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Intermodal connectivity and its impacts on HSR ridership: Seoul Station and Yongsan Station, South Korea

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Intermodal connectivity and its impacts on HSR ridership: Seoul Station and Yongsan Station, South Korea

by

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Dedication

This report is dedicated to my parent, who has supported my decision and my dream. I could not have done it without them. Thanks for their full support.

Abstract

Intermodal connectivity and its impacts on HSR ridership: Seoul Station and Yongsan Station, South Korea

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South Korea launched its first high-speed rail (HSR) system in 2004. The primary goal of developing the system was to serve the citizens with improved regional mobility. The government has also invested a large amount of capital in providing amenities and convenience to passengers for the purpose of increasing HSR ridership; improving intermodal connectivity is among the efforts taken by the government and related agencies Yet whether improved intermodal connectivity translates into increased HSR ridership remains under-documented and under-researched. . This professional report examines the question by focusing on two HSR stations in the South Koreea case: Seoul Station and Yongsan Station. This report first presents the basis information about Korean HSR and the stations. It then documents government programs pertaining to intermodal connectivity. For reference purposes, a number of international cases are also reviewed and presented. Lastly, the PR examines the relationship between intermodal connectivity and HSR ridership and offers policy recommendations aiming at increasing ridership and enhancing services.

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Chapter 1 Introduction of High Speed Rail

This research is for High Speed Rail in South Korea. Before researching for the High Speed Rail in South Korea, the general information about HSR is helpful to understand whole system of High Speed Rail. In this chapter, we would explain what is the in general definition of HSR and what is the characteristic of the HSR.

1.1 Definition of High Speed Rail

On 1 October 1964, the first high-speed rail (HSR) passenger service was launched on the Tokaido line between Tokyo and Osaka. This date marks the beginning of the modern HSR era. Since then, the HSR network has expanded, first in Japan, and later in other countries, and speeds have increased. Today, about 40 years later, the HSR is in many respects a distinct mode of transport (Givoni, 2006).

There is no single definition for high speed in the context of railway services, although the reference is always to passenger services and not to freight (Garmendia, Ribalaygua, & Ureña, 2012). High speed can relate to the infrastructure capability to support high speed (this might explain the term 'high-speed rail' (HSR), in addition to the fact that train and rail (or railway) are often used synonymously), the rolling stock capability to achieve high speed or the actual operation speed achieved. The European Union (EU) definition, given in Directive 96/48 (European Commission, 1996a), is 250 kph for dedicated new lines and 200 kph for upgraded lines in respect of the infrastructure capabilities. The same applies to the rolling stock (on specially built and upgraded lines, respectively). With some HSRs operating at speeds of 350 kph, 200 kph

might not seem high speed anymore.

High-speed railroad is divided into two categories. One is Wheel-On-Rail that runs on railroad using wheels as existing trains and the other is Magnetic Levitation that rises up on the railroad using magnetic attraction-resistance. The Wheel-On-Rail train was thought to be running at 330km/h maximum due to adhesive power limit, but France has succeeded test run of 513.3km/h at Southern railroad of Dae-Sung Yang-Sun Vendome section in May 1990, and is in constant development progress since then.

1.2 WHY WE NEED TO INVEST IN THE HIGH SPEED RAIL SYSTEM

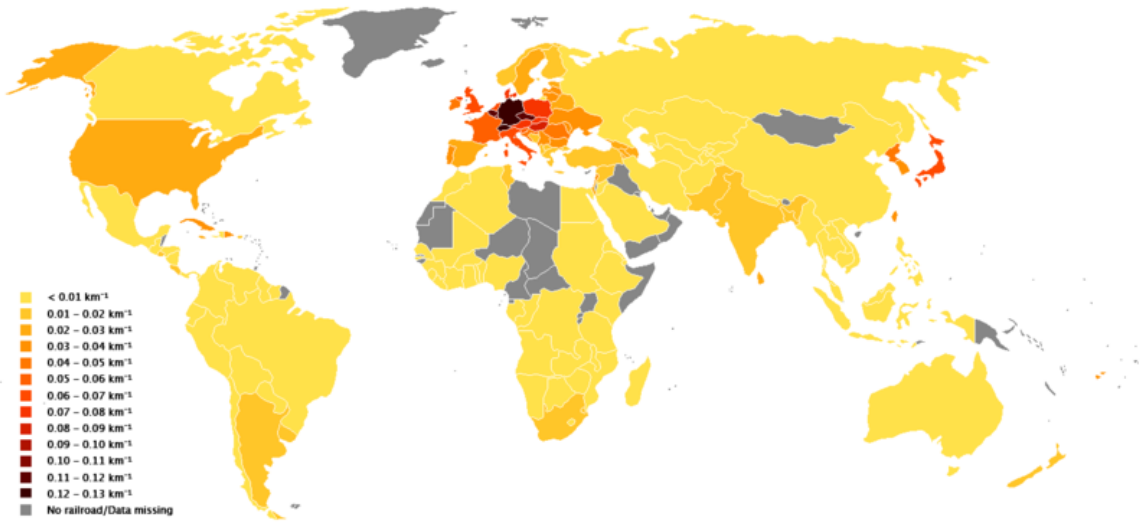
The total track length of the Korean rail system is 3,390 km (Kim, Shin, & Park, 2012). Compared to the total track length in the 1960s, which was 3,022 km, the rail system has merely increased approximately 370 km in fifty years. By contrast, North Korea has expanded its total rail system to 5,235 km of track (H. Kim, Shin, & Chung, 2011).

On the contrary, South Korea has more than tripled its regional roads for automobiles from 27,169 km to 99,325 km, and its highways from 313 km to 2,968 km, an expansion of more than 9 times the earlier distance (K. Kim et al., 2012). Thus, South Korea's transportation infrastructure has concentrated on cars and has relatively unsatisfied needed investments in railroads. The rail system has occupied less 10% of the total modal split, which would indicate railroads are a minor transit mode in the overall transit system. The South Korean government has adopted a road-oriented transportation policy causing rail transit to occupy a small portion of the category of modal split. Rail

traffic remains at about the same level as before the reformation of the railway system in 2003: about 8.2% of passengers (roadways: 76%) and 6.2% of freight (Sung & Oh, 2011).

The roadway transit modal split has fluctuated with oil costs, which affect the cost of operation for automobiles. In addition, the number of registered automobiles is steadily increasing and traffic congestion has been produced as a result of the increase in car ownership. Traffic and other socioeconomic costs have gradually risen, demonstrating the limitations of roadway transportation.

Since 1990, Japan and the major countries of the European Union (EU) have changed their paradigms of transportation policy from road-oriented to railway systems. For example the EU has planned the Trans-European Transport Network and executed approximately 22 projects for railway systems. The countries of the EU have transformed their transportation policy systems to expand investment for railways (Criqui & Mima, 2012). The major reason for this policy transformation is the high rise in oil prices; these governments faced profound energy needs. The major reason for this policy transformation is the high rise in oil prices; these governments faced profound energy needs.



Source: KEI 2010 Environment Analysis Report

Figure 1: World Rail Density Map

A research report by the Korea Environment Institute (KEI) has compared the social costs of road and rail at two periods: 2000 and 2010. The costs for road traffic are 3.1 times higher than rail systems in terms of air pollution, 3.6 times higher for greenhouse gases, 2.1 times higher in noise, and 646 times higher in terms of traffic accidents.

In addition, in 2010, the total cost was 50 times higher than railways. With these additional real costs in mind, the rail system is more cost efficient than road transportation. The changing trend of transportation policy in other nations is therefore

reasonable in consideration of socio-economic capital (Jin-kyung Lee & Ph, 2008).

	Air Pollution		Green house Gas		Noise		Land Use		Traffic Accident		Congestion fee		Total	
	Roa D	Rail	Road	Rail	Road	Rail	Road	Rail	Road	Rail	Roa d	Rail	Road	Rail
2000	1133	29.9	575	12.5	187	6.77	899	69.5	917	0.11	1125	0	4839	117
2010	964	17.9	545	11.5	344	8.97	1455	80.4	523	0.03	1737	0	5591	118

Source: KEI 2010 Environment Analysis Report

Table 1: Compared Social Cost between Road Traffic and Rail

Additionally, research by the Korean Railroad Technology Institute reviewed the energy consumption difference between rail transportation and road transportation. They found that if the energy consumption of rail transportation is 1, the energy consumption of bus will be 5.5 and taxis will be 15.7. If the same amount of freight will be conveyed by road, the energy consumption will be 15.8 times higher than the railway (Criqui & Mima, 2012)

	Mode	Consumption	Ratio with Rail
Passenger	Rail	76.0	-
	Bus	415.4	5.5
	Taxi	1192.2	15.7
Freight	Rail	106.0	-
	Road	1674.2	15.8

Source: KEI 2010 Environment Analysis Report

Table 2: Energy Consumption of Each Mode

Global climate change has emerged as a significant current issue. The greenhouse gas emissions of road vehicles are approximately 80 times higher than railway systems.

As a result, in investing in railway systems should become a major element of transportation policy. This tendency will reduce the socioeconomic costs of transportation.

1.3 HIGH SPEED RAIL CASES IN THE WORLD

1.3.1 Japan

Figure 2: Sinkansen Line Map

The *Shinkansen* ,literally means *new trunk line*, referring to the high-speed rail line network, is the most well-known high speed rail system in the world (Utsunomiya & Hodota, 2011). The system have served rail transit since 1964 started with the Tokaido

Shinkansen (515.4 km) . A network of high-speed railway lines in Japan operated by four Japan Railways Group companies. Present links most major cities on the islands of Honshu and Kyushu, with construction of a link to the northern island of Hokkaido underway. Speed characteristic is that the maximum operating speed is 320 km/h.

The Tōkaidō Shinkansen is the world's busiest high-speed rail line. Ridership is shown as 151 million passengers per year, this number has presented larger than any other high-speed rail line in the world. In general, the Shinkansen is regarded as a long-distance transport system, different from the general perspective about high-speed rail, the Shinkansen also provides appropriate line for commuters who generate daily trip to work in metropolitan areas from suburban area (Givoni, 2006).

1.3.2 Taiwan

Figure 3: Taiwan High Speed Rail Line Map

Taiwan's high-speed rail (HSR) started in early 2007 (Cheng, 2010). The system has eight stations in seven metropolitan area in Taiwan. The high-speed rail line runs parallel to the pre-existing west-coast railroad line. The new 90-minute Taipei–Kaohsiung HSR service thus compares with the existing regular long-distance service that takes about 4.5 hours. During the Japanese colonial period, investments in the old railroad network in the early twentieth century changed Taipei's form and structure. The visible features of construction are related to accessibility on the regional level and the

highest land prices shifted from ports and harbors to the areas around rail stations (Emanuel & Oliver, 2012).

The new HSR line has imported technical tools, methods, and hardware from Japan's *Shinkansen* line. The traffic management system, including traffic signals for the HSR and the scheduling process are supplied by a TGV and ICE system. Financial costs were about US $15 billion; this was the most expensive build–operate–transfer project in the world, and amounted to about 5% of Taiwan's annual gross domestic product.

The HSR stations in the Taipei metropolitan area, Taipei and Banciao, are collocated with major railroad stations and transit interchanges, but the other five stations are situated near suburban railroad (TRA) stations or on suburban greenfield or brownfield land. Two of these new station locations, Taoyuan and Tainan, would seem to defy economic common sense. It is likely the locations of these two stations were determined as the direct outcome of political bargaining among local interest groups. While the locations were justified as key assets for new town development, there has so far been less interest in developing these areas than in downtown redevelopment (Cheng, 2010).

1.3.3 France

France's high-speed rail had been named TGV, operated by SNCF Voyages, the long-distance rail branch of SNCF, the national rail operator (Leheis, 2012).

