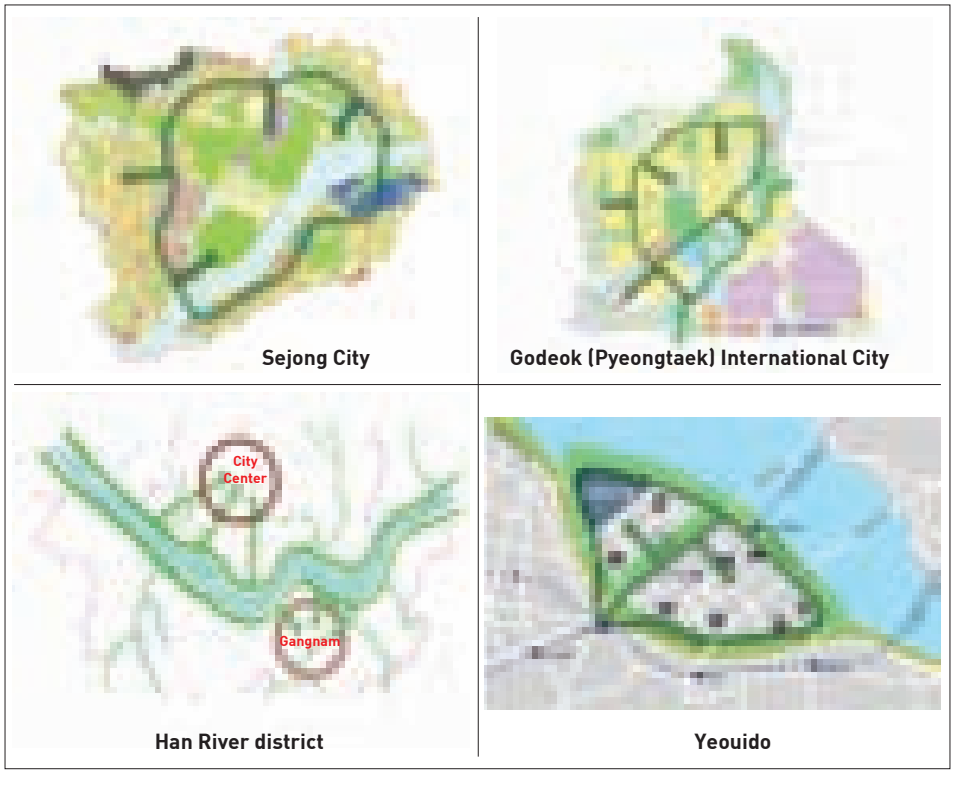
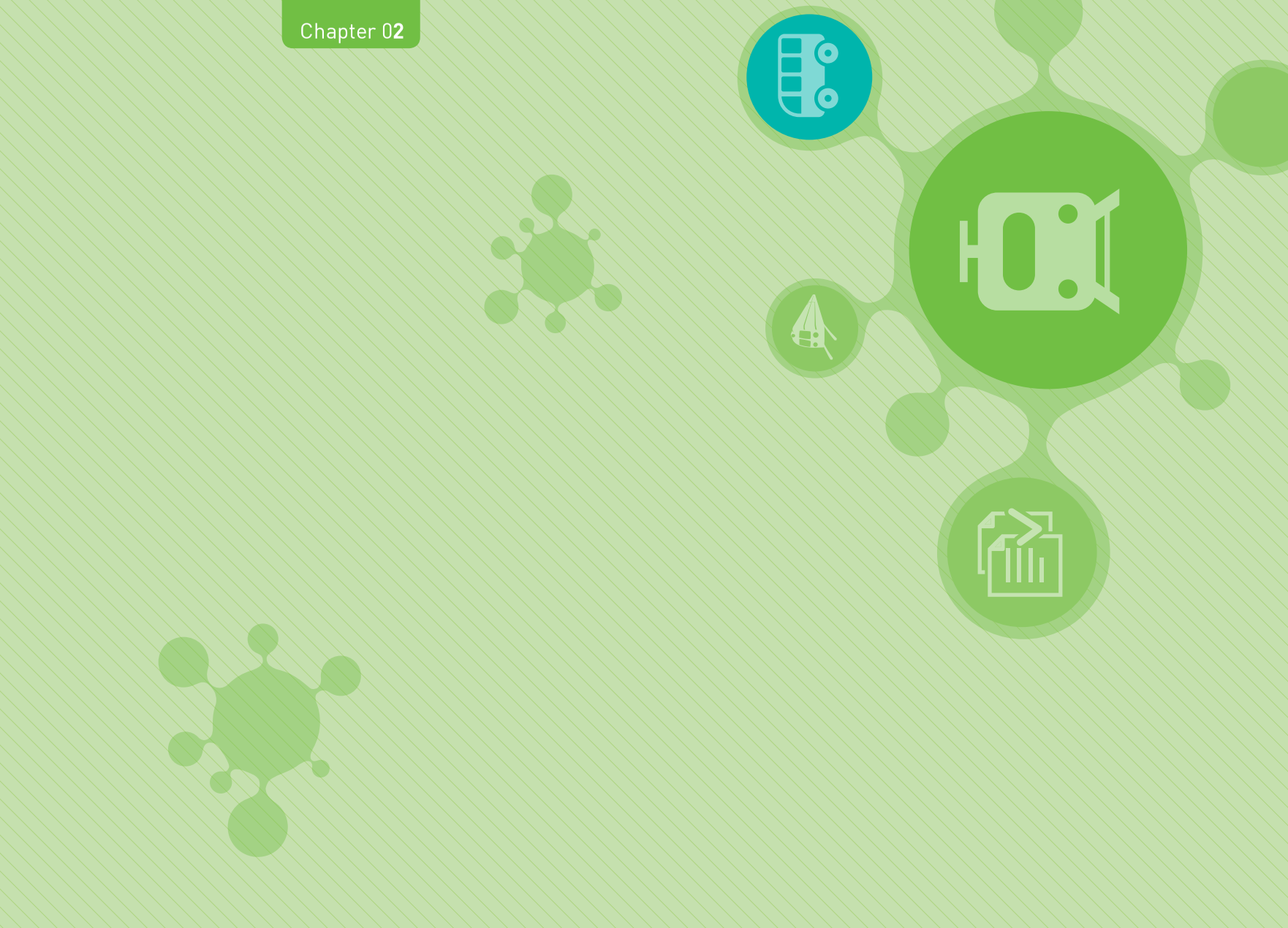


Figure 44. Potential Application Sites of BiRT System in Korea



10 Electric Vehicle in Operation

Sang-kyu Hwang / Senior Research Fellow

1. Introduction

The Clean Vehicle Policy is one of the most important policy topics in the Green Growth Policy which is pursued by Korean government. The average growth rates of energy consumptions for OECD countries have decreased by 0.2% on average, while the growth rates for Korea showed continual increase at an average of 1.7% during the decade from 2000 to 2009. Among the economic sectors, industrial sector accounted for 27% and transport and logistics sector accounted for 19.8% of Korean energy consumption in 2009. When comparing the growth rates of energy consumption in the road transport sector with those of economically advanced countries, the rates for France and Japan have decreased by 0.2% and 1.6% respectively. Even the U.S. who is considered as a high energy consumption country due to the high motorization rates has decreased by 0.3%. However, Korean's energy consumption growth rate has increased by 2.5%.

It might be a plausible conclusion that high energy consumption rates in the transport sector might closely related to the high GHG emission rates. Therefore, Korean government already set reduction targets for GHG emission rates for each economic sector. Among other transport subsectors, the automobile sector has heaviest burden on reducing GHG emission due to its high energy consumption rates.

As a result, in pursuant to decrease GHG emissions, it is inevitable to discourage driving vehicles with fossil fuel dependent engines while to encourage driving vehicles with alternative fuel or improved energy efficient engines. Also, a measure to control traffic demand which discourages single occupancy automobiles is required. In other words, public policies should be focused on improving energy efficiency with advanced technologies or controlling traffic demands with automobiles to reduce overall energy consumption.

This paper reviews major debate issues and current status of electric vehicle policies that is promoting EVs while discouraging vehicles with internal combustion engines (ICE) which run with fossil fuel. Furthermore, this paper will suggest policy directions as well as tasks for Korean EV policies comparing with those of major advanced countries.

2. Current Status and Prospects of EV Policies in Korea

EV Deployment Targets

The detailed EV deployment targets were announced in 2010 written in the report to the President titled ‘Plans for Development and Deployment of Electric Vehicles’. In the report, the EV deployment targets have set as to deploy 1 million vehicles and 2.2 million charging stands by 2020. Also, several policy measures promoting EVs were suggested in a report titled ‘Development strategies and tasks for Green Car Industry’ to the 10th Green Growth Korea

Committee meeting. The policy measures include tax credits and subsidies, Bonus and Malnus, support for charging facility installations, and selecting EV deployment leading cities for pilot projects.

The plan for Clean Vehicle development and deployment has legal ground on the law 'Law for Development and Deployment of Environment-friendly Vehicles'. To comply with the law, each central government has been leading policies within their mission area. For example, the Ministry of Knowledge Economy has been leading policies regarding vehicle technologies for automobiles and their parts. The policy results include launching an EV model "Blue-on" in 2010 and planning mass production plan for semi-sedan EV models. The Ministry of Environment has been granting subsidies and tax credits. Finally, the Ministry of Land, Transport and Maritime Affairs has been providing deployment infrastructures and facilities for EVs including toll fee credits and other amenities as well as vehicle safety inspections for EVs.

