ISSUE 23

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Korea's Best Practices in the Transport Sector

New Intermodal Transport Systems in Korea

Edited by KWON Young-jong

THE KOREA TRANSPORT INSTITUTE

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Issue 23: New Intermodal Transport Systems in Korea

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Preface

Transportation infrastructure has played a distinctive role of leading economic development of countries during times of focused national development. As with national economic development, personal income has also steeply increased resulting in rapid growth of auto ownership. This excessive motorization could not be adequately matched with a full-fledged supply of roadways. This has eventually caused increased traffic congestion over many parts of the highway network, suffering under the efficiency of the economy.

The deadlock in highway transportation has shed light on the importance of large capacity public transportation. In recent years, the international community has become more sensitive to reducing greenhouse gas and energy saving as well as green growth, which has raised greater concern over the wavering use of public transportation. However, public transportation has an inherent weakness due to required transfers in completing a journey while private cars provide a convenient door-to-door service. To expedite the use of public transportation, deliberate efforts must be exerted to reduce inconveniences in the transfer process.

This book deals with theories and practice of implementation of intermodal transportation systems by upgrading multimodal transit centers in a manner to effectively coordinate connecting modes and improve the transfer distance. We expect that our experience with the policy of intermodal transit centers will help additional countries develop their own unique policies of structuring efficient intermodal transportation systems.

LEE Chang Woon
President
The Korea Transport Institute

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Definition of Terms

- **Multimodalism:** using multiple modes of transport in a single journey
- **Intermodalism:** interconnected integrating multiple modes of transport to act like a single mode
- **Multimodal transportation:** system comprised of multiple modes arranged in parallel
- **Intermodal transportation:** system in which multiple modes are interconnected to function like a single mode as a whole
- **Interconnected transportation:** system in which multiple modes are connected to each other with relative ease
- **Modal interconnection:** connection between one mode to another to ensure a smooth transfer between modes, sometimes referred to as intermodal connection
- **Modal integration:** similar to modal interconnection, but more inclusive in that it includes an operation synthesis of modes in parallel as well as a combination of modes in an extended way
- **Transit center:** place where a variety of transportation modes merge together at one location to allow an easy transfer to a major transit mode
- **Intermodal transit center:** transit center with a special focus on the interconnection between connecting modes with smooth transfers
- **Intermodal transfer center:** intermodal transit center with an emphasis on the interconnection of modes
- **Intermodal station:** railroad or urban rail station as an intermodal transit center
- **Intermodal Surface Transportation Efficiency Act:** enacted in 1991 in the United States aiming to maximize travel efficiency through setting up a combination of available transportation modes for both freight and passenger transportation
- **National Integrated Transport System Efficiency Act:** originally enacted in 1999, it was affected by the Intermodal Surface Transportation Efficiency Act and later updated to the current version in 2015
- **Transfer facilities:** parking lots, airport terminals, ferry terminals, railroad stations, urban rail stations, and bus stations or bus terminals which help passengers of all

modes conveniently use other routes or modes as specified in Item 12 of Article 2 of the National Integrated Transport System Efficiency Act

- **Intermodal transit complex:** intermodal transit center among a high density development for passenger amenities and urban activities of visitors where transfer facilities and supporting facilities are arranged at one place to support both transfer activities for smooth interconnection between modes and socio-economic activities such as commercial and business lives as specified in Item 15 of Article 2 of the National Integrated Transport System Efficiency Act
- **Supporting facilities:** facilities except transfer facilities to be installed within an intermodal transit complex to support convenience for passengers and visitors, includes neighborhood living facilities, stores, medical institutions, sports facilities, business centers, hotels, tourist and resting places, cultural and convention facilities, and apartment complexes as specified in Item 14 of Article 2 of the National Integrated Transport System Efficiency Act
- **Transfer path:** stretch of the transfer process from point of alighting from one mode to the point of boarding another mode, which may be broadly broken down into several segments: internal, stairway, and outside. The internal segment is again divided into an internal walking-only section and a moving walkway section. The stairway segment is consisted of a stairway-only section, an escalator section, and an elevator section. The outside segment is composed of an outside stairway-only section, an outside escalator section, and an outside walking section.
- **Transfer impedance:** psychological inconvenience in making a transfer from one mode to another
- **Perceived distance:** distance expressed in the disutility of a transfer, reflecting terms associated with walking along a transfer path. Each component distance of the transfer process is evaluated against the internal walking-only path for its perceived distance. Summing up all components will yield an overall evaluation of disutility for the entire transfer path.
- **TOD:** transit-oriented development where land development is often made in a high density area with a transit mode as a central element

Introduction

Section 1

National Economic Development and Supply of Transportation Infrastructure

The process of developing transportation policies in Korea had nearly matched in coinciding with transportation infrastructure equivalent to the national economic development, specifically with construction and operation of the expressway network. The five-year economic development plans were successful throughout each of the six plans since starting in 1962. The rapid economic growth had entailed an unmanageably high traffic volume, which caused congestion problems throughout the highway network in spite of continuing investment in the transportation sector. The excessive traffic congestion was spreading and raised large social issues of transport discomfort and heavily increased distribution costs, which grew in importance as the country was orienting toward increased exports.

A series of expressways opened one after another starting with Gyeongin Expressway connecting Seoul to Incheon in 1969, Gyeongbu Expressway connecting Seoul to Busan in 1970 and later Honam, Namhae, and Yeongdong expressways. The phenomenon reflects rapid industrialization made around remote regions located 300 km to 400 km away from Seoul to the south and south-east direction, including industrial complexes in Gumi, Ulsan, and Yeosu cities.

The rapid industrialization had resulted in rapid growth of auto ownership. The number of nationally registered vehicles first reached one million in 1980. Registered vehicles increased exponentially to 10 million in 1997, and exceeded 15 million in 2005. The transportation infrastructure, taking a longer time to plan and construct, was insufficient to accommodate the ever increasing motor vehicles, and efforts to dissipate converging traffic volume, such as traffic demand management policies, did not keep pace with the speed of motorization. As a result, traffic congestion grew to become an urgent social issue.

Coming into the 1990s, a rigorous investment was made in the transportation social overhead capital (SOC) area to cope with the bottleneck in transportation. It was at this time concerns and investment were concentrated in large-capacity public transportation. In railroad the Gyeongbu High Speed Railway (HSR) project started construction to connect Seoul and Busan while feasibility studies for the Honam and Dongseo high-speed railway lines were launched and other measures were pursued to increase the capacity of the existing rail lines including alignment improvements, double tracking and electrification.

In 1983 a feasibility study on increasing capacity measures was conducted along the Seoul-Busan rail corridor according to conditions attached to the World Bank rail loan agreement. The study was finished with recommendations that by the end of 1990s a capacity increase would be necessary including the construction of high-speed rail between Seoul and Daejeon and other capacity increase strategies for remaining sections. However, these recommendations were set aside for quite some time due to the excessive financial requirements on the government. The plans were shelved until after the Seoul Summer Olympic Games were held in 1988 and the national economy experienced smooth growth. Instigated by these favorable economic conditions, the government set to establish a master plan for the Gyeongbu High Speed Railway. The study identified a construction feasibility to meet the future corridor demand in 2000 and acquire leading technologies involved in the project which the nation would need to command by that time. In the following year, 1990, the project officially began.

Since the 1990s, the size of investment in transportation facilities has continued to increase through the budgets of both central and local government along with bonds and securities. Investment in transportation from 1992 to 1997 increased an average of 20 percent annually, which exceeded the increase rate of the government's financial expenditures.

Section 2

Traffic Congestion and Public Transportation Policies

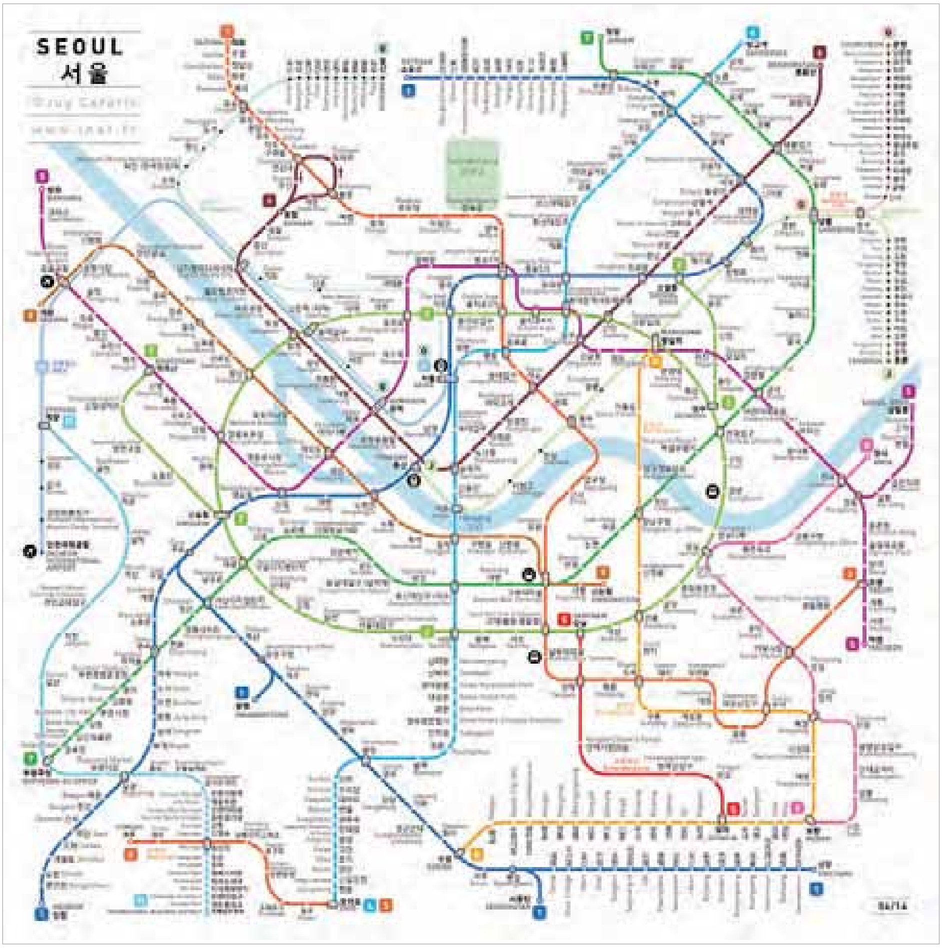
The subway systems drew attention as a solution for traffic congestion during rush hours in big cities whose commuters primarily relied on bus transportation. Coming into the 1970s, subway construction was driven to deal with rapidly increasing traffic volume. As a result, the Seoul Subway Construction Corporation was established on June 8, 1970.

Construction of Line 1 included 7.8 km of track with 9 stations including terminals at Cheongnyangni and Seoul stations. Construction started on April 12, 1971 and operation began on August 15, 1974. Line 2 is a circular line traversing the city with construction beginning in segments from March 9, 1978. The entire line is 48.8 km with 48 stations. Line 3's construction started on February 29, 1980. The section between Gupabal and Yangjae stations was opened in 1985, the section between Jichuk and Gupabal in 1990, in 1996 it was combined with Ilsan Line to the north, in 2010 the final remaining section between Yangjae, Suseo and Ogeum stations was opened and one additional station was added in 2014. Line 4 has a longer history of construction. Its construction started at the same time as Line 3 and the first opening occurred in 1985 for the 28.3 km section between Sanggye and Sadang stations. After that, a 1.2 km section opened Danggogae station past

Sanggye opened in 1993 followed by the 1.6 km section between Sadang and Namtaeryeong the following year. This line merged with Gwacheon Line adding 13.4 km beyond Namtaeryeong to Geumjeong station and later extended another 26 km as it merged with the Ansan Line ending with a transfer to the Suin Line at Oido station. The current Line 4 includes the merging of Line 4 with Gwacheon and Ansan lines and is operated by Korail.

Since 1972, the 1st (1972-1981) and 2nd (1982-1991) Comprehensive National Physical Development Master Plans were established and

Figure 1.1 Route map of the current Seoul Metropolitan Subway



Source: INAT, www.inat.fr

implemented in parallel with the 3rd, 4th, and 5th 5-Year National Economic Development Plans, which focused transportation as a positive strategic tool to take the initiative in the physical development of the country through dispersion of population and industries beyond its short-sighted view as the movement of people and goods. Specifically the reality that an overcrowded Seoul could not be adequately dealt with by the supply of infrastructure ended up with planned cities of Bundang and Ilsan at the outskirts of Seoul in the hope of dispersing incoming traffic to Seoul. Subsequently a large investment was made to construct the Bundang, Ilsan, and Gwacheon lines connecting to these new cities along with construction of subway lines 5, 6, 7, and 8.

The construction of these lines was organized by the Second Phase Subway Construction Corps established on November 3, 1989. The corps transformed into Seoul Metropolitan Subway Corporation which took over operation of these lines. After completion of the subway's Second Phase, the Third Phase of the subway network was planned by the Seoul city government for the purpose of extending line to create new transfer stations and expanding operation. Out of the third phase, the construction of Line 9's express service and the extension of Line 3 were given top priority by the Seoul city government.

Seoul Subway Line 9 opened as an express urban rail connecting Gaehwa station at Gangseo District and Sinnonhyeon station at Gangnam District with Phase 2 extending the line past Sinnonhyeon currently terminating at Sports Complex station also in Gangnam District. It opened for operation in 2009 and its construction was in the form of a profit based, build-transfer-operate type private investment and was the first of this type of subway in Seoul. Ridership of the line is reported as 222,320 persons daily average in 2012.

Section 3

Transportation System Efficiency and Intermodal Transportation Policies

1. Policies for Efficient Transportation Systems at an Early Stage

The bus transportation that had conventionally performed the most important role of public transportation in Seoul was later diminished through a series of adjustments of its service network instigated by the extension of the subway network. Buses had been carrying 7 million passengers daily until 1990 and enjoyed a sizable market share of 43.3%, representing the prime public transportation mode. As bus ridership decreased falling to 36.7% in 1995, 28.3% in 2000, and finally 26.2% in 2005 when it represented the lowest market share in its history with ridership of 4.47 million passengers a day.

In July 2004, an all-out restructuring effort was made to transfer the bus transportation system in Seoul. The outcome included a free transfer system based on RFID transportation cards which prompted an increase in bus ridership as the cards became commonly used. In 2006, the bus share increased to 27.5% with ridership at 4.55 million passengers per day. The current bus transportation in Seoul is under a quasi-public operation, where the Urban Transportation Department of the Seoul city government supervises bus companies which operate their specified routes. The bus system in Seoul comprises of 5 circulating bus routes, 108 arterial bus routes, 292 branch routes, and 43 urban long distance routes totaling 448 routes in which about 7,900 buses currently transport approximately 5 million passengers every day.

1) Interconnection Policies between Bus and Subway Systems through Adjustment of Bus Routes

Throughout the 1990s, major policies for public transportation in Seoul paving the way for a centrally controlled comprehensive transportation system by restructuring bus routes paralleling to subway lines and transforming bus routes into feeder lines leading to the subway, together with full-scaled construction of subways. The prime concern at this time was given to a simple combination of two transportation modes without consideration of ease of transferability, therefore the concept of a smooth interconnection between modes was lacking. Naturally the bus mode share continued to decrease while the subway continued to enlarge their ridership.

There were two fundamental problems in the continued decrease of bus ridership in spite of the efforts to integrate the two major public transportation modes. Firstly the bus and the subway had two completely different systems of fare collection and no room for incentive policies to promote usage such as fare discounts mutually applicable to both modes. As such transferring from one mode to another resulted in an additional fare imposed. Secondly the operators of those two major public transportation modes were different and cooperative work did not function properly. The bus system was operated by licensed private corporations while public corporations under the Seoul city government and city governments of adjoining cities were operating the subway system. This lack of cohesion laid significant limitations on cooperative action including adjustments or integration of routes competing with each other. Hence the effect of the comprehensive public transportation policy was limited and still needed significant time and effort to solve these problems.

2) Integration of Fare Collection Systems for Intermodal Transportation Systems

In order for a public transportation user to go to the final destination, he or she has to be able to select the best combination of available modes, which necessitates an easy transfer between the subway and a bus or among buses. For securing an easy transfer, the transfer between modes must be easy physically and ensure no additional fare burdens. The basic direction of bus route adjustments was such that the subway, when available, is made an arterial and the paralleling bus route is to be transformed into a feeder service to the subway to allow easy access to subway stations. This policy was premised on an assumption that an easy connection should be guaranteed between buses and the subway and a fare is to be imposed on only one mode or at a drastic discount.

As the IT industry advanced, the Association of Seoul Bus Operators officially launched the bus card system based on a pre-paid electronic fare payment card on July 1, 1996. In May 1997, the subway transport card based on Kookmin Bank credit card was introduced for usage in the Seoul Metropolitan Subway system. The electronic payment card system applied was simply one of several fare payment methods available due to its convenience in payment. Although the technology could allow for an integration of fares for different public transportation modes, the concept was lacking at that time. There were other bus fare payment methods long practiced including token tickets, student coupons, and cash while riding the subway required the use of special subway tickets. Therefore the newly introduced electronic payment system showed very low usage in the beginning and its widespread use was believed to be off in the distant future as other payment methods were long established and riders were unexperienced with the new system.

With the end of elections, new local government officials took office in July 1998 and viewed integration of fare payment cards as a priority among flagship policies. At the time, many civil appeals had been filed for inconveniences caused by the application of separate electronic transport cards for different public transportation modes in Seoul. The new city government decided to integrate these separately introduced systems with incompatible technology, and combine bus and subway cards into a mutually exchangeable system so that the foundation for a transfer fare system could be formed by adopting a discount fare policy to result in a reduced burden of transfers from one mode to another. The integrated card policy eventually lead to abolishment of all other existing payment methods and was enforced with the adoption of a drastic discount policy for card use resulting in expedited adaption rates in a short period of time. The proportion of card use for fare payment was less than 30% in 1998 and rose to over 70% by 2000 when the two cards were merged and fare discounts were applied for transfers between public transportation modes.

The bus card of the Seoul bus system began interchangeable use with the subway system on January 20, 2000 while the Kookmin Bank card initially intended for subway usage became interchangeably with the Seoul bus system on June 5, 2000, marking full use of integrated cards on both the bus and subway systems. Thereafter any one of the two fare cards can be utilized to pay a fare on either the bus or the subway and a free to reduced transfer rate can be applied to the latter mode at the time of transfer due to the identifiability of the former mode one is transferring from.

2. Advent of Intermodal Transportation Policies

1) Transport System Efficiency Act

As previously mentioned, the speedy growth of auto ownership from 1985 has led to serious traffic congestion at urban areas entering the 1990s. The Korea Transport Institute evoked national concern by showing the social costs caused by traffic congestion would amount to about 19 trillion won in 2000. Up to this time urban buses had been a primary public transportation mode and traffic improvement efforts had been primarily focused on the widening of roadways and extension of bus routes. However, the rapid increase in urban land prices made the widening of roadways more difficult with time. The situation was strained to remain under budget and alternatively focused on urban transportation policies toward initiatives centering on buses and the subway.

While the traffic congestion in urban areas became an important social issue, the Ministry of Transportation (currently the Ministry of Land, Infrastructure and Transport) took action to enact the Urban Traffic Readjustment Promotion Act from 1985 for the purpose of establishing urban transportation systems in a systematic way. Under this law the Ministry tried to efficiently manage and operate transportation facilities and industries to keep a smooth traffic flow in the urban transportation system. It also set up the Korea Transport Institute in 1986 as prescribed by the said law, which was entrusted with responsibilities to conduct necessary transportation studies, establish required transportation plans, and develop transportation policies for the government.

The Urban Traffic Readjustment Promotion Act triggered a change of the direction of urban transportation policies from formerly focusing on expansion and turned toward management oriented policies such as increasing the efficiency of existing facilities and controlling travel demand. Many attempts were tried including various transportation systems management (TSM) strategies to focus on smoothing the traffic flow and travel demand management (TDM) tactics such as a parking demand control, a toll applied at tunnels, and voluntary parking restrictions based on licensed plate numbers. These efforts for increasing the efficiency of transportation systems were further strengthened later by positive application of the intelligent transportation systems (ITS) technologies. ITS policies were adopted by the SOC investment planning corps as official government tasks, which added a driving force to the new policies. As a result, a national ITS master plan was established in 1997 and the Transport System Efficiency Act was enacted to support the master plan in August 1999.

This enactment was created from overall efforts of TSM and TDM strategies applied, derived from a common understanding that transportation investment alone cannot match effectively with ever-increasing travel demand and therefor more practical measures such as demand control policies should be institutionalized. However, these efficiency-raising efforts had been concentrated separately on each individual mode. Problems were diagnosed for buses, subways, and personal vehicles individually, which led to developing policies for treating the individual symptoms. To reduce traffic congestion, various policies designed to constrain the use of personal vehicles were developed as well as policies for improving the traffic flow by increasing the supply of parking lots and stronger enforcement of TSM strategies. Mode-specific improvement was the main target of treatments such as reducing inconveniences associated with using buses and subways to increase patronage and bus route adjustment to easy access to the subway.

The Intermodal Surface Transportation Efficiency Act was enacted in 1991 in the United States. It aimed to significantly maximize travel efficiency by a composite mode through setting up a best combination of available transportation modes for both freight and passenger transportation. Large parts of the Act were carried over much to the Korean transportation policy environment.

The Gyeongbu High Speed Railway began operation in 2004 after many difficulties and complications since its technical feasibility study started off in 1989. Korean bullet train service, KTX, paved the way to persuade rail operators to view their work from the users' point of view to give maximum satisfaction breaking away from the operator's preferences. Now that they realized the importance of high-speed operation, they came to know the necessity for improving the complexities and inconveniences of existing rail stations.

The realization of the importance of user friendly stations in rail spread to the bus industry. In 2004 the Seoul city government performed a massive bus industry reform. The city government focused on the importance of a bus-to-bus transfer system by making transfers more attractive and performed field improvements of existing transfer conditions to the extent possible at bus stations. With this user-friendly approach gaining in popularity, the importance of intermodal connectivity and smooth intermodal transfers at transportation nodes was recognized and officially promoted by the central government

2) Reformation of Bus Industry

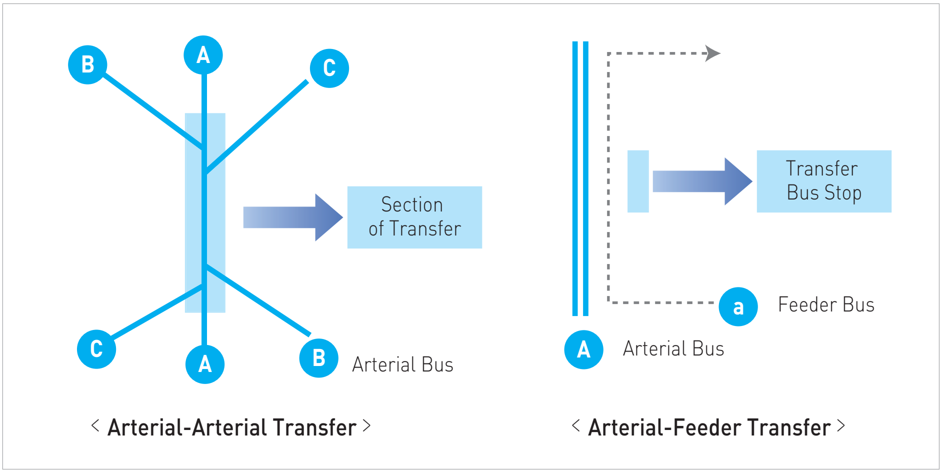
Coming into the 1990s, the city bus industry in Seoul was suffering with very poor operating conditions. Due to the chronic congestion on major city streets the bus operation was far from public satisfaction in speed and punctuality, which led to ever-decreasing patronage and worsening financial difficulties for the industry. The average operating speed of bus was barely 18.8 km/h, less than that of passenger cars at 19.5 km/h. The buses had many problems including a low operating speed, long travel times, and duplication of competing routes. On the other hand, the subway began to assume a major public transportation role as construction expanded its coverage but this led to increasing financial constraints. The financial limitations meant subway expansion would be limited, which forced efforts to focus on bus industry reform where the role of buses was remodeled primarily to have access to the subway and play a major transportation role where the subway was not available.

Table 1.1 Outline of bus industry reform in Seoul

Description		Major policies
Bus transportation system	Route system	• Reforming the route system into hub and spoke system
	Operating system	• Median bus exclusive lanes
	Industry operation	• Semi-public operation
Integrated fare collection		• Discounted transfer fare system • New fare card
Bus infrastructure		• Transit center construction

According to the reform, the bus industry was transformed into a semi-public system in 2004. As shown in Table 1.1, the bus industry was placed under semi-public operation, went through differentiated operation into arterial and access routes, free to discounted fares for an intermodal transfer under a united fare system, and improved bus operation policies with supporting facilities such as provision of median the bus exclusive lanes on

Figure 1.2 Transfer concepts between arterial and access buses



which arterial buses operate along corridors with no subway access.

First priority was to change bus operation into a semi-public operation system where privately owned and licensed bus companies were subject to city-control. This provided immense flexibility to the bus route adjustment in accordance with demand, which used to be a difficult task because of conflicting interests between concerned companies.

Then the fare collection system was integrated for public transportation as a whole through RFID fare cards. This enabled the system to identify which previous mode a passenger came from at the time of mode transfer and instantly perform an interconnected fare settlement between modes. It went on further to establish a full-blown transfer fare system to give incentives to passengers. The bus route system also went through an all-out reformation where arterial routes were integrated with access routes at major transfer stations. Under the reformed system, the transfer did not charge an additional fare and guaranteed minimum burden and maximum convenience for passengers, which resulted in a steadily increasing patronage for the bus network.

3) The Outset of the Intermodal Transit Complex Policy

A positive mindset of high-speed railroad transportation has been formed since opening of the Gyeongbu High Speed Railway. The two most critical factors in railroad transportation involve how fast riders can arrive at a rail station and how easily they can board a train after arriving at the station. The former is associated with the accessibility to the station while the latter is related to transfer convenience.

Seoul Station comprises high and low speed rails, three subway lines, the AREX airport line, and access to a significant number of buses. According to a study, about 53% of KTX rail passengers arrives at Seoul Station via subway lines 1 and 4. It is inferred that passengers arrive at Seoul Station from many different parts of Seoul via the subway and make a long transfer on foot to the KTX platforms. Subway transfers at Seoul Station are troublesome and time-consuming, requiring trips of multiple stairs and walking on a long concourse of 300-400 meters. It is cumbersome to transfer from either of those subway lines to access the rail platforms inside the rail station because of stairs and long stretches of walking. Once on board a KTX, however, riders enjoys a remarkable savings in travel time due to the high speed and a well-designed comfortable cabin environment. These benefits sufficiently compensate for the difficulties in getting access to the platform, which has been a key to the steady increase in KTX patronage. The positive public response to the KTX has made the government begin to realize the importance of efficient interconnection systems at KTX stations.

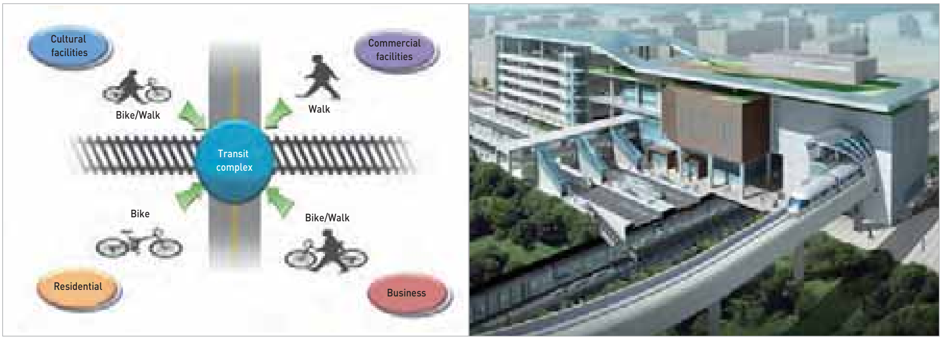
Suppose the walking distance for transfers is shortened to 100-200 meters from the current 300-400 meters and the long staircases are added by escalators, then the intermodal systems at Seoul Station would be far more convenient and efficient from a user's point of view. The basic layout of Seoul Station was made long before the concept of efficient transfers existed. The old concept did not consider convenient transfers with a higher emphasis on construction costs and is seen as unacceptable at today's context where personal convenience is treated above anything else. From the year 2000 and on, station planning has been influenced by the concept of an efficient intermodal connection.

To reflect the increased understanding of the importance of convenient transfers, a government research and development project was launched in 2006. Entitled *An R&D Project to Develop Transportation Connectivity and Transfer System*, the focus was on increasing convenience at transportation nodes. The project developed planning and operation standards for transfer facilities and focuses on designing an intermodal transit center to ensure minimum walking distances, maximum comfort, and safety to passengers at transportation nodes where many different modes converge together. To institutionalize design standards for intermodal transit centers, the government substantially revised the Transport System Efficiency Act. Their efforts results in the National Integrated Transport System Efficiency Act in December 2009. With this law in place the intermodal transit center complex policy was solidified with a legal foundation. This aimed at attempting to mandate greater cooperation with central and local government organizations by placing more focus on the intermodal transportation system in the process of transportation planning.

At an intermodal transit complex, there are many transportation modes including KTX, express bus, subway, city bus, taxi and privately owned vehicles, merging and diverging with frequent transfers made for easy interconnection with minimum walking distance. These complexes contain station-related facilities such as ticket office, waiting area, and passenger lounge, transfer facilities such as platforms, escalators, concourses, and parking lots, and supporting facilities including various business and commercial facilities to help visitors and passengers for the best possible accessibility. Intermodal transit complexes command superior accessibility and convenient intermodal transfer between modes. The fact that transfer facilities and supporting facilities are arranged at the same location with close connection to each other enhances passenger convenience as well as raises the efficiency of modal operation.

The former private-invested station policy was different from the new intermodal transit complex policy in that it neglected the importance of smooth interconnection between modes and focused more on commercial facilities, which often resulted in an awkward flow layout for passengers

Figure 1.3 Intermodal transit complex concept



by emphasizing too much on maximization commercial opportunities. The layout design reflected this as it was derived from a misunderstanding about visitors' behavior. Passengers are seldom the same individuals as shoppers in a commercial area. With older designs the two opposing flows of passengers and visitors conflicted with each other. The main purpose of the intermodal transit complex policy is that flows are treated differently for passengers and commercial visitors in order to optimize each, giving a smooth and short transfer to passengers and easy access to shoppers.

An intermodal transit complex is an innovative form of urban development, giving equal consideration to both transportation and land use. It houses two very important urban functions at one place: transfer-related facilities to help travelers easily access the location and smoothly transfer from one mode to another, and supporting facilities to expedite visitors or shoppers to have easy access and fulfill the desired function of urban activities including business or shopping purposes. A superior transportation infrastructure has both good access and transfers while justifying high density urban commercial development, which suggests a new type of urban growth potential.

Accordingly an intermodal transit complex provides a new opportunity in urban development where the facility goes well beyond a simple concept of transportation infrastructure investment and enforces a positive consideration of the effect of transportation on urban development, which leads to a new form of urban development, which is transit-oriented development (TOD). This policy will eventually make public transportation more attractive and produce another motive for urban growth through a compact city development to be expedited by the intermodal transit center equipped with good public transportation. Therefore, an intermodal transit complex is not simply a convenient transfer facility at transportation nodes, but a compulsory institutional design to coordinate all merging transportation modes currently regulated under different individual laws in a manner to provide maximum efficiency.

Before this policy was enacted, there were actually no laws to govern the overall coordination of modes merging at a node. Although individual transportation modes can be individually planned, constructed, and operated under respective laws, they are now supposed to be legally subject to overall coordination where they meet other modes at transfer nodes such as railroad stations and intermodal terminals to ensure an efficient connection and transfers. Individual transportation facilities have so far been prescribed by their governing laws for their planning, operation, and so on. This policy provides a driving tool to do more coordinated transportation planning by appointing a responsible institute for planning and designing transportation nodes where various modes interact.

Concepts and Theories of Intermodal Transportation

Section 1

Concepts of Intermodal Transportation

When a journey involves two or more modes, passengers are to change the vehicle somewhere during the journey. At a transfer point, the connection is made between the two modes and riders can change from one mode to another. The point where two or more modes meet together allowing transfers, play a central role in establishing an intermodal transportation system. If two modes of transportation are integrated seamlessly without causing arduous work or time in the process of changing the mode, then the composite mode consisting of these two modes will function as one mode, maximizing user convenience.

A theoretical case is where a passenger first goes by a city bus to a subway station and rides the subway to their final destination. If the bus stop is very close to the subway station, the walking distance to the platform is short and the subway operation is so frequent that riders don't feel burdened by the process of changing the mode from a bus to the subway, then you have a well-organized interconnected transportation system or in other words a good intermodal transportation system. The entire process from the bus stop to the platform of the subway is called a modal interconnection and transfer. This system is composed of a bus, interconnection and transfer to the subway as an intermodal transportation system with the subway as a principal mode.