Figure 4: France Rail Line Map

In 1981 following the HSR service between Paris and Lyon on the *LGV Sud-Est* (LGV (French: *Ligne à Grande Vitesse*, high-speed line)), the network, centered on Paris, has expanded the service that focused on to connect many cities across France and in adjacent countries on both high-speed and conventional lines.

In 2011, operated TGV trains had shown at the highest speeds in conventional train service in the world, the average speed reaching 320 km/h (200 mph) on the LGV Est and the LGV Méditerranée (Leheis, 2012) .

When TGV had invested the large amount of money to the HSR service, neighboring countries such as Belgium, Italy, Spain and Germany had built their own high-speed lines. Nowadays, TGVs link with Switzerland, Italy, Germany and Belgium; with Belgium, Germany and the Eurostar network links France and Belgium with the United Kingdom. Several lines are planned, including extensions within France and to surrounding countries. Cities such as Tours have become part of a "TGV commuter belt" around Paris.

In 1976 the French government funded the TGV project, and construction of the LGV Sud-Est, the first high-speed line (French: *ligne à grande vitesse*), began shortly afterwards. The line was given the designation LN1, *Ligne Nouvelle 1*, (New Line 1).

Chapter 2 Comprehensive Research for KTX

2.1 Introduction of KTX

Figure 5: Rail Road Map in South Korea

South Korea operates High-speed rail service since 2004. Eventually, South Korea could be joined the file of high-speed railroad countries. Established High-speed railroad usually speeds 200km/h, which service type is not for private firm factor. High-speed railroad business is considered as the largest government business in South Korea (Jang-ho Lee & Chang, 2004).

The high-speed railroad would provide dramatic movement for the people who are scattered around different cities great that is to connect the whole South Korea within 2 hours life zone based on faster speed compared with before starting the high-speed rail

service within South Korea. For example, from Seoul to Busan KTX has taken 2hours and 40 minutes, in contrast common train had taken over than 4 hours. From Seoul to Mokpo, KTX has taken 2 hours and 58 minutes; the common train had taken about 5 hours.

Korean high-speed railroad is actually designed to speed 350km/h and operated at 300km/h maximum for safety. The system is operated by high-pressure electricity of 25,000 volts, and high-speed vehicle receives this energy with pulling power of 13,560kw and electric damping of 300KN (Kilo-Newton).

2.2 Problems and Potential Risk of KTX

Korea's high-speed train system, KTX, is generally the fastest transportation mode for passengers. KTX is more competitive than other transportation modes in terms of cost-efficiency and time consumption. The map below illustrates a comparison of time required for KTX and automobile transport. KTX saves time. Except for Gwang Ju, if the passenger selects an automobile for transit, the time to travel from Seoul to every destination takes approximately twice as long as KTX. Despite this result, many travelers choose the automobile (Chang & Lee, 2008).

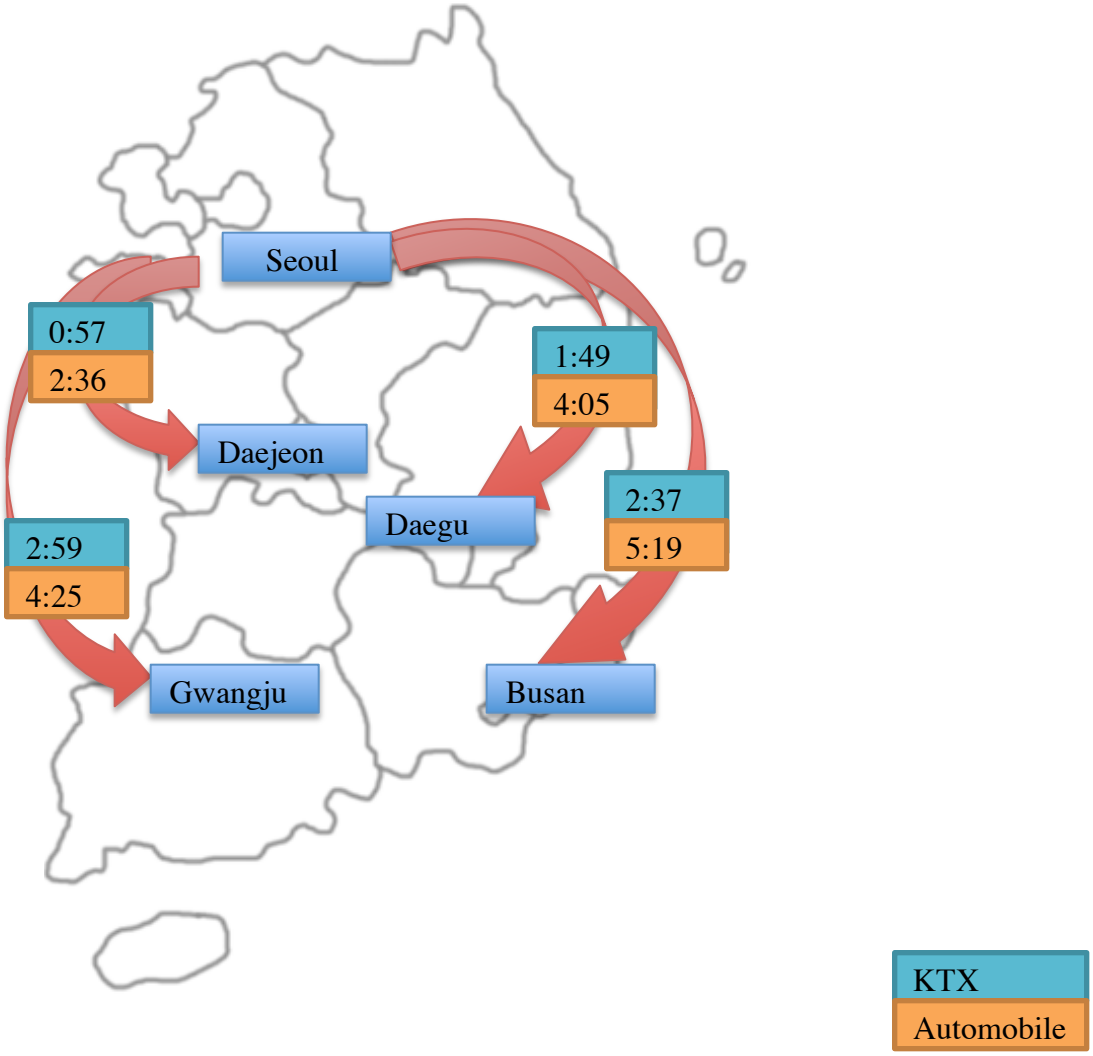


Figure 6: Time Consumption for KTX and Automobile Travel from Seoul

Figure 7 is based on a study of long-distance transit (Kwon, 2012). The chart explains why passengers select the automobile for major transit. The largest number of passengers answered that if they take the KTX; they face inconvenience at the final destination. Accessibility in the final destination is determined by the transit mode taken. The other negative opinion was about accessibility from home to the station. Generally,

people tend to include calculate travel time to and from the KTX station in addition to the KTX travel. This has caused passengers to think the automobile is faster than KTX (Jin-kyung Lee & Ph, 2008).

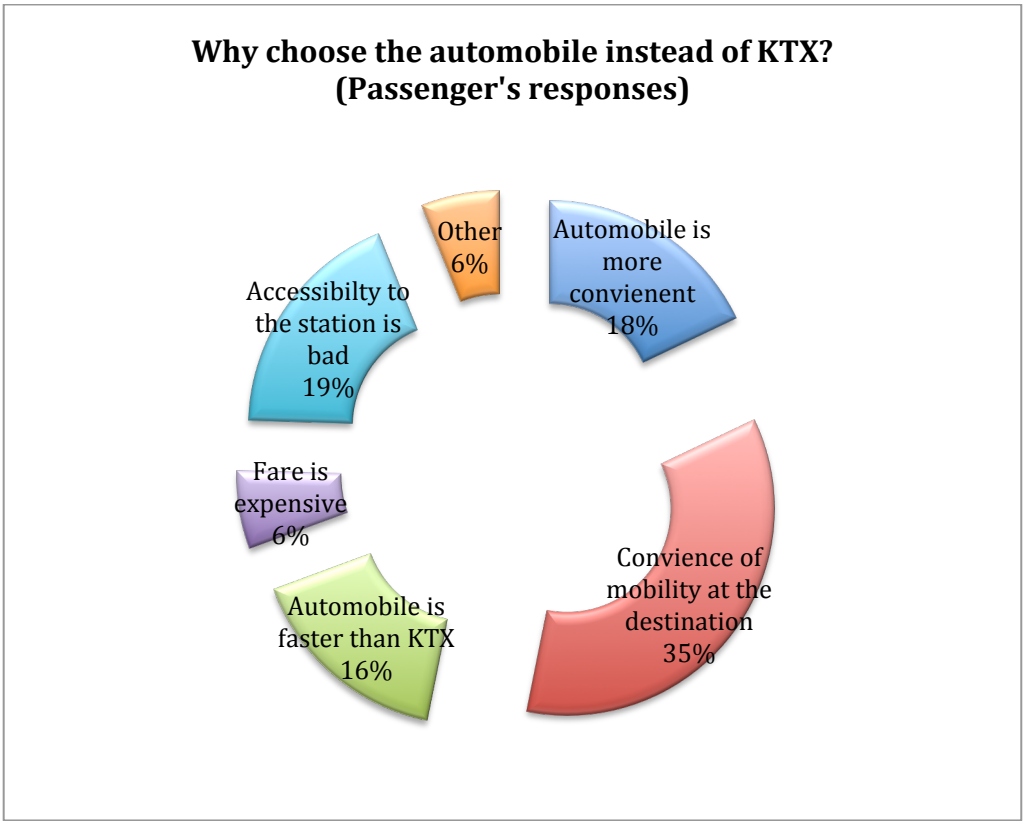


Figure 7: The Reason for Selecting Automobile Rather than KTX

Figure 7 below shows what the HSR system needs to do to increase ridership. The results originated from a passengers' survey organized by Korail (the South Korean national rail firm). Most passengers claimed that the current HSR system shows a lack of interconnectivity with mass transit; therefore interconnectivity is the most important factor to determine the transit mode for potential passengers. The other factor is the fare system. The potential passengers compare the travel cost between automobile and KTX;

the problem is that current fare system is does not induce potential passengers to shift from automobiles.

Passengers who take mass transit to arrive at the HSR station must transfer to the other transportation mode. This means the transfer system will play a role in the passenger's decision whether to selects KTX or an automobile. The automobile offers door-to-door service; KTX does not. Increasing HSR speed is not enough to attract potential passengers from the automobile; even with higher speed trains, the system cannot reduce the home-to-destination travel time without improving its interconnectivity with mass transit (Choi, Lee, Kim, & Sohn, 2011).

In conclusion, the government and planners would need to consider the factors mentioned above. Even though there are many benefits from the HSR system, system needs to improve before more passengers will choose to experience the direct advantages of the HSR system.