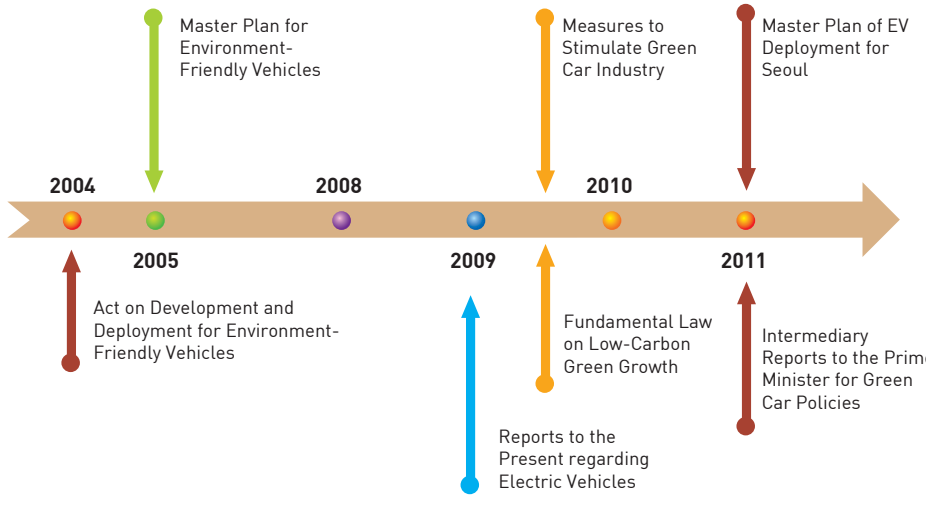


Figure 45. Chronological Display of Clean Vehicle Policies

In the report, a target market share for EVs has set as to take up 43% of Koran automobile market by 2020. The performance standards which are suggested in the 'Plans for Green Growth in 5 Year Span', especially in the section for visions and specific measures, include the number of deployment for green cars and target market shares. Especially , suggested yearly deployment target volumes (accumulative) are 8 thousand vehicles in 2011, 132 thousand in 2013, 877 thousand in 2015, and 1,046 thousand in 2020

Table 26. Green Car Deployment Target (Accumulative, thousand)

Category		2011	2013	2015	2020
Registered Vehicles/Total		18,100	19,300	20,130	22,190
Green Car	Electric	0.8	23.2	129.7	1,294.2
	Hybrid	30.5	78.5	151.5	405.5
	Clean Diesel	330.6	719.85	1,114.3	1,952.3
	Subtotal	361.9	821.55	1,395.50	3,652
Market share for Green Car		14%	17%	21%	43%

Source: Committee of Green Growth Korea, 'Development strategies and tasks for Green Car Industry', 2011. 8

Deployment Status for EVs and Recharging Facilities

Reviewing deployed models in Korea, Neighboring Electric Vehicles (NEV) with maximum speed of 60km/h have been supplied to the public organizations, at the initial stage of the deployment plan. To support the EV policy, the MLTM provided legal ground for driving NEVs on the road by amending the law 'Vehicle Management Law' and announced available roads for NEVs to drive at the end of 2009. Also, in April 2011, the Ministry of Environment announced to supply subsidies to public organization for purchasing NEVs which amounted about 5,780 thousand won per vehicle.

Currently 100 NEVs are in operation for park rangers and maintenance. However, the efficacies of the deployment measures have not yet been proven to be clear due to the high price with unproven vehicle safety and performance issues. After debates among the four government departments including The Ministry of Strategy and Finance, the Ministry of Land, Transport, and Maritime

Affairs, the Ministry of Knowledge Economy, and the Ministry of Environment, they concluded to ban NEVs to enter the conventional roads where the minimum speed is faster than 60km/h. The decision was based on the fact that the NEVs have potentially higher risks of hindering the traffic flow for its lower speed and may have higher damage risks when crashed as well as other safety issues. With this decision, the prospect for deployment rates of NEVs became unclear.

After Blue-on launched in the market, deployment of hi-speed EVs has gotten accelerated and it is expected to deploy 4 thousand vehicles by the end of 2012. To meet the deployment target, the government provides subsidies to the purchasers of EVs for 50% of the price difference, at the maximum of 20 million won, between ICE vehicle and EVs which have equivalent features. Currently, public organizations have purchased 350 EVs (100 of Blue on and 100 of SM3).

Table 27. Korean EV Models and Specifications

Model	Blueon	Change	e-Zone	Cobi	E-Primus
Image					
Developer	Hundai Motors	AD Motors	CT&T	AD Motors	HanKuk Fiber Co., Ltd
Maximum seating capacity	4	2	3 door	3 door	49
Electric motor	61kW	-	7.0kW	8.0kW	-
Length	3,585mm	-	2,570mm	2,900mm	-
Maximum Speed	130km/h	60km/h	60km/h	80km/h	100km/h
Battery	16.4kWh	10kwh	72V-140Ah (Lithium)	72V(Lithium)	102kWh
	Lithium Ion	Lithium			Lithium Ion
Charging Duration	6	-	6~7	2~3	-
Maximum Distance	140km	120km	70km	70~80km	120km

While, the charging infrastructure is one of the essential elements providing convenience for EV operation, the support to build charging infrastructure is not sufficient. Especially, without comprehensive and detailed charging infrastructure deployment plan, the public organizations that purchased EVs have provided charging stands spontaneously for free. 2,500 charging stands have installed in 2012. It is expected that the deployment of charging stand and private charging facility businesses will be stimulated once the overall profitability of EV market shows positive signals to market participants. Eight EV leading cities including Seoul, Jeju and Phohang plan to purchase EVs and install 315 charging stands by 2011 and 680 by 2012.

However, it seems difficult to meet the deployment target for EVs. According to an intermediary report for 'Development strategies and tasks for Green Car Industry' on August 2011, the deployment target for year 2011 was expected to fall in short that the shortages would have to be carried over to the next year. Various reasons have affected the failure to meet the target. The major reasons are such that the action plan may not sophisticated enough for the incentives to be effective or the recipients of the subsidies were limited only to the public organizations. In other words, with decreased private participants' confidence on EV markets as well as on government sides and limited production capacity for EVs, the government may have difficulty in stimulating private sectors to make medium to longer term investment on EV production.

Pilot Implementation of Electric Bus Operation in Seoul

The city of Seoul had deiced to develop EV bus system cooperating with bus manufacturers, since the EV bus has enormous potential to improve urban environment due to its features on reducing air pollutions and noises. Seoul dispatched 5 buses in 2010 and added 4 more buses in 2011 on the NamSan circular route. Seoul plan to extend EV bus services throughout the capital area with 3,800 EV buses. To carry out the EV bus project, Seoul, HanKuk fiber Co., Ltd., and

Hyundai heavy industry signed on memorandum of understanding to develop and operate EV buses cooperatively. Roles of each organization are as follow.

- City of Seoul: Overall project management including deployment of EV bus, Route operation, Set up Infrastructures
- Hankuk Fiber co, Ltd.: Production of electric buses and maintenance
- Hyundai Heavy Industry: Supporting electric bus technology development including motors and inverters

EV technologies adopted to the EV bus project on Namsam circular route are the most advanced technologies in the world. A fast charging stand for the Bus enables the vehicles to charge batteries in full within 30 minutes, and the capacity of the electric motor adapted to the buses was 240kw type which is the most advanced motor technology for EVs.

Table 28. Features of Electric Bus

	Features	Description
Vehicle	Weight	10.7ton
	Size	11m(Length) × 2.49m(Weight) × 3.5m(Height)
	Maximum Seating Capacity	Total 49 (Standing Room for 24, Seats 22, Wheelchair Seats 2, Driver Seats 1)
	Vehicle Chassis	Advanced Light complex Composite Material (Carbon + Composite)
Power	Motor	240kW (322 Horse Power)
	Battery	Lithium ion Polymer (87kWh)
Performance	Maximum speed	100km/h
	Gradability	15 degree
	Maximum Distance by one Charging	84km (at 60km/h)
	Charging Hours	30 min
Other parts		Electric heater, air conditioner, LED light, electric plug-in door

Instead of iron, the material used for electric bus vehicle chassis was carbon fiber complex which has been used only for futuristic concept cars. Adapting carbon fiber complex, the EV bus could reduce vehicle weight by 25% and

so does maximum distance of driving by one charging as well as energy consumption rates. Before launching EV bus, the vehicle passed performance and safety tests and received certificates for automobile safety on Oct. 2010 and environment certification for gas emission and noise on Nov. 2010.

The major advantages of EV buses are that it is an optimal transport mode for reducing air pollution and GHG emissions in urban area, and it has one of the best environment-friendly fuel sources compared with those of diesel and CNG bus vehicles. The authorities are expecting that the EV bus system could contribute to improve air qualities and to reduce noises in Seoul so that it can create a pleasant urban city. Also, the project could contribute to incubate hi-tech green industry as well as to create new jobs.