As with the creation of America's Intermodal Surface Transportation Efficiency Act in 1991, intermodalism has been given special consideration as a primary theme in transportation. Early in the 1970s the concept of comprehensive transportation was rooted deep in transportation planning where multimodal transportation was a major tendency of the time. However, it was not until the Act appeared in 1991 that the concept of intermodalism began to play a major part in transportation planning.

The early understanding of intermodal transportation was pretty broad and often very vague, with deviations made often as different perspectives were introduced. The main aspect to apply the concept of intermodal transportation was the transport of containerized freight. In response to the demand for increasing containerization of freight, efforts were made to coordinate the railroad and trucking into a combined system to save time and cost. The Intermodal Surface Transportation Efficiency Act emphasized the importance of efficient intermodal transportation in the transport of passengers as well as freight.

The Act specified its underlying philosophy by stating "It is the policy of the United States to develop a National Intermodal Transportation System that is economically efficient and environmentally sound, provides the foundation for the nation to compete in the global economy, and will move people and goods in an energy efficient manner." And it also prescribes "The National Intermodal Transportation System shall consist of all forms of transportation in a unified, interconnected manner, including the transportation systems of the future, to reduce energy consumption and air pollution while promoting economic development and supporting the United States' preeminent position in international commerce."

It is noted that the phrase "transportation in a unified, interconnected manner" addresses an important aspect of an intermodal transportation system, indicating the definition of intermodal transportation. This intermodal transportation is made by a composite mode created with plural modes seamlessly interconnected and functioning efficiently like a single mode. Due to the fact that the intermodal transportation system in this way makes the best use of the merits of individual modes and minimizes possible impediment in their connection, its potential benefits can be considerable. Therefore the importance of an efficient intermodal transportation system lies here.

The goal of intermodal transportation is to transport people and goods to the final destination by means of plural modes as efficiently as possible by coordinating those modes into a unified system. The efficiency of the intermodal transportation system is reflected by the level of seamlessness at the transfer node with which the transfer is made. A seamless connection, or smooth transfer, is an important factor in an intermodal transportation system. Given the level of service for individual modes to be connected to each other, the level of seamlessness at the transfer node becomes a determining factor in the intermodal transportation system.

The dominant share of air pollution and unmanageable traffic congestion of auto traffic have aroused growing interest in previously neglected public transportation due to its inconvenience. Public transportation has an intrinsic weakness by frequently requiring a transfer to complete a journey although it is positive in that it has a high capacity of passenger transportation and is energy efficient. The transfer process may involve a long distance necessitating arduous walking, tedious waiting times for the next mode, and additional fare payment for the connecting mode, which may become major factors in hindering the use of public transportation.

A conspicuous reduction in burdens accruing from the transfer process through a well-organized connection could lead to an efficient intermodal transportation system. Korean society today is characterized by a near-saturation of motorization and very high social activities driven by individual diversity and sophistication. Here a better solution may well be found where riders are provided with efficient intermodal transportation rather than coping with unbearable traffic congestion.

Fortunately many useful forms of IT are readily available these days. Public transportation may make use of these technologies to give real-time operation information to help prospective users make their modal choice.

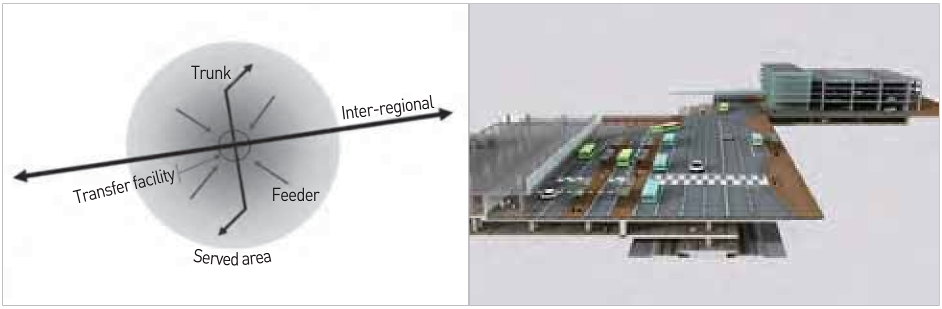
Under this IT based operation system, the information of bus routes and real-time operation has currently been put to practical use. The unified fare imposing system on public transportation covering the Seoul Metropolitan Area and the integration system of bus to bus and bus to subway in combination with the discount fare policy for transfers were established to lay the foundation for an efficient integration of operation. On the basis of these unification efforts, improved physical interconnection between modes at transfer nodes which used to be neglected for cost reasons would complete the base of an efficient intermodal transportation system.

It may be worthwhile to review the specific elements, i.e., connectivity and transfers in the integration of modes to form an intermodal system. Connectivity is defined as a state where a movement is maintained with no blockage between different forms of facilities, modes, or routes in case people or goods use two or more transportation modes or utilize facilities or routes at different levels within a mode. It is consisted of connecting modes which determine how many modes are available for access to and from, and connecting facilities which determine the capacity of loading and unloading facilities such as parking lots, stations, and platforms. Transfer is defined as an action that a passenger changes vehicles from one mode to another in their journey. It is evaluated for performance by how fast and comfortably riders can move from the point of exiting the former mode to boarding the latter one.

Connectivity and transfers are summarized as a condition that a passenger changes their mode, facility, or route without blockage in the process of moving between any origin and destination. The level of service of the connectivity and transfer may be evaluated by the diversities of access modes available, speed, and comfort during the process. The connectivity and transfer can be shown in the following figure with each element specifically depicted separately.

In such nations in the forefront of advanced public transportation as Japan and some European countries, they early realized the importance of connectivity and transfers in public transportation and have emphasized arranging a modal integration system that includes connectivity supporting

Figure 2.1 Connectivity and transfer schematics



facilities like railroad platforms, bus stops, taxi stands, bicycle depositories, and park & ride and kiss & ride facilities along with transfer facilities of smooth walking paths, transfer-expediting facilities and information systems. On the other hand, Korea's background of public transportation interconnection systems, especially at railroad stations, lacks consideration of the connectivity and transfer with no specific standards for design and layout, which entails inconvenient railroad stations with long walking distance between-railroads and rail-bus transfers, causing a major reason for weakening competitiveness of rail-based public transportation.

A recent trend in Korea is the importance of the connectivity and transfer is being realized and taken into consideration in the design stage. This tendency comes from the understanding that an efficient intermodal transportation system may lead to significant benefits to society as a whole as well as passengers and operators. Users may benefit by travel time reduction accruing from shortened transfer time and physical efforts required for the transfer and an increase in satisfaction with transfer improvement. Such designs will give operators increased competitiveness by increased user convenience that will eventually increase revenue and strengthen financial independence through station area development. Society will enjoy a reduction in traffic congestion costs, a decrease of energy consumption and environmental disruption. Additional ripple effects are important including an improved urban environment and increase in employment.

Section 2

Conditions for Intermodal Transportation Systems

Traffic congestion became ever increasing throughout the 1990s and went beyond society's tolerance level, which raised the necessity for various restriction policies on individual automobile use that used to be excessively popular. The Seoul city government initiated a toll policy on urban arterials at Namsan Tunnel #3 which provides a shortcut linking the city center with Gangnam, the busiest business area south of the Han River. The city also started up a new parking policy of charging fees at roadside parking lots which used to be free. Coming into the 2000s, society has been more sensitive to environmental issues caused by the air pollution, specifically the accumulation of carbon dioxide (CO_2) and climate change. The issue of carbon dioxide was not an exception in the transportation sector that resorted heavily on fossil fuels which makes a significant contribution to carbon dioxide emission. This realization necessarily entailed a new insight into public transportation, energy efficiency, and how to be environmentally friendly.

Resultantly, there was an increased investment in public transportation for improving its service quality. The Seoul bus reform ended in an extended application of median bus exclusive lanes, a differentiated operation of buses between arterial and access routes, and a unified fare collection system over the entire public transportation market in the region. At the same time, intercity transportation has also gone through a massive investment in high-speed rail starting with the Gyeongbu High Speed Railway. And thus with an increasing restriction on auto transportation, the investment policy changed towards improving service quality for public transportation.

Public transportation is energy efficient as a whole and its fuel source can come not only from fossil fuels but also various alternative sources of energy like solar and wind power. This fact will increase the importance of public transportation given additional consideration in 21st century energy-sensitive transportation policies. To achieve these policies, a prerequisite exists that intermodal transportation systems must have a satisfactory quality level at its connection nodes.

If you have a transportation mean which brings riders directly to their final destination without requiring a transfer, it would be the most satisfactory mode. This mode manifests itself in the explosive increase in auto ownership experienced in Korea as improved living standards provided non-stop direct service between origin and destination without transfers. A transfer is basically thought of as an impediment to travel. A transfer is conceived to be one of the most negative aspects of a trip, but it is true that any trip requiring more than one mode needs a transfer in completing the trip.

Our experience tells that in spite of an inevitable transfer in a trip, as the difficulty of transferring is reduced, our satisfaction with it increases and so does the amount of travel. Although we cannot entirely eliminate the transfer in trips, it is very important that transfers are completed as quickly and comfortably as possible. There may be various different ways of improving the transfer, which include better facilities, better operations, and better institutional arrangements.

An intermodal transit center is an important part of a very large system comprising of multimodal transportation services. At the core of an intermodal transit center is the transfer node where connecting modes merge, connect with each other, and allow transfers seamlessly. To make these connecting modes combined into a system to play an integrated transportation mode, the connecting node should be guaranteed to provide an easy physical connection, a smooth operational connection, and a unified fare collection system. This core is represented by an intermodal transfer system.

The intermodal transfer system normally extends over a vast area and involves a large number of modes, services, and other transfer facilities. In its design, it is important to assure it meshes with the remainder of the transportation system and also requires the transportation system fits well with intermodal facilities. It is worthwhile to think of planning stages of an intermodal transfer system to clearly grasp the concept. Start with defining the concept of an intermodal transfer system. Then go over the system design for a candidate site under consideration, the feasibility of modal integration and its access priorities are determined, the physical layout is depicted, demand is forecast, and the adequacy of holding and waiting areas, pedestrian paths, paths of access, parking and other physical elements are assessed. Next is the system integration plan where a plan for institutional, physical and operational integration is prepared and the plan will concentrate on ways to coordinate services at the facilities and establish mechanisms for communication among operators and with the public. In the final stage, the preliminary design and environmental impact statement is made. Here generalized floor plans, site layouts, and architectural renderings are prepared. Modal interaction, service interaction, and sightline analyses are performed, and a draft environmental impact statement starts off. In summary, the prerequisite for an efficient intermodal transportation system is to arrange a smooth interconnection system between connecting modes.

The physical connection is the most important, time-consuming, and costly. So it is one of the things that a first consideration should be given in designing an intermodal transit center. When two different transportation modes meet together, they should be connected with the shortest distance, most comfortable method, and with safety first. At subway stations constructed in the past, the issue of interconnection was overlooked, which resulted in today's situation where transferring to another subway line frequently requires walking a distance of sometimes 500 meters and cope with steep and long staircases. It would be especially difficult to move if you have baggage or for the elderly or handicapped.

To reduce a transfer distance, designers may locate one subway station vertically right under the other station, which will require the technological ability to support it and the willingness to undertake the necessary additional costs. Previously, society was satisfied with simply having the subway available, and did not complain of any inconvenience. Currently individuals' desire for quality of life is high enough to justify those additional costs for a direct connection at a transfer point.

With a good physical connection, it is still necessary to maintain a smooth interconnection of operation between connecting modes so that the service schedule is coordinated and an arrival from one mode allows direct connection to the departure mode. It is also necessary to provide bus users with arrival information on potential buses to transfer to. Since the bus reform project, the operation of arterial and access buses is managed and supervised by one agent, and major bus stations are equipped with an IT based bus arrival information system, bus users have enjoyed the service of a well-coordinated operation and a fairly advanced level of bus arrival information. However, a similar operational coordination is not yet made between buses and the subway, and between city and intercity railroad operations.

The fares for public transportation need be integrated and unified so that the travel cost should be minimized from an individuals' point of view, which will expedite the use of public transportation. The unified fare is based on the fare level calculated against the entire length of trip without regard to the number of transfers between the origin and the destination. Under the current bus system in Seoul, bus users pay a single flat fare for a trip without paying for transfers as long as the connection is made with an electronic fare card. The unified fare collection system enables the system to confirm which bus a particular passenger transferred from through their fare card identification. Under this system, the account settlement is automatically made by records kept in the terminal.

Section 3

Travel Demand Functions and Transfer Impedance

CHAPTER 02

1. Travel Demand Function

According to a conventional travel demand function, travel demand is inversely proportional to the generalized costs of which the main variables are travel time and travel cost. The supply curve in a transportation market is defined as a composite function of facility related costs including construction, maintenance, and operation, along with service providing costs such as bus operating costs. The interaction of supply and demand curves turns out to reveal various travel behavior and the effect of a policy, that is, a particular level of demand.

Given the supply of transportation service, the travel demand function will determine the effect of a particular policy. It is a widely known fact that for variable travel time, which is one of main variables in a travel demand function, the out-of-vehicle travel time has an influence 1.5 to 2.5 times greater on the demand than in-vehicle travel time. The same time duration may be appreciated differently depending on whether it is idle or productive from the point of a traveler. That is, the waiting time without doing meaningful things is perceived more arduous in comparison to the more productive in-vehicle time spent traveling.

At a transfer node where a mode change is made, the inconvenience due to waiting time is increased by difficulties with making a transfer, including walking a long distance or stairs, and as such will have a greater influence on the user's choice of modes. A transfer is basically view as an inconvenient and negative experience. Negative factors may be involved like time and cost requirements for the transfer as well as disconnection, unpredictable arrival time for a connecting mode, exposure to the weather and crowding, difficulty with handling baggage, and so on. Therefore, the purpose of an efficient modal interconnection policy in transportation is to reduce as much extent possible of not only the waiting time but also difficulties with making a transfer, i.e., transfer resistance.

Public transportation frequently needs a transfer to complete a journey. The difficulty with making a transfer is defined as transfer resistance, an analogy to disutility, will certainly have a significant influence on choosing a particular public transportation mode. Suppose the following mode choice model.

$$\log Q = -4.76 + 0.147\,(TW) - 0.0411\,(AIV - TSS) - 2.24\,(AC - F) + 3.78\,(A/W)$$

where Q = odds of choosing a private vehicle over a bus

TW = time for walking to the bus

AIV = time in private vehicle

TSS = total bus time for station to station

AC - F = private vehicle costs including parking cost minus bus fare

A/W = number of vehicles owned by a household

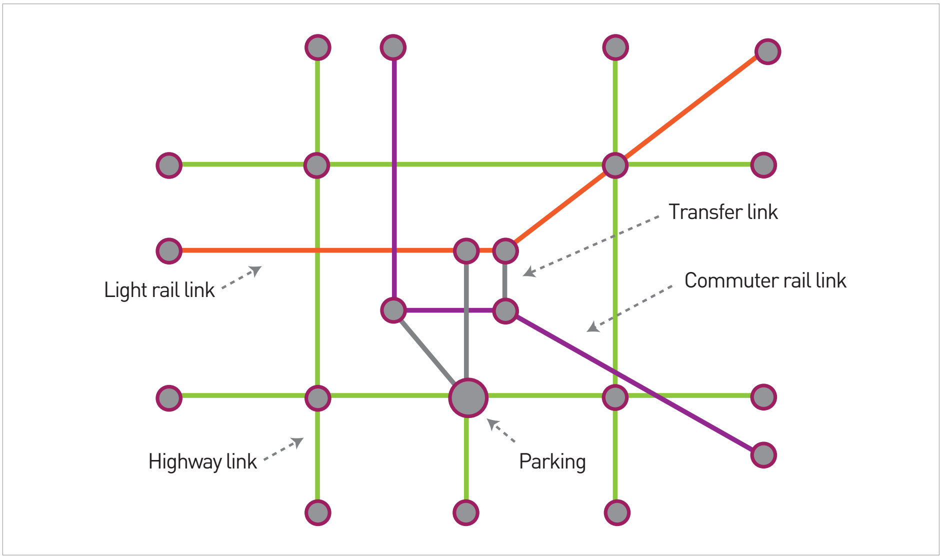
The equation above shows that the influence on a modal choice is 3.6 times bigger for the time walking to a bus than the total in-vehicle travel time. Applying this logic to the transfer situation, a mode which has a long transfer distance will have a proportionately less probability to be chosen.

As a result, the walking path at a transfer node is the most critical part in planning an intermodal transit center. This internal walking path is represented in Figure 2.2 by a link from the point of an arrival mode to the point of a departure mode. The schematic diagram shows an intermodal network involving three modes' interconnection through transfer links drawn in black. The transfer link is characterized by many attributes, out of which more important attributes of a transfer link are its distance, its walking speed, and its concentration of pedestrians. Theoretically many transfer links in an intermodal network may exist. The possible number of transfer links increases with the number of modes interacting together. For example, a two-mode transfer case requires only one two-way transfer link and a three-mode case necessitates three transfer links while a six-mode transfer point requires up to 15 transfer links.

Therefore, transfer links at an intermodal transit center will have to be prioritized in a practical application, according to a policy variable like a level of travel demand using a transfer link.

The necessity to make a transfer in the middle of a journey often arises. These transfers may be regarded as something negative to travelers as they don't like the time and cost required for the transfer. Additionally, they

Figure 2.2 Network with a three mode transfer



are reluctant to undergo other negative experience such as the possibility of missing a mode connection, the uncertainty of arrival time at their destination, exposure to bad weather, the need to find the connecting vehicle, difficulty of baggage handling, and waiting in unfamiliar surroundings. These negative factors, compounded together, may make the traveler not make a trip at all. A good intermodal transit center is the one which minimizes the unpleasantness of the transfer by directly addressing specific problems travelers confront in making a transfer.

2. Psychological Impedance of Horowitz

The difficulty of making a transfer is referred to as transfer resistance. Transfer resistance may be defined in many different ways, for example in terms of distance, time or subjective scaling of travelers. For our purposes, Horowitz's approach is introduced here for its easy understandability as the concept is intuitive.

Horowitz refers to transfer resistance as disutility of a transfer. The disutility is to assume to have a riding time unit, minutes. For example, a trip by an automobile of 10 minutes in duration has a disutility of 10 minutes. And disutility can be influenced by waiting, walking, weather, crowdedness, congestion, and money among other factors. It is assumed that a large number of mode choices in various situations can provide a reasonable inference of a set of weights and penalties for each component of a trip to be deduced from psychological scaling studies.

According to a study, travelers are most concerned with simply being able to make a trip. Time in transit; riding, waiting, walking and transferring, are also important. The convenience of a trip, particularly scheduling, can be important. However, cost, comfort and entertainment are of less concern in urban travel. A study done by the General Motors Research Laboratory indicates that poor weather has a large influence on the perception of any unprotected portion of a trip, such as waiting at a bus stop. The disutility values for an actual ten minute trip segment was strikingly illustrated with respondents rating the segment as 13 minutes when walking in fair weather, 27 minutes walking in summer rain, and 55 minutes walking in below freezing weather. The difficulty in walking is perceived as twice as hard when walking in rain and increases up to 4 times for walking under freezing conditions.

A widely adopted rule-of-thumb is that the value of time while waiting is twice the value of time riding. When applying this rule to the operation of public transportation, operators can achieve the same improvement in the disutility of a trip by eliminating 2 minutes of riding or eliminating 1

Table 2.1 Weights, penalties and time values

Time component	Weight
Riding	1.0
Walking	1.25
Walking with baggage	3.0
Unproductive waiting	2.0
Productive waiting	1.0
Queue time	3.0
Traveling while seated	1.0
Traveling while standing	3.0
Weather condition	**Weight adjustment**
Rain	+1.25
Below freezing	+4.25
Action	**Penalty**
Unprotected vehicle-to-vehicle	32 minutes
Protected vehicle-to-vehicle	16 minutes
Scheduled unprotected vehicle-to-vehicle	8 minutes
Scheduled protected time vehicle-to-vehicle	4 minutes
Walk-to-vehicle	8 minutes
Vehicle-to-walk	0 minutes
Trip purpose	**Time values**
Commute	0.333 of wage rate
Work-related travel	2.000 of wage rate
Other travel	0.167 of wage rate

minute of waiting through enhanced synchronization of the service schedule. Waiting can be reduced by better schedule coordination, improved passenger information, enhanced punctuality and by eliminating transfers wherever possible.

Other studies show the disutility for bus-to-bus transfers amounts to approximately 30 minutes while bus-to-rail transfers may cause a smaller disutility than bus-to-bus. It seems that passengers are influenced by the uncertainty of making a connection. This uncertainty is greatest in bus-bus transfers with bus-rail next and rail-rail following last. Based upon these previous studies, Horowitz summarizes relative weights and scales as written in Table 2.1.

The disutility weights, penalties, and monetary value of time in Table 2.1 can be used for designing an intermodal station. Suppose a hypothetical situation where a traveler goes to work from home with fair weather. He leaves home and walks 8 minutes to his car. He then drives 30 minutes, paying \$1.00 toll and parks his car, spends 10 minutes waiting. His wage rate is \$0.24/minute. We can calculate disutility by component as follows.

A. Access penalty to vehicle = 8
B. Walking time = 8 × 1.25 = 10
C. Riding time = 30 × 1.0 = 30
D. Waiting time = 10 × 2.0 = 20
E. Toll cost = 1.00 × (0.333 × 0.24) = 12.5

The sum of these components is 80.5 minutes. Although the real-time consumed for going to work is 48 minutes (walk 8 + ride 30 + wait 10), he perceives the total travel time as 80.5 minutes. The disutility would have been larger if the traveler had been standing or traveling in poor weather.

3. Evaluation of Transfer Satisfaction

A transfer is perceived as an impediment to travel. It is generally considered that a transfer is one of the most negative aspects of a trip. All trips involving more than one mode require a transfer. It is a conventional understanding that when the difficulty of making a transfer is reduced, user satisfaction will increase as will the amount of travel. It is essential to make the transfer as quick and pleasant as possible although it is not possible to eliminate it entirely. Transfers can be improved by several means including better facilities, better operations, and better institutional arrangements.

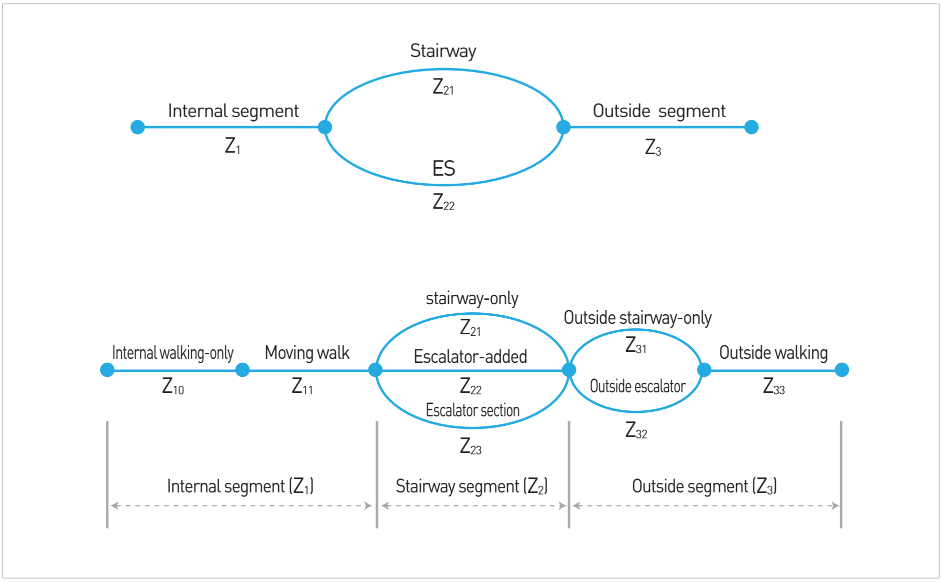
Transfers are made more often between different modes like bus-to-subway or subway-to-rail transfers than between same modes such as bus-bus or subway-subway. In real situations, the transfer process may consist of a disconnected line of movement and different operators involved. Many of today's railroad stations in Korea with transfers to subways have been constructed and managed from the perspective of operators rather than from users' point of view, which has resulted in a neglected consideration of an efficient interconnection of modes. This basis is the main cause for inconvenient transfers often observed in rail-based stations in Korea.

The inconvenience in transfer was acceptable in the past when the public was satisfied to be able to make a trip at all. However, Korean society has more recently achieved a significant economic development and enjoyed a very high standard of living. As such, former intermodal stations with poor connectivity between modes are far from satisfying today's travelers and are themselves impediments in expediting the use of public transportation.

Energy saving and environmental protection have become priority issues in today's society urging a greater use of energy efficient public transportation. For this matter, transfer difficulties frequently occurring at current intermodal stations must be eliminated or at least significantly improved. The first thing to do this is to reduce the transfer distance and time to the extent possible. A good intermodal station would provide such an interconnection system that the transfer distance falls short of 30 to 40 meters while the walking distance in transfer at many current intermodal stations generally exceeds 200 to 300 meters. For the improvement of transfer difficulties, first priority is given to the reduction of physical distance between modes, but being inevitable, auxiliary efforts may be added to reduce the walking time and inconvenience of transfers by putting in elevators, escalators, moving walkways, or other conveniences.

To find out how good a particular intermodal station is, you can rely on a method of evaluating users' perceived satisfaction with the transfer. A method suggested by KWON, Y. J. et al. to evaluate the appropriateness of the transfer by means of the user perceived transfer satisfaction is outlined here. A model is established to evaluate the distance a user perceives for the entire transfer process, or the perceived distance. The transfer process is the process as a whole to cover an entire walking path from the point of an access mode to the point of an egress mode. The transfer path may be broadly broken down into several segments: internal, stairway, and outside. The internal segment is again divided into an internal walking-only section and a moving walkway section. The stairway segment consists of a stairway-only section, an escalator-added section and an elevator section. The outside segment is composed of an outside stairway-only section, an outside escalator- added section and an outside walking section.

Figure 2.3 Divisions of the transfer process



The perceived distance of the transfer process is the distance expressed in the disutility-reflecting terms associated with walking along the transfer process. Each component distance of the transfer process is evaluated against the internal walking-only path (Z_{10}) for its perceived distance. Summarizing all the components will yield an overall evaluation of the disutility for the entire process involving different components.

The perceived distance based on the relative disutility of the component is adjusted for the speed against the average walking speed of 1.0 m/s. Then the perceived distance goes through adjustment for baggage handling and weather condition for each of the seven component distances. Table 2.2 shows the results of an experts' survey of the disutility for each of the component distances of the transfer process.

Table 2.2 Experts survey results of the relative disutility of the transfer process

Experts	Moving walkway	Escalator	Elevator	Stairs	Outside path	Baggage	Rain	Freezing weather	Responses
Professors	0.7	0.7	0.8	1.9	1.6	2.7	2.9	3.8	15
Researchers	0.8	0.8	0.7	1.8	1.6	2.4	2.8	3.4	14
Transport engineers	0.6	0.6	0.8	2.8	1.7	2.8	2.4	3.5	16
General	0.7	0.7	0.7	1.9	1.6	2.3	2.3	3.2	20
Other transport employees	0.7	0.7	0.6	2.1	1.8	2.7	3.5	3.9	35
Average	0.7	0.7	0.7	2.1	1.6	2.6	2.8	3.6	-

The above disutility evaluations can be averaged over all survey populations, resulting in the Table 2.3. The measured distances in meters will be weighted by these relative disutility factors, which produce perceived distances.

Table 2.3 Average disutility of the transfer process

Description	Internal path	Moving walkway	Escalator
Disutility	1.0	0.7	0.7
Description	**Elevator**	**Stairway**	**Outside path**
Disutility	0.7	2.1	1.6

For the adjustment against relative speed, average speeds are assumed; 1.0 m/s for internal and outside paths, and 1.5 m/s for moving walkway which is the sum of the speed of moving walkway (0.5 m/s) and that of walking speed (1.0 m/s). We apply 0.8 m/s to an upward stairs as frequently observed in the field and 1.0 m/s to an escalator. In the case of an elevator, the average speed is assumed as 0.3 m/s considering time is wasted waiting for the doors to open and close although elevators normally operate at 1.5 m/s. As the speed decreases, the disutility will increase by that degree. The adjustment factor is set to an inversed value of the average speed and shown in Table 2.4.

Table 2.4 Adjustment factors against average speed

Description	Internal path	Moving walkway	Escalator
Disutility	1.00	0.67	1.00
Description	Elevator	Stairway	Outside path
Disutility	3.33	1.25	1.00

A field survey on the proportion of passengers who carry baggage with them shows a wide variation depending on the type of facilities as shown below.

Table 2.5 Proportion of baggage carrying passengers

Description	KTX/railroad	Air/ship	Intercity bus terminal	Subway
Proportion (%)	11.8	19.1	10.2	1.6

The adjustment for baggage carrying is to be applied to the component only which is subject to baggage carrying. Taking an example of factor calculation for KTX / railroad, the factor is a sum of with-baggage and without-baggage cases. The relative disutility of baggage carrying is 2.6 from Table 2.2 and the adjusted disutility is calculated as $2.6 \times 0.118 + 1.0 \times (1 - 0.118) = 1.189$, as shown in Table 2.6.

Table 2.6 Adjustment factor of baggage carrying for each facility

Description	KTX/railroad	Air/ship	Intercity bus terminal	Subway
Disutility	1.189	1.304	1.163	1.026

Weather conditions are typically characterized by rain and freezing weather. Table 2.7 illustrates the number of days of rainfall and freezing conditions for major districts in 2009 from the statistics of the Meteoric Agency. Taking the national average, the number of raining days is 102, and 40 had freezing temperatures. Table 2.2 provides the relative disutility of 2.8 for rain and 3.6 for freezing. The weather condition is applicable to the outside path only. The adjustment factor is in the multiplicative form and no adjustment leads to a factor of 1.0. For example, the average adjustment factor is obtained by 2.8 × (102 / 365) + 3.6 × (40 / 365) + 1.0 × (365 - 102 - 40) / 365 = 1.788.

Table 2.7 Weather conditions adjustment factors

District	No. of rainy days	No. of freezing days	Adjustment
Seoul/Incheon	104	54	1.798
Gyeonggi	109	65	2.001
Daejeon	99	49	1.837
Busan	85	4	1.448
Daegu	83	19	1.545
Gwangju	112	24	1.723
Average	102	40	1.788

The perceived transfer distance (TR) is the actual measured distance of the entire transfer process weighted by average disutility (Table 2.3), speed adjustment (Table 2.4), baggage adjustment (Table 2.6), and finally weather condition adjustment (Table 2.7) in sequence. The effect of baggage carrying is distinctively different for different facilities, which necessitates a separate model for separate facilities.

As an example, a model of calculating the perceived transfer distance for a KTX or railroad facility is constructed by assigning the adjustment factor to each component path as shown below.

1) internal walking-only path (Z_{10}) needs adjustment for baggage carrying only: 1.189
2) internal moving walkway path (Z_{11}) needs to be adjusted for relative disutility, speed, and baggage: 0.7 × 0.67 × 1.189 = 0.557

3) stairway-only path (Z_{20}) needs to be adjusted for relative disutility, speed, and baggage: 2.1 × 1.25 × 1.189 = 3.121
4) escalator-added path (Z_{21}) needs to be adjusted for relative disutility and speed only: 0.7 × 1.0 = 0.700
5) outside stairway-only path (Z_{30}) needs to be adjusted for relative disutility, speed, baggage, and weather:2.1 × 1.25 × 1.189 × 1.788 = 5.580
6) outside escalator-added path (Z_{31}) needs to be adjusted for relative disutility and weather only: 0.7 × 1.788 = 1.252
7) outside walking path (Z_{32}) needs to be adjusted for relative disutility, baggage, and weather: 1.6 × 1.189 × 1.788 = 3.401

The perceived transfer distance for KTX is given as a sum of the individual component values:

$$TR = 1.189\ (Z_{10}) + 0.557\ (Z_{11}) + 3.121\ (Z_{20}) + 0.700\ (Z_{21}) + 5.580\ (Z_{30}) + 1.252\ (Z_{31}) + 3.401\ (Z_{32})$$

Table 2.8 Models of perceived transfer distance

Facility type	Perceived transfer distance
KTX/railroad station	$TR = 1.189 \times Z_{10} + 0.555 \times Z_{11} + 3.121 \times Z_{20} + 0.700 \times Z_{21} + 4.298 \times Z_{30} + 1.877 \times Z_{31} + 3.079 \times Z_{32}$
Intercity bus terminal	$TR = 1.163 \times Z_{10} + 0.543 \times Z_{11} + 3.053 \times Z_{20} + 0.700 \times Z_{21} + 4.230 \times Z_{30} + 1.877 \times Z_{31} + 3.038 \times Z_{32}$
Air/ship	$TR = 1.304 \times Z_{10} + 0.609 \times Z_{11} + 3.423 \times Z_{20} + 0.700 \times Z_{21} + 4.600 \times Z_{30} + 1.877 \times Z_{31} + 3.263 \times Z_{32}$
Subway	$TR = 1.026 \times Z_{10} + 0.479 \times Z_{11} + 2.692 \times Z_{20} + 0.700 \times Z_{21} + 3.869 \times Z_{30} + 1.877 \times Z_{31} + 2.818 \times Z_{32}$

where TR = Perceived transfer distance (m)
Z_{10} = Internal path (m)
Z_{11} = Moving walkway (m)
Z_{20} = Stairway-only path (m)
Z_{21} = Escalator path (m)
Z_{30} = Outside stairway-only path (m)
Z_{31} = Outside escalator path (m)
Z_{32} = Outside walking path (m)

It is a general understanding that as the disutility of making a transfer increases, the traveler will perceive the transfer as more difficult, experiencing a decreasing transfer satisfaction. A survey asked how travelers rate transfer satisfaction at a particular transfer station on a scale with a top possible score of 100. Then models can be constructed by associating the ratings of transfer satisfaction on one side with the perceived transfer distances on the other side, which gives a consistent standard of how satisfactory a particular transfer layout is at a specific transfer station. A sample model suggested by Dongdeug CHA, et al. (2009) is shown below.

$$Y = 100 \times exp\,[-0.072 - 0.00117\,(TR)]$$
$$(40.3) \quad (11.23)$$
$$(R^2 = 0.78,\ N = 38)$$

where Y = *ratings of transfer satiafaction*

TR = *perceived transfer distance*

$(\ )$ = *t scores*

N = *number of observations*

The following table shows the relationship between the perceived transfer distance and satisfaction ratings as calculated by the model.