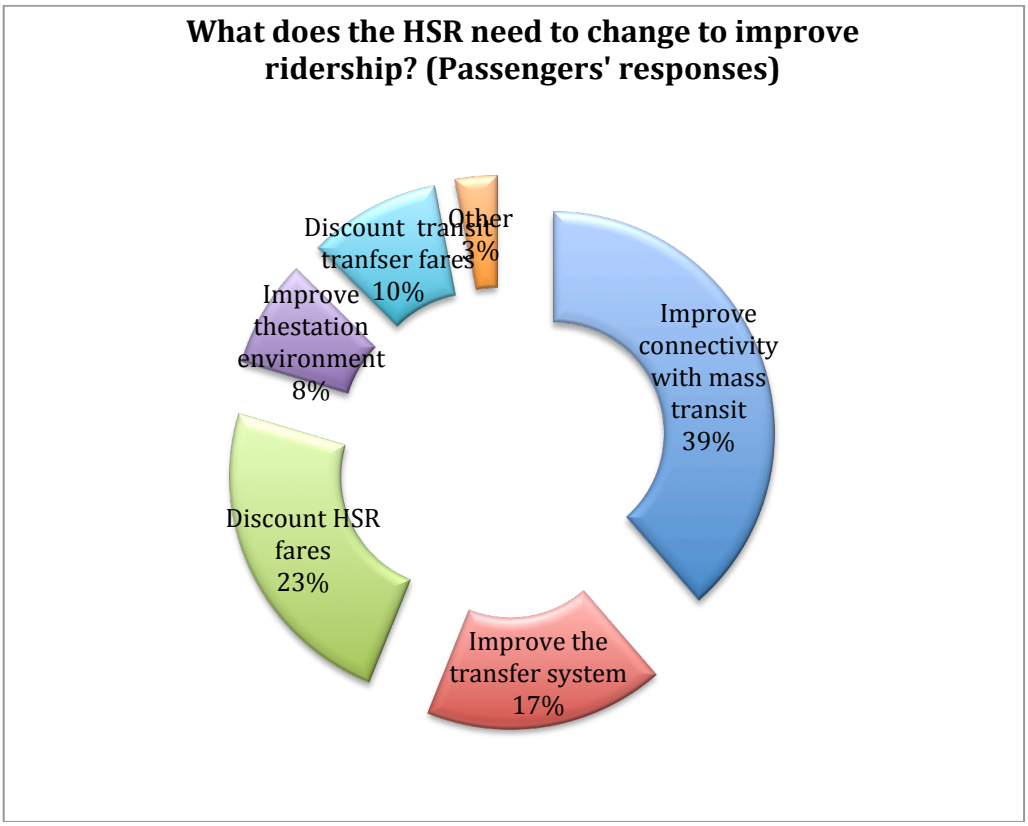


Figure 8: Ways to Improve Ridership

Chapter 3 Interconnectivity between HSR and Mass Transit

3.1 Definition of Interconnectivity System

An interconnectivity system addresses the degree of connectivity among rail, bus, taxi, automobile, and bicycle modes. The transfer system explains the transfer behavior to change the transit mode. Therefore, the subject of interconnectivity is the transit mode; in contrast, the entity of the transfer system is the passengers who use mass transit (Guo & Wilson, 2007).

Transfer facilities are generally divided into the following functions, defined by the convenience of passengers: train stations, subway stations, bus stops, long-distance bus stops and freight terminals (Iseki & Taylor, 2009). A transfer facility would be classified by the type of inter-transit mode and demanded facilities: transfer parking lot, transfer center, transfer terminal, and transfer stops. In the micro meaning of transfer system, a system contains elevators, escalators, and vertical and horizontal moving facilities. Additionally, bicycle parking, pedestrian roads, rest rooms, and waiting rooms would be involved in a transfer facility.

The ideal transfer system would minimize the travel time from the place of departure to the final destination through a well-organized mass transit system and schedule that would allow service at a level similar to that of an automobile (Cervero & Radisch, 1996). Train stations, bus terminals, transfer parking lots and vertical and horizontal moving methods, organically connected, would provide a satisfying service level to passengers who use the transfer facility. This sort of transfer system will provide faster and safer travel in a more comfortable atmosphere for the passenger. These benefits will promote transfer frequency among the different transit modes.

3.2 DEFINITION OF TRANSFER BEHAVIOR

Transfer behavior is entirely categorized by trains, commuter rail, and buses, which are methods of mass transit, and the automobile and bicycle, which are "semi-mass transit." Based on the transit mode, the transfer system is not merely divided into the necessary transfer facilities; it also distinguishes transfer features by the degree of service (Iseki & Taylor, 2009). Representative ways to transfer among the mass transit modes include subway to commuter rail, subway to subway, commuter rail to bus, commuter rail to taxi, subway to bus, and bus to bus.

The transfer behavior, again, refers to the countless way connecting systems have become more specified. The mass transit system in Korea is improving in this regard. The facilities necessary for HSR include ticket booths, moving walkways for connecting with the terminal, and the inner space of the station, and signs for passengers' convenience. In addition, an HSR station has waiting areas and spaces for improving passengers' convenience. Those factors are important to determine the level of the HSR service. The transfer facilities at most HSR stations are related to the bus system and include bus stops, corridors for transfer, and direction signs to present information about the connecting buses.

3.3 Case Studies for Interconnectivity System of High Speed Rail Station

3.3.1 Japan: Shinjuku Station

Shinjuku Station, located between Sinjuku province and Sibuya Province in Tokyo, is a multiplex station. Six lines pass through the station: the JR Yamanote line, JR Chuo line, JR Saikyo line, JR Shonan-Shinjuku line, Odakyu line, and the Keio Train. Ridership for the JR line per day is 1,570,000 people and the total ridership per day is 3,640,000, which is representative of the largest station ridership in the world (Zacharias, Zhang, & Nakajima, 2011).

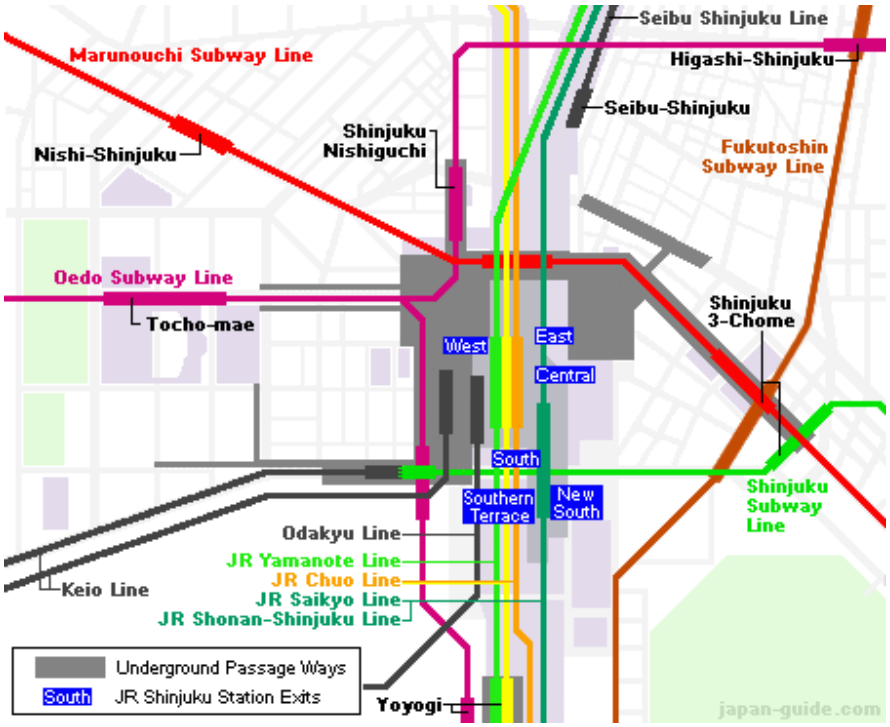


Figure 9: Shinjuku Station with passed lanes

This station is the main station for HSR in Japan. If Shinkansen passengers want to go outside, the station has more than 200 entrances. The East entrance is connected with the main hall in the station, which has various underground retail shops. The East

entrance serves as the corridor for transferring to Marunouchi subway and also has three stairways to the ground level (Zacharias et al., 2011). The area around the East entrance has escalators and stairways to help passengers transfer to other transit modes.

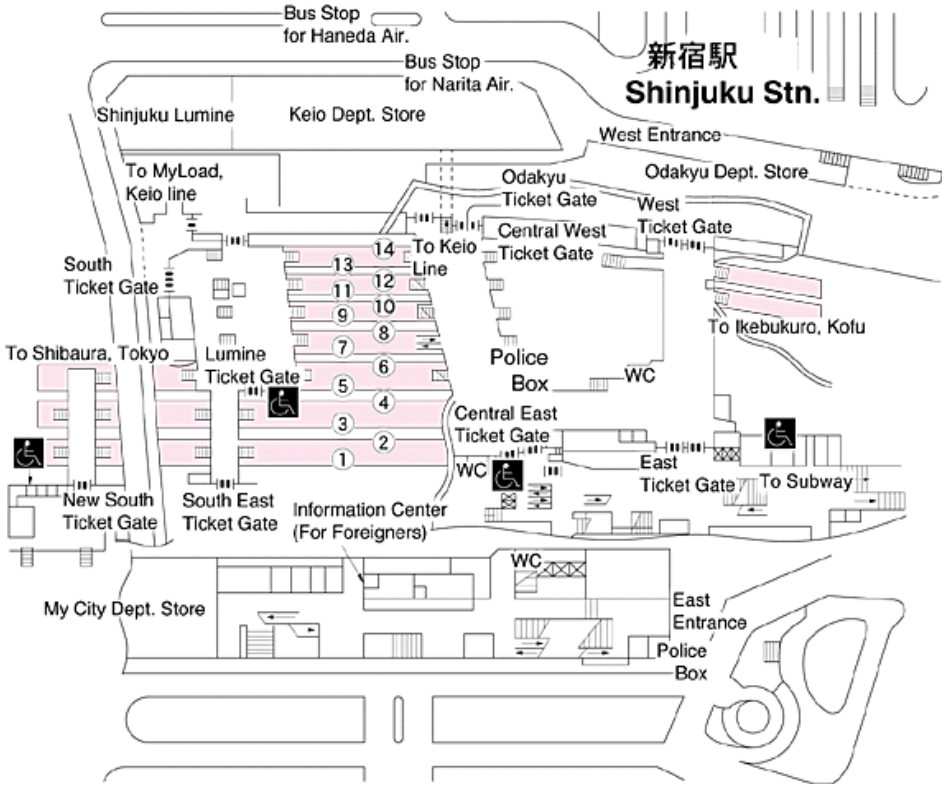


Figure10: Shinjuku Station Floor Plan

Passing through the JR line gate, the right part of the corridor serves the transfer system to the Shinjuku Station of the Marunouchi and Oeido lines. The left part of the corridor has retail shops and also transfers to Odakyu and Keio subway stations. Even the underground level is associated with the ground level of the road and taxi platform as part of the transfer facility. Additionally, the western entrance of the hall has a connecting corridor to the ground level, and is helpful for transferring to buses and long-distance buses because of its bus stops.

Illustration1: Lumine Department Store in Shinjuku Station

The Lumine gate is different from the others. The Lumine department store is connected with this gate, which could be associated with shopping behavior for passengers. Lumine is owned by JR East and located both next to and above Shinjuku Station's South and East Exits. Lumine is divided into "Lumine 1" and "Lumine 2" on either side of the South Exit and "Lumine East" (formerly known as "My City") above the East Exit.

If the passenger uses the Southern gate, Goshu Road is across the way. The New Southern gate and Southern Terrace gates provide a transfer system to the Tokyo government complex. This place has other available transfers to other transit modes: taxis and long distance buses. The Southern gate also has platforms for the Odakyu, Keio, and Oeido lines.

As a result, the Shinjuku Station has a mean transfer distance less than 100 m from the HSR gate to other kinds of transit: private rails, subways, buses, taxis, and bicycles. The short transfer distance helps HSR passengers to arrive at their proposed destinations. The transfer system of Shinjuku Station also involves recreation and entertainment facilities for passengers. Shinjuku Station has considered HSR passengers' desire for short transfer distances and several places to spend time while waiting. This environment gives great convenience to HSR and other transit mode passengers, as well as pedestrians who pass through the Shinjuku Station.