Table 29. Comparison of Air Pollution Substances

Vehicle Type Pollutant	CO_2	HC	NOx
CNG bus vehicle	150ton	208kg	178kg
EV bus	45ton (at the power plant)	-	59kg (at the power plant)
reduction rates	70%	100%	67%

Figure 46. Electric Bus for Seoul Pilot Project

3. Negative Arguments Raised by Stakeholders

Performance

The major factors that hinder stimulating EV deployment are retail prices of the EV and driving performances to fullfill travel needs rather than design and convenience. However it is assumed that the customer satisfaction for these two elements has been shown negative yet. Currently, average maximum distance to drive by one gas filling is about 300km for ICE vehicles, while that of EVs is about 150km. The developers of the EV-technologies are conjecturing that the maximum distances to drive will be improved to 250km ~ 300km which is equivalent to that of ICE vehicles by 2015. Also, time for refilling gas at current gas stations are about 5 minutes for ICEs, while it takes 30 minutes at express charging stands and 6 to 7 hours at residential chargers for EVs. Therefore, the vehicle performances for EVs are inferior to the ICE vehicles.

Table 30. Performance Comparison for EVs

Category	BlueOn	Nissan leaf	semi-sedan model year '14
Maximum Distance per Charge (km)	140	160	over 200
Conventional/Express Charging (hours/minutes)	6/25	7/30	less than 5/23
Maximum Speed (km/h)	130	140	145

Safety

The government ban on NEVs to drive on roads with maximum speed faster than 60km/h. The reason is that when a car crashe occurs on conventional speed road, NEVs have higher risks to cause human casualties than ICE. A battery safety is also a big issue regarding safeties. Recently, a battery explosion happened for a BYD vehicle in China which initiated debates on battery safety. However, US DOT claimed that there are not enough evidences to conclude on the EVs' higher risks on safety than ICEs. Also, Korean battery developers

claimed that they have secured battery safety. Even though these claims and technology advancement provide some confidence on battery safety, these issues should be paid carful attentions when promoting EV deployments.

Price

The current price of EVs is much higher than ICE vehicles with equivalent features, and it is the biggest barrier for consumers to make purchasing decisions. However, it is expected that EV technologies will be improved enough to obtain price competitiveness to the ICE vehicles after 2015 or 2017. The conjecture is that once battery prices drop by 1/3 from current price in 2017, the price competitiveness will be secured. Also, other than batteries, when motors and inverters become able to be produced in scale, that price will be reduced by 50%.

When vehicles drive 15 thousand km per year, expected yearly operation cost will become cheaper for EVs compare to ICE vehicles by 100 thousand or 150 thousand won due to the oil price for ICE. A domestic market research showed that respondents for a survey are willing to purchase EVs if the payback period is longer than 3 years.

To facilitate convenience for EV operation, basically charging infrastructures such as conventional charging stands as well as express charging stands should be installed. To stimulate EV deployment, several of problems should be resolved such as building charging facilities in the shorter term and electric power overload in the longer term. Charging infrastructures should be constructed in matching with consumers' charging needs in terms of charging duration and service fees. The overload problems are expected to occur once the EVs would be deployed in mass volumes. According to an estimation analysis, it is expected that if 1 million EVs are plugged in at the same time, 1 million kW of electricity will be needed. The 1 million kW is equivalent volume that four GwaCheon sized cities consume at once.

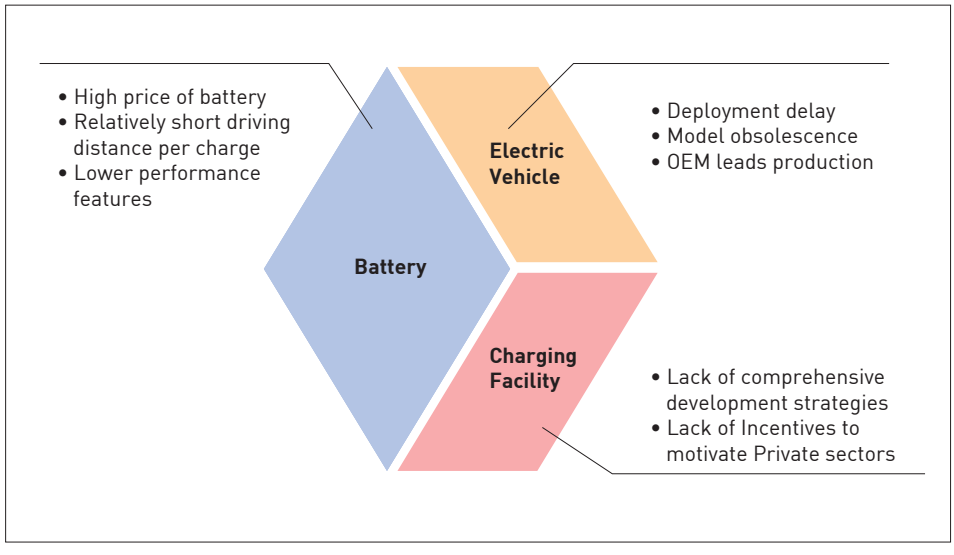


Figure 47. Problems and their Barriers by Category

4. Survey results to set up Policy Directions for EVs

Purpose of the Survey

The purpose of the survey was to gather opinions of EV experts to set up appropriate policy directions to stimulate EV deployment. The questionnaires included issues regarding policy goals and pursuant to the policy speeds for EV development and deployment, timing for EV market border opening to overseas players, related technologies, and government supports. 300 experts in Electric vehicle experts, research and development experts, interest groups, and transport experts are surveyed and 118 experts were responded.

Of those responded experts, 30.8% were involved in vehicle manufacturing industry, 14.5% were in charging infrastructure, and 20.5% were in transportation and road infrastructure industry. Involvement durations are such that 67.2% were involved for more than 10 years, and 20% were involved for more than 20 years.

The survey was carried out for three days from Nov. 30th to Dec. 2nd in 2011 through e-mail and online. The topics of survey questionnaires are evaluation for adequacy of EV deployment targets and policy execution speed, opinions on EV market board opening and priorities of EV policy measures, opinions of prioritizing EV policies, charging and battery tech, and business models and tasks for stimulating EV development.

Major Survey Results

Adequacy of EV Deployment Targets

Suggested EV deployment targets are 1,040 thousand vehicles by 2020, and respondents who think this goal is adequate compare with those of other countries are 42.7%, lower to those of others' are 21.4%, and higher to those of others' are 35.9%

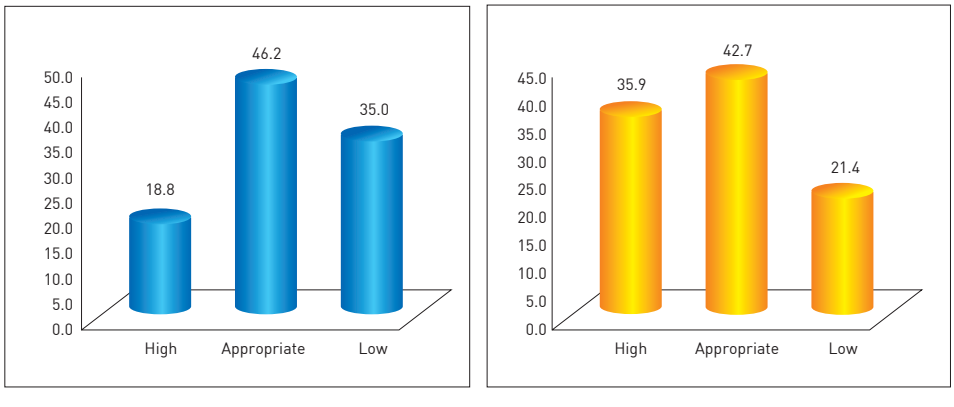


Figure 48. Evaluation on Appropriateness Deployment Target for 2015 and 2020

Regarding preference for places and types of charging stand, 46.6% of respondents selected home and workplace charging stand for conventional types, 36.3% selected public place for express charging stand, and 17.2% selected to install battery swap business type.

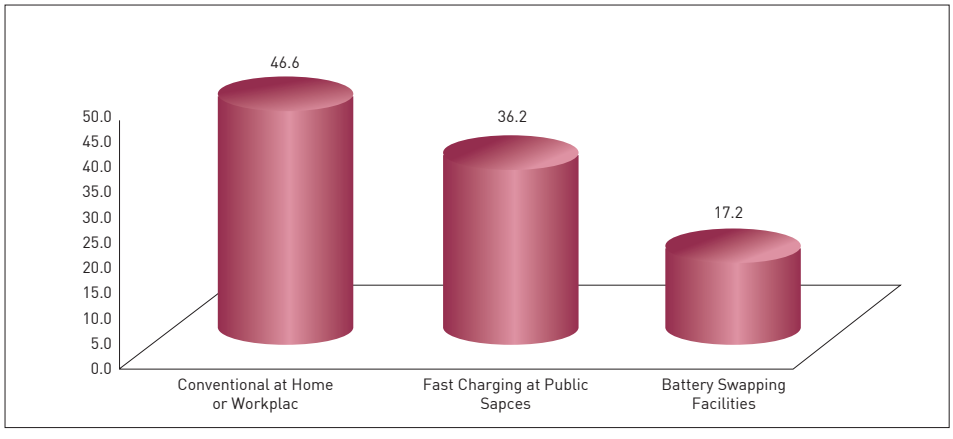


Figure 49. Priority Locations and Types of Charging Facilities

EV Features that Need Improvements

Among EV technology areas, increasing maximum distance per charging (55.6%) and shortening charging duration (36.5%) are the areas that need improvements most.