Table 2.9 Perceived distances and transfer satisfaction

TR (perceived distance)	Y (transfer satisfaction)
25 m	90.4
50 m	87.8
100 m	82.8
200 m	73.6
300 m	65.5
500 m	51.8
1,000 m	28.9
1,300 m	20.3

Given the two types of models, one in Table 2.8 and the other in the equation above, you can apply to a particular transfer process and end up with the perceived transfer distance and rating score of transfer satisfaction for a given transfer process. This approach is very useful because it is not ambiguous, but very specific in evaluation of a specific modal interconnection, or transfer process. As the perceived transfer distance decreases, the transfer satisfaction increases. In an ideal interconnection of two modes with a perceived transfer distance less than 25 meters, the model evaluates the satisfaction rating score as 90 out of 100. The increasing rating scores of transfer satisfaction will naturally push up travel demand for transfers. This hypothesis lays the foundation that transfer demand models from a short run point of view are established by a gravity formula with an impedance variable of the perceived transfer distance.

4. Transfer Demand Model

When a particular transfer process is remarkably upgraded in a manner of improved connections that provide convenient, rapid, efficient, and safe transfer of travelers from one mode to another during a single journey, it will make an efficient intermodal transportation system with the connection playing a prime role. This enhanced efficiency of the intermodal system will prompt the travelers to divert from their former modes or routes to the intermodal system through the transfer node. The diversion will occur over a wide network including all modes and routes before and after the diversion. An exact estimation of the diverted traffic due to the improved transfer process may well be made by a traffic analysis over an entire network and for a fairly significant period of time.

In the short term, the current trip propensity to make a transfer can be effectively structured by a gravity type model based on travel volumes of interconnected modes and the perceived transfer distance between the two modes in a form of $V_{12} = \alpha \times (V_1)^{\beta} \times (V_2)^{\gamma} / TR^{\varepsilon}$ where V_{12} = transfer volume between mode 1 and 2, V_1 and V_2 equal travel volumes for mode 1 and 2 respectively, and TR equaling perceived transfer distance. This model simplifies the transfer volume as a function of travel volumes of two interacting modes and perceived distance to connect these modes. Transfer travel volume will depend on comparison of the perceived distances over the entire path of alternative routes. However, the potential users at marginal areas where the effect of the perceived transfer distance is relatively big against the entire length of a journey will be affected immediately, which justifies the application of a gravity model in this case.

$$V_{12} = 16 \times (V_1)^{0.637} \times (V_2)^{0.155} / (TR)^{0.5}$$
$$(2.7) \qquad (1.3) \qquad (1.4)$$
$$(R^2 = 0.28,\ N = 38) \tag{4}$$

The above model provides a quick calculation of the transfer volume (V_{12}) based on values of three variables given: V_1 = travel volume of the main public transportation, here KTX is used, V_2 = travel volume of the approaching mode. For an explanation purpose, the averaged values of V_1 and V_2 are 14,191 and 6,452 persons, respectively, borrowed from a previous study can be put in the model for various different perceived transfer distances (Table 2.10).

Table 2.10 Sample calculation of transfer travel volumes

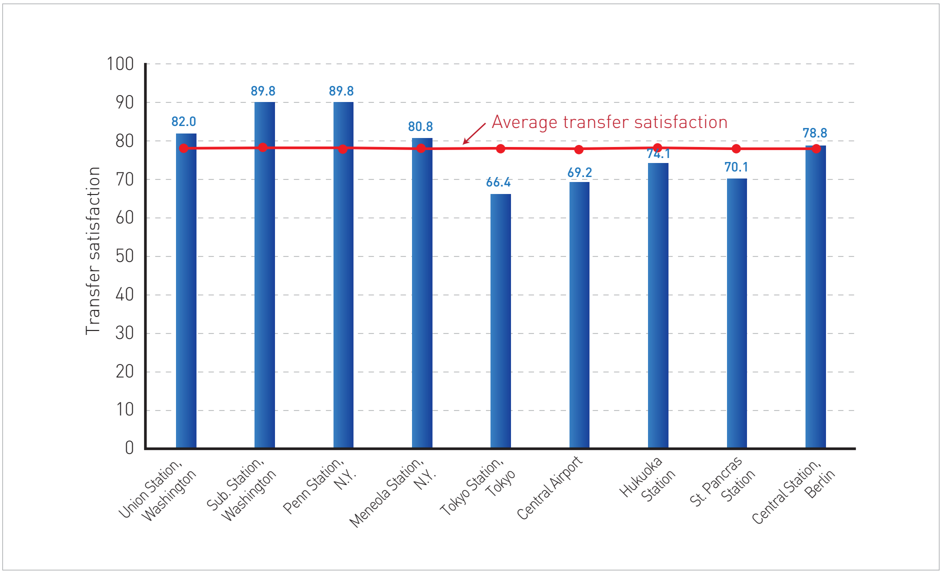
Perceived transfer distance (TR)	Transfer satisfaction (Y)	Transfer travel volume (V_{12})
50 m	87.8	3,980
100 m	82.8	2,751
200 m	73.6	1,945
300 m	65.5	1,588
500 m	51.8	1,230
1,000 m	28.9	870
1,500 m	16.1	710

A notably improved transfer system with a shortened perceived transfer distance is shown to increase transfer travel volumes, by which the volumes of mode 1 and 2 also increase. Table 2.10 shows that under the current situation, perceived transfer distances over 300 meters will drop the transfer volume abruptly, giving some yardstick of distance to be avoided for walking transfers.

The increased transfer travel volume is composed of three distinctive groups of people. The first group is the travel volume that continues to utilize the given transfer node both before and after improvement of the transfer process. This group of people is benefited by the amount of improved transfer resistance, i.e., the reduction of transfer time and costs within the transfer node. The second group is the traffic that used to use other modes or routes and now comes to the transfer node to go by the interconnected transportation system to be created by the improved transfer process. This traffic is benefited by the above mentioned reduction of transfer resistance within the transfer node plus savings of total travel time and costs for complete length of travel due to the diversion of mode and route. The amount of benefit would be relatively large. The network to study should be large enough to cover the routes and modes both before and after the improvement. The final group is the new traffic that is induced by the improved transfer node.

It is worthwhile to compare with competing transit centers based on the transfer satisfaction to see if they are consistent with our prior expectation. Perceived transfer distances can be calculated using the models in Table 2.8,

Figure 2.4 Graphical presentation of transfer satisfaction of intermodal facilities worldwide



then the perceived distance can be put in the transfer satisfaction model to predict the satisfaction score (Table 2.11). In most cases world-wide transit centers with good reputation turned out to have rather high satisfaction scores. Penn Station in New York has a score of 89.8, Hauptbahnhof Station in Berlin has 78.8, while Tokyo Station in Tokyo is rated rather low at 66.4.

Table 2.11 Evaluation of worldwide intermodal stations and terminals

Country	Stations / terminals	Measured transfer distance	Perceived transfer distance	Transfer satisfaction
U.S.	Union Station, Washington	93.8	108.4	82.0
	Sub. Station, Washington	30.0	30.5	89.8
	Penn Station, New York	28.8	30.5	89.8
	Mineola Station, New York	115.8	120.7	80.8
Japan	Tokyo Station, Tokyo	230.9	288.2	66.4
	Chubu Centrair Airport, Tokoname	185.3	252.8	69.2
	Fukuoka Station, Takaoka	155.5	195.2	74.1
U.K.	St Pancras Station, London	196.6	241.7	70.1
Germany	Hauptbahnhof Station, Berlin	136.0	141.9	78.8
Average		130.3	156.7	77.9

5. Prioritization of Improvement of Transfer Paths

Several modes may exist in an intermodal transit center, which entails several interconnected routes or transfer paths. It may not be possible or desirable to bring all these paths up to the same high satisfactory level because transfer paths have to compete for a limited space inside a transit center. Very often these walking paths cross each other causing delays, crowding and bumping. Therefore, important paths have to be given a higher priority in becoming direct and shortened. The priority can be set according to the volume of transfer traffic accessing the main public transportation mode. The path with a higher volume of traffic accessing the primary mode will be given a higher priority.

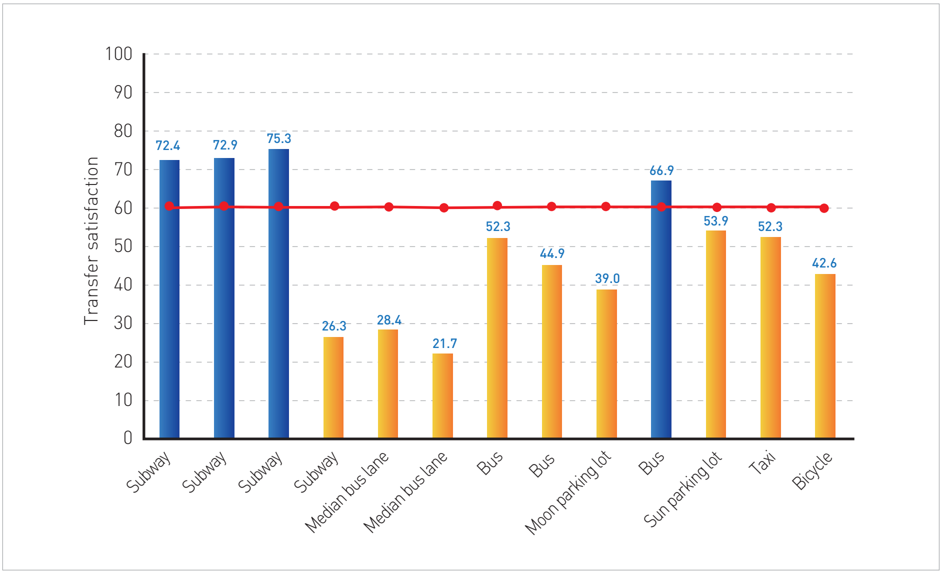
As with all investment projects, improvement of a transfer path should

Figure 2.5 Current transfer paths of Yongsan Station

be justified against a cost-effectiveness analysis. The target level of service of transfer paths should be higher for a new intermodal center than for existing facilities because the new facility can be more flexible in highlighting transfer paths.

Yongsan Station, one of large intermodal railroad stations in Korea, has been analyzed for the performance of transfer paths. There are 13 transfer paths identified currently. The path from the subway to KTX shows a good transfer performance, having over

Figure 2.6 Satisfaction scores of transfer paths at Yongsan Station



70 of a transfer satisfaction score because the two modes are interconnected at platforms on the same plane. However, all the remaining paths from other access modes reveal very poor levels of performance with the transfer satisfaction scores rated poorly from 20 to 50.

The target level of improvement of current transfer paths of Yongsan Station may well be set to a score of 70 which is a current level of performance for the best path from the subway to KTX. Transfer paths can be grouped according to the volume of transfer traffic and different target levels for improvement may be assigned to each group.

The target values of improved transfer paths were classified into three grades of superior, good and fair, according to the transfer satisfaction score. The following table exemplifies the relationship between transfer satisfaction scores and perceived transfer distances which have to be met for each performance grade.

Table 2.12 Relationship between transfer satisfaction scores and perceived transfer distances for performance grades

Performance grade	Existing transit center	
	Target in transfer satisfaction score (Y)	Target in perceived transfer distance (TR)
Superior	over 70	240 m or less
Good	over 60	370 m or less
Fair	over 50	500 m or less
Performance grade	**New transit center**	
	Target in transfer satisfaction score (Y)	**Target in perceived transfer distance (TR)**
Superior	over 80	130 m or less
Good	over 70	240 m or less
Fair	over 60	370 m or less

At the planning stage of an intermodal transit center, the first consideration should be given to the shortest physical connection between modes concerned. How close approaching modes are placed to the main public transportation mode becomes a prime concern because the efficiency of an intermodal transit center is, once completed, very hard to change after construction due to the fixed environment surrounding it.

The next consideration should be the layout prioritization of transfer paths. In placing a transfer path within the limited space inside a transit center, unavoidable competition may arise between other transfer paths associated with other accessing modes. As discussed above, the transfer paths should be graded and designed in a manner to be assigned with in an appropriate perceived transfer distance.

Section 4

Benefits of Intermodal Transportation Systems

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An intermodal transit center is a core place where a seamless modal interconnection is achieved, entailing an intermodal transportation system which functions like an efficient single mode. Here are three phases of the connectivity between modes as defined below:

1) spatial connectivity where both the quantity and quality of connections between routes and modes are dealt with in such a way that it gives efficient access and egress by placing gates close to waiting areas, providing a vehicle-level platform, and by eliminating physical barriers, and resultantly direct paths are to be made from access to egress point without jogs, loops, bends or other deviations
2) temporal connectivity which consists of a close coordination of operating schedules to guarantee a timely transfer between modes and to make it possible for travelers to make connections having sufficient time for walking
3) connectivity through coordinated fares which guarantee an integrated fare structure by eliminating duplicated fare collection on the transfer trip or fare inconsistencies like different rates among operators or inconsistent rates among like modes

Excellent accessibility of an intermodal transit center could lead to a compact land development which is based on joint development by expediting the public and private sectors to share the facility, its costs and revenues and to include amenity facilities like restaurants, personal services, newsstands, or arcades making the time spent at the facility more useful or pleasant during the transfer process. The result will be an efficiently designed intermodal transit complex.

The intermodal transit complex may entail significant benefits to travelers and visitors. The facility may create a wide range of benefits. Initial user benefits can be generated in terms of savings in travel time and travel cost due to enhanced connectivity. Improvements in comfort and convenient are also beneficial when they affect perceptions of travel time. User benefits can also include the ability to travel to destinations at different locations for a given activity and the ability to make entirely new trips. These latter types of benefits accrue primarily from the effects of urban development and renewal encouraged by the enhanced accessibility of the complex.

1. Direct Benefit of Reduced Perceived Transfer Distance

When the transfer impedance is reduced through shortening of the perceived distance or physical distance weighted by other difficulties of walking in the transfer, users will get the benefits accruing from it. This is analogous to the direct benefits of travel time reduction due to improved transportation facilities. It is a direct benefit to be derived from improvement of the transfer facilities. The reduction of perceived distance can be made by improvement of one or a combination of influencing factors.

2. Benefit due to Demand of Modal Shift

There is another type of benefit different from the direct benefit to current users of an intermodal transit center when a significant reduction is made of the perceived transfer distance. A potential user who currently goes by a different mode but switches after seeing the connection improved in the transit center benefits by a mode change. Taking an example, a traveler who starts at Samsung Neighborhood, Seoul and goes by car to Daejeon, which is about 150 km away. This traveler may abandon his car trip and go via subway to Seoul Station to catch a KTX bound for Daejeon when realizing an easy connection can be made between subway and rail at Seoul Station. This case involves changes in route and mode of travel. For this Seoul-Daejeon trip, one vehicle trip is eliminated over the entire length of traffic-congested highway from Seoul to Daejeon while one subway trip is created from Samsung Neighborhood to Seoul Station and one KTX trip between Seoul and Daejeon are added together with the walking transfer inside Seoul Station. The benefit of this modal change can be enormous when the reduction of marginal costs over the congested highway stretch is added to the user's direct benefit due to the travel time saving.

3. Benefit of Destination Changes to the Transit Complex

The premise of an intermodal transit center is that it provides good accessibility to and from the center and excellent connectivity between modes within. This premise has an important implication about an urban function. The good accessibility of an intermodal transit center makes it possible that the center can play dual roles of an interconnecting transportation point as well as compact development of land encompassing major urban functions for urban residents and amenities facilities for travelers. An intermodal transit complex is an intensified version of an intermodal transit center with compact size and has advantages over other places in attracting people to fulfill their desires for urban activities. People are motivated to change their destination to the complex for their desired activity. User benefits can arise from a destination change within the city.

Suppose a new convention center is constructed in an intermodal transit complex due to its enhanced accessibility. Users previously went through congested traffic to a convention center located in a crowded area of the city. They now come to the new easy to access convention center in the complex. In this case, the first benefit is the one visitors to the complex can receive through difference in time and costs in accessing the new convention centers over the former.

And another benefit is accredited to those who continue to use the former center will enjoy a reduced travel time and cost as a number of people who diverted to the new center are now removed from the streets. This diversion of destination will reduce the marginal cost of the transportation system for those who continue to utilize the former convention center.

An additional benefit is associated with the newly derived demand for the new convention center for its good service and location in terms of convention service. It is reflected by the increase in land price or rent of the new convention center.

Some of the benefits mentioned above are easily quantifiable while others are not. Depending on the characteristics of an intermodal transit complex, many benefits should be considered at the planning stage to justify the required costs for an improvement or construction of a new complex. It would be especially true when a high density complex development is considered as a part of the intermodal transit complex.

There are many examples of successful development of intermodal transit complexes in a manner that an effective high density urban development is made with the best use of an efficient interconnection between modes resulting in an increased use of a major mode, rail transport. Many advanced countries in pursuit of an efficient intermodal transit center have long had great concerns for the importance of expanding a simple transit center into an intermodal transfer complex with major urban functions. They are typical examples of transit-oriented development of the concerned site based on good accessibility of the intermodal transfer center.

Countries enjoying a high standard of living supported by a high average personal income have long recognized an improvement of the importance of intermodal transit center through reduction of access and transfer difficulties, and is increasingly becoming an important policy of public transportation in both making it attractive for daily use while helping to achieve policies of lower carbon dioxide emissions. The focus here has been on shortening the perceived transfer distance as much as possible and making as many modes accessible to public transportation as possible. Thus the improved accessibility of an intermodal transfer complex playing the role of an urban center with required urban activities will give motivation for high density development of the site in the form of transit-oriented development.

1) Pennsylvania Station in New York

Pennsylvania Station in New York is a railroad station located at a center point of Amtrak's northeast corridor where Acela Express trains provide intercity rail service between Washington D.C. and Boston. The Acela serves express operation with speeds reaching 150 mph and enjoys especially high passenger demand for the section between New York and Boston. This station also serves New Jersey Transit and Long Island Railroad commuter trains. These trains share 21 tracks and platforms to ensure smooth and efficient transfers between themselves at the underground station, where, through underground level 1 and 2 concourses, 430,000 passengers daily board and alight intercity and commuter trains at level 3 platforms. At either end of the station subway lines run along 7th and 8th Avenues. On the ground level New York City bus service is available. Altogether the station makes a well-organized intermodal transfer center.

Figure 2.7 Entrance of Penn Station from 7th Avenue

Source: Wikipedia, http://en.wikipedia.org/wiki/File:Penn_Station_NYC_main_entrance.jpg

Penn Station is also famous for

Figure 2.8 High-rise development over a rail station

Source: Wikipedia, http://en.wikipedia.org/wiki/File:Penn_Station_NYC_main_entrance.jpg

the transit-oriented development over its site. The station is located underground at 7th and 8th Avenues, between 31st and 33rd Streets, atop which Madison Square Garden and Pennsylvania Plaza are situated. Madison Square Garden is a multi-purpose indoor arena in Manhattan. It is used for professional basketball and ice hockey as well as boxing, concerts, ice shows, circuses, and other forms of sports and entertainment. It is home to the New York Rangers of the National Hockey League and the New York Knicks of the National Basketball Association. Pennsylvania Plaza is also the office, entertainment and hotel complex occupying Penn Station. With the sports arena and railroad station at its hub and 34th street retailers including Macy's nearing the complex, Pennsylvania Plaza remains one of the busier transportation, business and retailing neighborhoods in Manhattan. The location as a whole is always booming with travelers and visitors, who are adequately handled by the efficient intermodal transportation system consisting of one intercity rail combined with two commuter rails and two subway lines.

2) Shinagawa Station in Tokyo

Japan has a long tradition of high dependence on public transportation, especially rail. The nation has solid examples of high density development of station areas with an advantage of high proportion of high income earners and predominant use of rail in daily life. Many Japanese railroad stations are characterized as traditional in their layout, having a long history where the transfer distance is relatively long and inconvenient to walk. However, some new Shinkansen stations have been given special treatment in securing good intermodal connectivity between Shinkansen and other approaching modes like conventional narrow gauged rail, urban rail and city buses. While the reliance on rail is already satisfactorily high in Japan, the policy focus goes beyond a promotion of public transportation and is placed on high density transit-oriented development of station areas by putting urban centers near rail stations, entailing a maximized accumulation effect and producing profitable returns for rail operation. A typical development model is characterized as many interconnecting modes arranged in a Shinkansen station where along the transfer concourse amenities and commercial facilities are developed and at surrounding areas a large scale urban development is carried out to generate increasing demand for rail and promote local economic activities.

Shinagawa Station is a major rail station in Tokyo, under joint operation by East Japan Railway Company (JR East), Central Japan Railway Company (JR Central), and Keikyu. Users bound for the Miura Peninsula, Izu Peninsula, and the Tokai region utilize this station. The station is nearby an area consisting of Shinagawa Carriage Sidings, Shinagawa Locomotive Depot, and Tamachi Depot.

The primary JR station concourse is located above east-west platforms stretching the length of the station. The station is divided into two sections by a walkway. The southern section includes multiple shops and stalls making up the "e-cute" station complex. The Keikyu platforms are located on west side and are physically higher than the JR platforms. Some Keikyu trains terminate at Shinagawa while others intersect the Toei Asakusa Line at Sengakuji.

Shinagawa Station is one of the busiest stations in Tokyo. Thanks to being a conveniently located center of transportation and hosting a large number of hotels, offices, restaurant and stores it is supported by strong demand for visiting the location. Shinagawa Station serves Yamanote Line which is a loop line in Tokyo, Tokaido Shinkansen Line and many other lines. Keikyu Line makes a direct connection to Haneda and Narita airports and Narita Express trains are passing this station. These lines are laid in parallel and connected by a concourse, which provides a convenient intermodal connection between modes, attracting 3 million users a day.

Opening on June 12, 1872, Shinagawa is one of Japan's oldest stations as it started operation when service between Shinagawa and Yokohama provisionally started. "Japan's first railway" between Shimbashi and Yokohama through Shinagawa was inaugurated on October 14, 1872, four months later. This line is a section of the Tokaido Main Line. On March 1, 1885, the Yamanote Line started operation. Takanawa Station on the Keihin Railway Line (currently the Keikyu Line) opened on March 11, 1924 across

Figure 2.9 Exterior of Shinagawa Station

Source: Wikipedia, http://en.wikipedia.org/wiki/Shinagawa_Station#/media/File:Shinagawa_Station_-01.jpg the street from Shinagawa Station. Takanawa was renamed Shinagawa and relocated to the current location on April 1, 1933. Nothing of the original station's structure remains.

Located above the platforms, the eastern station concourse was extensively redeveloped in 2003. The work was in tandem with construction of the Shinkansen platforms along with improving access to Shinagawa Intercity, the new commercial development.

There are two exits at Shinagawa Station; Takanawa in the west and Konan in the east. The Takanawa exit leads to many hotel developments including Takanawa Keikyu Hotel, Takanawa Tobu Hotel, Grand Prince Hotel Takanawa, and Shinagawa Prince Hotel, together with a varying sizes of shopping malls. Epson Aqua Stadium hosts a variety of sea animals and shows and is located here. Japan National Route 15 is a busy highway

Figure 2.10 Major developments around Shinagawa Station

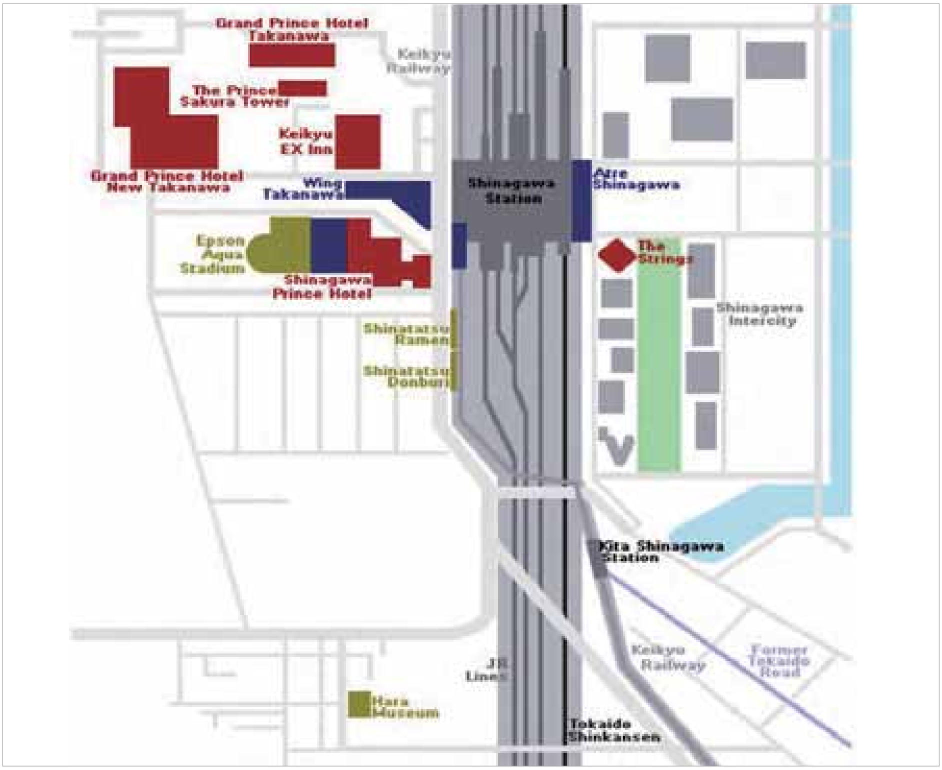


Figure 2.11 Concourse of Shinagawa Station

Source: http://www.japanbullet.com/images/2015/08/JRShinagawaStationaug5.jpg

connecting Tokyo and Yokohama and passes through this area as well.

Konan exit is to the east and leads to Shinagawa Intercity and Tokyo University of Marine Science and Technology. This is a new commercial area that was extensively redeveloped. A large number of offices and headquarters of big companies are housed in the buildings here. These new buildings are designed in such a way that employees working here can easily fulfill their daily needs from various in-house developments as almost all lower floors of these buildings are equipped with restaurants and stores, and many of them have big gardens to create a comfortable environment.

3) High Density Development in Hong Kong MTR

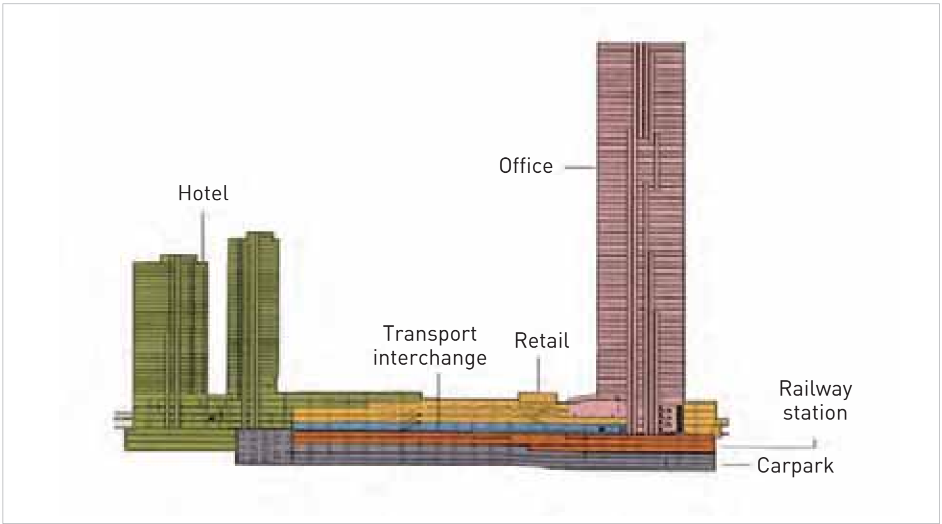
Hong Kong Station is a station of the Hong Kong MTR metro system and opened in 1998. It is situated in Central District on Hong Kong Island and sits underneath the International Finance Centre. The station is the eastern terminal of Tung Chung Line and Airport Express. Connections to Central Station are provided via two tunnels, which typically takes three to six minutes to traverse by foot. The tunnels travel under Connaught Road Central and also provide moving walkways. The station, retail mall, the master plan for the International Finance Centre development, pedestrian tunnels, and footbridges were all designed with input from the area's residents and businesses.

The complex includes check-in service for Hong Kong International Airport flights and free shuttle bus services to Central and Wan Chai hotels. Of the two platforms, Platform 1 provides service to Airport Express trains. For connectivity convenience, taxis and hotel shuttle services are provided on the same floor just outside the gates.

Access between the Tung Chung Line and Airport the Express are considerably distant from each other. As the Airport Express platform is located on a floor above the Tung Chung Line concourse, passengers make a transit via escalators to complete their transfer. Railroads in Hong Kong have a well-organized network carrying 2,220,000 passengers daily with an average of 1.6 km spacing of stations. The share of rail in transportation increased to 42.6% in 2009.

The MTR network connects all major areas of Hong Kong to keep the whole city integrated without the need for the use of personal autos. Hong Kong has been successful in achieving profitable operation of rail by an

Figure 2.12 Complex development of Hong Kong Station



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effective development of station areas, accomplishing the objectives of both facility usage by rail passengers and development profits. Figure 2.12 shows a complex development of an MTR station area by putting in commercial, business, and hotel facilities required for an urban center based on the convenient public transportation system.

4. The Role of Supporting Facilities

The intermodal transit complex is the primary location where an efficient intermodal transportation system can be established. In this place various transportation modes are merged and interconnect with seamless transfers. The place is easy to access because various modes are design to come in. Once arriving, it would be easy to find a connecting mode because of a good transfer arrangement. And hence the intermodal transit complex has two characteristics due to its superiority of access and transfer. The first is an increased demand for public transportation through a modal change from other modes. As is widely known, travel demand is inversely proportional to travel time and travel costs. The intermodal transit complex enables travelers to find the best mode for transfers which require the least time and cost from available choices located where many modal interconnections occur. An efficient intermodal transit complex is achieved where travelers find negligible transfer distance, giving them a minimum perceived transfer distance. The demand function predicts that demand for public transportation will increase at the transit complex with the minimum perceived distance for transfers.

The second characteristic is the ability to entice the population to do urban activities at an intermodal transit complex where good accessibility justifies a high density development for supporting urban functions. Such complexes have an advantage in attracting major functions of an urban center such as hotels, department stores, hospitals, and large office buildings. This is a frequently observed phenomenon of an efficient urban development at an efficient intermodal transit complex as seen in Shinagawa Station in Tokyo or Penn Station in New York. Above the Penn Station complex reside an arena for large scale sporting events or concerts and high-rise buildings for office and stores which often require a huge amount of traffic concentration that cannot be adequately dealt with without an efficient public transportation system consisting of underground railroads, subways and their interconnecting system. Shinagawa Station in Tokyo also reveals an extraordinary concentration of rush hour traffic generated by the population-attracting high density urban development including hotels and restaurants. The well-organized interconnection among approaching transportation modes at the station provides a good solution to the formidable rush hour traffic. As with the development of the station complex, the visiting population to the complex increases as a result of a destination change from the former urban center.

Synthetically, an intermodal transit complex will attract residents to visit here in an overall sense. Destination changes to the complex will be made in large quantities because the complex makes it possible to have easy access and make a convenient transfer to a connecting mode, which will result in both increased travelers and visitors. Trips to the complex through the destination change will alleviate traffic burden on the streets formerly used, reducing the marginal cost to the users remaining on those streets, in addition to a direct saving of time and cost due to a destination change to the changers themselves. When an intermodal transit complex takes its share of the role of an urban center through its supporting facilities, it will function as a core of developing the surrounding area.

The expanding process of station area development is roughly divided into three stages (Figure 2.13). It may start with a simple transfer station with no significant land development, then develop into an intermodal transit complex with supporting facilities through a limited amount of high density land development, and finally evolve into expanded station area development with an intermodal complex as a center of the development.

A well-organized simple intermodal transit center with no significant land development comes up with a good intermodal transportation system and hence helps to increase in travel demand for rail transportation, a principal mode of the center. A small scale rail station may take the form of a simple transit center.