3.3.2 France: Paris Nord Station

Illustration 2: Paris Nord Station

Paris Nord Station in France is the most important station in any European country in terms of ridership and connecting transfer systems. Ridership per day is approximately 480,000. Ridership per year is over 1,800,000.

Paris Nord Station was redeveloped in 2001; the construction period was about four years. This construction project received financial support from SNCF and Paris RATP and the Paris Metropolitan Administration managed the finances. This station is the most representative case from France as an improvement project for a connecting transfer system. The station includes connections to HSR, long-distance rail, commuter rail to northern suburbs of Paris, Paris Metropolitan Rapid Rail (RER), the Paris Metropolitan subway line and various bus lines.

This station features associated with the transfer system include moving walkways, moving corridors, escalators and improved facilities for handicapped persons. Additionally, the Paris Nord station has unified spaces managed by different public

transit companies: RATP and SNCF. Subsequently, the unification of space has reduced transfer distances between different transit modes. Furthermore, the station designers have worked toward an optimized lighting system, efficient CCTV, and to making a great atmosphere for waiting through the interior layout, colors, and convenience stores for passengers. To improve the environment of the inner space of the station, they constructed a transparent glass ceiling as well as a comprehensive information system for passengers.

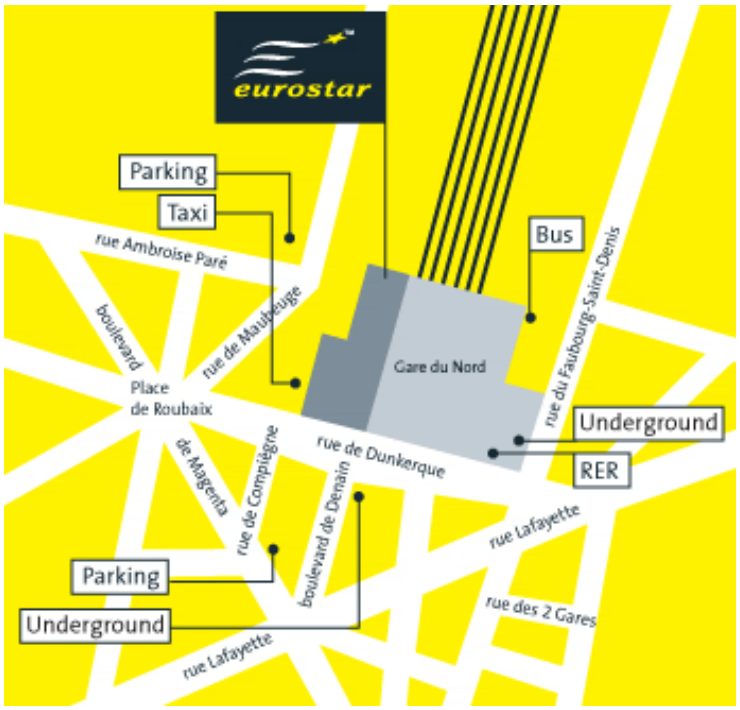


Illustration 3: Paris Nord Station Map

The connection system of this station includes three different subway lines: lines 2, 4, and 5. In addition, the station has service for regional Rapid Train lines B, D and E, which connect Paris Nord directly with central Paris, a sub-center of Paris, suburban areas and the airport. The transfer system also includes four bus lines with stops located

in front of the station to connect to the main districts of Paris. Passengers who are strangers to Paris and the Nord Station can find bus stop locations easily. The transfer system even extends to the parking lot, which uses a one-way system for comfortable access.

This transfer system between HSR, long-distance rail, buses, and subways has a mean transfer time of approximately 5 to 15 minutes. The mean time is optimized to passengers who take HSR. The most important way that Paris Nord improved transfers and passenger convenience was by creating a pedestrian-friendly environment. This improvement puts the priority on the pedestrian rather than the automobile or other types of transit. This priority is reflected in the development of a passage way only for pedestrians. For the convenience of passengers, the administration also announced that elevators are mandatory in HSR stations.

This new concept of construction makes smooth and rapid transfer from HSR to different mass transit modes possible.

In conclusion, Paris Nord Station has focused on increasing the convenience of HSR passengers through reducing transfer times. The government's goals for the HSR development led to a redevelopment project to add various types of facilities in the station. Subsequently, the station is a great environment for HSR passengers.

Chapter 4 Transfer System for KTX Station:

Seoul Station and Yong San Station

The KTX system is comprised of 38 stations at this point; the metropolitan area of Seoul and Kyeong-gi do has six stations: Seoul Station, Yeongdeungpo Station, Yongsan Station, Hangsin Station, Gwangmyeong Station and Suwon Station. Among these stations, Seoul and Yongsan Station are included in the administrative district of Seoul. These two stations are representative KTX stations that opened with the commencement of the KTX service in Korea. The two tables below show the arrival and departure ridership numbers of the six metropolitan stations from 2005 to 2010. Yeongdeugpo and Suwon Station have provided service since 2009 (Jang-ho Lee & Chang, 2004).

	Arrivals			
Station Name	**2005**	**2008**	**2009**	**2010**
Seoul	9,034,481	9,810,570	10,717,505	11,986,791
Yongsan	1,872,247	2,081,766	2,149,478	1,742,653
Haengsin	143,026	190578	228,612	228,496
Yeongdeungpo	N/A	N/A	12,854	78,381
Suwon	N/A	N/A	88,072	533,458
Gwangmyeong	1,829,181	2,658,308	2,895,466	2,649,387

Table 3: Arrivals Ridership of Metropolitan KTX Stations

	Departures			
Station Name	**2005**	**2008**	**2009**	**2010**
Seoul	9,356,536	10283246	11,049,839	12,158,744
Yongsan	2,124,944	2246855	2,273,620	1,882,758
Haengsin	132,890	167118	198,581	218,456
Yeongdeungpo	N/A	N/A	9,706	57,556
Suwon	N/A	N/A	85,620	497,875
Gwangmyeong	1,772,727	2685960	2,936,244	2,696,056

Table 4: Departure of Ridership of Metropolitan KTX stations

Seoul Station has the largest ridership in both regards, and these numbers have increased over time. In contrast, the Yongsan Station is only station to decline in ridership. In 2005, Yongsan Station had the second-largest ridership, but that ridership has been decreasing. This raises a question about what problem or problems have caused this decline (Chou & Kim, 2009).

Following these results, this report will focus on two targeted stations: Seoul Station and Yongsan Station. These two representative stations in Korea have tried to improve interconnectivity with KTX and mass transit to increase ridership. The two stations embody a green transportation environment dominated by eco-friendly transit; their uniqueness is the reason this report will focus on them instead of the other stations.

This chapter has the three sections, each a part of the analysis of the transfer system. The first describes the subway and rail transfer system with KTX. The subway and rail system is a popular transportation mode for Seoul's citizens and commuters from surrounding suburban areas. The second examines the bus transfer system. Seoul adopted a rapid bus system for faster and more comfortable travel. The third evaluates the

pedestrian environment. The pedestrian environment also includes promoting the transfer system for passengers.

4.1 INTRODUCTION FOR SEOUL STATION

Illustration 4: Seoul Station

Seoul Station is a main entry to Seoul; its daily ridership is 90,000 people, excluding travel in the underground levels. The station opened in 1900 as Kyeong Sung Station. In 1946, the station was renamed Seoul Station. In 1980, the station was designated a regional heritage site. This historical value is significant to Seoul Station. Its total land area is 260,9095 m², and total building floor area is 95.172 m². The station has two underground levels and five stories above ground (Chang & Lee, 2008)

Facility	Numbers
Subway Elevators	5
Escalators	21
Moving Walkways	5
Parking Lots	Spaces for 813 automobiles
Department Stores	2

Table 5: Facilities for Passengers in Seoul Station

The transit system is the most representative feature of the Seoul Station. The station serves as the predominant transit system for the KTX and is the primary terminus for the KTX and express services to Busan. The station also provides a dozen trains per day on the Honam line to Gwangju and Mokpo, and is the terminus for all long-distance trains on the Gyeongbu, Honam, Jeolla, and Janghang Lines. The station has express train service to Gimpo Airport and Incheon International Airport. Seoul metro rail Lines 1 and 4 pass through Seoul Station (S. Lee, Lee, Park, & Lee, 2010).

4.2 Introduction for Yongsan Station

Illustration 5: Yongsan Station

Yongsan Station is a major railway station in Seoul, South Korea, located in Yongsan District. The station offers high-speed and long-distance train services, including most trains on the Honam Line and all trains on the Janghang and Jeolla Lines. In 2004, the station opened KTX service taking over some of Seoul Station's services (Chang & Lee, 2008).

Facility	Numbers
Subway Elevators	10
Escalators	27
Moving Walkways	8
Parking Lots	Spaces for 2,140 automobiles
Department Stores	2

Table 6: Facilities for Passengers in Yongsan Station

Yongsan Station also provides also train services by metro rail on Line 1 and the Jungang Line on the Seoul Metropolitan Subway.

4.3 Subway Transfer System for KTX Stations: Seoul Station and Yong San Station

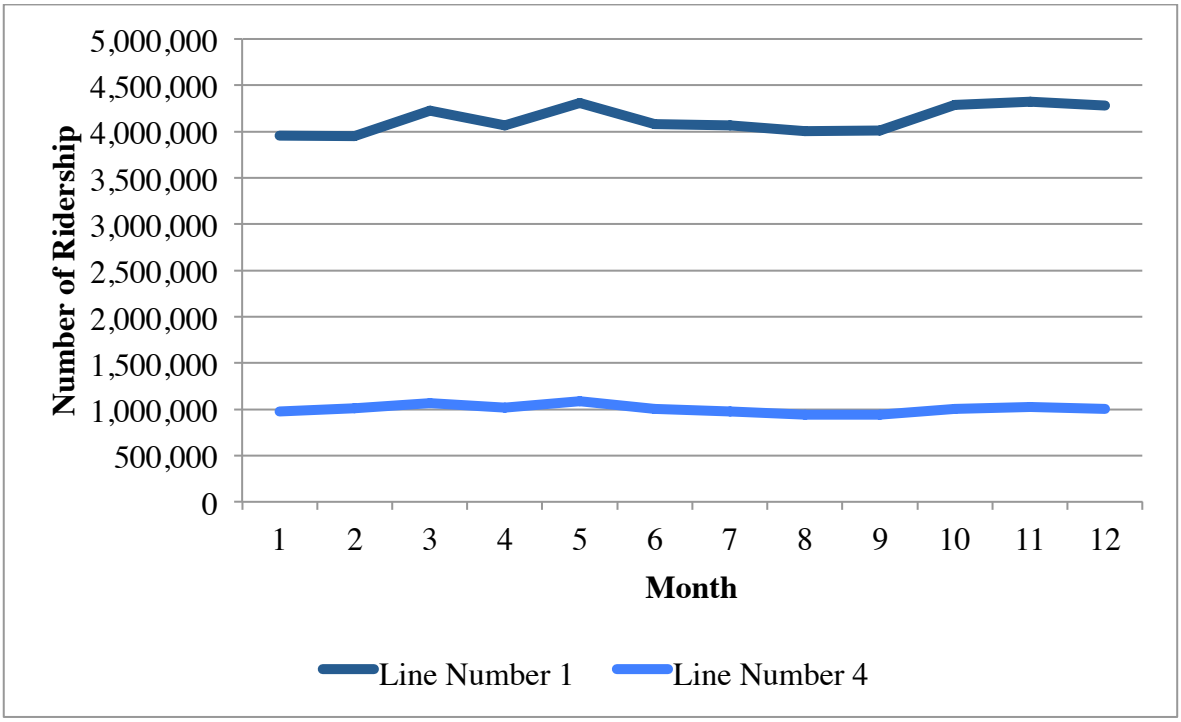
This section will review the subway systems around these KTX stations. We will explain how the KTX station and subway stations connect. We will also list the ridership data for each subway line and rail line to reveal the character of the ridership and the transfer system for each line of the subway and KTX stations.

