Current Situation and Future Development of the Trans-GTR Corridors (Segments in ROK)

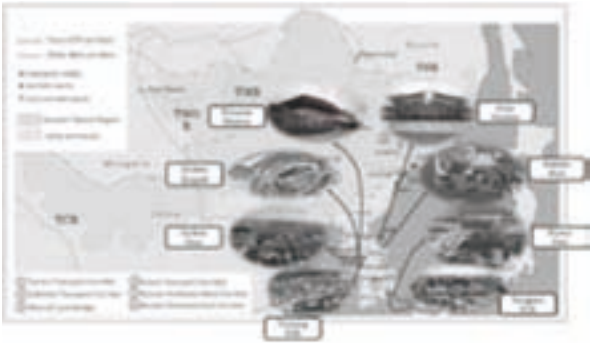
NA, Hee-Seung, Principal Researcher, Korea Railroad Research Institute

1 Introduction

The International traffic and logistics system in Northeast Asia can be composed by Asian Highway (AH), Trans-Asia Railway Network, arterial railway networks in China, Russia and Japan and regional logistics feeder networks. The key stronghold of traffic and logistics system in the Korean peninsula will also consist with six nodes and a linked structure of "Incheon, West Economic Zone" – "Pyongyang, Nampo zone" – "Wonsan, Hamhung zone" – "East (Mt. Kumgang) Economic zone" – "Busan, Ulsan zone" – "Saemangeum, Mokpo zone" will be formed centering on Seoul.

The existing state of traffic infrastructure along the corridors of ROK is shown in figure 1.1. The Jejin station, Sokcho and Pusan port, Yangsan ICD is located in Korean Peninsula East Corridor 6. The Dorasan station, Incheon port and airport, Uiwang ICD is located in Korean Peninsula West Corridor 5.

Figure 1.1 Existing state of traffic infrastructure along the corridors of ROK



2 Due Diligence Review of GTR Corridors

2.1 Traffic Review

In 2011, current state of freight traffic flows through ports is shown in Figures 2.1-2.2 and Tables 2.1-2.3. On the sea freights O/D by zone (ROK - the three Northeastern provinces, Hefei, Beijing/Tianjin, and Far-East Russia, etc.) is used. The ports of Busan, Incheon, Gwangyang and Pyeongtaek in ROK are taken into consideration for Korean Peninsula West Corridor 5. The ports of Busan, Sokcho, Donghae and Mukho in ROK are taken into consideration

Figure 2.1 Current data on freight traffic flows through ports of ROK (Import-Export)