Figure 2.13 Staged station area development

Simple transit center		Intermodal transit complex		Station area development
Interconnected transport system and station business through improved transfer system	⇨	Interconnected transport system and supporting facilities in limited land development	⇨	Intermodal transit complex and surrounding area development
Transportation planning		Transportation & urban planning		Transit-oriented urban development

When a railroad station becomes large in size and travel demand, it has a significant number of transfer passengers and then may need to be equipped with sufficient facilities for amenities and urban functions. In such a station, the number of approaching modes increases and the amount of travel demand increases as well. Therein lies the necessity for special treatment that could reduce the perceived transfer distance for major modal pairs and promote an efficient urban development in close connection with the good accessibility of the station. This form of an intermodal transit complex must justify the simultaneous development of an intermodal transportation system and high density development of the site. In this case, the effect of the destination change to the complex is such that reduction of the marginal costs for trips over the crowded urban center through a decentralization effect of the complex is much bigger than the savings of the converted travel demand to the complex. Therefore, the supporting facilities in the form of high density urban development in an intermodal transit complex should be understood as not optional but essential measures leading to a successful operation of the complex.

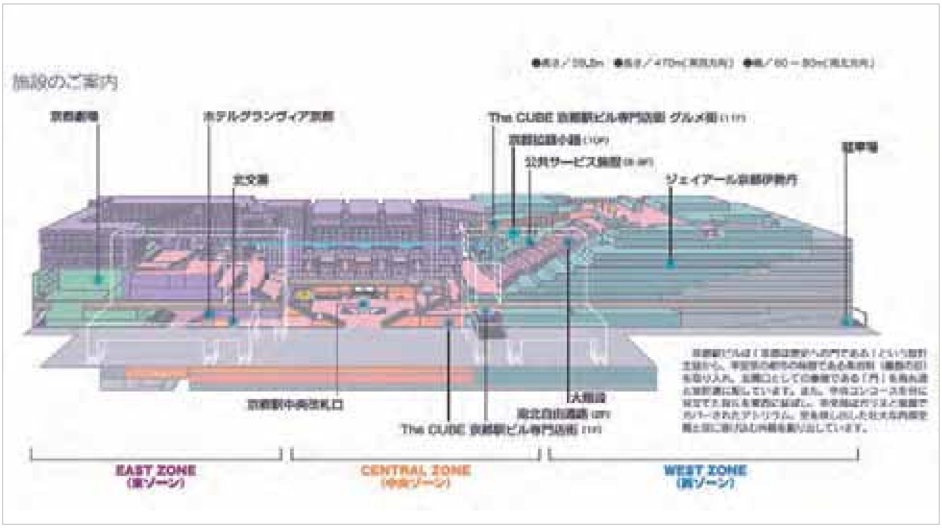
A good example of this is Kyoto Station in Japan. The station is a gateway to the famous scenic city of Kyoto and has recently been developed into an intermodal transit complex providing rail services for four rail companies; JR Central operating Tokaido Shinkansen, JR West, Kintetsu, and Kyoto Municipal Subway. Kyoto Station is a major railroad station and transportation hub in Kyoto which currently deals with over 600,000 tourists and commuters a day. This is Japan's second-largest station building, incorporating a shopping mall, department store, hotel, movie theater, and multiple local government facilities in a single 15 story structure. Up until August 31, 2002, it also formerly housed the Kyoto City Air Terminal.

The current Kyoto Station opened in 1997. The station is 70 meters high and 470 meters across, with a total floor area of 238,000 square meters. The architectural concept was futurism, with a slightly irregular cubic exterior consisting of plate glass over a steel frame. The concept was unique for the city due to the high number of cultural heritage sites. Its completion instigated a wave of new high-rise developments in Kyoto, culminating in the 20-story Kyocera Building.

Opposite the main building to the north, the Hachijoguchi Building was constructed on the south side to house the Tokaido Shinkansen. Underground facilities were constructed when the subway opened in 1981 and included a shopping mall.

As an intermodal transit complex evolves into full-blown growth and its

Figure 2.14 Overview of the Kyoto Station Building



Source: http://www.comingsoon.com.tw/web2/2010japan/kyoto_station/01.jpg effects spread out widely into the surrounding area, increasing travelers and visitors to the station complex may ignite an expanded development of a wider area adjacent to it. A good intermodal transit complex is characterized by both a useful transportation system with good access, secured transfers, and advanced land use with assorted urban functions which can induce travelers and visitors to justify a wider scale of urban development. As in a large railroad station in Japan or Hong Kong, such large scale development can be successfully made centering around an efficient intermodal transit complex.

The intermodal transit complex as defined in the National Integrated Transport System Efficiency Act is a center where an efficient intermodal transportation system is established with rail as the principal mode and the intermodal planning mechanism is implemented through organized planning and coordination of all modes approaching this station.

Before this law, no mechanism existed to specify the overall planning and coordination of all modes at the merging point, the station, although individual transportation modes are regulated by individual laws. Such being the situation, an efficient interconnectivity or transfer could not draw policy-making attention in comparison with the required costs, which resulted in a neglected consideration of users' convenience at transfer centers. The mechanism of an intermodal transit complex activates the policy to designate the responsible organization to plan intermodal transportation nodes, which used to be neglected in conventional transportation planning.

Intermodal transit complexes go beyond an overall transportation planning of all modes entering the complex and target on intensified high-density development of the site defined as supporting facilities, entailing an institutionalization of coordinated transportation and urban development. Conventional urban development has focused too much on space acquisition for urban activities while the travel supporting the activities has been given secondary consideration. It would be difficult and costly to later put in transport infrastructure after the development plan is completed. Considering transportation as secondary in the urban development plan would make it difficult to rearrange within competing space or change the development scheme. Intermodal transit complexes are a new form of policy for urban development in which transportation and development are coordinated together from the beginning in a manner that a large railroad station is developed into an efficient intermodal transfer center with access and transfer improved and a high density land development pursued with best use of the good accessibility of the site.

As the intermodal transit complex develops further, it will attract more travelers and visitors and the urban activities will accordingly proliferate centering around the complex. An adequate response to this trend of increasing activities and visitors will lead to a wider development of surrounding areas. That is, an intermodal transit complex takes the lead in the development of surrounding areas and the supporting facilities of the complex will have to include those facilities that will play a central role in the development of surrounding areas later.

Practices of Intermodal Transportation Policies

Section 1

Intermodal Transit Center and Transit Complex

1. Simple Transit Center

A transit center is a station which is planned and operated in such a way that a variety of transportation modes merge together and seamless transfers are made between themselves. Typical examples are bus terminals, railroad stations, airports, and ferry terminals. And a small scale transportation node, like a bus stop closely connected to a subway station or an arterial bus stop sharing with local feeder buses are good examples of transit centers. A small transit center like this could provide a good transfer service because the number of modes involved in the transfer is as simple as subway-bus or arterial-feeder bus connection and hence the transfer distance is relatively short. Without regard to the size, a transit center should place utmost focus on establishing an efficient intermodal transportation system through ensuring a seamless interconnection between modes. As the size of a transit center becomes large, the number of modes involved increases as with passenger demand, which makes it complicated and difficult to plan a good layout and structure of transfer lines of movement. In other words, this complicated transit center will be socio-economically more important and accordingly the construction costs will also be high, which requires that this type of transit centers be given a more careful treatment by a legally controlled planning and operation process.

A good intermodal transportation system is the premise of a seamless interconnection system to be achieved by the following efforts. First, an intermodal passenger transfer facility is part of a very large system of transportation services. Its design requires it to be integrated with existing modes, perhaps making fundamental changes to the operation of those modes. It is necessary to involve the expertise of transportation planners and managers, as well as engineers and architects, in the design. Even broader expertise might be needed to mitigate adverse impacts on the physical environment and on society. An intermodal passenger transfer facility is part of a larger transportation system. The system involves a large number of modes, services, and other transfer facilities. When you think of an intermodal facility, it is very important to assure its good fit with the remainder of the transportation system and assure the transportation system's fit to the intermodal facility.

Second, the institutional integration should be assured to achieve a well-organized system which can coordinate services at the facility, eliminate duplication and establish mechanisms for communication between different operators and with the public. An intermodal transfer facility is the most important part of an intermodal transportation system which an intermodal transit center encompasses as a principal element while the transfer facility again forms a major part of the intermodal transportation system by allowing smooth interaction with merging modes. This process necessarily requires a transfer which is perceived as one of the most negative aspects of any trip. Since transfers cannot be entirely eliminated, it is essential to make them as quick and pleasant as possible. Transfers can be improved by several means, including better facilities, better operations and better institutional arrangements, any of which can be achieved only when the planning of the concerned transit center is controlled by one responsible entity over all modes involved.

With a formal institution to designate an agency in charge of planning the transfer center, another concern comes up over how to make the land development in close connection with the transportation advantage. A transfer site has a considerable advantage in access because various transportation modes are arranged to connect seamlessly with each other. Having an accessibility advantage, central functions of urban activities may well be imposed on this place, leading to decentralization of urban functions and strengthening of urban activities. In other words, the intermodal transfer center can make the utmost use of its functions only when a transportation-dependent urban development comes into consideration. As a result, such a development should not be a form of general urban development but a large scale of facilities to induce high travel demand with strong peaking characteristics which is frequently observed in many intermodal transfer nodes.

2. Intermodal Transit Complex

The intermodal transfer node is a determining part of the efficiency of an intermodal transportation system. A main public transportation mode is merged with other modes with smooth connectivity creating excellent accessibility within a city while also being a gateway to the outside world with good outbound connection. An intermodal transfer station is a central place where intermodal transfers are made centering around high capacity public transportation. These places easily deal with a high volume of traffic flows, which makes it possible to install large traffic inducing facilities at the site and develop it into an urban center. Good examples include Penn Station in New York and Shinagawa Station in Tokyo.

The National Integrated Transport System Efficiency Act was enacted in 2009 in order to specify detailed prescriptions for structuring intermodal transit complexes to create an efficient transfer system and promote an energy efficient and environmentally friendly transit center. According to the law, an intermodal transit complex is defined to have two major functions; an efficient intermodal transfer system to ensure a smooth interconnection with connecting modes as well as high density transit-oriented development of the site to share a decentralized urban center supported by excellent transit-based accessibility enabling sufficient treatment of a high demand of passengers and visitors. A comprehensive planning of transportation and land use was formally officialized by related clauses of the law so that the development density of land is subject to the improvement level of transportation service. Past experience shows that previous station area development projects could not be successful because development was simply focused on land adjacent to the station without considering transportation effects including access and transfer. Those projects only focused on land development with no major improvement of transportation and therefore could not draw the public's interest. To overcome these these problems of the area development, the concept of an intermodal transit complex was introduced in the law to structure an efficient intermodal transportation system at the station by ensuring a seamless interconnection and make the best use of enhanced accessibility in land development. Therefore, the law defines an intermodal transit complex as a composite development of a transit center with an improved transfer system where internal and external transportation modes merge and a high density land development of supporting facilities to help the convenience and comforts of passengers and visitors with commercial and business facilities.

According to Item 13 of Article 2 (Definition of Terms) of the National Integrated Transport System Efficiency Act, an intermodal transit complex is a facility complex where transfer and transfer-supporting facilities come together at the same place with close interaction and have the dual purpose of supporting a smooth interconnection and transfer activity between transportation modes including trains, airplanes, ships, subways, buses, taxis, and private vehicles, and include a socio-economic activity of commerce and business. Item 14 of the same Law defines transfer-supporting facilities as non-transfer facilities to be constructed at the complex which perform supporting functions of amenities, commercial, cultural, business, hotels, residential facilities, etc. necessary for daily life and socio-economic activities.

The transfer-supporting facility is a new concept that did not exist previously. It specifies that a large high demand-inducing facility can be located in the site of an intermodal transit center where the transportation service is improved significantly enough to handle a large volume of accruing demand. However, the transfer facilities are defined very inclusively and ambiguously, which may cause conflicting understandings. A transfer is a process of changing one mode to another. And likewise, the transfer facility needs to redefined as an entire set of facilities directly involved in the entire transfer process including the entire stretch of a walking path consisting of an internal walking segment, stairwell, elevator, escalator, etc. Article 45 of the Law prescribes the conditions of legal designation of an intermodal transit complex. Item 1 of the Article says "The Minister of Land, Infrastructure and Transport, or Mayor, or Governor should designate, develop systematically and manage an intermodal transit complex to support an efficient transfer between transportation modes according to the following classifications."

Article 52 of the Law declares "At the time when the designator approves an implementation plan of an intermodal transit complex or its changes, the concerned project implementer is deemed as having obtained the concerned authorization or permission about the conditions already discussed with the director of the competent authorities according to Item 2 for the authorization, permission, approval, or decision of every item in the following." This regulation is important in that it can expedite the same time conclusion through consultations in a committee with all concerned parties participating about conditions raised by individual offices according to individual laws and regulations. This means individual offices governing individual transportation modes and facilities simply raise their opinions about the conditions to meet inside the transit complex and the decisions will come from the committee composed of competent authorities. It will help the consultation process to be expedited and the decision to be made from a broader perspective rather than from an individual sector's point of view.

Section 2

The National Integrated Transport System Efficiency Act

1. Establishment of an Intermodal Transportation System

1) Establishing a Master Plan for an Intermodal Transportation System (Article 36)

① The Minister of Land, Infrastructure and Transport shall establish and implement a 5-year midterm plan of the intermodal transportation system (hereinafter called "Midterm Intermodal Plan") through a review of the National Transportation Committee to establish the nationwide comprehensive intermodal transportation system including the establishment of intermodal transportation systems as prescribed in Item 2 of Article 37 and the establishment and implementation of action plans for intermodal transportation systems as prescribed in Item 1 of Article 38.

② Midterm Intermodal Plan shall include the following.

1. Goals and objectives
2. Current status and prospects for various development projects as the object of establishing intermodal transportation systems
3. Selection of projects of the intermodal transportation system and

determination of investment priority

4. Financial requirements of the intermodal transportation system and mobilization method
5. Additional things necessary for the establishment of an efficient intermodal transportation system

③ Necessary particulars of the process for the establishment and amendment of the Midterm Intermodal Plan shall be stipulated by a Presidential Decree.

2) Designation of Main Points of Transportation and Physical Distribution, and Establishment of Intermodal Transportation Systems (Article 37)

① The Minister of Land, Infrastructure and Transport or Mayor of Seoul Metropolitan City, Mayors of Integrated Cities, Governors of Provinces, Governor of Special Province (hereinafter called “Mayor or Governor”) shall designate and make an official announcement of the main points of transportation and physical distribution to establish and manage an efficient intermodal transportation system.

1. Class I Main Points: The Minister of Land, Infrastructure and Transport to designate and make an official announcement through a review of the National Transportation Committee after a consultation with the head of the concerned government office of the central government
2. Class II Main Points: Mayor or Governor to designate and make an official announcement through approval by the Minister of Land, Infrastructure and Transport

② The entity to designate the main points of transportation and physical distribution according to each case in above Item 1 (hereinafter called “designator”) shall establish the intermodal transportation system centering around the main points of transportation and physical distribution.

3) Establishing Action Plans for the Intermodal Transportation System (Article 38)

① The head of the concerned government office shall, in case of promoting each of the following development projects related to transportation facilities, establish and implement action plans of the intermodal transportation system (hereinafter called "intermodal action plans") to improve the interconnection and transportation with concerned national arterial transportation facilities.

1. Harbors pursuant to Item 7 of Article 2 in the Harbor Law
2. Airports pursuant to Item 7 of Article 2 in the Aviation Law
3. Physical distribution terminal complex pursuant to Item 2 of Article 2 of the Law for Development and Operation of Physical Distribution Facilities
4. Physical distribution complex pursuant to Item 6 of Article 2 of the Law for Development and Operation of Physical Distribution Facilities
5. Industrial complex defined by a Presidential Decree among the industrial complexes pursuant to Item 5 of Article 2 of the Law for Industrial Location and Development
6. Any other large development projects defined by a Presidential Decree

② The head of the concerned government office shall finalize the action plans for the intermodal transportation system through a review by the National Transportation Committee. The amendment of the final action plans for the intermodal transportation system shall follow the same process (except for minor amendments stipulated by a Presidential Decree).

③ The content, time to establish, and other particulars of action plans for the intermodal transportation system shall be stipulated by a Presidential Decree.

Definition of an Influence Zone for the Intermodal Transportation System (Article 40)

① The head of the concerned government office, when he establishes the Midterm Intermodal Plan pursuant to Article 36 or the action plans for the intermodal transportation system, shall define an influence zone (hereinafter called “intermodal influence zone”) where a development project may cause any problems or negative effects on the intermodal transportation system of the project site and surrounding areas and shall construct concerned plans and actions within the zone.

② The scope, time to establish, and other particulars of the intermodal influence zone of the intermodal transportation system shall be stipulated by a Presidential Decree.

Guidelines of the Intermodal Transportation System (Article 41)

① The Minister of Land, Infrastructure and Transport shall establish the guidelines of the intermodal transportation system about the criteria and methods for the intermodal transportation system and intermodal connectivity and transfer and shall notify the head of the concerned government office of the guidelines.

② The head of the concerned government office shall establish and implement concerned development projects, concerned plans and concerned actions pursuant to the guidelines prescribed in Item 1 above.

Authorization of the Highway pursuant to the Action Plan of the Intermodal Transportation System (Article 42)

Mayor, County Chief, or District Director (referred to a head of an autonomous district, and the same hereinafter) shall authorize the highway according to the Highway Law and promulgate its content for those roads to be constructed pursuant to action plans for the intermodal transportation system as prescribed in Article 38.

4) Financial Share of Intermodal Transportation System (Article 9)

① The Government or local governments may subsidize or share all or a part of the finances required for establishment and implementation of the intermodal transportation system pursuant to Item 2 of Article 37 and the action plans pursuant to Item 1 of Article 38.

② Autonomous local governments shall appropriate their shares of the finance in their current year budget with priority over other projects to expedite the construction of the intermodal transportation system.

③ Unless the share of the local government in the required finance according to Item 1 is properly appropriated in the current year budget, the Government may withdraw the subsidy or the share and suspend or cut down the financial assistance for the other intermodal transportation system.

2. Development of Intermodal Transit Complex

1) Establishment of the Development Plan of the Intermodal Transit Complex (Article 44)

① The Minister of Land, Infrastructure and Transport shall establish the 5-year Development Master Plan of the intermodal transportation system in order to expedite development of the intermodal transportation system through a review of the National Transportation Committee.

② The Development Master Plan pursuant to Item 1 shall include each of the following.

1. Implementation direction for an efficient development of the intermodal transportation system
2. Survey and analysis of present status of the interconnectivity and transfer facilities
3. Basic development method of the intermodal transit complex
4. Rough estimates of construction costs for the intermodal transit complex
5. Other details to be stipulated by a Presidential Decree for active development of an intermodal transit complex

③ Necessary particulars about the process of establishment and amendment of the Development Master Plan of the intermodal transportation system stipulated in Item 1 shall be stipulated by a Presidential Decree.

Figure 3.1 Process for developing an intermodal transit complex

STEP 1	**Development of Intermodal Transit Complex Master Plan** ① Discuss with concerned offices, review in National Transportation Committee, and promulgate
STEP 2	**Designation, Assistance of Model Projects (Ministry of Land, Infrastructure and Transport)** ① Invite to model projects, select through evaluation - Applicants to submit project reports ② Discuss with concerned government offices, review in National Transportation Committee, and designate ③ Assistance in administrative, technical, financial matters for model projects
STEP 3	**Designation of Intermodal Transit Complex (national arterial: Ministry of Land, Infrastructure and Transport / integrated and standard: city and province)** ① Establish Intermodal Transit Complex Development Plan ② Hearings from concerned residents and experts ③ Discuss with concerned government office, review in National Transportation Committee (national arterial and integrated over 300,000 square meters of lot size), and promulgation ※ Concerned government office or would-be project implementer to prepare development plan and ask to be designated
STEP 4	**Designation of Project Implementer (national arterial: Ministry of Land, Infrastructure and Transport / integrated and standard: city, province)** ① Invite project implementer, designate project implementer through evaluation - Applicants to submit applications
STEP 5	**Establishment of Implementation Plan (project implementer)** ① Apply for approval of implementation plan of intermodal transit complex (national arterial: Ministry of Land, Infrastructure and Transport / integrated and standard: city and province) ② Discuss with concerned government office and approve implementation plan
STEP 6	**Implementation (project implementer)**
STEP 7	**Authorization of Completion (national arterial: Ministry of Land, Infrastructure and Transport / integrated and standard: city, province)** ① Apply for authorization of completion by project implementer ② After inspection of completion, authorize completion, promulgate at official gazette

Article 70 (Setting Up and Management of Service Standards of an Intermodal Transit Complex)

① The Minister of Land, Infrastructure and Transport may establish and promulgate a set of standards (hereinafter called "service standards of an intermodal transit complex") as necessary in order to keep and improve the service of an intermodal transit complex above a particular level.

② Necessary particulars for establishing the service standard and its promulgation shall be specified by a ministerial ordinance.

2) Designation of an Intermodal Transit Complex (Article 45)

① The Minister of Land, Infrastructure and Transport or Mayor or Governor shall designate, develop and manage the intermodal transit complex to support efficient transfers between transportation modes according to the following classifications.

1. National Arterial Complex: Minister of Land, Infrastructure and Transport to designate
2. Integrated Complex: Mayor or Governor to designate with approval of Minister of Land, Infrastructure and Transport. In case of a large complex over the size stipulated by a Presidential Decree, it shall require approval of The Ministry of Land, Infrastructure and Transport after a review by the National Transportation Committee.
3. Standard Complex: Mayor or Governor to designate

② When the Minister of Land, Infrastructure and Transport tries to designate a national arterial intermodal transit complex according to Item 1, he/she shall establish a plan for developing an intermodal transit complex (hereinafter called "development plan of an intermodal transit complex"), take opinions from competent Mayor or Governor, discuss with directors of concerned central government authorities, and go through a review by the National Transportation Committee. Amendment of important conditions stipulated by the Presidential Decree of the development plan of intermodal transit complex shall take the same process.

③ When the Mayor or Governor tries to designate an integrated or standard intermodal transit complex, shall establish the development plan of an intermodal transit complex, take opinions from competent Mayor, County Chief, or District Director and discuss with the Director of concerned authorities. Amendment of the intermodal transit complex shall take the same process.

④ When the Director of concerned authorities or anyone falling within one of the entities from 1 to 6 of Item 2 of Article 49 considers it necessary to designate an intermodal transit complex, may request the Minister of Land, Infrastructure and Transport, Mayor, or Governor to designate a fixed site as national arterial, integrated or standard intermodal transit complex. In this case, anyone except for the Director of central authorities shall submit a development plan of an intermodal transit complex.

⑤ When a Mayor or Governor tries to amend important matters stipulated by the Presidential Decree of the designation contents for an integrated intermodal transit complex according to the conditional clause in Paragraph 2 of Item 1, shall gain approval of the Minister of Land, Infrastructure and Transport after a review of the National Transportation Committee.

⑥ Mayor or Governor, when he/she has designated an integrated or standard intermodal transit complex, shall notify the Minister of Land, Infrastructure and Transport of the result. In case of amendment of contents of designation, the process shall be the same.

⑦ The development plan of the intermodal transit complex from Item 2 to 4 shall include each of the following. However, in case that the project implementer of Item 3 has not been settled by the completion of the development plan of an intermodal transit complex or it is not possible to prepare the detailed contents of Paragraph 8 below, the designation of an intermodal transit complex may go in advance and the concerned contents may be included in the development plan after the designation.

1. Name, location and area
2. Objective of the designation of an intermodal transit complex
3. Project implementer
4. Construction period and method
5. Site, land use planning, plans related with intermodal transportation, and major infrastructure plans
6. Construction and operation of major facilities
7. Financial plan

8. Expropriation or use of land, buildings, or additional things, and detailed list of their rights
9. Size of floor area for each intermodal transit complex
10. Others to be stipulated by the Presidential Decree

⑧ Standards of permissible floor area size for each use according to Paragraph 9 of Item 7 shall be prescribed by an ordinance of the Ministry of Land, Infrastructure and Transport.

Hearings of Residents' Opinions (Article 46)

① When an authorized designator of an intermodal transit complex (hereinafter called "designator") tries to designate an intermodal transit complex, shall take opinions from the residents and concerned experts and reflect them when those opinions are considered reasonable. However, for minor issues stipulated by a Presidential Decree, the opinion hearing may be left out.

② Particulars necessary for taking the opinions from residents and concerned experts shall be stipulated by the Presidential Decree.

Designation, Promulgation, etc. of Intermodal Transit Complex (Article 47)

① When the designator has designated an intermodal transit complex or amended the content of the designation, shall promulgate the matters stipulated by the Presidential Decree in the official gazette or respective bulletins of Special City, Integrated City, or Special Autonomous Province (hereinafter called "City or Province") and shall forward a copy of concerned documents to competent Mayor (that includes the administrative mayor pursuant to Item 2 of Article 17 of the special law for the establishment of Jeju Special Autonomous Province and construction of the international city. The same shall apply in the following Item 4, Item 3 of Article 48, and Items 1 and 2 of Article 51) County Chief or District Director. In this case the promulgation Article 8 of the basic law of land use regulation shall apply.

② In case that there are land, buildings, and other things or rights in the

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site to be designated as an intermodal transit complex, the content of promulgation in Item 1 shall include the detailed contents of the land.

③ When the designator has designated an intermodal transit complex according to the conditions except for each paragraph of Item 7 of Article 45 and then included the contents of Paragraph 3 and 8 of the same Item in the development plan, shall promulgate it again including the latter contents according to Item 1.

④ Mayor, County Chief, or District Director who receives concerned documents according to Item 1 and 3 shall make the contents public for more than 14 days.

Cancellation of Designation of an Intermodal Transit Complex (Article 48)

① Unless the approval of the implementation plan of an intermodal transit complex has been applied pursuant to Article 50 for all or part of the complex within the period stipulated by the Presidential Decree from the date of designation and promulgation, the designation of the intermodal transit complex for the concerned area shall be considered canceled on the day after the end of the period.

② The designator, having no prospect of the implementation of all or part of an intermodal transit complex, may cancel designation of the complex for the concerned area pursuant to the Presidential Decree.

③ When the designation of an intermodal transit complex is considered as having been canceled or has been canceled according to Item 1 or 2, the concerned designator shall notify the director of concerned central authorities or Mayor or Governor of the fact and promulgate it, and Mayor or Governor who has got the notice shall make Mayor, County Chief, or District Director let the public peruse it more than 14 days.

④ In case the designation of an intermodal transit complex has been canceled according to Item 1 and 2 of the National Land Planning and Utilization Act and its utilization has been changed and transformed by the designation of the complex, the land use of the complex site shall be considered as having been restored to the original one in spite of the provisions of the same Act. However, the land use shall not be restored to the original one in case that the designation of an intermodal transit complex is canceled after completion of development of the complex.

⑤ In case that the land use has been restored to the original, the Governor of Special Autonomous Province, Mayor, County Chief, or District Director shall promulgate the fact.

3) Project Implementer of an Intermodal Transit Complex (Article 49)

① An entity who tries to conduct the development of an intermodal transit complex shall be authorized as an implementer according to the Presidential Decree.

② The entity who may get authorized as an implementer of an intermodal transit complex shall be any of the following.

1. Central government or local government
2. Organizations stipulated by the Presidential Decree pursuant to the Act on the Management of Public Institutions
3. Local corporations pursuant to the Local Public Enterprises Act
4. Corporations established according to a special law
5. Project implementer pursuant to the Act on Public-Private Partnerships in Infrastructure
6. Corporations established according to Civil Act or Commerce Act

③ The entity who tries to get authorized as an implementer of an intermodal transit complex according to Item 1 shall apply to the designator for designation of an implementer with a development plan of an intermodal transit complex.

④ The implementer may designate other entity among those falling within each paragraph of Item 2 and let him implement the development of an intermodal transit complex if the one coming under Paragraph 5 and 6 of Item 2 out of those who has been engaged in the development of an intermodal transit complex and got authorized as an implementer (hereinafter called “project implementer”) has not completed the development of the complex within the period specified by the implementation plan approved pursuant to Article 50.

⑤ The project implementer coming under Paragraph 1 through 4 of Item 2 may let an operator who has moved or will move into facilities of the concerned intermodal transit complex (hereinafter called “tenant of the complex”) represent him for a part of the development project of the intermodal transit complex when considered necessary to ensure an efficient development of the complex.

Approval of an Implementation Plan of an Intermodal Transit Complex (Article 50)

① The project implementer shall establish an implementation plan of an intermodal transit complex as stipulated in the Presidential Decree (hereinafter called “implementation plan of an intermodal transit complex”) and shall win the approval of the designator. The amendment of important matters stipulated by the Presidential Decree shall require the same process.

② The project implementer, at the time of establishing an implementation plan of an intermodal transit complex, shall follow the standards of design and layout of an intermodal transit complex (which includes an information and guidance system) which the Minister of Land, Infrastructure and Transport will develop and promulgate.

③ The implementation plan shall include items about disposition of developed land, facilities, etc.

Commission of Development Project of an Intermodal Transit Complex (Article 53)

① The project implementer may commission, according to the provisions of the Presidential Decree, central or local government or public organizations stipulated by a Presidential Decree to construct water facilities and other public facilities prescribed by the Presidential Decree.

② The project implementer may commission business about land purchase, loss compensation and resettlement for the construction of an intermodal transit complex to the organizations coming under each paragraph of Article 81, Item 1 of the Act on Acquisition of and Compensation for Land Etc. for Public Works. In this case, Item 2 of the same Article shall apply to the commission fee.

4) Fiction of Authorization, Permission, and Expropriation of Land (Articles 52, 65 and 54)

① When the designator gives approval or amendment approval of an implementation plan of an intermodal transit complex, for the matters discussed according to Item 2 with the director of competent authorities about the authorization, permission, approval or decision of each of the following paragraphs (hereinafter called "authorization or permission") of the implementation plan it shall be deemed that the concerned implementer has won authorization or permission, and when promulgated according to Article 51, Item 1, it shall be deemed as authorization or permission pursuant to the laws of each of the following paragraphs have been promulgated or publicized. <Revised April 15, 2010, May 31, 2010>

1. Building permission according to Article 11 of the Building Act, a building report pursuant to Article 14 of the same Act, amendment of contents of permission and report according to Article 16 of the same Act, report of building permission and construction of temporary construction according to Article 20 of the same Act
2 Permission of occupation and use of public waters pursuant to Article 8 of the Public Waters Management and Reclamation Act, establishment and amendment of the reclamation master plan of public waters pursuant to Article 22 and 27 of the same Act, reclamation license of public waters according to Article 28 of the same Act, consultation and approval of reclamation pursuant to Article 35 of the same Act, and approval of the implementation plan of reclamation of public waters according to Article 38 of the same Act

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3. Deleted <April 15, 2010>
4. Abolition of use of administrative property according to Article 11 of the Management of Public Property and Goods Act, permission for use and profit of administrative property pursuant to Article 20, Item 1 of the same Act
5. Permission for use of administrative property pursuant to Article 30 of the State Property Act
6. Decision on the city management plan pursuant to Article 30 of the National Land Planning and Utilization Act, permission of a change of the form and quality of land and land division pursuant to Article 56, Item 1, Paragraph 2 and 4 of the same Act, designation of an implementer of an urban planning facilities project according to Article 86 of the same Act, authorization of an implementation plan pursuant to Article 88 of the same Act
7. Approval for use other than agricultural infrastructure pursuant to Article 23 of the Act on the Maintenance and Improvement of Road Networks in Agricultural and Fishing Villages
8. Permission and consultation for a diversion of farmland according to Article 34 of the Farmland Act, report of diversion of farmland pursuant to Article 35 of the same Act, permission and consultation of temporary use of farmland as an alternative objective according to Article 36 of the same Act, approval of usage change according to Article 40 of the same Act
9. Permission for highway construction according to the Road Act, permission of occupation and use of a highway pursuant to Article 38 of the same Act
10. Authorization of an implementation plan according to Article 17 of the Urban Development Act
11. Permission for opening a private road according to Article 4 of the Private Road Act
12. Permission for lumbering according to Article 14 of the Erosion Control Work Act, deletion from the designation of land for erosion

control according to Article 20 of the same Act

13. Permission for conversion of mountain areas and report of it pursuant to Article 14 and 15 of the Mountainous Districts Management Act, permission and report of temporary use of mountain area pursuant to 2 of Article 15 of the same Act, permission of gathering soil and rocks pursuant to Article 25 of the same Act, permission and report of tree cutting etc. according to Article 36, Item 1 and 4 of the Forest Resources Creation and Management Act, permission and report of deeds within a forest preservation district (excluding the district of forest genetic resources preservation) pursuant to Article 9, Item 1, Item 2 Paragraph 1 and 2 of the Forest Protection Act.
14. Authorization of a waterworks project according to Article 17 and 49 of the Water Supply and Waterworks Installation Act, authorization of installment of exclusive water pipes pursuant to Article 52 and 54 of the same Act
15. Consultation of energy usage plan according to Article 10 of the Energy Use Rationalization Act
16. Registration for opening large stores according to Article 8 of the Distribution Industry Development Act
17. Permission for treatment of tombs etc. according to Article 27, Item 1 of the Act on Funeral Services, Etc.
18. Approval of a project plan according to Article 16 of the Housing Act
19. Report of initiation or amendment of a project according to Article 86, Item 1 of the Act on Land Survey, Waterway Survey and Cadastral Records
20. Consultation about feasibility of group energy supply according to Article 4 of the Integrated Energy Supply Act
21. Permission and consultation for conversion of grassland according to Article 23 of the Grassland Act
22. Permission for construction of public sewerage infrastructure according to Article 16 of the Sewerage Act, permission for occupation and use pursuant to Article 24 of the same Act, report of

installation of private sewerage treatment plant according to Article 34, Item 2

23. Permission for construction of river conservative works pursuant to Article 30 of the River Act, permission for occupation and use of a river pursuant to Article 33 of the same Act and permission for use of river water according to Article 50 of the same Act

② When the designator makes an approval or amendment approval of an implementation plan for an intermodal transit complex according to Item 1, the designator shall consult with the director of competent authorities in advance in case the content of the plan includes matters falling under any of the paragraphs in Item 1.