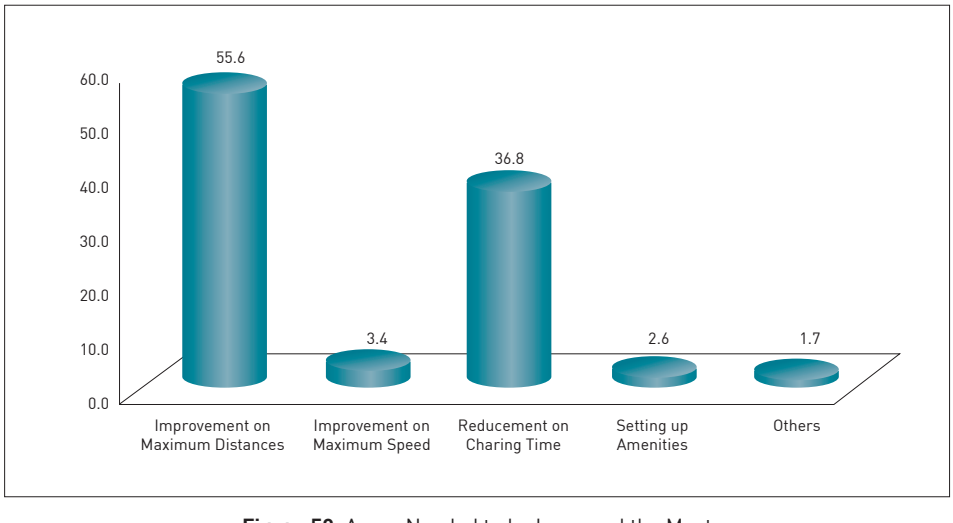
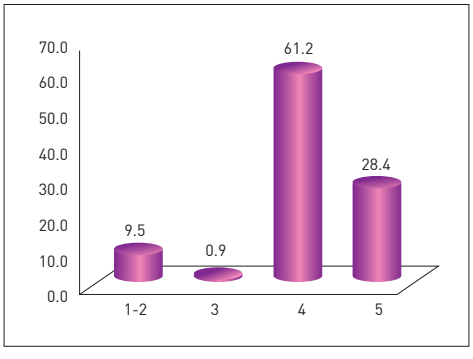


Figure 50. Areas Needed to be Improved the Most

Preference for Electric Vehicle Specification

Among the respondents, 61.2% favored four seats, 28.4% favored five seats, and 9.5% favored two seats. 59.9% of respondents answered that appropriate operation cost per year should be 30% less then ICE vehicle, and 33.6% answered that those of between 30 to 50%.



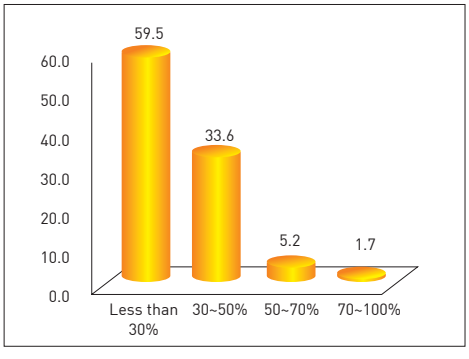


Figure 51. Maximum number of Passengers

Operation Costs Compared to ICE

EV Business Models

28.8% selected taxies and business vehicles for public organizations, and 10.3% selected car-sharing and police patrol vehicles.

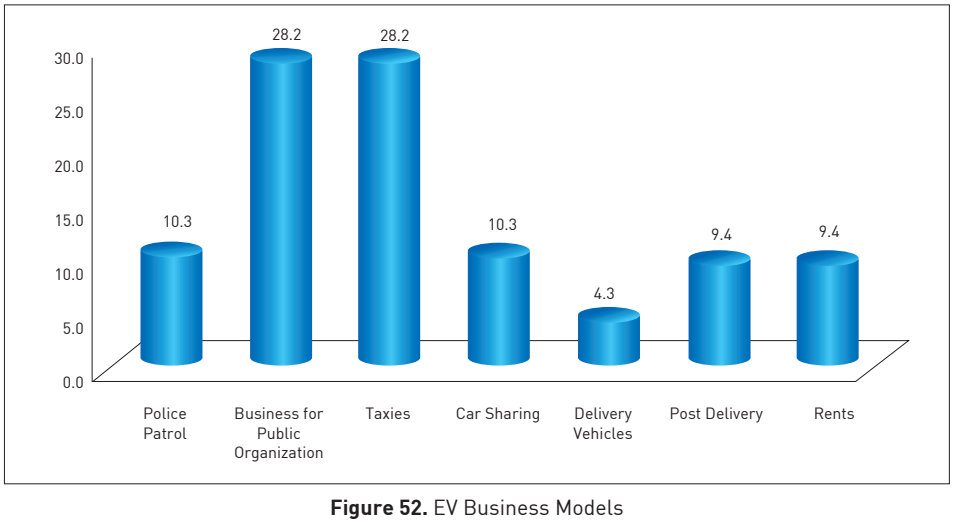


Figure 52. EV Business Models

Policy Implications

Regarding their estimation on appropriateness of deployment target volumes, the target volume for 2015 is higher than their estimations while target volume for 2020 is somewhat adequate. Since the target year has become closer, the prediction for 2015 becomes unlikely to be realized based on the past performance which provens that the predictions for 2015 was overestimated. Therefore, to stabilize market confidence, the government should provide clear targets more likely to be realized.

The primary obstacles in purchasing Electric Vehicles are the price (39%), maximum distance to drive per charging (24.10%), maximum speed (20%), and vehicle sizes (17%). The reason that the price factor has higher effect on purchasing decision can be interpreted that EVs have inferior performance features at the same price with ICE vehicles and vice versa.

The respondents preferred to provide subsidies at some portions. However, measures to provide subsidies should be carefully devised to avoid the side effects which would occur once the government terminates the subsidies to balance national accounts when providing subsidies for such expensive vehicles which also have the cheaper substitutes; the ICE vehicles.

5. Evaluations for Electric Vehicle Deployment Policy

Evaluation of EV Policies and Directions to Reform

As previously mentioned, higher prices compared with ICE vehicles are the major obstacles to deploying EVs. The price difference between EV (BlueOn) and ICE vehicles with similar features are about 20 million won. The maximum distances EV can drive per charging is about 130km which is 1/3 of ICE vehicles. With inferior features compared with predominant ICE vehicles and enough charging facilities have not yet built, it is difficult to stimulate EV markets to emerge without government supports.

Specially, the price of battery takes up a large portion of the high prices of the EVs. Through developing advanced battery technology, overall EV prices might decrease. Therefore, some policy efforts should be allocated in lowering battery prices such as supporting battery technology developments to improve performance and to make mass production become available.

With current EV technologies, the necessary conditions for EV developments are vehicle technologies and charging infrastructures. Even though, necessary conditions would be satisfied, the sufficient conditions should also be satisfied to stimulate the market activities. New business models that reduce EV prices and regulations regarding EV operations are sufficient conditions.

Also, EV policy directions should be extended their interests shifting from domestic market stimulation to global issues such as GHG emission reductions.

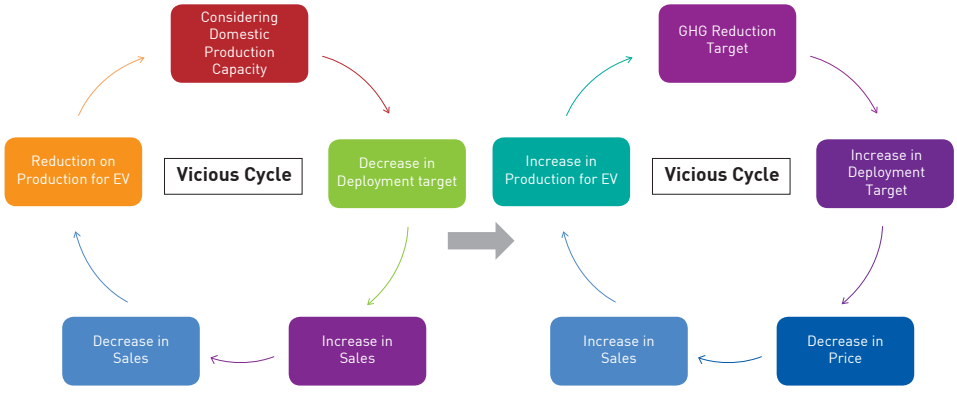


Figure 53. Vicious vs. Virtuous Cycles

Further Tasks

Subsidies on EV Purchases

Currently, overseas countries devised two types of subsidy measures. One is to grant a 50% of the price difference between EVs and ICE vehicles up to a certain maximum amount. The other type is to grant a total subsidy based

on number of EVs sold. If the subsidies are granted for the price difference, consumers who purchase more expensive ones with fancy features would get more benefits which may violates social justice. Therefore, the price difference measures should be carefully devised considering vehicle features such as battery capacities, operation purposes, and prices as well.

The total amount of subsidies should be minimized, and the duration of the grants should be carefully devised until the deployment targets meet or the EV market grow enough to be able to function with the market price mechanism. Therefore, it will be appropriate to grant EV purchase subsidies until the EV market shifts to the mass production phase in 2014. Also the government should devise incentives to encourage EV producers to invest on the EV industry independently so that they would not delay deployment on purpose. Although subsidies on batteries and PHEV could encourage market competitions so that it could strengthen domestic producers' competences, major beneficiaries could only be foreign companies. Therefore, this measure should be implemented considering market conditions.

Tax Credits to Encourage EV Productions

The scales of economy might reduce production costs. For EV market players to benefit from this principle, the demand for EVs should be increased. One of the popular policy measures to reduce EV price could be the tax incentives. Therefore, providing tax credits for business based on the number of EV produced or sold could be an efficient measure. Also, the measure to open domestic EV market to overseas EV companies to reduce EV price needs to be considered carefully, and tax credits currently granted on HEV sales should be extended to EVs.