4.3.1 Seoul Station Subway Transfer System

Figure11: Current Seoul Station Subway Transfer Map

KTX Seoul Station has two different subway lines: Line 1 and Line 4. In addition, the station has a commuter line (the Center Line) that connects with the suburbs around the north of Kyeonggi do. The Airport Express Line also passes through Seoul Station and is the most convenient transit mode from Seoul to Incheon International Airport.

Line 1 at Seoul Station has the largest subway ridership in Seoul. The table below list the subway ridership by the month. Line 1 has significantly more riders than Line 4. Annual ridership is as follows: Line 1 has 49,565,718 passengers; Line 4 has 12,054,755; the Center Line has 4,218,348 passengers (Korail, 2010).



Source: Korail 2010 Ridership Report

Figure 12: Number of Ridership for Seoul Station Subway ;Line 1and 4

Line 1 is the closest to the KTX station. By comparison, Line 4 is quite far from the KTX station gate. If the KTX passengers want to transfer to Line 4, they must move

200 m more than for Line 1(Sohn & Shim, 2010). The Center Line and the Airport Express Line share the same gate with the KTX, so KTX passengers using either of those lines would not need to get out of the KTX station and could transfer at the same gate.

To understand the transfer environment, gate location and the amenities within the station are also important factors. Line 1 has 39 gates within the station, three entrances for subway passengers and nine entrances that connect with the ground level. Additionally, the transfer corridor with the KTX station has six escalators: three going up and three going down. There is a transfer corridor between Lines 1 and 4.

The public meeting space in the Line 1 station has 10,335 m^2. The other public meeting space inside the gates is 2,080 m^2. Amenities for handicapped person and elderly in this station include a lift for handicapped people located in the directions of Seodaemoon and Namdaemoon.

Underground Line 4 has 26 gates within the station, 2 entrances just for passengers and four exits to the ground level. The public meeting space inside the station for Line 4 passengers is 5,833 m^2; the meeting space located inside the gates is 2,867 m^2. Here there are no lifts for handicapped people.

The subway operation frequency is different from the line numbers. As seen in the table below, subway Line 1 has the most frequent train service. Frequency should reflect an attempt to mitigate the waiting time, so in this case the added frequency of trains on Line 1 should help avoid passengers on that line from spend more time waiting than passengers on Line 4.

Subway Line	Weekday	Saturday	Sunday
Line number1	600	590	452
Line number 4	289	288	233

Source: Korail 2010 Ridership Report

Table 7: Subway Line 1 and 4 Operation Frequency

4.3.2 Yongsan Station Subway Transfer System

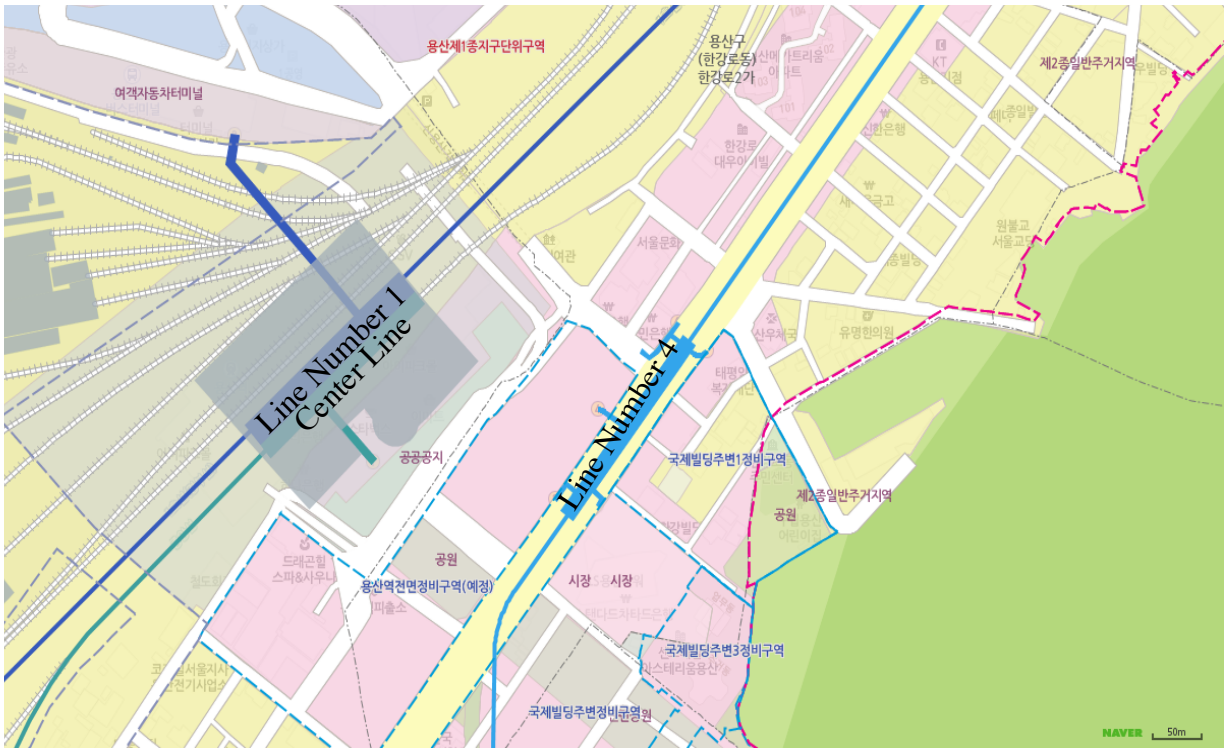
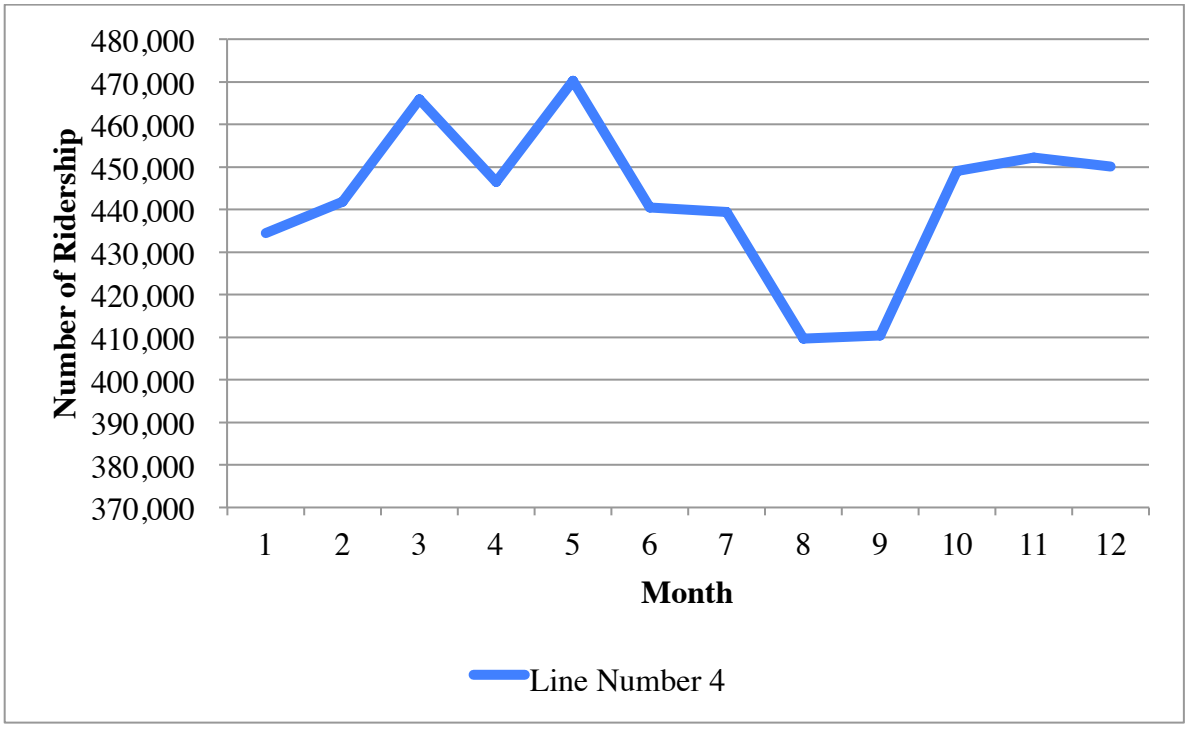


Figure 13: Current Yongsan Station Subway Transfer Map

Yongsan Station has three different rail lines: Line 1, Line 4, and the Center Line. Yongsan Station and Seoul Station are geographically adjacent, so both stations share the

same subway lines, except for the Airport Express Line(Sohn & Shim, 2010). Line 1 and the Center Line use the same station name, "Yongsan Station," but Line 4 uses a different station name, "Sin Yongsan Station." The Yongsan Station, which serves the KTX line, Line 1 and the Center Line, is not connected to the "Sin Yongsan Station" with a corridor for passengers who want to transfer, although the two stations are part of the same complex. As a result, passengers who want to take Line 4 must exit Yongsan Station; this transfer environment causes inconveniences for passengers.

The types of passengers for the various lines from this complex are not as uniform. In general, Lines 1 and 4 are used by daily commuters who work in the CBD area. The Center Line is not.



Source: Korail 2010 Ridership Report

Figure 14: Number of Ridership for Yongsan Station Subway :Line 4

The above chart represents the number of ridership for Sin Yongsan station. The Seoul Station has approximately twice as many riders as Sin Yongsan on Line 4. Line 1 and the center line share the same gate in the station, so it is not possible to separate the ridership for each line. The ridership of both lines combined was 33,499,321 in 2012. This total ridership of the two lines is smaller than the total ridership for Line 1 at Seoul Station. Thus, the annual ridership for Yongsan Station is relatively lower than the Seoul Station.

Yongsan Station has 12 gates and 2 entrances. Sin Yongsan Station for Line 4 is approximately 400 m from the KTX station, so passengers have an additional travel time of 5 minutes. The most visible inconvenience is that these passengers must use a crosswalk, which causes a discontinuous trip.

4.4 BUS TRANSFER SYSTEM FOR KTX STATIONS: SEOUL STATION AND YONG SAN STATION

This section will describe the bus transfer system around these two different KTX stations. Both stations contain numerous bus stops within a 500 m buffer zone. This feature has served to connect the station to the various districts within Seoul, even suburban areas. Seoul adopted a bus rapid line to promote the satisfaction of passengers who take buses (Cervero & Kang, 2011). This section presents the location of bus stops and ridership for each stop. Additionally, it describes the representative features about the bus stops that would help the transfer conditions around the KTX stations.

The HSR system has expanded the interconnectivity between the KTX stations and bus stops. The government has placed a priority on bus use and has targeted establishing a better bus transfer system(Jun, 2012). The basic direction for solving the problem is to expand the bus operation frequency and build a bus information system for passengers. In addition, the bus bay is designed to make a more comfortable environment for passengers than before.

The subway system demands more capital for changes to the system, compared to the bus stops. This is one of the most important reasons why the government and researchers emphasize busing to transform the existing transfer environment.

4.4.1 Seoul Station Bus Transfer System

Figure 15: Current Bus Transfer System for Seoul station Map

Within a 500 m buffer zone, there are 39 bus stops. The area has the largest number of bus stops of any section of the city. These bus stops tend to cluster on Seoul Station and Namdaemoon, which is the most prestigious heritage site in Korea.