③ In a case that is deemed to have authorization or permission pursuant to other laws according to Item 1, the fees accruing from authorization or permission to be imposed by concerned laws and ordinances of the concerned local government are exempted.

④ The director of competent authorities in charge of governing over any of the paragraphs of Item 1 shall notify the Minister of Land, Infrastructure, and Transport of its administration standard. Its amendment shall take the same process.

⑤ When the Minister of Land, Infrastructure and Transport is notified of the administration standards, this information shall be promulgated. The same process shall follow when the Minister is notified of an amendment of the promulgated standards.

Permission of Construction and Approval of Use of an Intermodal Transit Complex (Article 65)

① When an entity who tries to construct the transfer or transfer-supporting facilities within an intermodal transit complex has obtained permission of construction pursuant to Article 11 of the Building Act, he/she shall be deemed as having obtained authorization or permission for each of the following paragraphs.

1. Permission or report of temporary construction pursuant to Article 20,

Item 1 and 2 of the Building Act, report of construction of a structure pursuant to Article 83 of the same Act

2. Permission of installation of a high-pressure gas storage facility according to Article 4, Item 3 of the High-Pressure Gas Safety Control Act
3. Permission of development deeds pursuant to Article 56, Item 1, Paragraph 1 of the National Land Planning and Utilization Act, designation of a project implementer of urban planning facilities pursuant to Article 86 of the same Act, authorization of an implementation plan pursuant to Article 88 of the same Act
4. Permission or report of the installation of discharge facilities pursuant to Article 23 of the Clean Air Conservation Act, Article 33 of the Water Quality and Aquatic Ecosystem Conservation Act, and Article 8 of the Noise and Vibration Control Act
5. Permission of occupation and use of a highway pursuant to Article 38 of the Road Act
6. Consent for construction permission etc. pursuant to Article 7, Item 1 of the Installation, Maintenance, and Safety Control of Fire-Fighting Systems Act, report of construction of fire-fighting facilities pursuant to Article 13, Item 1 of the Fire-Fighting System Installation Business Act, permission of installation of a manufactory pursuant to Article 6, Item 1 of the Safety Control of Dangerous Substances Act
7. Authorization of installation of exclusive water supply system according to Article 52 and 54 of the Water Supply and Waterworks Installation Act
8. Permission of construction of storage facilities of liquidated petroleum gas pursuant to Article 6, Item 1 of the Safety Control and Business of Liquidated Petroleum Gas Act
9. Authorization or report of a work plan of private electric installation pursuant to Article 62 of the Electric Utility Act
10. Application for a registration of land use pursuant to Article 62, Item 2 of the Act on Land Survey, Waterway Survey and Cadastral
11. Permission for installation of temporary storage facilities for

explosives pursuant to Article 25, Item 1 of the Control of Firearms, Swords, Explosives, Etc. Act

12. Report of installation of object facilities for special soil contamination control pursuant to Article 12 of the Soil Environment Conservation Act
13. Approval or report of installation of waste disposal/treatment facilities pursuant to Article 29, Item 2 of the Wastes Control Act
14. Occupation and use pursuant to Article 24 of the Sewerage Act, report of installation of drainage facilities pursuant to Article 27, Item 3 of the same Act, report of installation of private sewage treatment facilities pursuant to Article 34, Item 2 of the same Act

② When anything falling within one of each of the paragraphs of Item 1 comes under the authority of government authorities other than concerned City Mayor, County Chief, or District Director, these latter shall consult in advance with the director of the other authority.

③ When any entity who has constructed transfer facilities or transfer-supporting ones according to Item 1 or has constructed transfer facilities or transfer-supporting ones through a fictitious treatment of a building permission resulting from an approval of an implementation plan of an intermodal transit complex pursuant to Article 50, Item 1 obtains an approval of use of the concerned facilities pursuant to Article 22 of the Building Act, the concerned facilities shall be deemed as having gone through investigation and report of each of the following paragraphs.

1. Completion investigation of installation of facilities for manufacturing, storage, sales, import of containers for high-pressure gas manufacturing facilities pursuant to Article 16, Item 3 of the High-Pressure Gas Safety Control Act, completion investigation of special high-pressure gas facilities pursuant to Article 20 of the same Act
2. Completion inspection pursuant to Article 62, Item 1 and Article 98, Item 2 of the National Land Planning and Utilization Act
3. Report of operation start of discharge and control facilities pursuant to Article 30 of the Clean Air Conservation Act, Article 37 of the Water

Quality and Aquatic Conservation Act, and Article 13 of the Noise and Vibration Control Act

4. Completion investigation pursuant to Article 14 of the Fire-Fighting System Installation Business Act, completion investigation of a manufacturing place pursuant to Article 9 of the Safety Control of Dangerous Substances Act
5. Completion investigation of storage facilities installation and gas supplies manufacturing facilities pursuant to Article 18, Item 2 of the Safety Control and Business of Liquidated Petroleum Gas Act
6. Inspection before use of private electric facilities pursuant to Article 63 of the Electric Utility Act
7. Inspection before use pursuant to Article 36 of the Information and Communications Construction Business Act
8. Completion inspection pursuant to Article 43 of the Control of Firearms, Swords, Explosives, Etc. Act
9. Report of operational start of waste disposal and treatment facilities pursuant to Article 29, Item 4 of the Wastes Control Act
10. Completion inspection of private sewage disposal facilities pursuant to Article 37 of the Sewerage Act

④ The director of central authorities who is charged with matters which fall into one of the paragraphs of Item 1 shall notify Minister of Land, Infrastructure and Transport of its treatment standard. Its amendment shall take the same process.

⑤ When the Minister of Land, Infrastructure and Transport is notified of the administration standards, the Minister shall promulgate it together. The same process shall follow when notified of an amendment of promulgated standards.

Expropriation or Use of Land (Article 54)

① The project implementer may expropriate or use the land necessary for developing an intermodal transit complex. However, if the entity is an implementer specified in Paragraph 5 and 6 of Item 2 of Article 49, he/she

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may expropriate or use the land when he/she has purchased two thirds or more of the land.

② In case of expropriation or use of land according to Item 1, the development project of an intermodal transit complex shall be deemed as having been authorized by Article 20, Item 1 of the Act on Acquisition of and Compensation of Land, Etc. for Public Works and having been promulgated by Article 22 when the designation and promulgation of an intermodal transit complex pursuant to Article 47, Item 1 has been made (which refers to the time of promulgation according to Article 47, Item 3 in the case of inclusion of detailed contents of land to be expropriated or used pursuant to the partial conditions except for each of the paragraphs of Item 7 of Article 45)

③ The decision of expropriation or use of land within the intermodal transit complex to be designated by Minister of Land, Infrastructure and Transport shall come under the authority of the Central Land Expropriation Committee and the decision of the land of the complex to be designated by Mayor or Governor shall be under the authority of competent Local Land Expropriation Committee. In this case, the application for a decision may be made within the period specified in the development plan of the complex in spite of the provision of Item 1 of Article 23 and Item 1 of Article 28 of the Act on Acquisition of and Compensation of Land, Etc. for Public Works.

④ The Act on Acquisition of and Compensation of Land, Etc. for Public Works shall apply to the expropriation or use according to Item 1 except for a special provision.

Exceptional Application of the Law of Land Use Planning and Its Utilization (Article 55)

① The project implementer who has won an approval of an implementation plan of an intermodal transit complex according to Article 50, Item 1 of the National land Planning and Utilization Act will make a contract of land transactions within the intermodal transit complex, Article 118 of the same Act shall not apply.

② Standards concerning building restrictions of an intermodal transit complex, including the building to land ratio, floor area to site ratio, minimum lot area, height limit, etc., may be separately specified by a Presidential Decree in spite of provisions of Article 76 through 78 of the National Land Planning and Utilization Act and of Article 57 and 60 of the Building Act.

Land Substitution to Land Owners (Article 56)

① When an entity who owns land inside an intermodal transit complex wants to manage the facilities defined by the development plan of the complex, the project implementer may enforce a development project of the complex including land, and upon completion of the concerned project, he/she may give the owner of the land a substitute lot according to a Presidential Decree.

② When making a substitution of land pursuant to Item 1, except for the matters prescribed in a Presidential Decree the provisions of Article 28 through 49 of the National Land Planning and Utilization Act shall apply.

Access to Land (Article 57)

① The project implementer may access or temporarily utilize the land of other people if necessary for constructing an intermodal transit complex, and may transform or remove trees, soil, rocks, and other obstacles.

② Concerning access to other people's land, compensation of an accruing loss pursuant to Item 1, Article 130 and 131 of the National Land Planning and Utilization Act shall apply.

Disposition Restriction of Public Land (Article 58)

① Land owned by the central government or local governments located within the site of an intermodal transit complex, and necessary for the development of the complex shall not be sold or transferred for purposes other than the development of the complex on and after the date of a designation as an intermodal transit complex according to Article 47, Item 1.

② Land owned by the central government or local governments located within the site for developing an intermodal transit complex may be sold out in a negotiated contract to the project implementer in spite of provisions of the State Property Act, Public Property and Commodity Management Act and any other applicable laws. In this case, for the abolition of its use (applicable to administrative property only, hereinafter the same) and sale, the Minister of Land, Infrastructure and Transport, Mayor, or Governor shall consult in advance with the director of competent authorities.

③ Upon requests for consultation pursuant to the latter part of Item 2, the director of competent authorities shall take necessary steps for an abolition of use, sale and others within 30 days from the request.

④ The property in which ownership is not certain out of properties to be sold to the project implementer according to Item 2 shall be managed or disposed by Minister of Strategy and Finance in spite of other laws and provisions.

Reversion of Public Facilities, Land (Article 59)

① In case the project implementer pursuant to Paragraph 1 through 4 of Item 2, Article 49 installs or has installed new public facilities or substitutes for existing public facilities through the development of an intermodal transit complex, the existing public facilities, in spite of the provisions of the State Property Act and the Public Property and Commodity Management Law, shall be reverted free of charge to the implementer and the public facilities newly installed shall be reverted gratuitously to the central government or local governments to be in charge of its management.

② The public facilities newly installed through the development of an intermodal transit complex by the project implementer pursuant to Paragraph 5 and 6 of Item 2, Article 49 shall be reverted gratuitously to the central government or local governments to be in charge of its management, and properties of the central government or local governments which fall into disuse resulting from the development of an intermodal transit complex, in spite of the provisions of the State Property Act and the Public Property and Commodity Management Law, may be conveyed gratuitously to the project implementer within the scope of the costs for the construction of the newly installed public facilities.

③ The designator, in case of approving an implementation plan of an intermodal transit complex involving matters of reversion and conveyance of the public facilities pursuant to Item 1 and 2, shall take opinions in advance from the authority which manages the public facility (hereinafter in this chapter referred to as "management authority"). The same shall apply in the amendment of an implementation plan.

④ The project implementer shall notify the management authority of the public facility to be reverted to the central government or local governments, the type of property, and detailed list of the land to be reverted or conveyed to the project implementer according to Item 1 and 2 before completion of the development of the intermodal transit complex, and those public facilities and properties shall be deemed as having been reverted to the central government or local governments or reverted or conveyed to the project implementer when completion of the project is authorized and notified to the implementer pursuant to Item 3 of Article 61.

⑤ Concerning registration of public facilities and properties according to Item 4, a certificate of approval of the implementation plan of an intermodal transit complex and certificate of authorization of completion may replace the documents, certifying the grounds of registration pursuant to the Registration of Real Estate Act.

⑥ The scope of public facilities pursuant to Item 1 and 2 shall be specified by a Presidential Decree.

5) Assistance of a Development of an Intermodal Transit Complex (Article 60)

① The costs required for the development of an intermodal transit complex shall be borne by the project implementer.

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② The central government or local governments may subsidize or loan a part of the costs necessary for development or operation of an intermodal transit complex according to provisions of a Presidential Decree.

③ The central government or local governments shall give priority support to the installation of infrastructure such as transportation interconnection, water supply facilities, etc. necessary for efficient development and operation of an intermodal transit complex.

Reduction and Exemption of Tax (Article 68)

The central government or local governments, for an efficient development of an intermodal transit complex and smooth invitation of tenants for the facilities, may reduce or exempt local taxes, farmland conservation charges, replacement charges for forest resources creation, development charges, or overcrowding charges according to the Local Tax Act, Framework Act on Agriculture and Fisheries, Rural Community and Food Industry, Farmland Act, Mountainous Districts Management Act, Restitution of Development Gains Act, Seoul Metropolitan Area Readjustment Planning Act, and the ordinances of local tax reduction and exemption.

6) Management of an Intermodal Transit Complex (Article 66)

① The intermodal transit complex shall be managed by an association autonomously formed by the tenants of the complex (hereinafter called as "tenant association"). However, the project implementer may manage it before the tenant association is formed.

② The designator, in spite of Item 1, may let a special entity pursuant to a Presidential Decree manage the intermodal transit complex when deemed especially necessary to efficiently manage the complex.

③ The Minister of Land, Infrastructure and Transport shall make out a guideline for the management of an intermodal transit complex (hereinafter called as "intermodal transit complex management guidelines") and promulgate it in the official gazette.

④ The Minister of Land, Infrastructure and Transport shall, upon creating the intermodal transit complex management guidelines, take opinions from the Mayor or Governor and consult with the director of competent authorities. The same shall apply in the amendment of matters prescribed by a Presidential Decree out of the intermodal transit complex management guidelines.

⑤ Necessary matters for the formation and operation of the tenant association and special entity for management pursuant to Item 1 and 2 and content and making of the intermodal transit complex management guidelines pursuant to Item 3 shall be prescribed by a Presidential Decree.

Management Plan of an Intermodal Transit Complex (Article 67)

① The management organization pursuant to Article 66, Item 1 or 2 (hereinafter referred to as "management organization of an intermodal transit complex") shall establish a management plan of an intermodal transit complex including each of the following paragraphs and submit to the designator.

1. Matters pertaining to the management area and scope of the intermodal transit complex
2. Matters pertaining to installation and management of transfer facilities and transfer-supporting facilities
3. Other matters necessary for the management of an intermodal transit complex

② The management organization of an intermodal transit complex may collect a management fee or common shares in expenses from the tenants of the complex according to a Presidential Decree for the purpose of an efficient management of a complex.

③ Matters pertaining to creating the management plan of an intermodal transit complex shall be prescribed by a Presidential Decree.

Section 3

Standards of Design and Layout of Intermodal Transit Complexes

An intermodal transfer facility is among the most complicated of transportation system components, often composed of a large number of different design elements. An effective design must carefully balance these elements to achieve the best facility within the budget allotted. Hence, evaluation is not a single step but a process that starts with the design of alternatives and ends with a decision incorporating the opinions of experts, potential users and the community at large. Designers must be cognizant of evaluation criteria, just as evaluators must be knowledgeable of the details of a design. Herein lies the necessity for preparing a guideline to induce the conformity in planning an intermodal transit complex. However, the standards should be interpreted as a minimum level of service to satisfy the criteria for a given element.

The past practice in the domestic treatment of transportation nodes was so poorly organized that there had been no specific criteria or standards for the modal interconnection system. The individual transportation facilities used to be planned, constructed and operated independently by the organization in charge without much thought about other related modes. So primary transportation nodes such as railroad stations, bus terminals and the like were not centralized in one place, they were situated a significant distance away from each other or often scattered around, which hindered a synergy effect through an improved modal interconnection, the most important aspect of a public transportation operation. The current poor service in the modal interconnection is characterized by a long walking distance of intermodal transfer between connecting modes, a complicated path for transferring, and lacking in or inadequate deployment of moving walkways or escalators, resulting in public transportation not favorably accessible to the general public as well as the handicapped or elderly.

The average transfer walking distance from KTX stations to subway stations is 358 meters and 228 meters from KTX stations to bus terminals, which is long compared to those of good examples overseas where it is 156 meters at Fukuoka Station in Japan, 136 meters at Hauptbahnhof Station in Berlin, and 197 meters at St. Pancras Station in London.

The Ministry of Land, Infrastructure and Transport acknowledged these problems and created a substantial revision of the Transport System Efficiency Act in January, 2010. The revised law was named the National Integrated Transport System Efficiency Act with provisions for intermodal transit complexes to provide an efficient interconnection between modes and a high density development of cultural, commercial, and business facilities inside the complex. It also has the grounds for standards of the design and layout of an intermodal transit complex which provides the basis for specific standards to be observed at the time of structuring a modal interconnection system in the development of an intermodal transit complex.

An intermodal transit complex is defined to incorporate more than two primary transportation modes interconnected with each other, such as railroad station, bus terminal, airport, and ferry terminal. The transfer distance at a newly constructed intermodal transit complex is set to be within

Table 3.1 Level of service for transfer distance between modes

(Unit: meters)

Level of service	A	B	C	D	E	F
Transfer distance	Less than 60	60-120	121-180	181-240	241-300	Over 300

Note: Transfer distance is the average distance between the main node and access modes.

180 meters to a bicycle stand, bus stop and subway platforms.

However, in a case that a railroad station is difficult to be relocated because of too large a relocation cost is included within intermodal transfer facilities, the existing transfer distance may be upgraded to a reduction by 20% or more. It suggests the standards of transfer supporting facilities such as elevators and moving walkways under which one or more escalators should be installed for every stairway to ensure a convenient and comfortable transfer. It also prescribes that an intermodal transit complex should be equipped with an information center to support a smooth transfer by monitoring the operation of all approaching transportation modes, managing facilities, and providing users with modal interconnection information.

1. Basic Elements of the Design and Layout

Detailed Facility Types of an Intermodal Transit Complex

1) Transfer Facilities

Transfer facilities are facilities directly involved in the intermodal transfer, including walking facilities, access mode related, information and guidance facilities, and individual facilities.

Table 3.2 Types of transfer facilities

Facilities	Components
Walking facilities	Stairs, entrance, concourse, escalators, elevators, moving walkways
Transfer supporting facilities	Ticket office, ticket machine, ticket gate, waiting area, restroom
Access mode related	Bus stops, passenger waiting area, taxi stands
Information and guidance facilities	Variable message signs, information signs, LCD signs, kiosk, transfer supporting information system
Individual facilities	Passenger terminals, railroad stations, airports, ferry terminals, parking lots

Level of Service Objectives for Design and Layout

1) The project implementer shall create the design and layout in conformity with the level of service (LOS) objectives suggested by the standards for each type of facility.

- The level of service refers to the state of service to be provided to users by the transfer facility of an intermodal transit complex including the intermodal transfer distance, passenger traffic flow, and occupying area.
- The standards divide the LOS to be applied to the design and layout of an intermodal transit complex into 6 levels from A to F. Level A refers to the top quality of service while Level F means the lowest level of service.

2) In the current standards the LOS may apply primarily to waiting areas, stairs, and escalators. However, separate LOS may be specified for different facilities.

Level of Service of Waiting Areas

The minimum standard of 0.23 m^2 an adult can occupy in a waiting area is defined as LOS E and LOS A is set to the state where one more person can be put in between adjacent persons.

Table 3.3 Level of service of waiting areas

LOS	Occupancy (m^2/pers)	Separation distance (m)	Walking flow state
A	≥ 1.18	≥ 1.2	Free flow
B	0.78-1.18	1.0-1.2	Passing easily
C	0.54-0.78	0.8-1.0	Passing difficultly
D	0.34-0.54	0.6-0.8	Waiting out of contact with other persons
E	0.23-0.34	< 0.6	Waiting in contact with other persons
F	< 0.23	Compact	Pressed to contact with others, psychological discomfort

Level of Service of Stairs

The minimum area of 0.47 m^2 necessary for an adult to move their legs and swing their arms in a stairwell is set as LOS E and LOS A sets the minimum occupancy area to 1.66 m^2 to allow moving hands freely. The pedestrian flow rate (persons/minute/meter) is converted from the relationship between the occupancy area (m^2/person) and the walking speed (m/minute) as 0-18.66 persons/minute/meter for LOS A and 41.47-48.64 persons/minute/meter for LOS E.

Table 3.4 Level of service of stairs

LOS	Pedestrian flow rate (pers/min/m)	Occupancy area (m^2/pers)	Walking state
A	0-18.66	≥ 1.66	Free walking speed
B	18.66-25.57	1.18-1.66	Stable speed, disturbed with a contra flow
C	25.57-33.63	0.87-1.18	Passing prohibited, limited speed
D	33.63-41.47	0.61-0.87	Limited speed, disturbed with a contra flow
E	41.47-48.64	0.47-0.61	Minimum level of stairway walking
F	> 48.64	< 0.47	Congested traffic, drifting state

Level of Service of a Hallway

LOS E is defined to a minimum area of 0.67 m^2 necessary for an adult to walk in a hallway and the ability to walk freely is defined as LOS A. The pedestrian flow rate (person/minute/meter) is converted from the relationship between the occupancy area (m^2/person) and the walking speed (meter/minute) as 0-27.15 person/minute/meter for LOS A and 59.51-73.70 person/minute/meter for LOS E.

Table 3.5 Level of service of a hallway

LOS	Pedestrian flow rate (pers/min/m)	Occupancy area (m^2/pers)	Walking state
A	0-27.15	≥ 2.84	Free walking speed
B	27.15-34.34	2.21-2.84	Stable speed, passing allowed in same direction
C	34.34-45.44	1.61-2.21	Passing limited
D	45.44-59.51	1.05-1.61	Walking speed limited
E	59.51-73.70	0.67-1.05	Below regular speed
F	> 73.70	< 0.67	Drifting, stopping intermittently

Calculation of Design Volume

1) Pedestrian Moving Equivalent and Pedestrian Waiting Equivalent to Reflect Pedestrian Characteristics

- The design volume for an intermodal transit complex is calculated by using the pedestrian moving equivalent (PME) or pedestrian waiting

Table 3.6 Pedestrian moving equivalent and pedestrian waiting equivalent by primary mode

Description	Railroad		Bus	Air		Ferry
	Express / standard	Urban / metropolitan	Bus terminal	International	Domestic	Ferry terminal
PME	1.457	1.126	1.315	2.100	1.776	1.400
PWE	1.516	1.173	1.360	3.217	2.442	1.648

Table 3.7 Peak volume duration by mode type

(Unit: minutes)

Description			Railroad		Bus	Air		Ferry
			Express / standard	Urban / metropolitan	Terminal	International	Domestic	Ferry terminal
Walk related facility	Walk facility	Stairs	5	5	5	15	15	5
		Entrance	5	5	5	15	15	5
		Hallway	5	5	5	15	15	5
		Escalator	5	5	5	5	5	5
		Elevator	5	5	5	5	5	5
		Moving walkway	15	15	15	15	15	15
	Supporting facility	Ticket office	15	15	15	15	15	15
		Ticket machine	15	15	15	15	15	15
		Ticket gate	5	5	-	5	5	-
		Waiting area	15	15	15	15	15	15
		Restroom	5	5	5	5	5	5
Access mode	Rail	Platform	5	5	5	5	5	5
	Bus	Bus stop	5	5	5	5	5	5
		Waiting area for passengers	5	5	5	5	5	5
	Taxi stand		5	5	5	5	5	5
	Bicycle storage		60	60	60	60	60	60

Note: A separate peak volume duration is applicable through a separate study of an intermodal transit complex.

equivalent (PWE) to reflect pedestrian characteristics of a primary transportation mode (person with suitcase, handbag bearer, adult with infant, etc.).

① PME is an index to explain how much space a standard pedestrian occupies walking with luggage or a handicapped person uses.

② PWE is an index to explain how much space a standard pedestrian occupies while waiting with luggage or a handicapped person uses.

- The values of PME and PWE for each primary transportation modes are shown in Table 3.6.

2) Peak Volume to Reflect Operational Characteristics of a Primary Mode

- The peak 5 minute volume shall apply to the facility where demand concentrates heavily in 2 to 5 minutes and the peak 15 minute volume shall apply in the facility with a relatively uniform distributed demand pattern. However, the facility whose duration of use is more than one hour shall apply the peak one hour volume as peak hour volume.

Table 3.8 Sample origin-destination table for calculation of duplicated design volume

(Unit: people)

Destination Origin		Access mode				Primary mode			Supporting facilities			Total
		Bus	Car	Taxi	…	KTX	Urban rail	…	Dept. store	Restaurants	…	
Access mode	Bus											
	Car											
	Taxi											
	…											
Primary mode	KTX											
	Urban rail											
	…											
Supporting facilities	Department store											
	Restaurants											
	…											
Total												

3) Calculation of Duplicated Volume for Transfer and Supporting Facilities

- Escalators inside an intermodal transit complex and the like are shared by the users of transfer facilities as well as visitors to the supporting facilities. And hence the design volume of such facilities shall reflect both conditions.
- First an O/D (origin-destination) table shall be generated as shown in Table 3.8. Then the lines of movement for the transfer process shall be drawn on the floor plan of an intermodal transit complex. Finally the demand for each facility shall be distributed over the lines of movement, and summarizing the demand over all facilities will give the final demand.

2. Facility Layout Standards

Basic Principle

To expedite the modal interconnectivity and transfer function of an intermodal transit complex, main transfer facilities like a railroad station shall be situated in the center of the complex and a necessary modal interconnection system shall be established centering around it.

The transfer facilities including boarding and alighting facilities of access modes situated in an intermodal transit complex shall be laid out in such a way that the lines of movement are shortest to help users conveniently access modes and the transfer distance to the primary mode is minimized, resulting in an improved level of service and an ensured interconnection between modes.

The transfer supporting facilities of an intermodal transit complex shall be situated together with the transfer facilities as their space structure is heavily dependent on public transportation, to be in good conformity with urban development land use, and not impede the use of access and primary modes.

Location Requirements for the Modal Interconnection System of an Intermodal Transit Complex

The intermodal transit complex shall fulfill one of the following location requirements to ensure an efficient transfer and connectivity between modes.

- More than two different primary transportation modes shall be located together in an intermodal transit complex.
  - Good example: rail station - bus terminal combination
  - Bad example: rail station - subway station or bus terminal - bus terminal combination

Table 3.9 Primary transportation modes for an intermodal system

Description	Railroad	Bus	Air	Ferry
Primary modes	Rail stations (KTX/standard/metropolitan/urban)	Bus terminal	Airport	Ferry terminal

- The intermodal transit complex with a single primary mode situated alone shall be linked with connecting modes and facilities according to types of complex outlined in Table 3.10. However, a bus terminal cannot be located individually in an intermodal transit complex.

Table 3.10 Types of intermodal transit complexes

Types	Location requirements1)
National arterial intermodal transit complex	(a) 2 or more express bus lines, 2 or more intercity bus lines or 10 or more metropolitan bus lines2) to be situated in the complex equipped with transfer facilities including boarding and alighting facilities (b) 10 or more city bus lines or 20% or more of existing bus lines within 2 km radius of the complex rerouted through the complex3) to be situated in the complex equipped with transfer facilities including boarding and a lighting facilities
Metropolitan intermodal transit complex	(a) One or more express bus lines, one or more intercity bus lines, one or more metropolitan arterial bus lines (BRT) or 5 or more metropolitan bus lines to be situated in the complex equipped with transfer facilities including boarding and alighting facilities (b) 10 or more city bus lines or 20% or more of existing bus lines within 2 km radius of the complex rerouted through a complex equipped with transfer facilities including boarding and alighting facilities
Standard intermodal transit complex	(a) 10 or more city bus lines or 20% or more of existing bus lines within 2 km radius of the complex equipped with transfer facilities including boarding and alighting facilities

1) Each type shall satisfy all suggested requirements.
2) Metropolitan bus refers to a bus which operates over two or more special, metropolitan cities or provinces.
3) Rerouted city bus line refers to a bus line put through the intermodal transit complex by changing the route within a 2 km radius of the complex or setting up a new route.

Standards of Layout for the Transfer Facilities in an Intermodal Transit Complex

1) Development Case at a Node of an Existing Primary Mode

- The major transfer facility situated within an intermodal transit complex shall be laid out in a manner that the equivalent flat distance to the primary transportation mode is shortened. In this case, the concerned major transfer facilities shall be laid out in a shorter equivalent flat distance so that the direct access mode has a higher number of users and the equivalent flat distance of individual direct access modes cannot exceed 300 meters. However, in the case of moving existing railroad stations (including standard, metropolitan, urban rail) to major transfer facilities, the relocation of which is difficult due to high costs and other issues, therefore the equivalent flat distance may be allowed up to 150% of the standard.

> • Equivalent flat distance: the transfer distance for direct access modes in terms of the shortest distance from a boarding/alighting point of main access modes to a boarding/alighting point of the primary mode, calculated by
> – distance of walking hallway (m) + α × distance of stairway (m) + β × distance of moving walk (m)
> where $\alpha=2$, $\beta=½$, ($\alpha=½$ in case E/S)

- Neighborhood transfer facilities situated in an intermodal transit complex are purported to ensure the convenience of visitors to transfer supporting facilities and their layouts shall reflect the size of visitors to transfer supporting facilities and their access routes, etc.
- Transfer supporting facilities of an intermodal transit complex shall be such that they ensure a close interrelationship with the transfer facilities, promote the development of the surrounding area to keep a conformity with urban development, increase the efficiency of land use through an

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integrated development of commercial, cultural, business, and the like.

- Auxiliary facilities to use the direct access mode such as a boarding/alighting facility shall be laid out in such a way that the level of service is upgraded by one level or more than before the development of an intermodal transit complex. However, in cases of relocation existing railroad stations (including standard, metropolitan, urban rail) to major transfer facilities is difficult due to high costs and additional issues, the related transfer facilities shall be upgraded so that the weighted average equivalent distance (abbreviated as WAED) should be improved by 20% or more. In applying the LOS, the weighted average equivalent distance of a direct access mode shall be measured against the primary transportation mode.

$$\text{Weighted average equivalent distance} = \Sigma \frac{P_i \times Ph_i}{P},\ P = \Sigma P_i$$

P_i = the travel demand of direct access mode I to transfer to the primary mode of an intermodal transit complex

Ph_i = the equivalent flat distance required to move from the alighting point of a direct access mode to the boarding point of the primary mode

– equivalent flat distance = distance of walking hallway (m) + α × distance of stairway (m) + β × distance of moving walk (m)
where α=2, β= ½, (α= ½ in case of E/S)

Table 3.11 Existing level of service by weighted average equivalent distance of direct access mode

LOS	Transfer time	WAED
A	less than 1 min	less than 60 m
B	1-2 min	60 m-120 m
C	2-3 min	120 m-180 m
D	3-4 min	180 m-240 m
E	4-5 min	240 m-300 m
F	over 5 min	over 300 m

Note: Walking speed is assumed to be 1 m/sec.

2) Development Case at a New Primary Mode Node

- The major transfer facility situated within an intermodal transit complex shall be laid out in a manner that the equivalent flat distance to the main transportation mode is shortened. In this case, the concerned major transfer facilities shall be laid out in the shorter equivalent flat distance in the order of the direct access mode having a higher number of users and the equivalent flat distance of individual direct access modes shall not exceed 300 meters.

> • Equivalent flat distance: the transfer distance for direct access modes in terms of the shortest distance from a boarding/alighting point of main access modes to a boarding/alighting point of the primary mode, calculated by
> – distance of walking hallway (m) + α × distance of stairway (m) + β × distance of moving walk (m)
> where α=2, β= ½, (α= ½ in case E/S)

- The neighborhood transfer facilities situated in an intermodal transit complex are purported to ensure the convenience of visitors to transfer supporting facilities and their layouts shall reflect the size of visitors to transfer supporting facilities, their access routes, etc.
- The transfer supporting facilities of an intermodal transit complex shall

Table 3.12 New level of service by weighted average equivalent distance of direct access mode

LOS	Transfer time	WAED
A	less than 1 min	less than 60 m
B	1-2 min	60 m-120 m
C	2-3 min	120 m-180 m
D	3-4 min	180 m-240 m
E	4-5 min	240 m-300 m
F	more than 5 min	more than 300 m

Note: Walking speed is assumed to be 1 m/sec.