Automobile Tax Reform for Predominant ICE Vehicles

To encourage EV use, tax on ICE vehicles for its GHG emission or energy consumptions could be an efficient measure. The automobile tax reform plan

which is currently on debate is based on volume of exhaustions, especially CO2 emissions, to encourage more drivers to shift from fossil-fuel vehicles to environment friendly vehicles.

Packaging Policy Measures

To maximize efficiency of the financial support, the government should focus on a few EV projects. However, current policies that granting limited funds to lots of different EV related projects might not be an appropriate strategy to stimulate EV markets within near future. Therefore, granting system should be revised. Also, each of EV relevant projects such as EV leading city project, a charging facility development project, and smart grid project could create synergy effects when connected together. Further, connecting relevant business models such as the EV leasing business, car rental business, and the EV-sharing business to encourage private sector movements may contribute to initial demand for EVs.

Setting up comprehensive plan for charging facility construction

A comprehensive approach is required among relevant government agencies to set up 'Comprehensive Plan to Build Charging Infrastructures' so that it can devise hierarchies based on charging facilities such as within cities and inter-cities or living zones. The plan for installing charging infrastructures should be designed considering charging types such as fast or conventional, major charging time such as day time or night time, and charging areas such as at home, at work, or at some other public spaces.

The measures to reduce installation costs should also be devised. The price of DC fast charger which currently costs 30 to 40 million won per charger should be reduced to 10 million won, and the price of AC conventional charger which currently costs 4 million own should be reduced to 2 million won per charger. To reduce the price, it is required to realize scales of economy for EVs to cover charging costs as well as charger production costs and to improve charger technologies as well.

Table 31. Incentives by the Governments

Stages	Authorities	Descriptions
Tax Credit	Ministry of Strategy and Finance	Income Tax and Business Tax Credits for Charging Infrastructures, Tax exemption for properties including land
		Value added tax credits on Charging Infra Purchase, Depreciation of Standard Purchasing Prices
	Ministry of Knowledge Economy	Permission to install charging stands at Gas stations and battery leasing
Permission for Installation	Ministry of Knowledge Economy	Safety assurance for public charging facilities
	Ministry of Land, Transport, and Maritime Affairs	Installation of charging facilities in apartment complexes
		Compulsory installation of EV charging facilities for new apartment complexes
		Installation of charging facilities on development restricted area

Reference

HongGwan Shon, *"Trends on Electric Vehicle Charging Infrastructure and Direction to Construction"*, in Korean, Korea Electrotechnology Research Institute, 2009.

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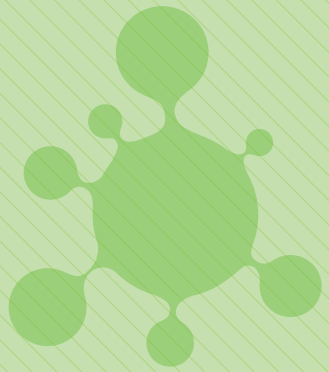

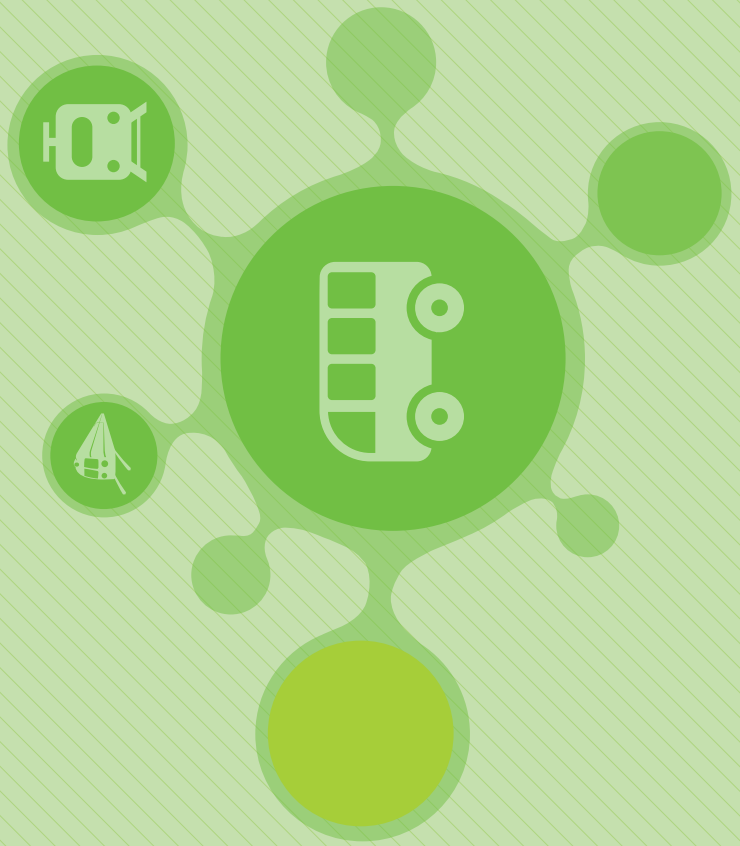

Box 2

Mega Project for Nationwide Integrated Public Transport System in Korea

• Background

The Korea Transport Institute (KOTI) suggested to develop a nationwide integrated public transport system as a device for coordinating transport networks, transport modes, and information physically, economically, and administratively. The ultimate goal of the integrated transport system is to improve passenger convenience physically and economically so that the system could 1 public transportation ridership regardless of the regions they reside in and destinations to travel.

• The Five Principles and Directions

Physical Continuity	· Securing Seamless Transport Network · Developing Transport Modal Connectivity System by Integrating KTX and Inter-regional rail and bus systems
Time Cost Minimization	· Optimize Transportation Dispatch Intervals and Operation Hours to Minimize Transfer, Access and Standby Time · Securing Connectivity for Hub and Spoke
Economic Efficiency	· Ensuring Price Competitiveness for Public Transportation by Providing Transfer Discount, Monthly Fare Plan, and Other Various Fare Plans · Maximizing Convenience for Paying Fare by Introducing a Fare Care Compatible for Nationwide
Convenience in Information Attainment	· Improve Efficiency and Convenience for the Passengers in Providing Information for Transportation Operation, Facilities, and Transfer · Providing Real Time Information for Transportation Operation and Transfer
Administrative Efficiency	· Forming a Inter-Regional Transport Administration for Operation Inter-Regional Public Transportation and Provide Transport Service Facilities · Securing Immediate Decision-Making and Responsiveness for Integrated Operation to Deal With Fare Level, Fare Discount, and Social Conflict Management

Figure 54. Five Principles for Integrating Public Transportation System

Throughout the process of achieving the goal, it is also expected to reduce the consumption of time and resources, the volume of pollutant emission, traffic congestions, and other negative externalities. The mega project is expected to launch in 2013 and complete in 2016 with estimated budget of 1.8 million dollars.

• Detailed Policy Directions for Each Sector

Network Integration

To integrate transport network, revamping public transport system for all of the inter-regional networks in Korea in accordance with the KTX-centered arterial public transport is required. To revamp public transport system, the priority task is to analyze demand trends per route and mode and to develop transfer networks both within a mode and between modes.

Physical Integration

The purpose of the physical integration is to install facilities to provide passenger the convenient transfer options by developing Hub & Spoke/Sub Hub transfer network and Seamless transfer networks.

Hub, Sub Hub, and Spoke networks will be developed at KTX, railroad stations, and regional bus terminals with higher public transportation demands.

Information Integration

To integrate nationwide public transportation information system, there are three sectors in information system including information management system, information providing system, and payment system.

Fare Integration

The suggested system facilitating customer convenience is so-called "One Card All Pass" which will be compatible for almost all of the transport payment system in Korea with some other auxiliary functions.

Institutional Integration

Various interest groups, authorities, and public transportation operators are involved in delivering the public transportation.

The integrated authority will be in charge of coordinating facility installations for bus and other transport, service areas for each mode, and revenue distributions.

Source: Wonjae Jang, "Public Transport", Economic Growth and Transport Models in Korea, the Korea Transport Institute, 2012

Lessons from Transition in Urban Transport Policy

Chapter 03

Perspectives on Green Transport in Korea and Policy Suggestions

1 Green Transport Policy

Sang-kyu Hwang / Senior Research Fellow

1. Goal for Developing Green Transportation System

The goal of shifting predominant car-oriented transport system to the green transportation system is to reduce traffic volume of private passenger vehicles by expanding greener vehicle or reducing commute distances with closely locating work place and residential area.

In order to develop the green transportation system, a holistic approach is needed by engaging transport and urban planning. Recommendable approaches to embody green transportation include transport space development considering their effects on reduction in GHG emission, encouraging eco-friendly transport modes which run with renewable energy, encouraging public transportation ridership, and expanding green transportation modes.

Especially, in stimulating green transport infrastructure development, it is crucial to develop an environment-friendly and public transit-oriented system

that could absorb passengers who may shift from private passenger vehicles. At the same time, some relevant measures should be established such as eco-friendly parking planning by setting up Car free Zones and installing greener parking places.