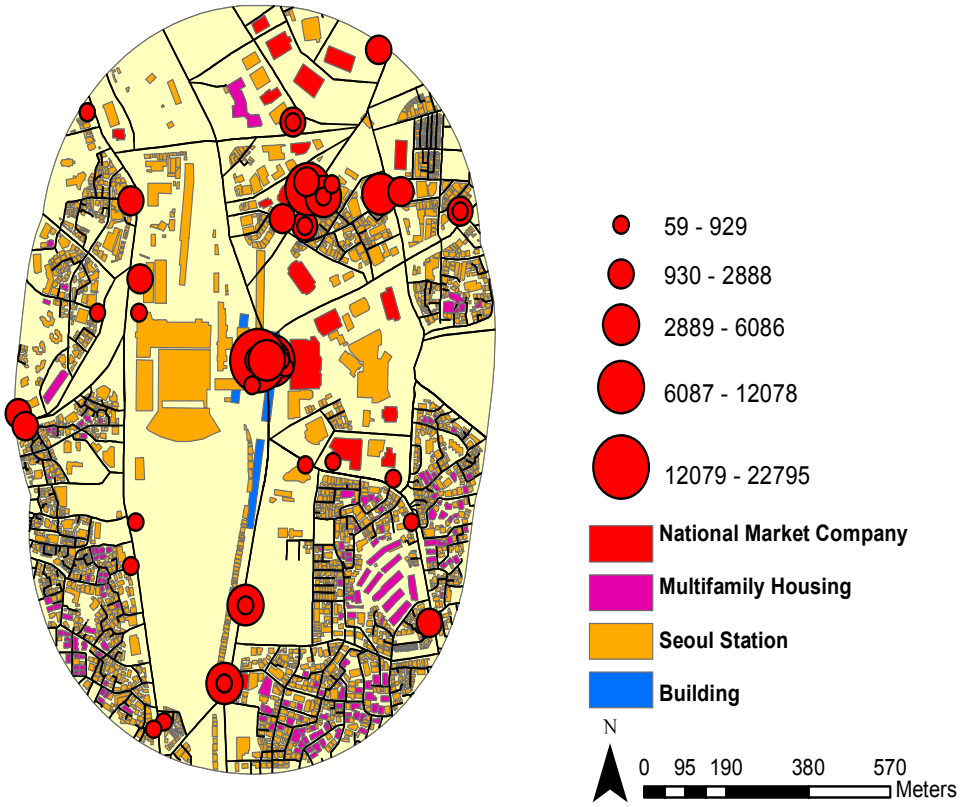


Figure 16: Number of Ridership for Bus Transfer System for Seoul Station Map

The map above map presents the ridership for each bus stop. The bus stops located closer to the station tend to have more ridership. The bus stops farther from the KTX station have less ridership.

The current bus connection system is shown in the table below. There are seven bus stops very close to Seoul Station. The City Circle bus has 2 lines; there are 65 local bus lines, 9 regional bus lines, and 5 express bus lines as well.

Seoul Station						
Type of Bus	City Circle Bus	Local	Regional	Long Distance	Express	Airport Express Bus
Number of Bus Lines	2	28	65	9	5	2

Table 8: Feature of Passed Bus lines for Seoul Station

The Express Airport bus has two lines: the general and exclusive. Operation frequency is 10-15 minutes and the travel time for the exclusive type is 50 minutes from the Seoul Station to the airport. The general airport bus takes about 70 minutes.

Type	Operation Time	Frequency	Fare	Travel Time
Exclusive	05:20-21:40	10-15mins	12,000(Won)	50mins
General	05:20-21:00	15-20mins	6,500(Won)	70mins

Table 9: Operation Time for Express Airport Bus lines

The table below shows the transfer distances from the Seoul Station to seven nearby bus stops. Each stop serves different bus lines.

Location	Transfer Distance	Type of Buses
Station Plaza	100m	City Circle Bus, Local Bus, Regional Bus, Long Distance Bus, Express Bus, Airport Express Bus
Station Post Office	300m	Express Bus,Local
Namdaemoon	350m	Regional Bus,Local Bus
Severance Building	250m	Local Bus
YTN Broad Casting	400m	Local Bus
Nam Young Dong	200m	Local Bus
Man-ri Dong	200m	Local Bus

Table 10: Location of Bus Stops around Yongsan Station

Thus, the average distance from the station to the bus stops is 257 m. Except for the bus stop in front of Seoul Plaza; most of these bus stops serve local bus lines. The Seoul Plaza bus stop has the shortest transfer distance and serves the most lines among the bus stops.

4.4.2 Yong San Station Bus Transfer System

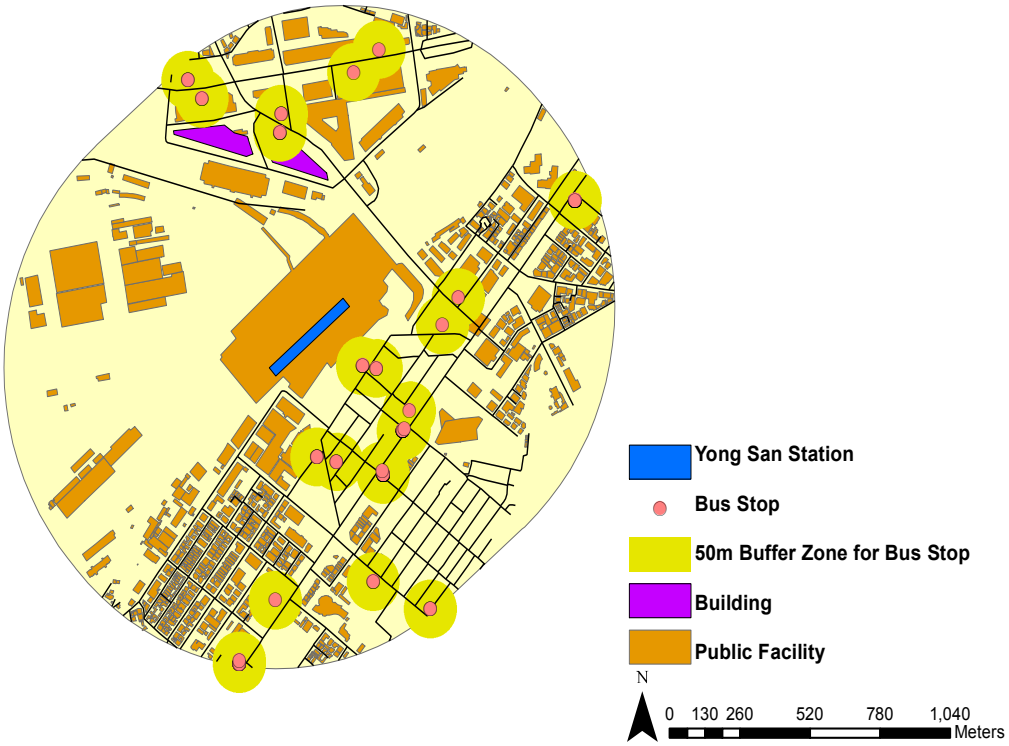


Figure 17: Current Yongsan Station Subway Transfer Map

In a 500 m buffer zone, Yong San Station has 20 bus stops, a smaller number of bus stops than the Seoul Station. Yong San Station is farther from the CBD than the Seoul Station and is not located in the core of Seoul. In addition, the bus stops for the Sin Yong San Station fall outside the 500 m radius. Therefore they do not appear on the map.

As the map shows, the bus stops do not have a tendency to cluster. The 500 m buffer zone does not covered most of Yong San Station. Thus, the Yong San Station offers less convenience and availability for passengers to take a bus.

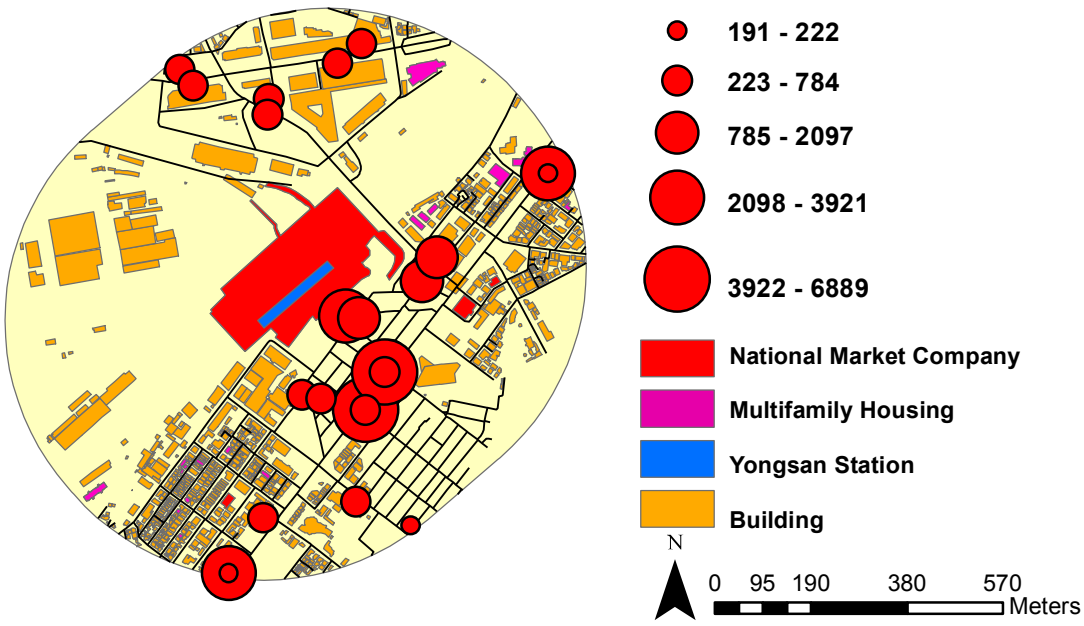


Figure 18: Number of Ridership for Bus Transfer System Yongsan Station Map

The map above presents the ridership for each bus stop. The largest number is shown in front of Yong San Station. Bus stops behind the station have smaller ridership. The absolute bus ridership is also significantly smaller than Seoul Station. This reflects that the Yong San Station is a transit spot that does not induce a large ridership to mass transit and HSR.

Yongsan Station			
Type of Bus	Local	Regional	Airport Express Bus
Number of Bus Lines	26	27	2

Table 11: Feature of Passed Bus lines for Yongsan Station

The current connected bus system around the Yong San Station is shown in the table above. Yong San Station does not have Express buses and long-distance buses like the Seoul Station. Local and regional buses are predominant instead. However, the Airport Express bus line shares the route with the Seoul Station.

There are six main bus stop locations at Yong San Station. The table below shows the distance from the station to the bus stops. The average distance for the Yong San Station to a bus stop is 441 m. The third floor of the station offers direct access from the HSR gate to the bus stop, but that stop has served only the exclusive Express Airport Bus. In front of the station plaza is a narrow road that services two bus lines, so passengers have difficulty transferring to the other bus lines. Overall transfer distances are also significantly longer than Seoul Station.

Location	Transfer Distance	Type of Buses
Station 3rd Floor	50m	Exclusive Express Airport Bus
Station Plaza	120m	Regional Bus,Local Bus
Terminal Electronic Market	550m	Regional Bus,Local Bus
Na Jin Market	700m	Regional Bus,Local Bus
Seon In Market	500m	Regional Bus,Local Bus
Sin Yong San station	550m	Local Bus, Regional Bus, General Express Airport Bus

Table 12: Location of Bus Stops around Yongsan Station

4.5 Taxi Transfer System for KTX Stations and Parking Lots Service: Seoul Station and Yong San Station

In the transit system of HSR stations, the passengers who have taken the subway and connecting buses tend to decide to take the HSR. Taxis and automobiles may be less preferred by HSR passengers. The government and planners recognized that taxis and automobiles could provide door-to-door service to passengers, so they focused on improving the mass transit system (Sung & Oh, 2011). Seoul Station has only one parking lot for transfer passengers. This lot is significantly far from the HSR gate—491 m—and it takes about 8 minutes to walk from the station to the parking lot. This has created difficulty for passengers who used their own cars.