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be such that they ensure a close interrelationship with transfer facilities, promote the development of the concerned lot in conformity with surrounding developments, increase the efficiency of land use through an integrated development of commercial, cultural, business, and the like.

- The transfer facilities of a newly constructed intermodal transit complex shall be laid out in a manner that an efficient modal interconnection and transfer system is considered from the planning stage of the complex to perform a level of service C or better. However, in case of relocating existing railroad stations (including standard, metropolitan, urban rail) in major transfer facilities is difficult due to its high costs and additional issues, the related transfer facilities shall be upgraded so that the weighted average equivalent distance should be improved by 20% or more.

3. Design Standards of the Facility

Walking Facilities

1) Stairs

- The accessibility from every direction shall be ensured with consideration of a smooth interconnection with public transportation.
- The number of flights of stairs shall be determined by considering the simplicity of passenger lines of movement using transfer facilities and reflecting the evacuation design and roadway conditions.
- The number of flights of stairs to be put in shall also consider the location characteristics of stops and stations, surrounding conditions, accessibility of passengers, etc.
- The typical dimension of standard stairs shall be width 300 mm and height 150 mm and may be adjusted according to local conditions when placed in parallel with an escalator.

- Stairs to be placed in parallel with an escalator shall be situated close to the end of the platform rather than the escalator to avoid a conflict with it.
- Stairs to connect the waiting area and the platform shall be installed in sets of 2 for each side, totaling 4 sets or more for a separate type platform and 2 sets or more for an island type platform.
- For the transfer, a separate stairway shall be installed to separate the lines of movement of boarding/alighting passengers and transfer travelers.
- The width of stairs shall be that for LOS D to keep the passenger flow rate of 41.47 persons/minute/meter or less.
- The design width shall be minimum 3 meters or over (1.5 m or over in case of a paralleling escalator).
- In cases sidewalk installation, the width of the sidewalk shall be 2 meters as a standard and be subject to a lane-width adjustment in unavoidable situations.
- The length of a landing space at an entrance of a stairway shall be 1.5 meters or over, preferably over 3 meters.
- The stair width of which is 5 meters or over shall be equipped with a central railing every 3 meters.
- Except for a compelling situation, no obstacle shall be placed within 10 meters before and after a stairway.
- In case that an elevator is installed between two stairways, the two stairways shall be separated 15 meters or more from each other.
- The clearance space where passengers can take time to decide their next place to move to need a safe uncrowded space with the following minimum standards.
  ① hallway - stairway: 4 meters
  ② stairway - ticket gate: 6 meters
  ③ stairway - street: 6 meters
  ④ landing space of a stairway: 1.5 meters

Formula for the width of a stairway

$$W_s = \frac{V_1}{PFR_s}$$

where W_S = width of a stairway (m)
V_1 = 1 minute passenger demand (persons/minute)
PER_S = passenger flow rate of a stairway (pers/min/m)

Example:

- Stairways are planned at an urban rail platform in both east and west sides.
  The peak hour demand is 15,000 pers/hour, PME of 1.126. The design volume is based on the peak 5 minute demand (concentration of 15%). And the directional flow to both locations is the same.
  - The 1 minute design volume of a stairway is 253 pers/min.
    · V_5 = *15,000(pers/hr) × 1.126 × 0.15 ÷ 2(two directions) = 1,267(pers/5min)*
    · V_1 = *1,267(pers/5min) = 253(pers/min)*
  - The passenger flow rate (PER_S) of 41.47 (pers/min/m) gives the required width of stairs at 6.1 m.
    · W_S = *253 (pers/min) ÷ 41.47 (pers/min/m) = 6.1 (m)*

  ☞ The minimum width of stairs shall be 6.1 m or over.

2) Exits and Entrances

The width of the exits and entrances shall be LOS D to keep the passenger flow rate at 59.51 persons/minutes/meters or less. The effective width of exits and entrances shall be 0.9 meters or over with effective height of 2.1 meters or over. The doors, if not automatic, shall be equipped with an activity space of 0.6 meters or over by the side of the door.

Formula for the width of an exit or entrance

$$W_e = \frac{V_1}{PFR_e}$$

where W_e = width of an exit or entrance (m)
V_1 = 1 minute demand (pers/min)
PER_S = passenger flow rate of the exit/entrance (pers/min/m)

Example:

- Two of the exits and entrances must be planned on the ground level of an intermodal transit complex of a new KTX station. The peak hour demand is 15,000 persons per hour and the PME is 1.147. The design volume is based on the 5 minute peak demand (concentration of 15%) and the directional flow is 60:40 (south:north). What is the width of the south gate?
  - The one-minute design volume is calculated as 394 pers/min.
    - · $V_5 = 15{,}000(pers/hr) \times 1.147 \times 0.15 \times 0.6(south) = 1{,}967(pers/5\ min)$
    - · $V_1 = 1{,}967(pers/5\ min) = 394(pers/min)$
  - PER_e of 59.51 (pers/min·m) is applied to produce the width of 6.7 m.
    - · $WS = 394\ (pers/min) \div 59.51\ (pers/min{\cdot}m) = 6.7\ (m)$
  - ☞ The required width of the gate shall be over 6.7 m.

3) Hallway

The width of hallways shall be designed to perform the LOS D supported by a passenger flow rate of 59.51 pers/min·m. The width shall be bigger than one corresponding to demand calculated by travel forecast with a minimum of 3 meters.

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Formula for the width of hallways

$$W_p = \frac{V_1}{PFR_p}$$

where W_p = width of hallway (m)

V_1 = 1 minute demand (pers/min)

PER_p = passenger flow rate of hallway (pers/min·m)

Example:

- A hallway is planned in the east-west direction of an intermodal transit complex serving a new urban rail. The peak hour demand is estimated as 15,000 persons per hour with PME of 1.126. The design volume is based on the peak 5 minute volume (concentration of 15% and the demand is the same for both directions. What is the required width of the hallway?
  - The 1 minute design volume of the hallway is calculated as 253 pers/

min.

· V_5 = 15,000(pers/hr) × 1.126 × 0.15 ÷ 2(each direction)

= 1,267(pers/5 min)

· V_1 = 1,267(pers/5 min) = 253(pers/min)

- The pedestrian flow rate (PER_s) of 59.51 (pers/min·m) gives the width of the hallway at 4.2 meters.

· W_5 = 253 (pers/min) ÷ 59.51 (pers/min·m) = 4.2 (m)

☞ The width of the hallway shall be 4.2 m or more.

4) Escalators

The number of escalators to be installed shall be such that LOS D is performed with an occupancy area per person of 0.34 m^2. The extra space for a safe stay of passengers shall be prepared as in the following.

Escalator - escalator: 12 meters
Escalator - hallway: 6 meters
Escalator - ticket gate: 8 meters
Escalator - street: 6 meters
Moving walk - hallway: 6 meters

Formula for computing the number of escalators necessary

$$N_{es} = \frac{V_{es}}{PPR_{es}}$$

where N_{es} = number of escalators (unit)
V_{es} = demand for an escalator (pers/min)
PPR_{es} = carrying capacity of an escalator (pers/min·unit)

Example:

- Escalators are going to be installed leading to an urban rail platform. The peak hour boarding/alighting demand is 15,000 pers/h with PWE of 1.173, peak 5 minute demand (concentration of 15%), utilization rate of 60%, and speed and width of an escalator is 0.5 m/s and 1.2 meters respectively. What is the number of escalators to be required?

- The 1 minute design volume is calculated as 528 pers/min.
  - V_5 = 15,000 (pers/hr) × 1.173 × 0.15 (peak factor) = 2,639 (pers/5 min)
  - V_1 = 2,639 (pers/5 min) ÷ 5 = 528 (pers/min)
- The 1 minute demand for an escalator is 316 pers/min.
  - V_{es} = 528 (pers/min) × 60% (utilization ratio) = 316 (pers/min)
- The moving area of an escalator for one minute divided by the occupancy area for LOS D of 0.34 m^2/min gives the required carrying capacity.
  - *The moving area of an escalator for one minute =* *0.5 (m/s) × 1.2 (m) × 60 min = 36 m^2/min*
  - PPR_{es} = 36 (m^2/min) ÷ 0.34 (m^2/pers) = about 106 pers/min·unit

☞ The required number of escalators is 3.
  - N_{es} = 316 (pers/min) ÷ 106 (pers/min·unit) = 2.98 (unit)

5) Elevators

The number of elevators shall be selected so that at minimum LOS D can be attained with an occupancy area of 0.34 (m^2/pers) or better.

Formula for calculating the number of elevators necessary

$$N_{ev} = \frac{V_{ev}}{PPR_{ev}}$$

where N_{ev} = number of elevators
V_{ev} = demand for elevators (pers/min)
PPR_{ev} = 1 minute capacity of elevators (pers/min·unit)

Example:

- An elevator is being planned exclusively for the mobility handicapped. The PWE is 2, the peak hour demand is 15,000 pers/h, and the proportion of the mobility handicapped is 2%. The 5 minute peak demand (concentration of 13%) is used for a round trip of an elevator taking 1 minute and the dimensions are 1.4 meters × 1.4 meters (1.96 m^2). Calculate the required number of elevators.
  - The 5 minute design volume is calculated as 78 pers/min.
    - V_5 = 15,000 (pers/hr) × 0.13 (utilization ratio) × 0.22 × 2 (PWE) = 78 (pers/5 min)

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· V_1 = 78 (pers/5 min) ÷ 5 (min) = 15.6 (pers/min)

☞ Dividing the 5 minute design volume by the carrying capacity for LOS D, the required number of elevators is determined to be 3 units.

· PPR_{ev} = 1.96 (m^2/min) ÷ 0.34 (m^2/pers) = 5.76 (pers/min·unit)

· N_{ev} = 15.6 ÷ 5.76 = 2.7

6) Moving Walkways

The width of a moving walkway shall be designed so the LOS for the occupancy should be at level D at 0.34 (m^2/pers) or higher. The minimum effective width of a moving walkway shall be 1.0 meter and the landing space requires a space of 1.5 m^2 for each passenger waiting.

Formula for computing the number of moving walkways

$$N_{mw} = \frac{V_{mw}}{PPR_{mw}}$$

where N_{mw} = number of moving walkways to be necessary (unit),
V_{mw} = 1 minute demand for a moving walkway (pers/min)
PPR_{mw} = 1 minute carrying capacity of a moving walkway (pers/min·unit)

Example:

- The peak hour demand for an international airport is 3,000 (pers/h and the peak 5 minute concentration is 10%. The PWE is 2.1 and the speed of a moving walkway is 0.5 m/s. What is the required number of moving walkways with a width of 1.2 meters?
  - The 1 minute design volume of a moving walkway is calculated to be 126 pers/min
    · V_{mw} = 3,000 (pers/hr) × 2.1 × 10% × 5 (min) = 126 (pers/min)
  - Dividing the space movement of an moving walkway by the occupancy (0.34 m^2/pers) of LOS D, the carrying capacity for one minute is determined.
    · *The 1 minute space movement* = 0.5 (m/s) × 1.2 (m) × 60 sec = 36 m^2/min
    · PPR_{mw} = 36 (m^2/min) ÷ 0.34 (m^2/pers) = about 106 pers/min

☞ The required number of moving walkways is 2.
· N_{mw} = 126 (pers/min) ÷ 106 (pers/min) = 1.18

Transfer Aid Facilities

1) Ticket Counter

Considering the characteristics of passengers for each type of an intermodal transit complex, the waiting time at a ticket window shall be such that will satisfy LOS D with a waiting time of 4 minutes at the most for KTX and bus terminals and 2 minutes for urban rail.

Table 3.13 Level of service for ticket window

Level of service	Waiting time
A	1 min or less
B	1-2 min
C	2-3 min
D	3-4 min
E	4-5 min
F	over 5 min

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Formula for computing the number of ticket windows

$$N_{tb} = \frac{V_1}{\lambda_{los}}, \quad \lambda_{los} = \frac{LOS_{tb} \times \mu_{tb}^2}{1 + LOS_{tb} \times \mu_{tb}}$$

where N_{tb} = number of ticket windows (unit)
V_1 = 1 minute demand for a ticket window (pers/min)
λ_{los} = arrival rate of passengers at a ticket window for a specific LOS (pers/min·unit)
LOS_{tb} = waiting time at a ticket window for a specific LOS (min)
μ_{tb} = rate of service at a ticket window (pers/min)

Example:
- The peak hour demand is 5,000 pers/h (15 minute concentration of 30%). The utilization rate of a ticket window is 15% and the service rate is 3

pers/min. What is the number of ticket windows needed for LOS D?

- The 1 minute design volume of a ticket window is calculated as 15 pers/min.
  - V_1 = 5,000 (pers/hr) × 30% × 15% ÷ 15(min) = 15 (pers/min)
- The arrival rate at a ticket window for LOS D is calculated as 2.8 pers/min.
  - $\lambda_{los} = \dfrac{4 \times 3^2}{1 + 4 \times 3} = 2.8$ (pers/min.unit)

☞ The required number of windows is determined to be 6 units.

- $N_{tb} = 15 \div 2.8 = 5.4$

2) Ticket Machines

The number of ticket machines in an intermodal transit complex shall be such that the waiting time of users should be within two minutes corresponding to LOS D.

Table 3.14 Level of service for ticket machines

LOS	Waiting time
A	0.5 min or less
B	0.5-1.0 min
C	1.0-1.5 min
D	2.0-2.0 min
E	2.5-2.5 min
F	over 2.5 min

Formula for computing the number of ticket machines

$$N_{tm} = \frac{V_1}{\lambda_{los}}, \quad \lambda_{los} = \frac{LOS_{tm} \times \mu^2_{tm}}{1 + LOS_{tm} \times \mu_{tm}}$$

N_{tm} = number of ticket machines (unit)
V_1 = 1 minute demand for a ticket machine (pers/min)
λ_{los} = arrival rate for a specific LOS (pers/min·unit)
LOS_{tm} = time duration for a specific LOS (min)
μ_{tm} = rate of service of a ticket machine (pers/min)

Example:

- A new KTX station has an intermodal transfer center with the peak hour demand of 5,000 pers/h and a 15-minute concentration of 30%. Ticket machines have a utilization rate of 5% and a service rate of 0.75 pers/min. How many machines are necessary for LOS D?

- The 1 minute design volume is calculated as 5 pers/min.
  · $V_1 = 5{,}000\ (pers/hr) \times 30\% \times 15\% \div 15(min) = 50\ (pers/min)$
- The arrival rate for LOS D is given as 0.45 (pers/min·unit).
  · $\lambda_{los} = \dfrac{2 \times 0.75^2}{1 + 2 \times 0.75} = 0.45\ (per/min)$

☞ The required number of machines is 12 units.
  · $N_{tb} = 5.00 \div 0.45 = 11.1$

3) Ticket Gates

The number of ticket gates shall be such that the waiting time should be within 10 seconds to satisfy LOS D.

Table 3.15 Level of service for ticket gates

LOS	Waiting time
A	2.5 sec or less
B	2.5-5.0 sec
C	5.0-7.5 sec
D	7.5-10.0 sec
E	10.0-12.5 sec
F	over 12.5 sec

Formula for computing the number of ticket gates necessary

$$N_g = \frac{V_g}{\lambda_{los}}, \quad \lambda_{los} = \frac{LOS_g \times \mu_g^2}{1 + LOS_g \times \mu_g}$$

N_g = number of ticket gates (unit)
V_g = 1 second demand for a ticket gate (pers/sec)
λ_{los} = arrival rate for a specific LOS (pers/sec·unit)
LOS_g = time duration for a specific LOS (sec)
μ_g = service rate of a ticket gate (pers/sec)

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Example:

- A new urban rail has a transfer center with a peak hour demand of 5,000 persons and a peak 5 minute concentration of 15%. What is the number of ticket gates necessary for 0.5 pers/sec?
  - The 1 sec design volume is calculated as 2.5 pers/sec.
    - · $V_g = 5{,}000\ (pers/min) \times 15\% \div 15\ (min) \div 60\ (sec) = 2.5\ (pers/sec)$
  - The arrival rate for the specific LOS is computed as 0.42 pers/sec·unit.
    - · $\lambda_{los} = \dfrac{10 \times 0.5^2}{1 + 10 \times 0.5} = 0.42\ (pers/sec)$

  ☞ The required number of gates is 6 units.
    - · $N_g = 2.5 \div 0.42 = 5.95\ (units)$

4) Waiting Areas

The air space of a waiting area shall be 0.34 m² or larger to satisfy LOS D. However the area of the waiting area should be 10 m² or over.

Formula to compute the necessary area of a waiting area

$$TS_{wr} = V_1 \times S_{wr} \times T_{wr}$$

TS_{wr} = area of a waiting area (m²),
V_1 = 1 minute demand for the waiting area (pers/min)
S_{wr} = area to satisfy a specific LOS (m²/pers)
T_{wr} = average time of staying in the waiting area (min)

Example:

- A new KTX station has a transfer center planned with a peak hour volume of 30,000 pers/h and a peak 15 minute concentration of 30%. The rate of using a waiting area is 20% and the average staying time is 10 minutes. If the PWE of the KTX service is 1.516, what is the area of a waiting area for LOS D?
  - The demand for a waiting area is calculated as 182 pers/min.
    - · $V_1 = 30{,}000\ (pers/hr) \times 30\% \times 20\% \times 1.516 \div 15\ (min) = 182\ (pers/min)$

  ☞ The necessary area of a waiting area is given as 620 m².
    - · $POS_{wr} = 182\ (pers/min) \times 0.34\ (m^2/pers) \times 10\ (min) = 618\ (m^2)$

5) Restrooms

The number of toilets in a restroom shall be such that the waiting time should be two minutes or less to satisfy LOS D. The service time for women's restrooms is twice as much as that for the men's on average, which means to meet the same demand level the number of toilets in a ladies' restroom needs to be twice as many as that of the men's. The area of the restroom shall be not less than the minimum (33 m^2 or more in the overall area) according to domestic public restroom standards.

Table 3.16 Level of service for restrooms

LOS	Waiting time
A	0.5 min or less
B	0.5-1.0 min
C	1.0-1.5 min
D	1.5-2.0 min
E	2.0-2.5 min
F	over 2.5 min

Formula for computing the number of toilets

$$N_{rr} = \frac{V_1}{\lambda_{los}}, \quad \lambda_{los} = \frac{LOS_{rr} \times \mu^2_{rr}}{1 + LOS_{rr} \times \mu_{rr}}$$

N_{rr} = number of toilets (unit)
V_1 = 1 minute demand for restrooms (pers/min)
λ_{los} = arrival rate for a specific LOS (pers/min·unit)
LOS_{rr} = level of service for restrooms
μ_{rr} = service rate of restrooms (pers/min)

Example:

- A restroom is planned one the first floor of a transfer center of a new KTX station with peak hour male demand for the restroom expected at 5,000 pers/h (the peak 5 minute concentration of 15%). The rate of toilet utilization is 5%. What is required number of male toilets of LOS D? (the service rate of 0.5 pers/min)
  - The 1 minute demand for the toilet is calculated as 7.5 pers/min.
    - $V_1 = 5{,}000\ (pers/hr) \times 15\% \times 5\% \div 5\ (min) = 7.5\ (pers/min)$

- The arrival rate for the LOS D is computed as 0.25 (pers/min·unit).
  - $\lambda_{rr} = (2 \times 0.5^2) \div (1 + 2 \times 0.5) = 0.25$ *(pers/min)*

☞ The number of the toilets needed is 30 units.
  - $N_{rr} = 7.5 \div 0.25 = 30$ *(units)*

Design Standards of Access Facilities

1) Bus Stops

The number of bus shelters at a bus stop shall be determined as follows.

Formula for computing the number of bus stops

$$P_b = \frac{V_b}{T_b}$$

P_b = number of bus shelters in a bus stop lane (shelter/min)
V_b = 1 minute number of stopping buses (bus/min)
T_b = average turnover of bus stops (bus/shelter·min)

Example:

- 200 buses stop in the stopping lane of a bus stop during the peak hour. When the peak 5 min concentration is 10% and the average turnover of a stop is 2 (bus/shelter·min), what is the number of bus shelters necessary?
  ☞ The 1 minute number of stopping buses is computed as 4 bus/min.
  - $V = 200$ *units* $\times 10\% \div 5$ *min* $= 4$ *units/min*

  ☞ The required number of bus shelters is given as 2.
  - P_b = 4 (units/min) / 2 (units/lot·min) = 2 (lots)

The area of space for waiting bus passengers shall satisfy LOS D to have 0.34 m^2/pers.

Formula for computing the area of a bus shelter

$$TS_{bwr} = V_1 \times S_{bwr} \times T_{bwr}$$

TS_{bwr} = area of bus shelter for bus passengers (m^2)
V_1 = 1 minute demand for the bus shelter (pers/min)

S_{bwr} = occupancy for a specific LOS (m^2/pers)
T_{bwr} = average waiting time (min)

Example:
- For the bus access mode to connect to the major mode, KTX, a bus shelter for bus passengers is planned. The peak hour demand is 1,000 persons and the peak 15 minute concentration is 30%. What is the waiting space necessary to satisfy LOS D? The PWE of KTX is 1.516 and the average wait time in the location is 10 min/pers.
  - The 1 minute demand for the location is computed as 30.3 pers/min.
    - $V_1 = 1{,}000\ (pers/hr) \times 30\% \times 1.516 \div 15\ (min) = 30.3\ (pers/min)$
  - The bus shelter space required is given as 110 m^2.
    - $TS_{bwr} = 30.3\ (pers/min) \times 0.34\ (m^2/pers) \times 10\ (min) = 103\ (m^2)$

3) Taxi Stands

The number of shelters for a taxi stand shall be determined as follows.

Formula for computing the number of shelters for a taxi stand

$$P_t = \frac{V_t}{T_t}$$

P_t = the number of shelters for the taxi (lots)
V_t = 1 minute demand for stopping (taxi/min)
T_t = the average rate of turnover for the shelter (taxi/lot·min)

Example:
- The demand for taxis is 100 taxi/h and the 5 minute concentration is 12.5%. The average turnover rate is 1.2 taxi/lot·min. What is the number of shelters for a taxi stand are necessary?
  - The 1 minute demand for the shelter is computed as 2.5 taxi /min.
    - $V_t = 100\ taxi/h \times 0.125\ /\ 5\ min = 2.5\ taxi/min$
  - ☞ The required number of shelters is given as 3 lots.
    - $P_t = 2.5\ (taxi/min)\ /\ 1.2 (taxi/lot{\cdot}min) = 2.08\ lots$

3) Bicycle Storage

The number of spaces for bike parking shall be determined by the following formula.

Formula for computing the number of bicycle parking lots

$$P_c = \frac{V_c}{T_c}$$

P_c = number of bicycle parking lots (lots)
V_c = hourly demand for bike parking (bike/h
T_c = average rate of turnover for the lot (bike/lot·h)

Example:
- The hourly demand for bicycle parking is 100 bike/h and the average rate of turnover is 1.27 bike/lot·h. What is the number of parking lots required?
  ☞ The number of parking lots is given as 79 lots.
  · P_c = *100 (bike/h) ÷ 1.27 (bike/lot·h) = 79 (lots)*

Design Standards of Information and Guidance Facilities

1) Variable-Message Sign

The color of information to be displayed on a variable-message sign shall consist of LEDs displaying red, yellow or amber, and green. The letter style of the character variables shall be Gothic, the thickness of characters set at 0.125H, and the width-height ratio set at 1:1.

Table 3.17 Design value of variables for variable-message signs

Item		Design value	Remarks
Character variables	Character style	Gothic	-
	Character thickness	0.125H (0.0625H)	Designed in 0.125H as the standard and 0.0625H in unique cases
	Width-height ratio	1:1 (0.9:1)	Designed in 1:1 as the standard and 0.9:1 for large numbers of characters
Message variables	Letter interval	0.25H	-
	Word interval	0.375H (0.25H)	Designed in 0.375H as the standard and 0.25H in unique cases
	Line interval	0.375H (0.25H)	Designed in 0.375H as the standard and 0.25H in unique cases

Note: Design values are the results of evaluation of experiments and the value in the parenthesis represents 70% of the optimum values.

2) Information Signs

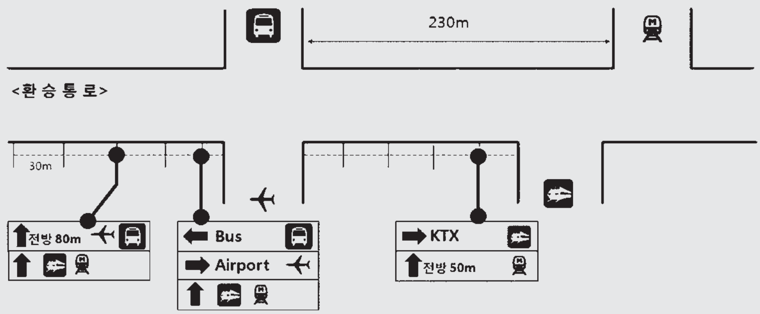
The dimensions of hanging information signs will be 1,000 mm × 290 mm, 1,500 mm × 200 mm, 1,000 mm × 420 mm, 1,500 mm × 290 mm, or 2,000 mm × 200 mm and wall mounted signs will be 1,000 mm × 750 mm, or 1,250 mm × 1,000 mm. The display order shall be an arrow, route number, direction, and instructions. The arrow shall be displayed in 8 directions in blue for the left side of the N-S vertical line including itself and in red for the right side.

Formula for computing the number of information signs

$$N_{gu} = \frac{S}{30} + P$$

N_{gu} = the number of information signs (unit)
S = transfer distance (m)
P = number of intersections

Example:
A bus passenger is going to transfer to the subway within an intermodal transit complex. The distance from the bus stop to the subway gate is 230 meters and there is an intersection in between leading to the KTX gate. What is the minimum number of information signs necessary?



☞ The minimum number of signs required is computed as 9 units.
· *230 m ÷ 30 m + 1 (number of intersections) = 8.6 　 9*

3) LCD Signs

The standard size of an LCD sign shall be 42 inches or bigger. The effective distance and area per size shall be as follows.

- effective distance (m) = size of characters (cm) × 3
- effective area (m^2) = (effective distance (m^2) × π) ÷ 2

The minimum resolution shall be 1,024 mm × 768 mm and the minimum contrast rate 10,000:1.

Formula for computing the number of LCD signs

S_v = the size of characters (cm) × 3

$$W_v = \frac{S_v^2 \times \pi}{2}, \; N_{lc} = \textit{Waiting Spaces} \div W_v$$

S_v = effective distance $\qquad$ W_v = effective area

N_{lc} = number of LCD signs

Example:

A transfer complex of a new KTX station is expected to need a waiting space of 163.2 m^2 for the ticket counters. What is the number of LCD signs needed for information display? The size of characters is assumed to be 2 cm.

- Effective distance is computed as 6 meters
  - · $S_v = 2 \times 3 = 6$ *meters*
- Given effective area is 56.52 m^2
  - · $W_v = \frac{6^2 \times \pi}{2} = 56.52\ m^2$

☞ The required number of LCD signs is 3.

· N_{lc} = *163.2 (m^2) ÷ 56.52 (m^2/unit) = 2.89 (unit)*

4) Kiosks

The number of kiosks shall be such that the waiting time to use one should satisfy LOS D or better.

Table 3.18 Level of service for kiosks

LOS	Waiting time
A	0.5 min or less
B	0.5-1.0 min
C	1.0-1.5 min
D	1.5-2.0 min
E	2.0-2.5 min
F	over 2.5 min

Formula for computing the number of kiosks needed

$$N_{ki} = \frac{V_1}{\lambda_{los}}, \quad \lambda_{los} = \frac{LOS_{ki} \times \mu^2_{ki}}{1 + LOS_{ki} \times \mu_{ki}}$$

N_{ki} = number of kiosks (units)
V_1 = 1 minute demand for a kiosk (pers/min)
λ_{los} = arrival rate for a specific LOS (pers/min·unit)
LOS_{ki} = waiting time for a specific LOS (min)
μ_{ki} = rate of service (pers/min)

Example:

- The peak hour demand for a new transfer complex is 20,000 pers/h and the peak 15 minute concentration is 30%. How many kiosks will be necessary for LOS D? The utilization rate of kiosks is 1% and the service rate of kiosks are 1.2 pers/min.
  - 1 minute design demand is calculated to be 4 pers/min.
    - · V_1 = 205,000 (pers/hr) × 30% × 1% ÷ 15 (min) = 4 (pers/min)
  - Arrival rate of kiosks for LOS D is given as 0.847 pers/min.
    - · $\lambda_{los} = \dfrac{2 \times 1.2^2}{1 + 2 \times 1.2} = 0.847$
  - The necessary number of kiosks is 5 units.
    - · $N_{ki} = 4 \div 0.847 = 4.72$

Chapter 04

Examples and Practices of Intermodal Transit Centers

Section 1

The Bus Transit Center of Seoul Station

1. Background

A large city like Seoul is already crowded with people competing over limited land space, which makes it almost impossible to put in a new road to solve a transportation problem. As such the solution must frequently rely on public transportation. However, public transportation inevitably necessitates a transfer in the middle of a trip to complete the journey, resulting in being less competitive compared to cars considering their door-to-door service. Park-and-ride lots situated near subway stations are among the rare current examples of transfer facilities in a city. Park-and-ride lots have been functioning too much on the function of a simple parking lot, lacking in a transfer function.

The Seoul city government initiated a significant reform of public transportation in July 2004. At present, bus-based transfer centers are operated in Seoul, Cheongnyangni, Yeouido, and Guro stations where a large volume of transfers are made between arterial and feeder buses, and between buses and the subway. In Gyeonggi Province transfer centers are operated at Suwon Station and Ansan Station.

Since Seoul has sprawled widely into surrounding regions including Incheon City and Gyeonggi Province, the travel demand has surged and the transport mode relied heavily on passenger cars causing congestion at city limits. Inside Seoul, the inconvenient transfer prompted the use of private cars, resulting in urban traffic congestion. The bus stations near Seoul Station and Cheongnyangni Station were scattered especially far from the rail stations creating many transfer problems including inconvenient transfers due to a long transfer distance, significant transfer time, lack of capacity in handling passengers at bus stations, and conflicting passenger flows. These problems hampered the use of public transportation and kept increasing private vehicle demand which in turn increased traffic congestion and continued in a vicious cycle.

To solve these problems of the urban public transportation system, Seoul city government established four bus transit centers as a part of the public transportation reform program in July 2004. The purpose of the bus transit centers was to encourage automobile passengers to shift to public transport through a convenient transfer system prepared in city centers in the hope of helping mitigate traffic congestions within Seoul proper and the greater Seoul area.

2. Implementation History

The bus transit center policy was implemented almost five years after the Seoul transit reform. As a result, serious problems arose at the initial stage of the reform in association with bus transfers.

For example, in the transit center at Seoul Station an evaluation meeting was held in October 2005 concerning initial work for a master plan to reform the Seoul Station area. In November 2006, a consulting project was launched to do the preliminary engineering and implementation design of the reform. The master plan was completed by April 2007, then went through discussion meetings with related city departments. The engineering and implementation design was finally completed in December 2008. The construction for the transit center was

Table 4.1 Transit centers in Seoul and Gyeonggi Province

Transit center	Location	Facilities
Guro Station	Seoul	Bus bays, transfer parking lot, bus information signs, etc.
Seoul Station	Seoul	Bus bays, taxi bays, bus information system, bus information signs, escalators connecting to subway, etc.
Yeouido Station	Seoul	Bus bays, bus information signs, etc.
Cheongnyangni Station	Seoul	Bus bays, taxi bays, bus information system, bus information signs, etc.
Suwon Station	Gyeonggi Province	Bus bays, taxi bays, bus information system, monitoring system for parking violations (CCTV), bus information signs, etc.
Ansan Station	Gyeonggi Province	Bus bays. taxi bays, bus information system, elevators for the handicapped, transfer parking lot, monitoring system for parking violations (CCTV), bus information signs, etc.

completed in July 2009 and opened for service on July 25, 2009.

The Seoul bus transit center started in the form of a public-private partnership. The cost of the transit center of Seoul Station totalled 12.1 billion Korean won. The city covered 9.4 billion won in infrastructure, platforms, and lane construction. The remaining 2.7 billion won came from private sources invested in the installation of shelters, guard fences for the platforms, signs, etc. The private share came from a consortium and participated in the project on a build-transfer-operate condition of operation for 8 years and 9 months. The private consortium takes advertisement revenue for operating expenses, operates the facilities, and is in charge of cleaning and maintenance of the facilities. The Cheongnyangni transit center cost 2.2 billion won in total. The city budget of 0.7 billion won was invested in infrastructure facilities and private investment totalled 1.5 billion won in the superstructure including bus shelters. The private backers took part in the project on the condition of build-transfer-operation for 15 years.