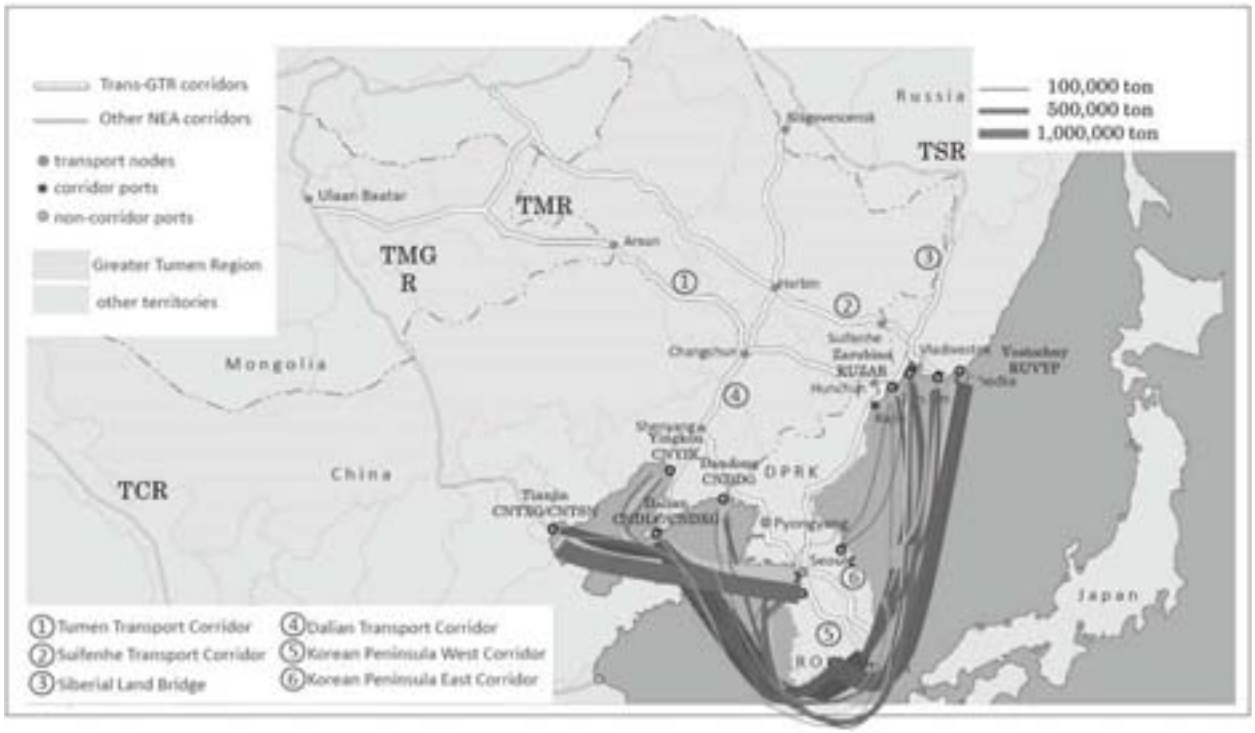


Figure 2.2 Current data on freight traffic flows through ports of ROK (Transit)

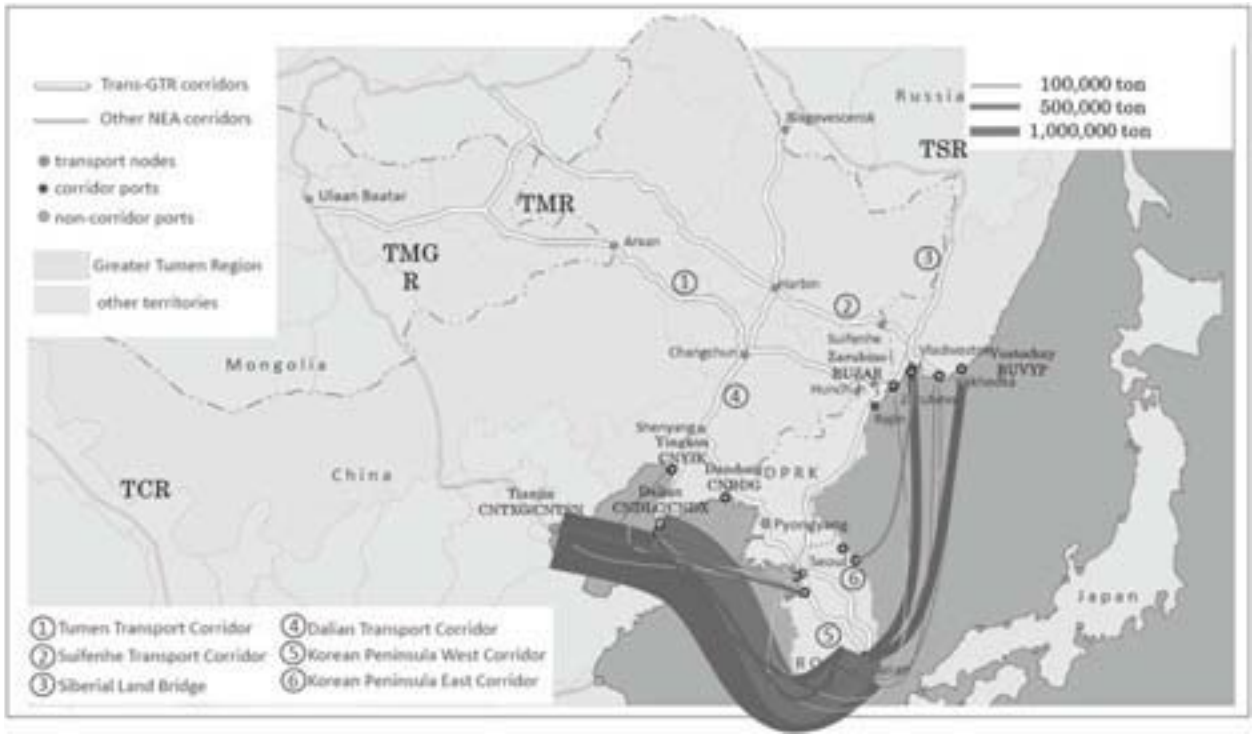


Table 2.1 Current data on freight traffic flows through Busan port

(Unit: ton)