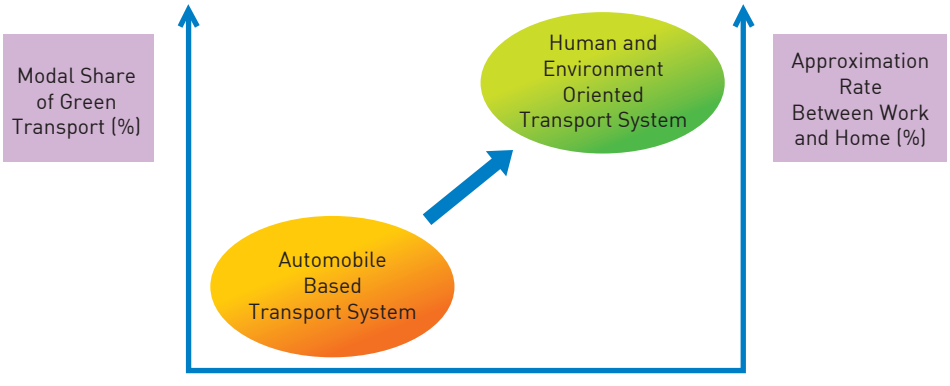

Figure 55. Direction for Future Transport System

2. Strategies in Developing Green Transportation System for the Future

Evolution of Relationships between Mobility and Urban Space

To develop green transportation system in urban area, some considerations should be given to the prospects of urban structures, mobility, and transport technologies so that the green transportation system would be sustainable for the long period of time.

Shape of Society, Urban Structure, and Mobility

The urban space structure will be changed to harmonize with its function. The function of cities might be divided in to three parts such as preservation and revival, communication, and production and consumption. Also, three spaces

including historical space, cultural and information space, and production and consumption space could emerge in matching with urban functions.

The historical space is a space with heritages that needs to be protected for urban revival and cultural diversity. Therefore, the historical space should be developed with green transportation system to respond to traffic demands for tourism and leisure activities. Also, urban spaces are designed with mixed land use measure for locating commercial and residential areas and open spaces. For example, skyscrapers are located in the center of large cities along the major public transportation network, while low-density eco-cities are located in suburbs.

In cultural and informational spaces, communications among residents with various backgrounds would occur, and various cultural information exchanges. To foster the open spaces with cultural ambiance, safe and convenient transportation should be provided for anyone who demands them, in particular for disabled people.

In production and consumption spaces, economic activities would occur focused on service industry. In this space, more efficient transportation system is needed to stimulate economic activities.

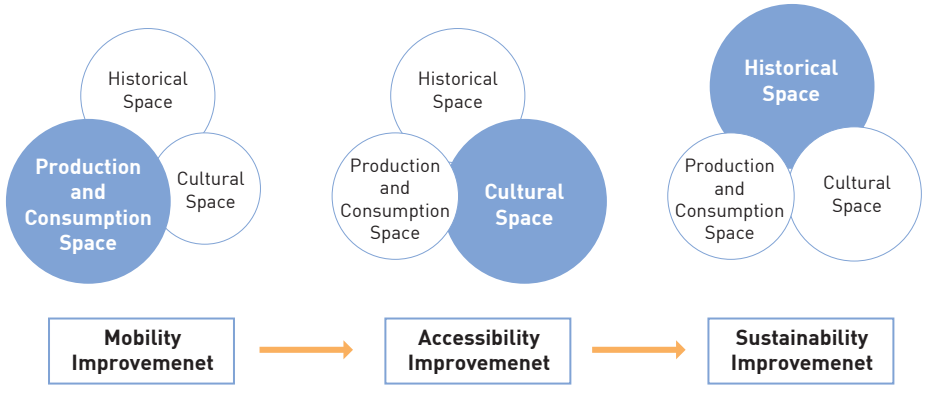

Figure 56. Evolution of Relationship between Mobility and Urban Space

Changes in Traffic Pattern Based on Changes in Socio-economic Structures

As Koreans became affluent and demographic structures changed, their traffic demand patterns have changed. Since the income growth gives Koreans more leisure time that affect work hour patterns, traffic demand for non-peak hours and weekends increased. Especially, the intra-zone traffics in a city have decreased due to the changes in work hour pattern and an increase in mobile office, while extra-zone traffics increased for weekends due to increased leisure activities.

Looking Korean demographic structure, elderly population has increased due to improved quality of medical services. Also, as the Korean society became affluent, the social welfare programs started to benefit disabled people. As a result, traffic demands for elderly and disabled people have increased due to their active participation in the economy, especially demand for the public transport has increased.

Also, recent telecommunication technology advancement have affected forming various trip chains dramatically. SNS enabled passengers to maximize itinerary by providing real time traffic information. Therefore, with reduced travel length, passengers may reduce green house gas emissions in addition to save time and cost.

Changes in Transport Technology

The advanced vehicle and smart transport technologies altered transport pattern dramatically. With the vehicle technology advancement and strict transport demand management, passengers would become prefer car-sharing and small sized vehicles that are equipped with state-of-the-art technologies. Also, as the family structure have changed to form a single or only a couple family, number of vehicles per household would increase.

Korean citizens have started to pay attention to health and this phenomenon has started to affect urban design trends. To meet citizen's needs, cities tend to

expand pedestrian spaces in the center of the city. Also, to protect historic sights and cultural spaces, cities raise the rate of public-transit -oriented districts.

Visions and Policy Goals for Future Urban Transportation System

When devising strategies for future Urban Transportation System, the considered vision was providing convenient mobility and harmonizing transport system with urban heritages. In pursuing future urban transportation policy, the chosen strategies are efficient transportation system supporting city vitality, providing convenient, safe, and barrier free transportation services for everyone, providing environment-friendly and safe transportation system, developing transportation system harmonized with urban features, and improving efficiency in share-based transportation resources. The tasks to meet the goal of each policy strategy are provided in the table.

● Efficient Transportation System Supporting Urban Vitality

To meet the goals of the strategy for developing efficient transportation systems that supports urban vitality, several tasks are presented. They are developing herb & spoke-type public transportation network, introducing advanced and individually customized public transportation services, expanding state-of-the-art BRT system, constructing skyscrapers and underground transportation system, and building traffic volume management system.

● Safe and Convenient Transportation Services for Everyone

The tasks for the strategy of safe and convenient transportation services for everyone are such that; constructing pedestrian and bicycle facilities for any weather condition, information management system for transport facilities to help disabled people utilizing electronic map, developing mobile information system for public transport and stimulating the usage, and providing special public transportation services for transport vulnerable area.

● Future (Environment-Friendly/ Safe) Transportation System

The tasks for the strategy of the future (environment-friendly and safe) transportation system include the one card all pass for any places and any modes, individually customized transportation information services based on real-time information, providing public transportation One Card and integrated information, and developing electric vehicle-based smart transportation system.

● Develop Transportation System Harmonized with Urban Features

In developing transportation system harmonized with urban features, several tasks are involved such as expanding exclusive public transportation Zone, expending urban pedestrian trail, setting up axis of urban green transportation, and Zero-carbon transportation city.

● Improve Efficiency of Share-Based Transportation Resources

To improve efficiency of share-based transportation resources, considered tasks are such that; developing system of share-based vehicles and parking lots, implementing congestion fee system based on HOT, fostering working environment based on smart office, pursuing Moving Office construction, introducing automobile share system, and imposing cap on volume of vehicle carbon dioxide emission.

Table 32. Policy Goals and Tasks for Future Transport Strategies

Strategies	Tasks
Ⅰ. **Efficient Transportation System Supporting Urban Vitality**	· Developing Herb & Spoke-type public transportation network · Introducing advanced and individually customized public transportation services · Expanding State-of-the-art BRT system · Constructing skyscrapers and underground transportation system · Building traffic volume management system
Ⅱ. **Safe and Convenient Transportation Services for Everyone**	· Constructing pedestrian and bicycle facilities for any weather condition · Information management system for transport facilities helping disabled people utilizing electronic map · Developing mobile information system for public transport and stimulating the usage · Providing special public transportation services for transport vulnerable area
Ⅲ. **Future (environment-friendly/safe) Transportation System**	· One card all pass for any places and any modes · Individually customized transportation information services based on real-time information · Providing public transportation One Card and integrated information · Developing electric vehicle-based smart transportation system
Ⅳ. **Develop Transportation System Harmonized with Urban Features**	· Expending exclusive public transportation Zone · Expending urban pedestrian trail · Setting up axis of urban green transportation · Zero-carbon transportation city
Ⅴ. **Improve Efficiency of Share- Based Transportation Resources**	· Developing system of share-based vehicles and parking lots · Implementing congestion fee system based on HOT · Fostering working environment based on smart office · Pursuing Moving Office construction · Introducing automobile share system · Imposing cap on volume of vehicle carbon dioxide emission

3. Guidelines for Developing Green Transport System

Direction to Develop Green Transportation Systems

The future urban transport system should be constructed considering environment-friendly and sustainable road systems, public transport systems, intelligent transport systems, traffic calming methods, multi-dimensional transfer centers, parking spaces, and connectivity and integration of transport-land use-environment-health.

In order to build the future urban transport system, road system should be constructed considering functions, hierarchical systems, and connectivity with neighboring areas. Also, in developing public transport system, the new transport modes and BRT system should be implemented taking into account city sizes and other conditions.

Further, by installing transport transfer facilities including inter-modal transfer centers and park & ride spaces, smooth transferability in intermodal transport should be promoted among new types of transport modes such as passenger vehicles, buses, taxies, bicycles, and BRT. To build pleasant, environment-friendly, safe and healthy, energy saving, and sustainable urban space connecting transport-land use-environment-health-economy, it is required to integrate each sector together at the initial development phase.