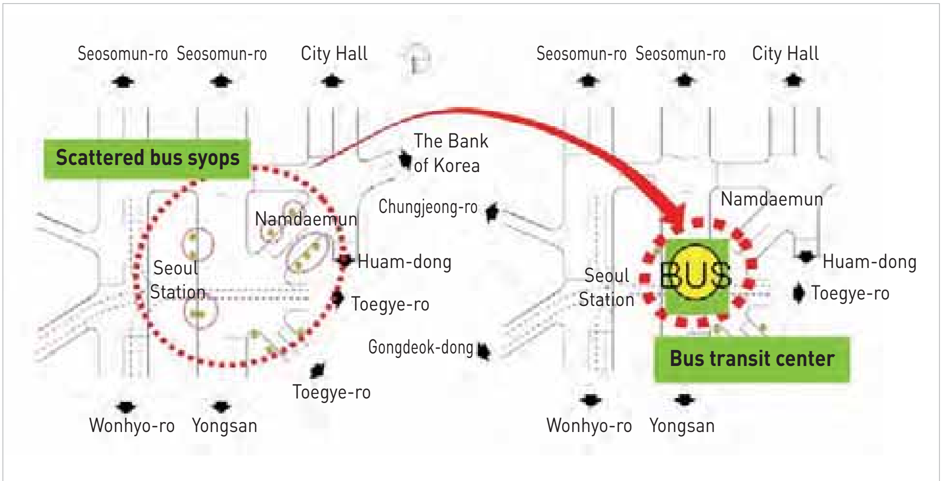
3. Basic Concept and Major Contents

A bus transit center is an important basic transportation facility to improve service quality and encourage use of public transportation by providing efficient bus-based intermodal transfers. Generally, a transit center is a complex transfer facility which houses transfer-related facilities like ticket booths, passenger amenities, and transfer hallways with smooth interconnection and convenient transfers between modes, all at one location where the subway, rail, and bus transportation nodes merge together with

Table 4.2 Improvements at Seoul Station bus transit center

Classification		Contents of transport system renovation
Transit center	Place	• Median lanes in front of Seoul Station concourse
	Scale	• 5 stands with 23 bays (2 stands are 3.5 m wide, the others are 9.75 m, 3.25 m, 3.0 m) • 5 bus-only lanes (2 U-turn lanes) • 2 passing lanes
	Direct transfer paths	• Walkway to subway lines 1 and 4 with an effective width of 5.6 m • Escalators with 1,200 mm width (2 people wide) • Elevators for the handicapped, CCTV
	Other facilities	• Pedestrian crossing (between Seoul Station and Daewoo Building)
Taxi stands		• Taxi lane extension from 2 to 3 lanes • Separate lane for accessing Seoul Station
Traffic operation facilities		• 2 sets of bus traffic signals • 1 camera for signal violation detection
Transportation system parts		• 1 pedestrian crossing in front of Seoul Station • 2 U-turn bus-only lanes • Bus-only median lane in the transit center area • Relocation of the pedestrian crossing to Huamdong Road
Miscellaneous		• Closed the underground road in front of YTN Building • 1 center lane bus stop with 4 bays in front of YTN Building

Figure 4.1 Seoul Station bus transit center, before and after



CHAPTER 04

transfers made between them.

The purpose of the Seoul Station transit center was to make the station area a central part of the intermodal transportation system consisting of the KTX service, subways, and city buses in connection with the bus corridor of the Siheung-Hangang Road axis through a median bus exclusive lane, and build the transfer center as an environment-friendly pedestrian mall as well as an efficient transfer point for public transportation. Nine out of twelve bus stops which were formerly dispersed around the station area are now

Figure 4.2 Lane arrangements after improvement

① Private vehicle lane for kiss-&-ride
② Taxi boarding
③ Taxi alighting
④ Buses bound for Yongsan, Gimpo
⑤ Buses southwest bound
⑥ Buses southeast bound
⑦ Buses northeast and west bound
⑧ Buses bound for Hangang Road

Source: Yonhap News.

Figure 4.3 Direct underground pedestrian pathway

integrated closely together in the median bus lanes in front of Seoul Station. The new integrated bus stops were relocated to the center lane to provide a convenient transfer with subway lines 1 and 4 and the KTX station. A direct pedestrian pathway was installed from the bus platforms to the subway lines with the taxi stands arranged nearby. A crosswalk was added to the station square to help pedestrians safely cross the wide street. The former bus route

Figure 4.4 Aboveground pedestrian crossing

Figure 4.5 Bus arrival information systems at Seoul Station transit center

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pattern in the northern part of the station area came through Sungnyemun Gate (Namdaemun) from Yeomcheon Bridge was changed to come around the Seoul Station intersection, pass through the transit center and go back

Figure 4.6 Bus route information at Seoul Station transit center

Figure 4.7 Bus transit center at Cheongnyangni Station

Source: http://www.mta.go.kr/app/trans/center/center_detail_list.jsp?inst_no=26 to Sungnyemun Gate. Likewise, most bus routes passing around Seoul Station now have been rearranged to ensure a convenient interconnection between modes including city buses, subways, and KTX rail service. At Cheongnyangni Station, the average transfer distance between bus stops and subways has been shortened by 129 meters. Previously the average distance was 177 meters and now is 48 meters.

4. Effects and Implications

The formerly dispersed bus stops around Seoul Station have been integrated into one bus transit center where the intermodal transfer distances are dramatically shortened and easy interconnection between modes is attained. The transit center has been equipped with public real-time arrival information through the bus information system, an installation of an assisting system for the handicapped, and a reduction of walking distance between bus stops to the subway station through a direct pedestrian pathway

A comprehensive overview evaluation of the Seoul Station transit center is as follows. First, the introduction of the Seoul Station transit center and the exclusive median bus lane on Namdaemun Road has decreased the average operating speed of buses due to the bus routes rerouted through the transit center and the stopping time for passengers' boarding and alighting at an integrated location. However, the average speed for other vehicles outside the median bus lane has increased.

Second, as a result of the reform of bus routes to come through the transit center, the bus traffic between Seoul Station and crossroads of the Seoul Station square has increased while other traffic on nearby streets has decreased. This result may be interpreted as the transit center has stimulated the use of public transportation and has been affected by the overall traffic reduction trend in downtown Seoul.

Third, the newly installed pedestrian crosswalk directly connecting the square and Daewoo Building at ground level has made a significant contribution to the area transforming into a friendly and efficient passenger transfer system together with underground pathways connecting the subway lines and the bus stops in and around the transit center.

Fourth, according to a survey on passenger satisfaction at the transit center, 76.8% of respondents were generally satisfied with the center. When asked for their reasons, 41.5% answered as being due to the convenience to use buses and 39.9%, due to the convenience for transfers. These results lead to the conclusion that the Seoul Station transit center has contributed to making public transportation more convenient.

Lastly, after the opening of the transit center, the number of passengers boarding and alighting for each bus platform showed a significant change. The highest passenger volume has been observed on platform 4 which showed a 12% increase one month after the opening. The reason for this passenger increase of the center has been attributed to the improved transfers for subway-bus, bus-bus, and KTX-bus connections as well as continuing to broadcast the merits of the system to the general public.

The success factors of the Seoul Station transit center are summarized as follows. First, the city government showed a strong will to complete the project. Second, close cooperation was achieved between the local government and the operating organizations. Third, the efficient intermodal connection and transfer system was supported by technology development. Fourth, transportation experts actively participated in the development of the

Table 4.3 Proposed improvements for Seoul Station transit center

Classification	Proposed improvements
Traffic safety	• Pedestrian safety from the passing lane on the platform • Barrier limiting jaywalking at end of platform
Passenger amenities	• Improved shelter with a sun shade • Adding a pedestrian crosswalk • Trash cans at transit center • Resting lounge at transit center
Information systems	• Information on intercity buses • Bus route search capabilities • Bus route information signs
Miscellaneous	• Facilities for the handicapped and elderly

concerned technology.

There are still some areas that need to be improved further including transportation security, amenities, and information. According to the survey, the highest level of discontentment within the Seoul Station transit center was "crowdedness in the bus", representing 42.5% of respondents. The lack of amenities accounted for 22.4% and increased traffic congestion 20.1%.

After the implementation of the Seoul Station transit center and the median bus lane on Namdaemun Road, the average speed of standard traffic improved overall and the transit center is considered to have qualitatively positive effect on the convenience for intermodal transfers, comfort, and safety. With the opening of the transit center at Seoul Station, the boarding and alighting passenger volume has been progressively increasing influenced by the center itself, bus route adjustment through it and a campaign promoting the convenient transfer path.

All these positive changes concerning public transportation in the Seoul Station area seems to have been derived from improvements of the public transportation intermodal transfer system and the pedestrian pathway. In order to evaluate the effects of the transit center from a more comprehensive viewpoint, it is necessary to develop broader and in-depth measures of the effectiveness to show the efficiency and convenience of the transit center. A future study is necessary to develop appropriate alternatives for improvement and set the timing for the action based on problems raised previously. Focusing on the transit center, a more detailed consideration shall be given to the selection of location, how to improve accessibility, and passenger safety.

Section 2

Expressway Transit Centers for Intercity Expressway Users

1. Background

The primary purpose of rest areas on express highways is to provide drivers and passengers with a place for refreshment, allow light vehicle maintenance, resupply fuel, or get a light meal. The Korea Transport Institute proposed expressway rest areas to be redesigned to function as a passenger transfer station. In the past, express buses used to be fully loaded from the origin terminal and have no room to accept additional passengers in the middle of travel. However, currently the load factor of intercity buses became so low it began to jeopardize the bus industry. The institute found that expressway rest areas are a place in which many intercity or inter-region buses with different origins and destinations drop in and share a brief stop. Almost all these buses have vacant seats available due to a low load factor and so passengers who cannot find the right bus for their destination can come to a rest area by any other bus, find the right one to transfer to, and change their bus. With this research in hand, the Korea Transport Institute proposed the government to use expressway rest areas as intermediate transfer centers.

Looking at statistics regarding express and intercity bus passengers,

Figure 4.8 Yearly travel demand for express and intercity buses

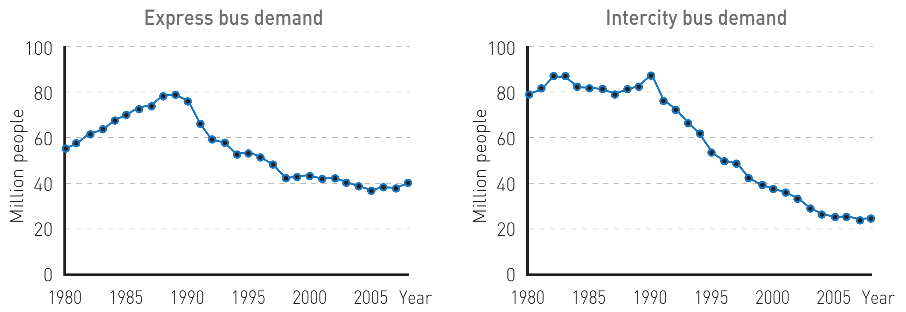
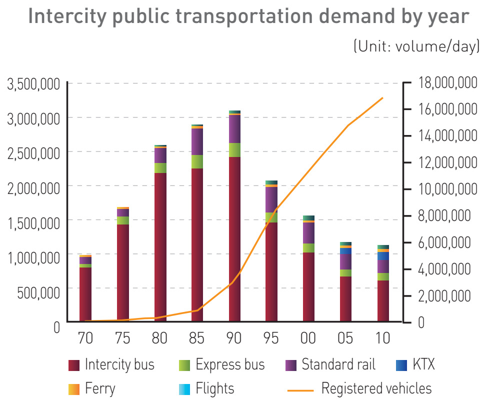


Figure 4.9 Public transportation demand trends



Change of demand by mode

(Unit: volume/day)

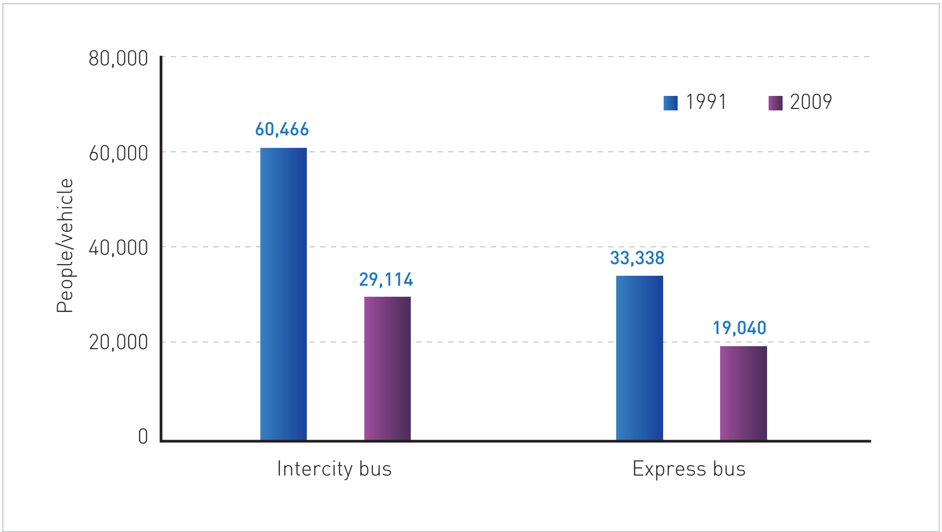
Mode	1990	2010	% change
Intercity bus	2,411,765	618,586	-74 %
Express bus	209,602	104,461	-50 %
Standard rail	411,164	307,104	-25 %
Ferry	22,630	39,212	73 %
Flights	30,312	55,367	83 %
Total	3,065,473	1,124,750	-64 %

patronage for express buses went through a gradual decline from 70 million in 1991 to 40 million in 2009, and the annual volume of intercity buses was reduced sharply from 700 million in 1991 to 250 million in 2009. While registered automobile numbers increased 4.5 fold, public transport inter-region traffic volume reduced 64%. In particular, traffic volume for intercity buses dropped 74%.

In addition to the overall decline of demand, the per-vehicle bus patronage is also gradually decreasing, which has entailed a rapid increase in government subsidy to cover the financial difficulties of the bus industry.

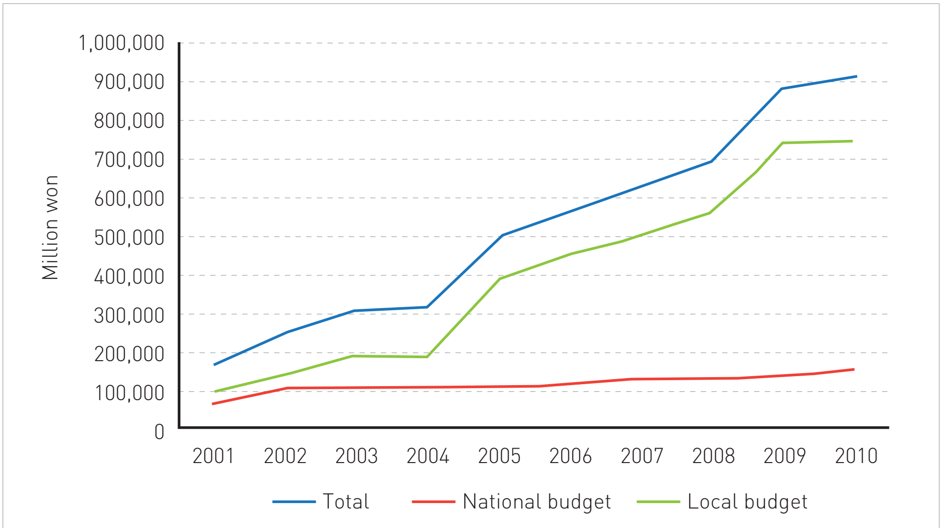
As one of the countermeasures, the Ministry of Land, Infrastructure and

Figure 4.10 Change of per-vehicle bus demand



Transportation initiated a demonstration project by installing a bus transfer center at a expressway rest area from November 2, 2009 with the purpose of increasing bus patronage by making the express buses more easily accessible to residents of small and midsized cities. The express bus networks were

Figure 4.11 Changes of government subsidies



originally built centered in large cities such as Seoul, Busan and Daegu. Therefore, passengers in smaller cities like Goyang, Yongin, and Uijeongbu have to suffer by making an additional trip to a nearby bigger city due to no service or wait longer due to a lower frequency of vehicles.

The number of express bus routes with origin or destination in Seoul amounts to 73 (50.3%) out of the total of 145 routes while the small and medium cities have only 3 express bus routes on the average. For example, the Seoul-Gwangju route has an express bus service operating every 5 to 10 minutes while the express bus service on the Goyang-Gwangju route operates every 80 minutes, while other routes have an operating interval of 3 hours. Transfer centers at expressway rest areas were designed to make them a hub center of the hub and spoke public transportation system by arranging for bus passengers at the rest area to change buses en route to their destination.

2. History

For the demonstration operation, the government installed a transfer center for both directions at four major rest areas of the Honam and Yeongdong corridors and operated the service on weekdays only from 8 o'clock in the morning till 8 o'clock in the evening starting from November 2.

The Honam Corridor was furnished with a transfer hub center at Jeongan rest area in both directions to allow passenger transfers of bus routes between the six northern cities of Seoul, Goyang, Suwon, Seongnam, Uijeongbu, and Yongin and the nine southern cities of Jeonju, Gunsan, Gimje, Namwon, Iksan, Jeongeup, Gwangju, Mokpo and Suncheon. The Hoengseong rest area of the Yeongdong Corridor was equipped with a transfer hub center where inter-bus passenger transfers were made between the four western cities of Seoul, Incheon, Goyang and Daejeon and the nine eastern cities including Gangneung, Sokcho, Donghae and Samcheok.

The Ministry of Land, Infrastructure and Transport added the Seonsan rest area of the Gyeongbu Expressway as a transfer hub center on March 2, 2010 and was extended from October 8, 2010 to apply this policy over the entire expressway network including Gyeongbu, Honam and Yeongdong expressways. The operating hours of the system also extended to the weekend. However, the rest area transfer service was not provided during excessive demand periods like the Chuseok festival.

The inter-bus passenger transfer system at expressway rest areas was provided at the expense of the bus operators and the owner of the rest area while the government granted administrative support. As part of licensing regulations, intercity buses operating through expressways were formerly not to make an intermediate stop in the middle of its operating section, i.e., a rest area on the expressway. The government amended related enforcement regulations of the Passenger Transport Service Act so these buses could legally make stops at expressway rest areas and therefore allow passengers to transfer between express buses.

The inter-bus passenger transfer policy at expressway rest areas was designed to induce an increase in intercity bus passengers as an effort to reverse the declining trend. The policy was accepted by both rest area owners and bus operators since an increase in bus patronage was believed to be beneficial to both parties. The bus operators took the expense of ticket offices amounting to 30 to 40 million won per year and the rest area authority arranged for 1~2 staff members for the ticket office and two persons for parking lot management. Labor costs were intended to be covered by an additional fee attached to the ticket sale. Due to insufficient ticket sales the express bus operators currently bears a part of these staffing costs.

3. Basic Concept and Major Contents

The introduction of transit transfer centers at expressway rest areas brought about a transportation paradigm shift from the hub and spoke bus transportation system based on large cities to a new hub and spoke system with an intermediate hub added to expressway rest areas. Prior to the new system, travelers had to make a local trip to a nearest hub terminal and take an express bus for intercity travel and potentially make another local trip to get to their final destination. With this system, the traveler had to endure two transfers and often a backward trip to get to their destination or return to their origin, both requiring additional time and cost, neither of which travelers want to do. With expressway rest area transit centers allowing inter-bus passenger transfers, passengers could come to an expressway rest area by any kind of buses at their origin which then provides a wider range of buses to go to their destination.

The most important aspect in planning the expressway transit center is to select the right location of rest areas for transit centers. Three selection criteria were adopted including the place that had infrequent bus service, the frequency of buses using the expressway, and the number of parking lots and demand for the rest area.

With these criteria, the government selected six rest areas and installed transit centers which are currently in operation. Passengers can purchase tickets to the transit centers (Jeongan, Hoengseong) at departure terminals, and tickets to the final destinations can be purchased at the transit centers.

Figure 4.12 Concept of new spoke and hub bus transportation system

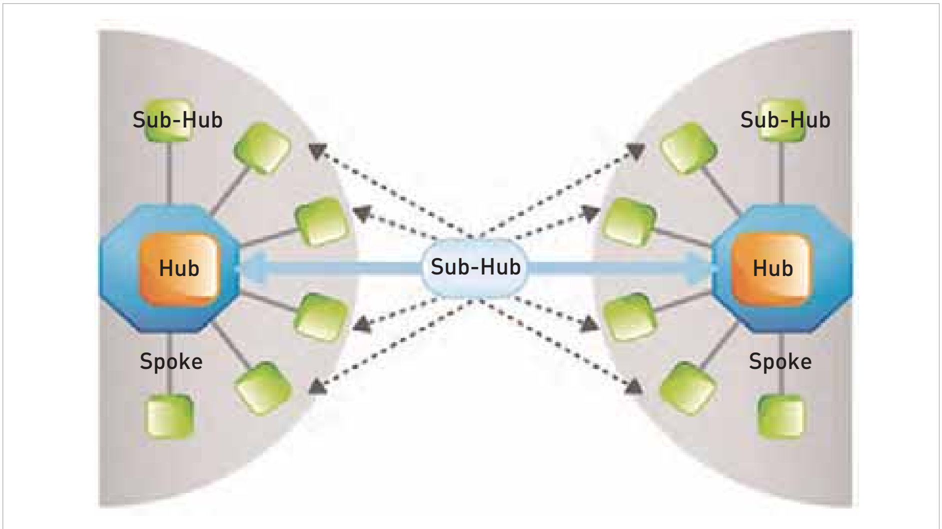


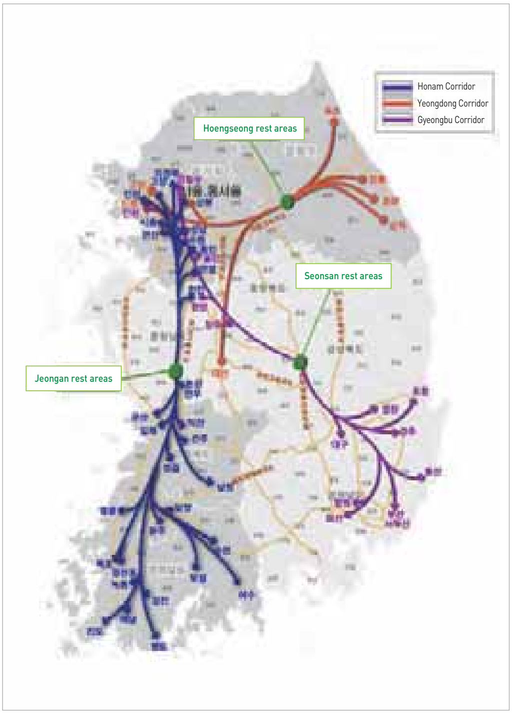
Figure 4.13 Rest area transit centers at expressway corridors

Honam corridor	Seoul (Gangnam, East Seoul, Sangbong), Goyang, Suwon, Uijeongbu, Seongnam, Yongin, Ansan, Siheung, Cheonan, Anseong	↔ Jeongan ↔	Jeonju, Jeongeup, Iksan, Gimje, Namwon, Gunsan, Gwangju, Mokpo, Suncheon Yeonggwang, Naju, Gangjin, Yeosu, Jindo, Wando, Haenam, Nokdong, Damyang, Boseong, Nonsan
Yeongdong corridor	Seoul (Gangnam, East Seoul), Incheon, Goyang, Daejeon	↔ Hoengseong ↔	Gangneung, Sokcho, Donghae, Samcheok
Gyeongbu corridor	Seoul (Gangnam, East Seoul), Seongnam, Uijeongbu, Yongin, Incheon, Cheonan Cheongju	↔ Seonsan ↔	Daegu, Yeongcheon, Gyeongju, Pohang, Ulsan, Changwon, Masan, Busan

The advance purchase of tickets can be made through the internet (www.kobus.co.kr) and automated phone menu service (1588-6900). A smartphone bus information and ticketing system is to be established in the near future. The fare setting is similar to that of existing express bus systems in that the fare is for the whole distance from the initial origin to the final destination with the distance diminishing rule applied, which guarantees no additional burden to passengers compared to the existing fare.

The government installed four express bus transit centers at rest areas for 25 bus lines of the Honam and Yeongdong expressways in November. The Jeongan rest area on the Honam Expressway is playing the role of a transit hub to allow a smooth transfer for passengers to Seoul, Goyang,

Figure 4.14 Location of expressway transit centers



Source: New Times, http://www.newtimes.co.kr/news/articleView.html?idxno=24736

Figure 4.15 Exterior and interior of an expressway transit center in Hoengseong

Source: http://blog.daum.net/_blog/BlogTypeView.do?blogid=0LF2e&articleno=8555435&categoryId=555420&regdt=20120125124818

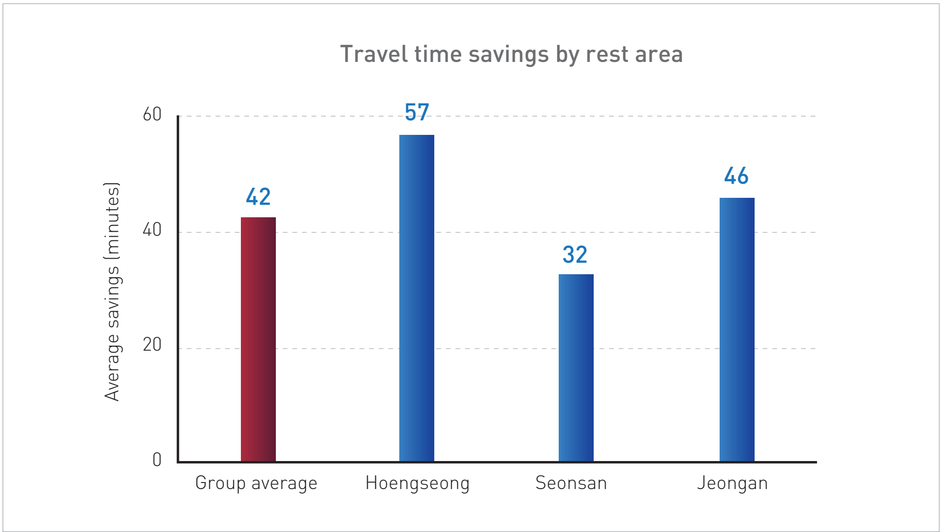
Suwon, Seongnam, Uijeongbu, and Yongin cities in the northern part of the country and nine small cities including Jeonju, Gunsan, Gimje, Namwon, Iksan, Jeongeup, Gwangju, Mokpo, and Suncheon, which are located in the south. The Hoengseong rest area facilitates the transfer between the buses for the cities of Seoul, Incheon, Goyang, and Daejeon located in the west and the cities of Gangneung, Sokcho, Donghae, and Samcheok located in the east.

The government is going to install inter-bus transfer centers at expressway rest areas for the additional 45 bus routes. By using express buses in small and medium sized cities, the waiting time has been shortened by an average of 47 minutes, the total travel distance by about 35 km, and fares reduced by an average of 2,500 won (standard 2,000 won, first class 3,000 won). On March 2, 2010, a new transit center was opened at Seonsan rest area in the Gyeongbu Corridor.

4. Effects and Implications

Expressway transit centers have contributed greatly to improving intercity accessibility and mobility by allowing bus passengers to make transfers between buses coming into the expressway rest areas. Prior to the rest area transit center policy, there used to be no bus with direct connection between small and medium sized cities. The rest area transit center policy has given

Figure 4.16 Positive effects of rest area transit centers on time

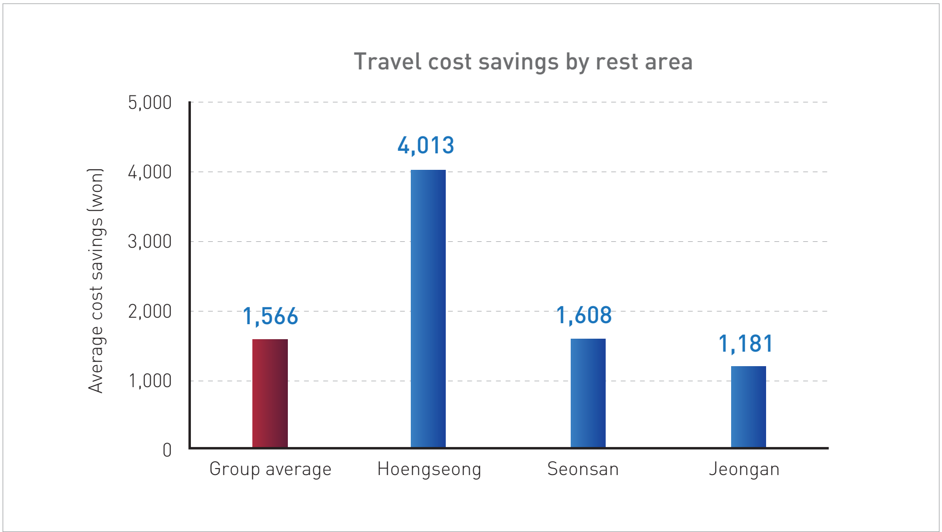


bus passengers an extended range of service through pooling the bus fleet sharing the center. Under this policy, the easy inter-bus connection at the center could lead to a great saving of overall travel time and cost to the bus travelers.

A survey was carried out on passengers who used the transit centers at Jeongan, Hoengseong, and Seonsan rest areas of Honam, Yeongdong, and Gyeongbu expressways. The effect of the transit centers was analyzed by a path tracing method. The number of routes utilized increased from 181 to 436 (140.9%). In particular, on the Honam Expressway, routes increased 388.9% from 54 routes to 264 routes. And the modal shift from automobiles to intercity express buses accounted for 25.8%, from trains at 9.6%, and shift from aircraft represented 0.4%. The average travel time decreased 42 minutes and average expenses decreased by 1,566 won.

Bus transfer at expressway rest areas is currently applicable only to buses coming to an expressway and stopping at the rest area. The users of standard intercity buses are exempted from the policy and alienated from the benefit of the policy. If standard intercity buses are allowed to enter the expressway and stop at rest areas to pick up riders whose destination is matched with

Figure 4.17 Positive effects of rest area transit centers on cost



other buses that frequent there, the effects of the policy shall be considerable. For this purpose, the Korea Transport Institute recommends the government to amend related laws and regulations to allow the policy of rest area bus transfers to be applied to standard intercity buses as well as express buses.

Passenger satisfaction survey results for expressway rest area transit centers showed that 36.9% of passengers were suffering from the shortage of available bus routes, 20.9% complained about low punctuality, and 15.1% claimed of long operation intervals. To cope with the passenger's complaints, transit centers need to be installed at more rest areas. A further effort to expand bus coverage for intercity travel may well be pursued by installing bus transfer centers at service areas over the national highway network as well as expressways.

Section 3

At Grade Transfer Treatments

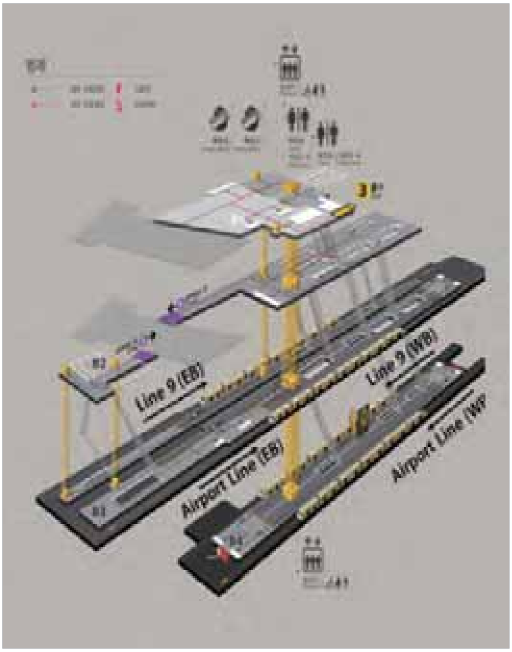
A good form of inter-bus transfer system can be found in an at grade interconnection where two different routes approach each side of an island type platform, a cross intersection where two routes intersect at a right angle with the grade separated, and a double-decked interconnection where two routes run in parallel with the grade separated at a station.

1. At Grade Transfer Structure

Gimpo International Airport Station is where Subway Line 9 meets the Incheon Airport Railroad and is structured in an at grade intersection (Figure 4.18). A passenger alighting from one line may walk only a few steps across the platform to board the other line going in the same direction. Since most transfer passengers continue to proceed in the same direction at this station, this structure works well with the situation. Even if the transfer is made in the reverse direction passengers may do so easily through a stairway or escalator.

Geumjeong Station is another example of an at-grade transfer station where subway lines 1 and 4 meet together at grade at the station. As shown in Figure 4.19, the two island type platforms are laid out at grade in parallel. A same direction transfer to the other line requires only a few steps across the platform to board the other line. For a reverse direction transfer, the passenger has to go up to the concourse in the upper level and come down the other side, which requires a fairly long walk. An additional problem lies in that the facility is 25 years old and the outdated platform is narrow in width.