There are two taxi stops around Seoul Station. The first is located on the Seoul Station plaza, but the stop consists of only one lane, so taxi users inevitably suffer an uncomfortable transit condition (Jun, 2012). The second one is located behind the station, and except for the taxi stop, the location does not involve other kinds of transit types.

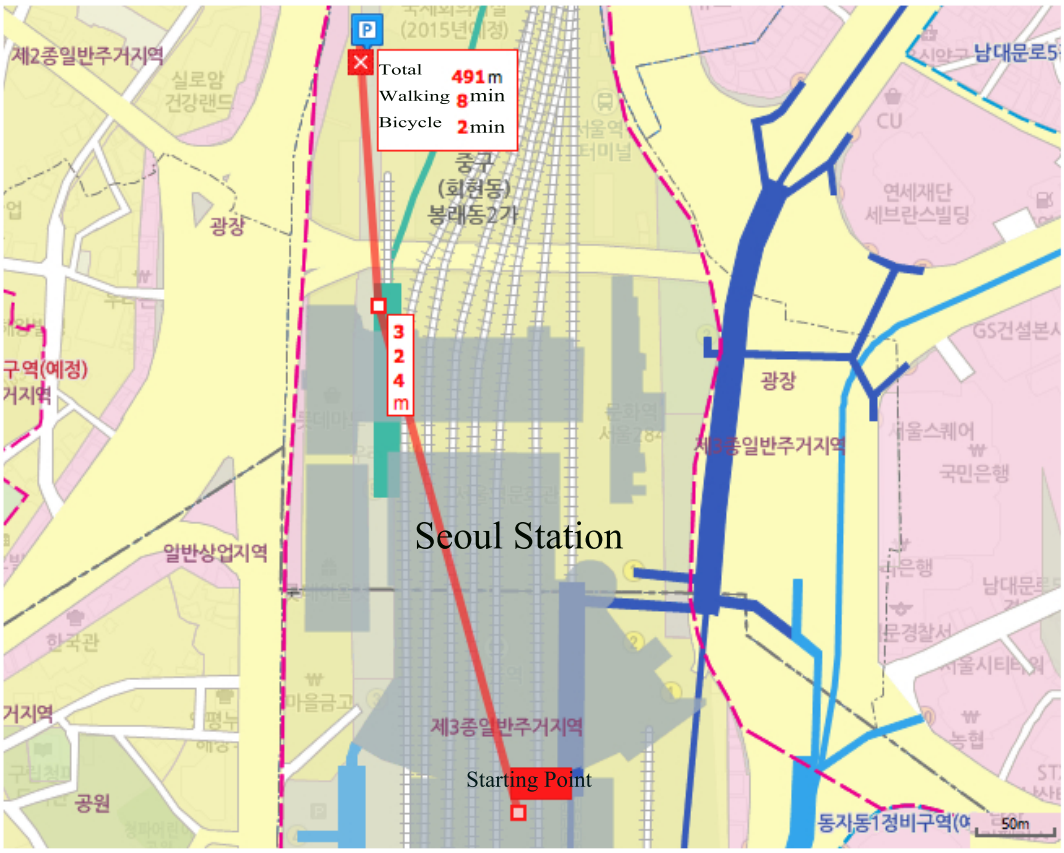


Figure 19: Parking lot for Seoul Station Map

By contrast, the Yong San Station has no parking lot for transfers. Instead of parking spaces for transfer, the Yong San Station has three public parking lots. The three parking lots are not connected with the HSR station directly. The passengers who take a car must use a crosswalk. The lot farthest from the station is approximately 500 m away. The closest station is located within about 360 m.

Unlike its mass transit transfer system, the Yong San Station tends to have difficult access for car or taxi passengers to the gates for the HSR system. Yong San

Station has a number of taxi stops. However, the transfer system for taxi passengers is inconvenient.

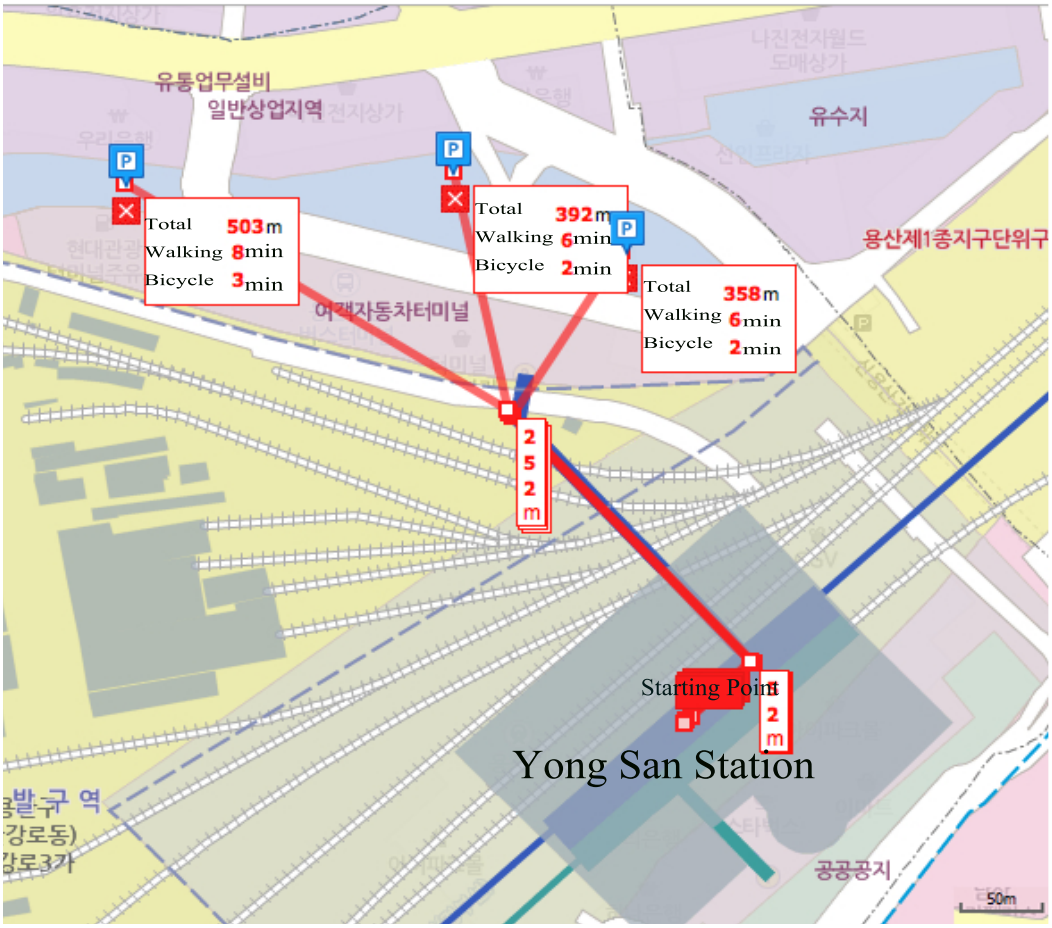


Figure 20: Parking lot for Yongsan Station Map

These facts would tend to indicate the HSR system would not be popular for car users who take an automobile from their home to the HSR station. However, the fare system for the parking lots around the targeted stations offers a 30 percent discount for HSR passengers.

Chapter 5 Transfer System Problem for KTX Stations

5.1 Features of Pedestrian Environments

The designers of these stations should consider the pedestrian environment when locating connecting buses, long-distance trains and subways. This will increase the efficiency both the walking and mass transit system. It is an effective way to attract passengers to take the HSR instead of an automobile or long-distance bus lines (Cervero & Radisch, 1996).

Seoul Station and Yong San Station must improve their plans for pedestrian, focusing on the moving distance becoming more effective and efficient. The trip distance from a mass transit stop to the HSR station must be minimized to fulfill the standards of pedestrian safety and walking time. These conditions are critical factors for passengers who are deciding which transportation mode to use.

In addition, the trip distance must include clear directions to the station. For many passengers, traveling to an HSR station is not common trip behavior, compared with the subway or buses (Cervero & Kang, 2011). Therefore, many passengers might have more difficulty navigating on the road to the station. The planners and government should consider this trip characteristic to improve the ridership of the KTX system with mass transit.

Pedestrians are affected by several elements: time, internal environment, external environment, social conditions, walking distance, and more (Cervero & Radisch, 1996). Therefore, the government or urban planners who need to create the pedestrian environment must recognize the main characteristics of each factor.

The time element involves the season, weather, and the time of day. This element affects the psychological conditions, street lighting, and condition of a building. Temperature, humidity and sunlight also directly impact the individuals' internal conditions. Other internal elements are about personal characteristics: gender, age, height, social status, preferences, and personal characteristics (Guo & Wilson, 2007). Those elements are connected with the need for and sense of space. External elements are about the physical conditions around the pedestrians. They include the width of walkways, flooring materials, walkway gradients, and physical facilities. A comfortable walking distance is affected by the pedestrians' internal elements, weather, physical conditions, and the location of the destination. For example, an unfriendly atmosphere may make a walking distance of 100 m seem long. In contrast, an attractive space that provides various experiences could make walking over 400−500 m seem reasonable.

Selecting the path to the destination for a pedestrian is different from the time value and the available time, but generally pedestrians might choose the shortest path from the perspective of time consumption. Walking time is changed by the sidewalk interventions and physical types of sidewalk. Walking time is divided into three types: connective, detouring, and disconnected.

With the connective type, the travel time is uniform. The pedestrian facilities are located appropriately. As a result, the elements affect the pedestrians less.

The detour type has various facilities: stairways, escalators, and walkway obstructions that intervene in smooth walking behavior for pedestrians. The space may have higher traffic density. Subway passages could be classified as detours, because most

have passageways with escalators, elevators, gates, or entrances where passengers are delayed.

The disconnected type can have higher traffic density. It demands longer waiting times than other types. As a result, the flow of pedestrians is uneven and they are less satisfied with their travel experience.

These travel types highlight the factors needed to improve the pedestrian environment for the potential passengers of the HSR. To allow continuous movement for pedestrians, barriers and physical interventions would be excluded; the walkways should use the shortest, straightest lines possible. As mentioned in the above paragraphs, the problem of the HSR system in Seoul and Yong San Station is transfer interconnectivity with mass transit.

5.2 THE PROBLEMS OF THE TRANSFER SYSTEMS: SEOUL AND YONG SAN STATION

The transfer system for traffic flow of humans among each transit mode from an HSR train from Seoul Station comprises is a long line. The taxis and connecting buses from Seobu station and Namyeong dong District and post office serve the mass transit mode to Seoul station and go to the bus stops on the section of road. The bus stop in front of the Seoul Station is the only one of the station that can approach the Seoul Station without passing through the subway station attached to the HSR station. Therefore, the transfer passage way through the subway station is used by passengers who need to access the HSR station.

The most visible problem between the subway station and HSR station is the single connecting escalator. This has caused congestion problems during rush hour and

train arrival times. It forces passengers to wait in line, increasing their sense of inconvenience.

In front of Seoul Station, the plaza has well-organized taxi stops. However, the taxis have monopolized the two lanes. Taxis are parked constantly at the taxi stops, and block other transit passing through the stops. This requires changes to avoid conflict between different transit modes.