Planning Tool Kit for Green Transportation Development

Examples of Urban Design for Public Transit Oriented Development

① **Setting up Districts Exclusive for Public Transport: Transit Malls**

Transit mall is one of the transport measures to vitalize urban centers by locating shopping areas along with public transport routs and reducing traffic congestions caused by private passenger vehicles. In down town of Portland, America, transit malls have been developed. In this zone, accesses of all other transport modes are restricted except for the trams, and both of side spaces along arterial lanes are reserved for pedestrian. Besides arterial lanes where transit malls have been formed, other streets are designated as one-way road to encourage smooth traffic flows.

Figure 57. Example of Transit Mall

② **Developing Public Transit-Oriented Infrastructures**

In Creteil, Southeastern of Paris, public transportation is given a priority in urban design by equipping BRT lane in the center of the road. In both sides of the road, two lanes were reserved for general vehicles and one lane for pedestrian. As a result, the city reduced traffic volume considerably by constructing central arterial lane exclusively for public transportation in downtown where apartments are densely located.

③ **Multi-dimensional Utilization of Various Public Transportation Modes**

It is a policy measure to develop and operate public transit oriented system by building railroad modes under the groundand setting up pedestrian-oriented system on the ground to improve pedestrian accessibility in the downtown area. In La Defense of Paris, the public transit-oriented and the multi-dimensional transport system has been built and in operation successfully that separates pedestrian and vehicle traffics on the ground and under the ground respectively.

Figure 58. Underground and on the Ground figure for La Defense of Paris

Critera for Designing Public Transportation System

The transit mall is a certain district of a city where prohibiting conventional passenger vehicles while permitting green transports such as public transports, bicycles, and pedestrian. It should be developed considering the features and scales of the town or the city. Mostly the public transport exclusive zones are located in the center of commercial and cultural areas of a city hoping for realizing new city life style and smart growth. The facilities such as the signboard are installed systemically to limit certain types of vehicles into the Zone.

Several criteria should be considered in planning for public transportation system. The sizes of a city, other urban conditions, and hierarch of public transportation should be taken into account when deciding primary public transportation mode such as new transport modes, city bus, and BRT system. It is necessary to aggressively adopt the green transportation facilities at the initial stage of an urban planning to develop an energy-saving and sustainable new city. By networking public transport modes that connecting throughout the whole new city area, the network system should devised to deal with various traffic demands for commuting, shopping, and doing businesses. Also, to encourage smooth transfer among new transportation modes such as automobiles, taxis, bicycles, and BRT, inter-modal transfer center should be installed. The major public transportation should be easily accessible from large-scale residential

areas such as the apartment complexes and shopping areas in downtowns. Further, development plan for the new transportation modes should considered depending on the growth trends of population scale, industrial and economic activity scale, and traffic volume by stages.

In planning transport development, the urban features are important factors to determine a type of new transport mode. In case of a single-centered city, building circulation system to connect the inner center within the city is plausible. The considerable transportation systems are Surface Rail (SLRT) and BRT system. The SLRT is suitable as a mode for dealing with circulation traffic volume within the city and BRT system as a mode for linking outer spaces with the city. In case of a multi-center city, developing a system networking sub-centers is plausible. The suitable system for networking inter-city centers is SLRT and LRT, while the suitable system for connecting outer city is BRT and Subways.

Also, if it is a case for a new town in a city, BRT and LRT are suitable modes to connect the new district with last of the preexisted city area. In case of a new city, BRT and Subway are should be prioritized for both considering the independence of the new city and an efficiency of connecting with preexisted city.

Table 33. Criteria for Designing Public Transportation System

Category	Sub-category	Criteria
Public Transportation System	Public Transit Mall	· Setting up public transport exclusive zones where prohibiting conventional automobiles while permitting green transports considering the features and scales of the city · Placing public transport exclusive zones in the center of commercial and cultural centers of the city · Pursuing to realize new city life style and smart growth · Installing sign boards systemically to limit certain types of vehicles in the Zone
	Public Transportation Oriented Infrastructures	· Structuring new transport modes, city bus, and BRT system based on size and other conditions of the city considering hierarch of public transportations · For building an energy-saving and sustainable new city, amplifying green transportation facilities at the initial stage of urban planning · By networking public transport modes that connecting through out the whole new city area, dealing various traffic demands of commuting, shopping, and doing businesses · Encouraging smooth transfer among new transportation modes such as automobiles, taxis, bicycles, and BRT by installing transfer centers · Installing public transportation modes at large-scale apartment complexes and downtowns · Implementation of new transportation modes step by step considering growth trends in population scale, industrial and economic activity scale, and traffic volume
	Transportation Mode Based on Urban Features	· Transportation Mode Based on Urban Features · Surface Rail (SLRT) as a mean to deal with circulation traffic within the city and BRT system as a mean of linking outer spaces with the city are considerable transport system · In case of a multi-center city, building a system connecting sub-centers is plausible · SLRT and LRT are modes to connect sub-centers in the city and BRT, Weight Subway are modes to connect with outer city · In case of a new district in a city, BRT and LRT are suitable modes to connect the new district with pre-existed city · In case of a new city, BRT and Weight Subway are suitable modes for both considering independence and efficient connectivity with pre-existed City

Selection Criteria for Public Transport by City Characteristics and Size

To introduce a new public transport mode, characteristic and size of the city should be considered. Major factors such as population scale, industry and economic activity scale, and traffic volume and its growth trends should be considered.

● Characteristics of Population

Factors relate to population characteristics are scale, population density, and structure. For cities with population less than 0.5 million, either BRT or SLRT is suitable considering the facility construction costs and expected revenue from the ridership. However, subway system is suitable for the cities with population more than one million.

● Characteristics of Transportation Traits

Factors relating to transportation trait are classified as accessibility and mobility. The accessibility to the transportation facilities and mobility means the traffic modal share factors and traffic volume for the city. Also, estimation of traffic demand for commute to workplace and school and for inter-regional demand could allow safe estimation for investing public transport mode since those two types of traffic demand caused most of complaints.

● Characteristics of Urban Structures

Factors relating to city trait are city space structure (whether it is mono or multi-core city), city type (new town type or new city type), and city function (complex city, indstrial city, tourism city). In case of a single-centered city, building circular system to connect inner center within the city is plausible. Also if the city is a new town type, the BRT and the LRT are suitable modes to connect the new district with pre-existed city. While if it is a new city, the BRT and the Conventional Subway are suitable modes for both considering independence and efficient connectivity with pre-existed city.

● Financial Conditions and Local Economic Scales

Financial conditions and local economic scales are important factors. The rates for financial independence of the regional municipals, the availability to support for public transportation subsidies, local income, weight train, and pre-existed debt would be important factors to decide scales and quality of the public transport sectors. Even though these are necessary factors, they are not mandatory factors to consider since financial supports are manageable from channeling funds from various sources such as at the national government level support, public-private partnerships, and loans from the banks.

● Other Factors

Other factors that need to be considered are accessibility to transport for disabled groups, environment and safety issues, the effects on land use, local characteristics, and images of transportation modes. Among these factors, environment and safety issues, effects on land use, and accessibility to transport for disabled group should be stressed.

Table 34. Criteria for Introducing Public Transport Mode by Socio-Economic Characters

Sub-Classification	Detailed Item	Evaluation standards	BRT	Surface Rail (SLRT)	LRT	Conventional Subways
Characteristics of Population	Population	Less than 0.5M				
		0.5M- 1M			■	
		Over 1M				■
	Population density (1,000/㎢)	Less than 15		■		
		15-30			■	
		Over 30				■
Characteristics of Transport demand	Commuting traffic (1,000/day)	Less than 1,000				
		1,000-3,000			■	
		Over 3,000				■
	Inter-regional traffic (1,000/ day)	Less than 5,000	■			
		5,000-20,000			■	
		Over 20,000				■

Remarks: ■ means transportation mode in recommendable criterion and
■ means recommended transportation mode

Table 35. Criteria for Introducing Public Transport Mode by Urban Characters

Sub-Classification	Detailed Item	Criteria
Urban Characteristics	City space Structure	· In case of a single-centered city, building circular system to connect inner center within the city is plausible · Surface Rail (SLRT) as a mode to dealing with circulation traffic within the city and BRT system as a mode of linking outer spaces with the city are considerable transport system · In case of a multi-center city, building a system connecting sub-centers is plausible · SLRT, LRT are modes to connect sub-centers in the city and BRT, Weight Subway are modes to connect with outer city
	City type	· In case of a new district in a city, BRT and LRT are suitable modes to connect the new district with pre-existed city · In case of a new city, BRT and Weight Subway are suitable modes for both considering independence and efficient connectivity with pre-existed City
	City traits	· In case of complex city, BRT, LRT and Weight Subway are suitable modes because population scale is large and traffic demands are high · In case of industrial city, BRT and LRT are suitable because commute traffic ratios form neighboring cities are high · In case of sightseeing city, building Surface Rail (SLRT) and LRT are better to contribute to tourism city image improvement, even though bus is proper for it

Table 36. Criteria for Introducing Public Transport Mode by Finance, Environment, and Accessibility

Sub-Classification	Detailed Item	Evaluation standards	BRT	Surface Rail (SLRT)	LRT	Weight Subway
Finance and Expenses	Financial independence	High				
		Medium				
		Low				
Characteristics of Transport Modes	Construction Expenses	High				
		Medium				
		Low				
	Operation cost	High				
		Medium				
		Low				
	Environment feasibility	High				
		Medium				
		Low				
	Public Transportation Accessibility	High				
		Medium				
		Low				
	Effect on Land Use	High				
		Medium				
		Low				
	Images of transportation mode	Very good				
		Fairly Good				
		Not good				

Remarks: means transportation mode in recommendable criterion and
means recommended transportation mode.