Figure 4.18 Passenger transfer between subway and airport rail at Gimpo International Airport Station



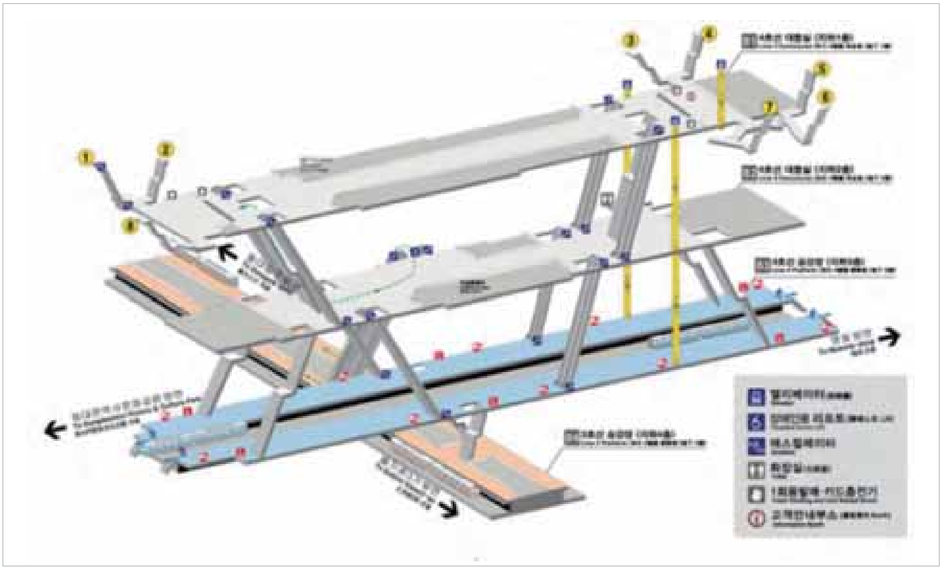
Source: Rigvedawiki, http://adserv.rigvedawiki.net/w/%EA%B9%80%ED%8F%AC%EA%B3%B5%ED%95%AD%EC%97%AD

Figure 4.19 Transfer system at Geumjeong Station

2. Cross Intersecting Structure

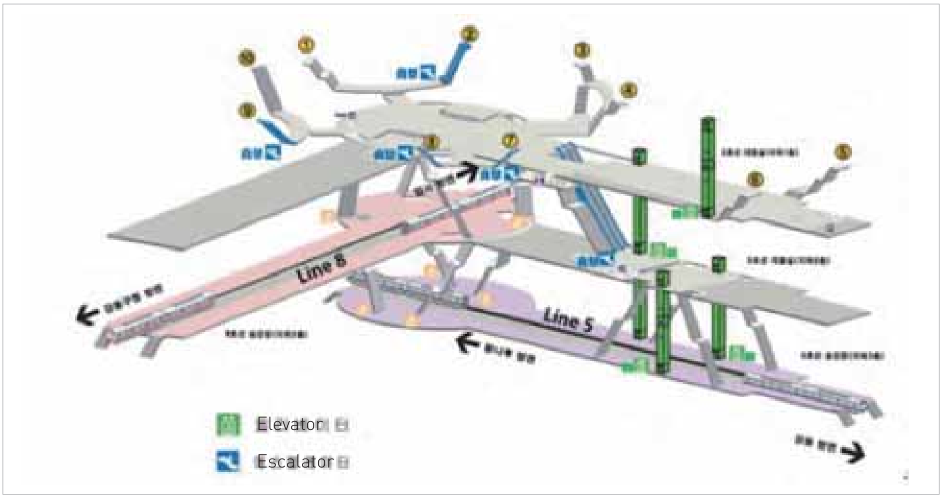
Chungmuro Station provides subway service for lines 3 and 4 and is a place where the two subway lines intersect each other at a right angle. Passengers may easily access the other platform through a stairway (Figure 4.20). Line 3 has an island type platform to provide an easy transfer to the other trains while Line 4 has separate platforms and transfer from Line 3 requires attention to go the right direction. The width of the stairs connecting the two lines is insufficient, which causes bottlenecks during rush hours.

Figure 4.20 Transfer system at Chungmuro Station



Source: Seoul Metro, http://www.seoulmetro.co.kr

Figure 4.21 Transfer system at Cheonho Station



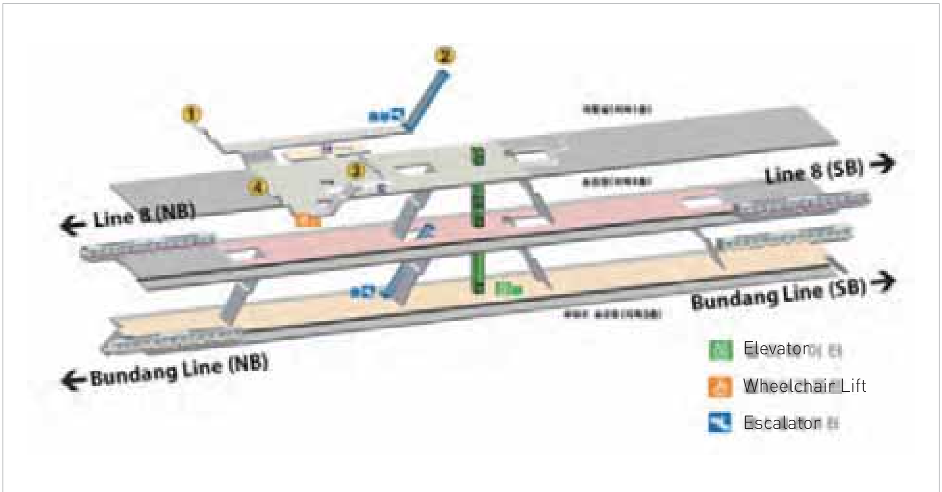
Source: Seoul Metro, http://www.seoulmetro.co.kr

At Cheonho Station, lines 5 and 8 of the subway meet together at a right angle with the grades separated. Passenger transfer between the two lines is made easily through stairways (Figure 4.21). However, the intersection is made at the end of each platform, which requires the passenger flow to the end of the platform which is vulnerable to bottlenecks at the stairways connecting them. As both lines separate platforms, the connecting stairway becomes crowded depending on the direction at the time of transfer.

3. Duplex Type Structure

Bokjeong Station provides an intersection of Seoul Subway Line 8 and the Bundang Line taking the form of a typical duplex type structure (Figure 4.22). Because the planning and the construction of the two stations were performed at the same time, the platforms were placed in parallel, separated in grade, on the same vertical plane. The transfers for all directions are made through stairways.

Figure 4.22 Transfer system for Bokjeong Station



Source: Seoul Metropolitan Rapid Transit.

Section 4

The National Integrated Public Transportation System Project

1. Background

In spite of incessant efforts for a high speed and quality public transportation over two decades (1990-2010), the demand for intercity public transportation has continued to decline. Although the KTX service took a significant portion of a long distance travel demand, private vehicles still amount to 47% of long distance travel 300 km or over, especially due to outdated public transportation remaining active.

- Public transportation volume: 3,085,473 trips/day in 1990 → 1,124,750 trips/day in 2010
- Auto registration increased 4.5 times over 20 years, travel demand for intercity public transit reduced 64%

The highest share of intercity travel is taken by private vehicles while the share of buses is the biggest among public transportation modes.

- Modal shares: private vehicles 63.5%, bus 24.5%, rail 11.2%, flights and ferry 0.8%
- Modal shares by region: Seoul metropolitan region has the lowest

Figure 4.23 Mode share trends of national intercity public transportation

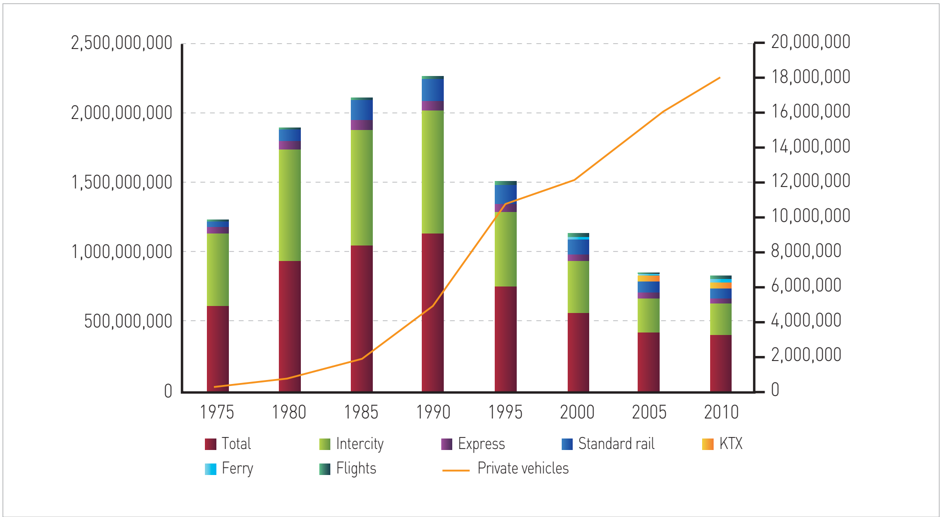
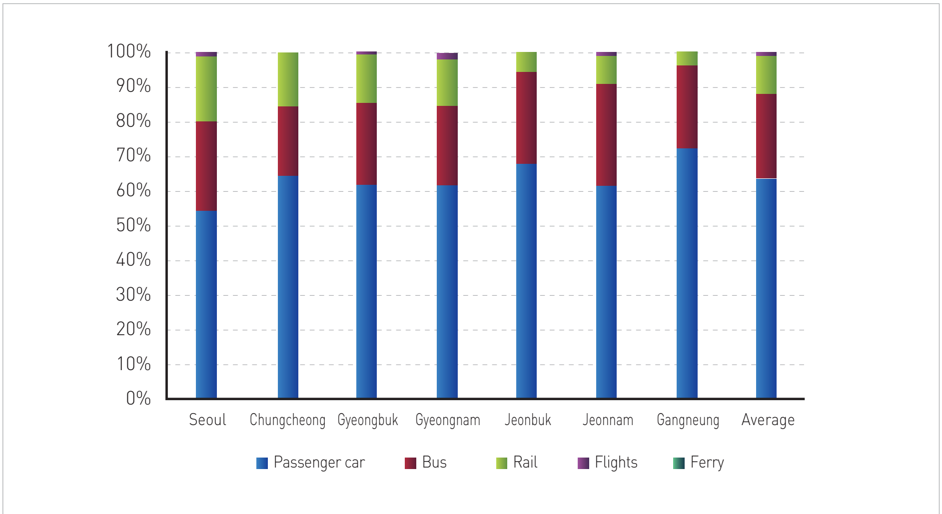


Figure 4.24 Mode shares of public transportation by region



private vehicle share.

The decrease of public transportation usage has resulted in a difficult financial balance for operators, which required frequent increases in federal financial subsidies. Keeping the bus fleets maintained at certain standards in

CHAPTER 04

spite of decreasing demand for intercity and express buses entailed financial deficit of transportation companies.

- Government subsidies: 17.4 billion won in 2001, 50 billion won in 2005, 98 billion won in 2010
- Travel demand for intercity and express buses reduced 1/3 compared to 1980 resulting in increased government subsidy
- Decreased revenue of the intercity and express buses resulted in a

Figure 4.25 Bus travel demand and fleet size

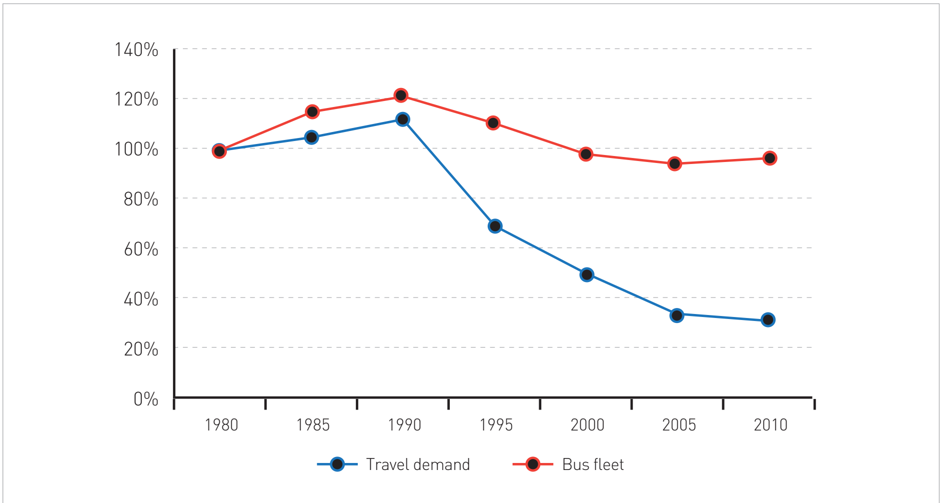
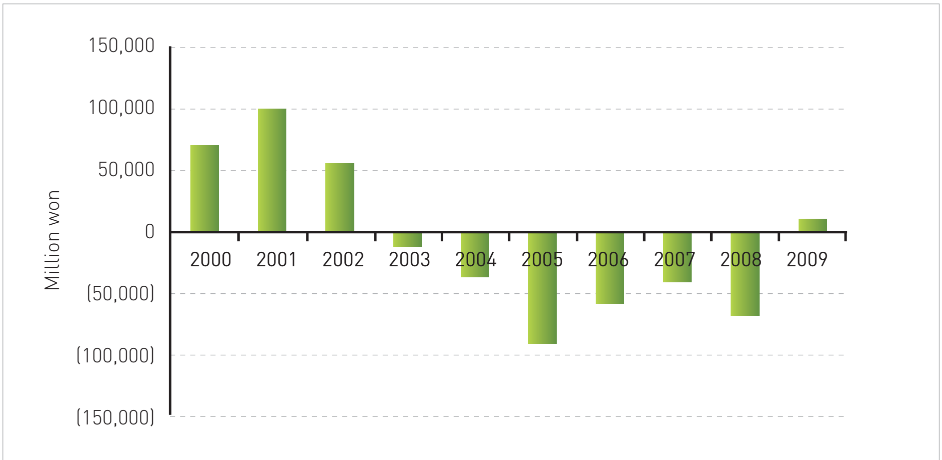


Figure 4.26 Operating revenue of intercity and express buses



financial deficit

The fare system and fare discount vary by region and public transportation mode, which creates a great deal of inconvenience. Although the fare system is integrated in a big city, for example the Seoul Capital Area's integrated fare system, a travel to an outside local city would require a separate fare payment upon entry to the city due to the different fare systems. The bus system allows a very limited discounted fare system while the KTX service provides a variety of discount systems.

The inconsistent operating schedule of the transport modes to be interconnected, a lack of on-time information, and the inconsistent fare system are all associated with an unnecessary increase in travel time and cost. For example, the unmatched operating schedule between connecting modes at a transfer node like a railroad station and a bus terminal will cause an increase in waiting time. Although the transportation information is currently provided by mode and by region, the user-oriented, path-based integrated transportation information is yet to be available, which is still a bottleneck in using public transportation. Frequent use of intercity public transportation are supposed to pay separately for each connecting mode with no discount policy, which causes an increased fare burden.

The transportation investment has been made independently by mode and route, which may cause a loss of the efficiency of the transportation system as a whole. The poor interconnection between modes or routes resulting from it makes intermodal transfers inconvenient. A link-based improvement of a transportation system may play a very limited role in improving overall efficiency of the entire network. Although the opening of KTX service entailed a structural change of the nationwide transportation system and travel behavior of passengers, the appropriate intermodal transportation system for the change is not yet established. That is, the complementary role of the highway and the railroad has not been established with each other. When using public transportation, the issues of transfer distance and time burden still exist to the level that it makes users hesitant to use public transit.

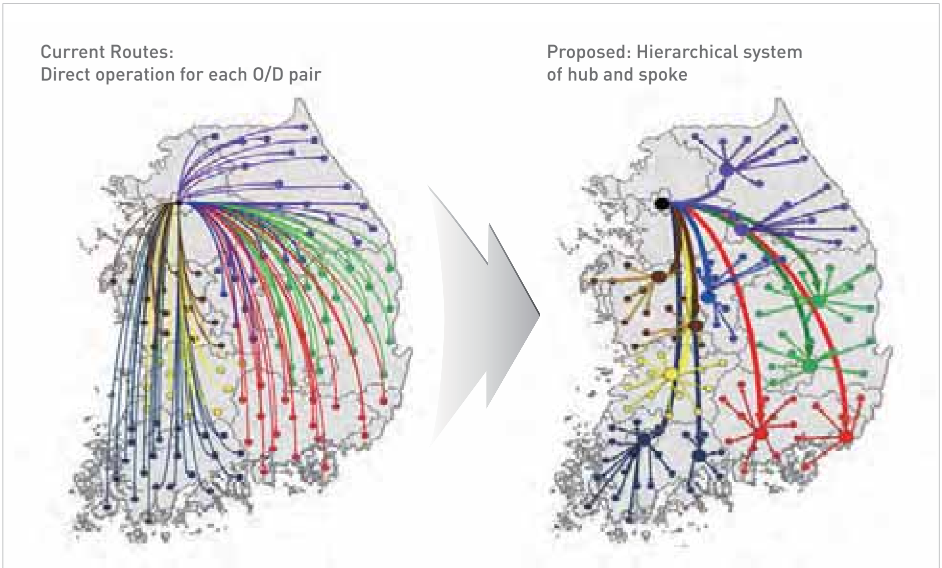
Especially in cases of a transfer between a railroad station and a bus terminal, the transfer distance is often long to make the transfer arduous and difficult while a railroad station is frequently laid out with many stairways and a bus terminal has a long outdoor unprotected walking path.

2. Implementation Direction

1) The Concept of Network Integration

The overall concept of the project may be outlined as follows. The project aims at reestablishing the national public transportation system into a hierarchical system of arterial and feeder on a national scale. All public transportation routes will be divided into inter- and intra-region systems in the form of a hub and spoke. A basic route system is formed by the intercity and express bus system for a direct inter-region connection. In a KTX influence zone, the intermodal transportation system is established based on

Figure 4.27 Proposed change to intercity and express bus routes



a KTX station while the intermodal transportation system of regions with no KTX service is established on the basis of an express bus terminal or standard railroad station. Areas with no terminal of public transportation are provided with an intermodal transportation system based on the rest area of an expressway. The route shall be defined for its role depending on the length: short length route of 200 km or less is kept under government regulation while long distance routes of over 200 km are subject to a competitive marketplace through a deregulation policy. The government subsidy policy shall be route specific and only applicable to intercity base routes under deficit and feeder routes in a region in deficit.

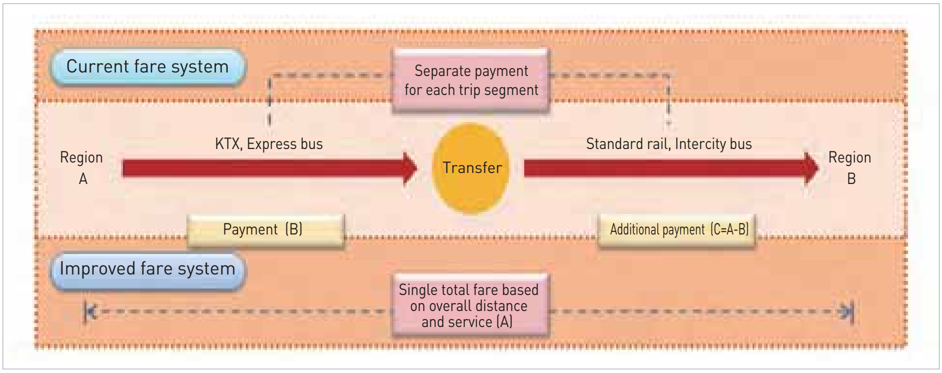
2) Physical Integration

At a transportation node such as a railroad station or bus terminal, a transfer center where interconnecting modes connecteach other is established through an intermodal transportation system. For bus passengers, the bus based intermodal transportation system is promoted through providing the transfer center at the rest areas of expressways and national highways, which can start immediately at low cost. For railroad passengers, stations are to be developed as an efficient transfer center in such a way that more public transportation modes are induced to connect and be connected, platforms are located in short distances, and walking facilities are added, which together will reduce the perceived transfer distance and promote a transit oriented development of station areas. The rail based unified operation of all intervening modes and an integrated management of these modes will lead to a significant reduction of transfer time and increased convenience. The time standards for each action may be set to not more than 3-5 minutes for mode transfers, 10 minutes for waiting, and 1 hour for approaching.

3) Fare Integration

A nationwide integrated fare system shall be established for all forms of

Figure 4.28 Proposed national integrated fare system for public transportation



public transportation including railroad, express and intercity bus, city bus, taxi, etc. A variety of fares shall be implemented to reflect the user characteristics and commutation tickets shall be introduced as well. A discount policy and commutation tickets for commuters on weekly, monthly, and yearly basis will be introduced. The discount system shall include a family discount, a weekday discount and other discounts in association with department stores and rest areas. Other discounts in the form of mileage system, advance reservation discount, and a membership priority system will be considered. The rule of transportation cost sharing among the central government, local governments, and users shall be defined in advance and institutionalized to be set by a particular ratio of the average monthly wage of an urban laborer or the GRDP.

4) Information Integration

A comprehensive information service system shall be established in which the entire service of inquiries and confirmation nationwide bus routes, reservations, real-time transfer information, and a fare discount can be made at one place. Under the new system, the current problems of a mode-specific individual information systems and accruing inconveniences in making reservation and separate fare payment systems shall be improved to enhance the overall level of service for public transportation. The nationwide integrated public transportation fare payment and information system will provide a firm basis of a rational policy and financial support for public transportation.

The transportation information centering on public transportation and pedestrians will be developed with mobile-based itinerary and fare payment services like e-tickets. For this purpose, the monitoring and supply of information, integrated fare system, and interagency cross accounting will have to be made.

Figure 4.29 Mobile all transit system

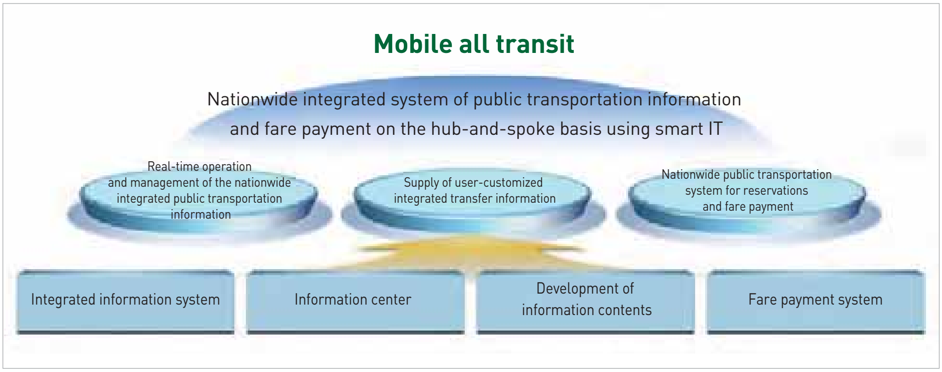
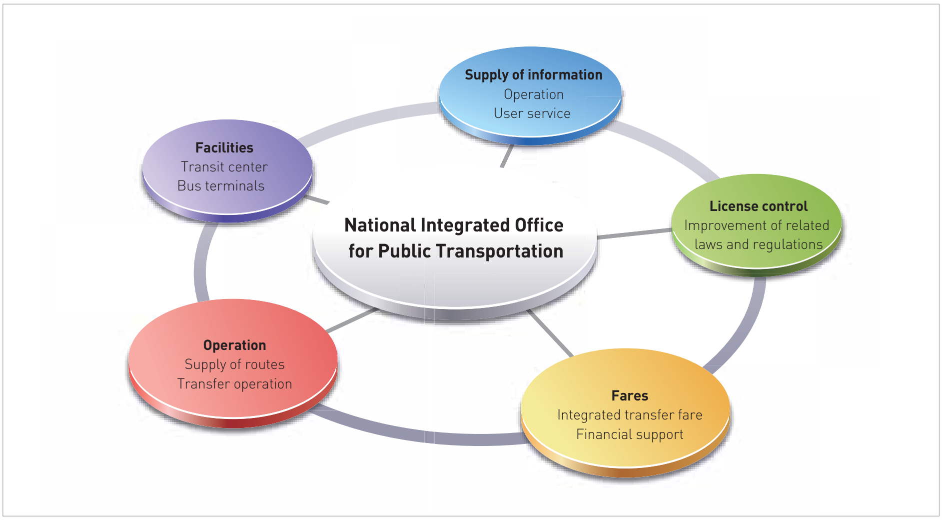


Figure 4.30 Nationwide public transportation integrated management system



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5) Institutional Integration

A national integrated office for public transportation shall be established to actively deal with integrated operation and management of the nationwide public transportation by settling conflicts between different parties, authorizing and providing permission for public transportation service, fare setting, financial support, etc. The office shall perform administrative services to integrate the license control of the bus industry, operation of transfer facilities, and integration of fare and transportation information.

Conclusions and Policy Recommendations

Section 1

Conclusions and Implications

Past practices of intermodal transit centers in a domestic context reveals no consideration was given to efficient connectivity or the ease of transfers, which resulted in a poor transfer level of service. Those considerations should have been made at the planning and design stages where the conventional efforts were made barely to placed on supply transportation services and not to make it efficient and convenient. About the time construction of subway systems in big cities began, the concept of a transit center was adopted at major subway stations along the city limit line by installing transit centers with large parking lots for park and ride service. This policy has been neglected in downtown areas which necessitate it the most due to difficulties in land acquisition and high construction costs.

However, public concerns have increased regarding crucial social and economic problems of traffic congestion, traffic safety, and unhealthy emissions that an auto-based transportation policy creates with no easy solution found. The pressure to reduce the CO_2 emissions influencing climate change has forced a change in policy focus to more efficient public transportation as an effective way of reducing auto emissions. The popularity and successful revenue earnings of the KTX high-speed rail service which was introduced for public use in 2004 gave a strong support to the new policy direction of public transportation, especially by rail.

Rail-based public transportation has raised a lot of practical issues. The first and most important problem was the fact that the current management practice of rail transportation was far from a user orientated service because rail transportation was usually based on the operators' viewpoint, which inherently creates problems of low accessibility and inconvenient transfers. Next the rail operator has no mind-set on how the rail station, a focal point of attracting many connecting modes, should be developed into a central part of transit-oriented development which is an underlying concept of an intermodal transit complex. This latter point shall provide a significant opportunity for making profits from the land development as well as inducing more patronage for the rail mode due to improved accessibility and transfers, both of which will play a vital role in long-term financial stability of the rail operator.

Conclusions are made as follows.

1) Public transportation shall be enhanced in such a way to play a central role in establishing a good intermodal transportation system. Then it will attract its patronage increasingly due to its convenience and efficiency and be effective in response to today's emission-sensitive environment.
2) The intermodal transportation system shall be made very efficient and convenient by ensuring easy access to the rail station and efficient transfers to a connecting mode. This leads to an efficient transit center.
3) The transit center shall come together with a transit-oriented development of the surrounding area. This concept of an intermodal transit complex will fulfill the need for visitors and passengers to do urban activities and enjoy amenities with good accessibility and transfer functions.
4) The concept of an intermodal transit complex has been institutionalized by the National Integrated Transport System Efficiency Act. Under this law, the transportation node shall prioritize inter-modal connections

from the planning stage.

5) Intermodal transit complexes have a dual purpose of both a government role to provide easy and efficient accessibility and transfers and a private role to create a transit-oriented high density development. The two purposes shall be balanced and conform with the underlying principle to help each other.

Section 2

Policy Recommendations

A good intermodal transit center has an administrative organization in charge of a metropolitan transportation system and intermodal connection policy. A strong administrative authority is essential to a successful public transportation oriented policy to maintain consistency and speed of implementation. Consequently, it is necessary that the special administrative organization in charge of the intermodal transit center should implement an intermodal transportation system through a consistent and streamlined process of administration and finance.

An efficient establishment of an intermodal transportation system is proposed in the three aspects of facility, operation, and institution. From a facility point of view, an efficient development of an intermodal transit complex is suggested to lead to an efficient and convenient transfer system through a physical integration of transfer facilities. Next, the operation point involves efficient operation of the interconnecting modes, a good scheduling practice, improvement of public transportation routes, improved information system, and a fare setting system. The institution aspect includes laws and regulations, a management organization, and a financing method.

First, to ensure an efficient intermodal transportation system, physical integration has to be achieved through a government initiated investment system in the transfer facilities. Since traffic congestion accruing to intermodal transfer facilities is directly associated with a weakened national competitiveness in transportation and physical distribution, improvement of intermodal connection facilities should not be left to the hands of local governments which are weaker in budget and personnel and instead should primarily be dealt with by the central government. To do this, the government should establish a long and medium range plan for the intermodal transit center system and arrange a budget plan for supporting it. It is also necessary to set up a legally defined plan for the intermodal transportation system and implement those facilities already planned in due time while stronger support and more positive intervention of the central government is required for the intermodal transportation system in the local area.

Second, the user oriented intermodal transportation service needs to be strengthened. To expand the role of the service area centered in a transportation node, an increased investment shall be made in connecting highways and railroads as well as an early introduction of an advanced operating system for efficient intermodal operation. LOS improvement of public transportation at major transit centers may be of some use to encourage private vehicle users to change into using public transportation. Improvements of an operating system which may help to increase user conveniences include a rearrangement of operating routes, optimum scheduling, establishment of an information system, and a resetting of the fare system.

Third, an inter-sector cooperative system shall be established to assure an efficient intermodal connection. It is necessary that the top level national transportation plan should be strengthened with overall coordination to control the implementation organization for the intermodal transportation system. It is also essential that the required budget be provided for implementing the intermodal transportation system as well as the management of it.

Fourth, KTX stations shall be promoted into regional transportation centers. The investment in SOC shall be based on the selective enforcement strategy to keep efficiency. Considering this principle, a strong focus shall be placed on improving the connecting transportation facilities centering around KTX and the intermodal transfer facilities there, which will eventually improve the modal interconnection and transfer function of these stations as transportation transfer nodes. It is also necessary that related laws and regulations be amended in such a way to integrate the express and intercity bus terminals with KTX stations through establishing a hierarchical route system focusing on KTX stations.

Although the National Integrated Transport System Efficiency Act prescribes the designation of major centers of transportation and physical distribution, a specific place and time for the designation solely depends on the designator. Consequently if the designator does not develop a personal interest in the designation, the designation will not be made and no improvement will follow the intermodal connection and transfer facilities. A lack of appropriated funds could also lead to the lack of improvement of the connecting transportation system. Therefore, to achieve a practical improvement of the intermodal transportation system and physical distribution center, a clause should be added to the law to force the designator to designate the center and appropriate the necessary budget to improve the intermodal transportation system. In order to increase the practicability of the intermodal transportation system there should be active measures to give incentives or impose a penalty for the achievement identified through continuous monitoring of the plan and decisions on how much the plan is to be implemented.

To do an integrated realignment of the express and intercity bus terminals, a project such as the one just mentioned need to be launched as “A Master Plan for an Integrated Realignment of the Nationwide Bus Terminals.” For such a plan to be meaningful, it shall be institutionalized by incorporation into a related law. To develop the express and intercity bus terminal as an intermodal transit complex, it is essential that the intermodal transit complex should be defined to specifically include express and intercity bus terminals and a clause should be added to the National Integrated Transport System Efficiency Act to give the licensing of terminals pursuant to the Automobile Transportation Business Act.

For the intermodal transfer system to be improved through developing an intermodal transit complex, the related law shall be amended in such a way that the government subsidy for transfer facilities should be applied in the form of a flexible rate. If a center has a poor intermodal transfer system and is not economically feasible due to high costs, it should be given a higher rate of government subsidy, allowing the center to achieve its role as a public resource.

Under the current practice of classifying the allocation of government budget, a project for the intermodal transfer system or intermodal transit complex may be difficult to be classified into any existing category of a transportation sector including air, rail, or highway. Such being the situation, it is necessary to specifically define the agency in charge of the project and budget planning. Budget appropriation is very important to practically improve an intermodal transit center. Therefore, an improvement project to connect a highway to a transfer center shall be incorporated into a separate budget item of interconnecting highways under the Highway Account and the planning of a port and physical distribution center shall also have a special appropriation under their account.

To keep improving and expanding the intermodal transfer system, the law must require to periodically establish a plan of intermodal transit centers, leading to a practical intermodal transportation system. Under the periodic plan, the central government and local governments shall present a detailed plan of implementation including the agency in charge, the implementation schedule, and the budgeting plan for each improvement project within the intermodal transit center.

The transportation improvement master plan of a local government shall be stipulated to make it a duty to evaluate the performance and supply level of the intermodal transportation system and establish improvement actions, which will raise implementation of the intermodal transit center on the local level. To support it, the central government shall re-establish government subsidy criteria for local intermodal transit centers and separately manage the annual budget execution of the intermodal transit center by local governments at the time of evaluating the mid-term transportation investment.

Lastly, a separate agency to manage the above mentioned conditions shall be newly established and exclusively manage the intermodal transportation system in general. To establish an efficient intermodal transportation system, the agency shall coordinate a variety of transportation plans established by each sector and direct the agencies to be in charge of construction and operation of the transportation facilities in such a way as to achieve an efficient intermodal transportation system. A discussion unit for concerned sectors (a committee) under the National Transportation Committee shall be installed to propel and coordinate the appropriation of a necessary budget for local transit centers.

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New Intermodal Transport Systems in Korea

The Korea Transport Institute (KOTI) is a comprehensive research institute specializing in national transport policies. As such, it has carried out numerous studies on transport policies and technologies for the Korean government.

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