Yongsan Station is located in the center of a looping main road, so the transfer flow system for each transit mode is comprised of a type of circle. The majority of the station's bus stops are located far from the station passengers must use crosswalks to get to the stops, caused discontinuous walking behavior. The average transfer distance is over 390 m and some bus stops are more than 500 m away, which is inconvenient for passengers. The congestion level is also higher because of the electronic market and department stores.

Another point is related to a problem with signs. There are no direction signs to the HSR station. If the passengers take Line 4 and get off at Sin Yong San station instead of the Yong San station, they must walk about 400−500 m through a crosswalk. Yong San Station also has a problem with its taxi stops, which cause traffic congestion.

If passengers arrive at either Seoul or Yong San subway stations, they need to use stairways. When people climb stairways, they use more than ten times the energy compared with walking on a flat road. Accordingly, considering the moving distance, the construction should be more concerned with easing vertical movement than horizontal movement.

Passengers who are strangers to these stations and have less knowledge of mass transit lines around HSR stations will spend more time than expected because of unclear transfer information and confusion cause by the complex spatial characteristics around the station. As a result, the passengers could not avoid increasing their transfer time and therefore their total travel time. This point will be the most critical factor for passengers who do not want to take the HSR with mass transit. Each transfer location must provide clear signs for connecting buses, bus lines, and operation directions, including maps, which will be helpful to estimate the shortest path between the current location and station to passengers and contain information about the location's characteristics and landmarks.

A comprehensive intermodal system must merge the bus stops, subway stations, and even taxi stops to reduce the traffic congestion to increase passengers' convenience. Walking time, distance, and physical conditions are important factors to passengers in choosing whether select the HSR as the major long-distance transit mode instead of an automobile. At this point, the mass transit system partially determines the HSR ridership. If Seoul Station and Yong San Station would like to increase their ridership, the stations need to improve the physical facilities and road conditions for mass transit, and contrive solutions to increase the atmosphere of convenience for passengers.

Chapter 6 Reformation for Transfer System and Strategy for the KTX

6.1 Definition of Multi –Transfer Center for HSR

A Multi-transfer Center for HSR is defined by the legal section of the National Comprehensive Transportation Efficient System. It states that a multi-transfer center is a facility providing various services for promoting connections among trains, flights, subways, buses, taxis and automobiles. In addition, the section mentioned that commercial activity would be a socio-economical benefit from a transfer center (Rivasplata, 2001).

The government has adopted the multi-transfer center concept for HSR for several reasons. First, in the current system the government operates the transportation infrastructure through different departments and private firms. Inefficient operating systems have scattered train stations, bus stops, and bus terminals across cities. This causes long transfer distances. Transfer facilities, which include moving walkways, escalators, and elevators, are insufficient to fulfill the transfer requirements of passengers (Liu, 2012). Some train stops are inconvenient for the handicapped and elderly due to the lack of transfer facilities; in others, everyone has suffered from the lack of appropriate services.

Therefore, the land and transportation ministry enacted the directive for the National Comprehensive Transportation Structure. This directive gives grounds for why the existing transfer centers and system need reform. The government has tried to reform the transportation stations in the major cities; the main feature of this reformation is concentrated on the high-density development of cultural, commercial, and office

facilities within a 300 m buffer zone around a station (Florida Planning Department, 2004). In addition, the directive established design and location standards specific to multi-transfer center development for an efficient system of connection.

The standard establishes that transfers between different transport modes should be aggregated and a multi-transfer center should have a transfer distances less than 180 m (level "C" on a comparative chart derived from the directive). This level of service is a dramatic change compared with conditions before the multi-transfer center concept was created (K. Kim et al., 2012).

Service Level	**A**	**B**	**C**	**D**	**E**	**F**
Transfer Distance (m)	Less than 60	60 ~ 120	120 ~ 180	180 ~ 240	240 ~ 300	Over than 300

Table 13: the Service Level as Following the Transfer Distances

Additionally, the multi-transfer center concept has design standards for every stairway, elevator, and moving walkway for the passengers' convenience. The multi-transfer center directive also contains descriptions about the transfer information system, which monitors operations and the condition of facilities of mass transit modes.

6.2 Policy Implementation for Multi-Transfer Center Plans

The ministry and government have released the directive for the multi-transfer center as part of the legal system and policy. The existing system has demonstrated a large number of problems for passengers. This has limited the beneficial effects of KTX from reaching the levels expected by the national government and city councils.

The government has presented a development direction containing three different types of multi-transfer center: HSR station, airport connected with an HSR station, and international ferry terminal connected with an HSR station. Additionally, the centers are dividing into the types of available traffic service: national level, regional level and local level. The government will specify the transfer center to optimize each function and service.

Category	National Multi Transfer Center	Regional Multi Transfer Center	Local Multi Transfer Center
Designator	Minister of Land, Infrastructure and Transportation	City and Province Header	City and Province Header
Transportation Feature	Transportation regarded as the national level of infrastructure	Transit system to connect between different two regions	Transit system to improve the convenience for the local
Subject of Transit Facility	The Transit node which is related to High Speed Rail station	General train station	Urban commute rail and subway station
Land development Feature	The center of National growth: the region involves the national economic subjects	Regional growth Center	Center of Business District

Table 14: Features for Transfer Center Type

Multi-transfer transportation centers should increase accessibility for passengers and potential passengers. The way to increase accessibility is shown in the table below and involves providing functional infrastructures: walkways, mass transit districts, local transit districts, and regional transit districts. These different types of transit combine in a plan for a multi-transfer center.

Category	Scope of the District	Restoration Direction
Sidewalk **Mass transit restoration District**	500m	• Only for mass transit district designation, pedestrians district and the street for bicycle. • Improvement of accessibility for mass transit which is located around High Speed Rail station
Local Transportation restoration District	Approximately 5-10km	• BRT, City commute rail, which is connected from the center of the city to the suburban area. • The multi transfer center would become improve the accessibility from suburban to High Speed rail station
Regional Transportation Restorations District	Approximately 40Km	• Improvement of Multi-transportation center and connection system between level of national transportation infrastructure: Airport, International Ferry terminal and high-speed rail station served various line for going to the other regions.

Table 15: Different Category for Transfer Center Type

The minister and government should announce a plan for multi-transfer centers centered on the HSR. The government has regarded KTX as a fundamental national infrastructure, which is why most transfer system plans are related to the HSR system. KTX is the one transportation system that can serve as a regional connection transit system in Korea.

The type of multi-transfer center is defined by the radius distance. Different distances mean distinctive functional facilities for passengers. The goal is to give every different multi-transfer center the same accessibility with the other types of transit to the HSR stations to increase daily ridership (Chou & Kim, 2009).

When implemented, the multi-transfer center standards will help realize the "Transit Oriented Development" concept in Korea(S. Lee et al., 2010). The TOD is new, and was not a part of the development of HSR stations, which were located in the existing general rail stations. The multi-transfer center adds dense development around the HSR stations to improve the adjacent areas from the perspective of urban aesthetics. Creating harmony with the commercial, cultural, and official tasks are the key factors to adopting the concept of TOD for the HSR system(S. Lee et al., 2010).

The government proposes building multi-transfer centers for KTX. The government would like to grow the KTX stations into the "green" transportation hubs in Korea. These will adopt tools for improving the management system for transit demand through mass-transit-oriented districts and maximum occupation rates for automobile parking. Additionally, the bicycle system, BRT, and bimodal trams will also be involved within the "green" transportation hub area, because the government determined

approaching the ultimate goal of "green" transportation with KTX requires new transit systems (H. Kim et al., 2011). The government has proposed the financial burdens should be allocated to both private and public sources, because the transportation development must pursue public benefits with private benefits for investors.

6.3 Policy expectations for Multi-transfer Centers

The government expects the multi-transfer centers will improve the KTX ridership. They have realized that increasing ridership could combine different positive externalities in terms of the economic development and community viability of the areas adjacent to the KTX stations. The ultimate goal of establishing KTX stations is to improve the economic vitality while reducing the regional economical disparity. The multi-transfer center would help to increase ridership by increasing the mass transit usage rate; it would provide a great environment to transfer from the KTX to mass transit without long transfer distances.

Subject	Expectations of the Multi-transfer Center
Passengers	• Transfer convenience • Safety • Fresh atmosphere • Comfortable atmosphere to purchase the goods what they should buy
Public factors	• Increasing Tax Income from the land value and commercial facilities • Expecting to increase the number of population in city • Promoting the convinces for City Images
KORAIL (Public Rail Firm)	• Increasing ridership and operational income • Increasing income from the commercial facilities in the multi-transfer center
Local Merchant	• Increasing ridership gives possibility to increase selling products rate.

Table 16: Different Expectation from Subjects

The multi-transfer center implies different kinds of expectations from subjects, which means the center has different value for different subjects. These various expected benefits are the reasons the government has adopted the multi-transfer center as the solution for increasing the KTX ridership. The government has enacted a legal system for the multi-transfer center and has performed economic feasibility studies for their

development. The multi-transfer center would solve several problems at the same time because of the unique features of the center compared with other transit facilities.

Chapter 7 Conclusion

The world countries have tended to expand the HSR service rather than extending the road system for automobile. It is currently focused on regional planning in terms of the eco-friendly urban development, transportation reformation and green transportation system. South Korea has one of the countries which has well-developed HSR system. Additionally, South Korea has been well known as highly organized mass transit system. The reason of large amount of energy put into the green transportation is that South Korea has no resource, which is the main source for automobile, to exploit. Another reason is about high population density. This unique feature of the countries has naturally induced the high interests of HSR.

Traditionally well –known the HSR countries: France and Japan already consider the transfer convenience for passengers, which is the main factor to select the HSR as the long distance mode, in terms of the transfer facilities and the environment to transfer to mass transit around HSR station. Elements such as entrance and gate locations, appropriate amenities for passengers and demanded transfer facilities would be the key factor to be succeeded in transfer system.

Compared with the good examples, this report has explored current transfer system and intermodal connectivity, which are based on the two stations. Subway systems, bus transfer systems and parking lots environment would be the main factor to investigate for the stations. Coincidently, every year ridership for HSR of two stations is important data set for comparison by two stations features. Seoul station shows better environment to transfer than Yongsan station in terms of transfer distance and subway gate location from HSR entrance to each different subway lines.

In terms of connectivity with HSR and existed mass transit system is important issue to the passenger who would not want to take the own car from home to station. Convenient transfer atmosphere is demanded to two stations as high competition with automobile. As a result, the HSR station has needed to consider how the station makes a great environment to increase convenience for passengers. The government has made a policy and legal system represented as multi-transfer center, which is for focusing on transfer system around HSR station. Multi-transfer center is not only to improve the transfer environment between the HSR station and mass transit stations and stops, but also the multi-transfer center has expected to improve the community economy and life of quality of residents around the station. The motivation to launch the policy is for improving the transfer system, but the induced effect is to develop around the station so that the policy implication is good for the transportation system and also the community development has gotten positive externalities from multi-transfer center.

This report has given the groundwork for why the transfer system and inter modal connectivity need to be investigated for HSR station. Compared between the different countries HSR station and transfer system would be given great grounds to invest transfer facilities and the elements, which is helpful to increase the ridership of HSR.

In general, HSR systems have been shown the difference with the features of cities and countries so that the researcher has the difficulties to make a general idea for the system. As following the unique feature of HSR system, we would need to make a comparative studies would be most effective way to study about HSR system. Especially, intermodal connectivity and transfer system with mass transit should consider the context of transportation policy and mass transit system. it would add the fact that why comparison studies are appropriate to investigate the current intermodal connectivity with HSR station.

From this report, it would be hoped to expand the research for intermodal connectivity in terms of mass transit and consider the positive externalities of multi-transfer center in terms of transportation policy and community development. Increasing the intermodal connectivity and put a large amount of interests in the transfer system would become the main key for getting the successful expectation from HSR system development.

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