Creating Pedestrian-friendly Transport Spaces by Traffic Calming

The Traffic Calming Method

The goal of the traffic calming method is to shape streets in residential area as safe and environment-friendly transport spaces. In these spaces, the streets can function not only for facilitating traffic flows but also for accommodating social meetings for the neighbors so that humans and vehicles could share the spaces without any constrains. To forge such safe and pleasant transport spaces, it is necessary to adopt traffic calming method in planning new residential and commercial areas where pedestrian traffic volumes are high.

The traffic calming methods can be classified with non-physical and physical methods or education, enforcement, and engineering measures. Non-physical traffic calming methods are those which lowering the speed of vehicles through implementing traffic regulations and control rather than building transport facilities. Setting up speed limits on certain streets such as near the schools and hospitals and speed monitoring cameras could be examples of non-physical traffic calming methods. While, physical traffic calming methods are those which forcefully reducing vehicle speeds through installing facilities. A number of visual facilities are included in the physical methods such as colored lanes for bicycles and signs for narrowing lanes and speed limits. Also, physical facilities such as speed bumps, curb extensions at pedestrian crossings, pedestrian refuges, and pools that separate bicycle and vehicle lanes. These methods can be classified as vertical or horizontal methods by shape of facilities.

By networking roads for non-motorized vehicles which are environment-friendly, energy saving, and healthy transport modes such as walking and bicycling, it is possible to improve convenience for commute, shopping, leisure, and recreation as well as to reduce GHG emission and energy consumption. In order to deal with ordinary traffic demand by bicycles, transport safety facilities for bicycles such as exclusive lanes are needed for safe traffic control.

Table 37. Criteria for Designing Pedestrian-friendly Spaces

Category	Sub-category	Criteria
	Public Transit Mall	· To lower traffic speed in residential and commercial area in new city, adopting various physical and non-physical transportation calming methods · In downtown area with high traffic volume of pedestrians or child safety zone, introducing vertical and horizontal methods and traffic flow shifting methods and separate vehicles and pedestrian with physical facilities
Pedestrian Friendly Space	Pedestrian Road	· Pedestrian road width is over 1.5M in principle · Connecting various amenities within living area · In case of the road is shared by pedestrian and bicycle, distinguishing color and texture and installing mark on the road and signboard · In downtown of new city, designating district only for pedestrian and bicycle · In district of exclusive for pedestrian, prohibiting vehicles in the district as well as stacking stuffs on the road · Planning pedestrian exclusive road by separating pedestrian and vehicle road in the residential area of bio-ecological city · Planning pedestrian exclusive spaces where separated from vehicle · Connecting park and playground within residential complex and locating plantings on median of pedestrian road · Utilizing water permeable pavements and locating pedestrian mall at the center of the downtown for shopping, entertainment, culture, tourism, and community meeting space · Draw 2m of minimum valid width around obstacles on the pedestrian road · In case due to peripheral topographic condition, it can be adjusted up to 1.5M
Bicycle Road Facilities	Bicycle Road	· By networking bicycle transport connecting whole area of a new city, accommodating traffic for commuting to work and school, shopping and business purpose · Building clear traffic flow system so that it won't be disconnected and guaranteeing connectivity with public transportation · Discouraging to build steep road to secure safety of bicycle users · Determine width of bicycle road considering topography or incline of road. For one-way is designed over 1.5m and for both ways is designed over 3m · In case of installing bicycle road, the width should be determined considering facilities on the road, planting, and volume of snowfall. Designing maximum speed of bicycle road abides by guideline regarding bicycle road plan and facilities standards

Appendix

The efforts of the authors dedicated to this publication were rewarded by the fact that some of Korea's best practices introduced in this book were cited in the paper "Cities at a Crossroads: Unlocking the Potential for Green Urban Transport" prepared for discussion at the G20 Leaders Summit in Los Cabos on June 18-19, 2012. The areas that shaded lights on are the policy for a comprehensive action plan for greening transportation, the plan for TOD in the new town of Unjeong, Smartcard fare system under Public-Private Partnership, and Bicycle Sharing program in Changwon City with new bike lane development.

Box 3: Republic of Korea- a comprehensive action plan for greening transportation

In July 2009, the Republic of Korea adopted a National Strategy for Green Growth. The Strategy includes specific actions targeting urban areas, such as the development of eco-cities, green building projects and green infrastructure. A set of policy papers were developed to help local authorities implement the Strategy, including the following Action Plan for Greening Transportation:

- Implement compact city planning principles through transit-oriented development, the development of intermodal transit centers in major railway stations, and the efficient management of densely populated urban centers through cutting-edge technological initiatives, such as the Ubiquitous City or Smart City projects
- Prioritize low carbon infrastructure investments by increasing the share of national spending on railway and restricting road investments by 2020
- Control traffic demand through the expansion of congestion charges in major cities, more efficient road uses (via the Intelligent Transport Systems) and the introduction of a "Green Traffic Priority Region" to manage areas of heavy traffic volume
- Expand pedestrian and bicycle infrastructure through the development of pedestrian priority districts and the construction of 3,114 km of bicycle lanes by 2018 Promote public transit use by expanding bus rapid transit (BRT) lanes, expanding the metropolitan-wide railway and completing the second bullet train line
- Promote transit-oriented develop ment and green transportation through the construction of a Multi-Modal Transfer Center, which entails:
  - Concentrating transport facilities such as railway stations and bus terminals in each multi-modal transfer centre to reduce transferring time/distance by 50% and improve convenience for travelers;
  - Connecting public transport services lines within the multi-modal transfer centers;
  - Developing multi-modal transit centers as multi-functional areas by installing various neighborhood living facilities such as commercial services, cultural facilities and offices; and

- Promoting non-motorized transport (walking and cycling) around multimodal transfer centers by reinforcing regulations including designating public transport exclusive zones or pedestrian exclusive zones.

Source: World Bank and ADB, 2012, "Cities at a Crossroads: Unlocking the Potential for Green Urban Transport", pp. 11

In action…

Korea – Having experienced acute congestion problems in central urban areas, the Republic of Korea has initiated a formal program to promote Transit-Oriented Development (TOD) in new cities. The plan for TOD in the new town of Unjeong is the first of its kind in the Republic of Korea in terms of offering an alternative to standard car-oriented development. The new town will be developed based on two regional public transport networks which will link the new town with Seoul. Within the new town, bus rapid transit (BRT) will be the principal public transport option, with a regional railway offering access to Seoul within 35 to 45 minutes. The Unjeong TOD project is a comprehensive approach to coordinating green development and green transport in newly developing areas in order to reduce traffic congestion, enhance energy security, and reduce environment degradation. TOD in new towns helps achieves two core objectives, accommodating rapidly increasing population growth; and reducing the negative impacts of the transport sector on energy security and the environment.

Source: World Bank and ADB, 2012, "Cities at a Crossroads: Unlocking the Potential for Green Urban Transport", pp. 35

In action…

Korea - Under a Public-Private Partnership, the Korean government has set up a national standard and quality assurance system for smart card fare systems. In general, the private sector in Korea has assumed the lead in system operation since publically-operated systems have not proven to be as efficient. Also, the private sector has the better capability of developing new markets for smart card systems through convenience stores and commercial centers. The public sector's role has been to monitor and control fare levels and to oversee service quality through contractual arrangements

Source: World Bank and ADB, 2012, "Cities at a Crossroads: Unlocking the Potential for Green Urban Transport", pp. 37

In action···

Korea – Changwon City introduced its Bicycle Sharing program in conjunction with new bike lanes connecting most parts of the city. The Bicycle Sharing program was initiated in 2008, and currently boasts 230 bike sharing terminals and 4,630 bicycles. Participants in the Bicycle Sharing system can register at the system's web site with a payment of US$20 per year or US$3 per month. These members are then permitted to use the bicycles for free if returned within a two hire period for each hire. A user survey has indicated that over 86% of the members are quite satisfied with the system. Members responded that they used the program to go to work/school (46.7%), to enjoy leisure activities (27.2%), and to make business visits or others (7.7%). Hence, the Bicycle Sharing System plays a central role in addressing peak hour travel in Changwon.

Dis-incentivizing private car use must be accompanied by well-run and extensive public transport systems and, where feasible, by making non-motorized transportation attractive for short trips. Examples of the latter include the bicycle sharing systems in Changwon and Hangzhou, cycle ways and car-free days in Bogota, Cape Town, and Jakarta, and pedestrian greenways in Seoul and Guangzhou.

Source: World Bank and ADB, 2012, "Cities at a Crossroads: Unlocking the Potential for Green Urban Transport", pp. 38

Transition in Urban Transport Policy

As one of the series publication of KOTI Knowledge Sharing Report, it introduces best practices for urban public transport system developments achieved by Korea … directions and criteria for developing master plans for urban public transport … visions and policy tasks for the future urban transport systems with the hope to contribute to economic development. … some of the best practices for transportation policies were introduced in the report for G-20 leaders' summit in Mexico, 2012

- Quoted from the Preface -

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