		2011											
		Export			Import			Export_Transit			Import_Transit		
		Full Con.	Bulk		Full Con.	Bulk		Full Con.	Bulk		Full Con.	Bulk	
Busan Port	CNDDG	0	0		0	93,341		18	0		0	0	
	CNDLC	237,921	8,695		690,346	407,465		1,045,446	235		2,824,146	0	
	CNDXG	2,939	0		7,054	0		205,518	0		304,717	0	
	CNTSN	219,023	2,806		299,759	22,239		96,524	0		492,241	112	
	CNTXG	331,808	24,332		700,938	0		1,969,333	1,003		4,140,651	1,587	
	CNYIK	8,320	0		58,381	1,505		570	0		38,770	0	
	China_Total	800,011	35,833	835,844	1,756,478	524,550	2,281,028	3,317,409	1,238	3,318,647	7,800,525	1,699	7,802,224
	RUVVO	324,279	353,314		38,756	110,469		1,088,357	3,537		78,976	992	
	RUVYP	488,003	9		119,020	8,582		730,412	81		307,748	0	
	RUNJK	5,680	3,812		0	36,474		27	6,014		0	0	
	RUZAR	0	0		0	0		0	524		0	0	
	Russia_Total	817,962	357,135	1,175,097	157,776	155,525	313,301	1,818,796	10,156	1,828,952	386,724	992	387,716

Note: CNDDG(Dandong), CNDLC(Dalian), CNDXG(Dalianxingang), CNTSN(Tianjin), CNTXG(Tianjinxingang), CNYIK(Yingkou), RUVVO(Vladivostok), RUVYP(Vostochniy), RUNJK(Nakhodka), RUZAR(Zarubino)
Source: KOREA CUSTOMS SERVICE

for Korean Peninsula East Corridor 6. The Port of Dandong, Dalian, Dalian Xingang, Tianjin, Tianjin Xingang and Yingkou in China are taken into consideration for Korean Peninsula West Corridor 5. The Port of Vladivostok, Vostochny, Nakhodka and Zarubino in Russia are taken into consideration for Korean Peninsula East Corridor 6. For transport demand, freight is targeted not only the import-export freight but also the transit. The freight traffic data of 9 years old is investigated to be contemplating Korea Customs Service data base. The freight traffic volume increased steadily for 9 years despite world economic crisis in 2008. Especially, freight traffic volume of Pusan Port for import-export and transit is massive. The freight traffic volume of Incheon, Gwangyang, Pyeongtaek and Mukho Port for import- export is crucial factor. Recently freight traffic volume for transit increased rapidly between ROK and Russia. The current data on freight traffic flows through ports to be considered are shown below;

2.2 Infrastructure capacity review

There is various infrastructure policy of ROK to solve the bottlenecks. GTI corridors need to satisfy the growing transportation demand, so it needs to increase the capacity and operating speed. The expansion of highway network and high speed railway project should be secured for

Table 2.2 Current data on freight traffic flows through Incheon port

(Unit: ton)

		2011											
		Export			Import			Export_Transit			Import_Transit		
		Full Con.	Bulk		Full Con.	Bulk		Full Con.	Bulk		Full Con.	Bulk	
Incheon Port	CNDDG	45,674	9,839		206,374	139,344		17,452	785		581	3,668	
	CNDLC	98,957	24,139		229,924	478,532		619	129		1,779	562	
	CNDXG	0	0		0	4,553		0	0		0	0	
	CNTSN	11	210		0	43,542		0	0		0	0	
	CNTXG	239,353	35,304		345,392	975,975		128	706		945	1,243	
	CNYIK	61,426	259		98,761	0		63	0		130,895	118	
	China_Total	445,421	69,751	515,172	880,451	1,641,946	2,522,397	18,262	1,620	19,882	134,200	5,591	139,791
	RUVVO	136	13,435		2,703	281,156		80	0		4	0	
	RUVYP	601	0		13,209	186,523		0	0		20	0	
	RUNJK	0	0		0	440,067		0	0		0	0	
	RUZAR	0	4,034		0	0		0	0		0	0	
	Russia_Total	737	17,469	18,206	15,912	907,746	923,658	80	0	80	24	0	24

Note: CNDDG(Dandong), CNDLC(Dalian), CNDXG(Dalianxingang), CNTSN(Tianjin), CNTXG(Tianjinxingang), CNYIK(Yingkou), RUVVO(Vladivostok), RUVYP(Vostochniy), RUNJK(Nakhodka), RUZAR(Zarubino)
Source: KOREA CUSTOMS SERVICE

Table 2.3 Current data on freight traffic flows through Donghae port

(Unit: ton)

		2011											
		Export			Import			Export_Transit			Import_Transit		
		Full Con.	Bulk		Full Con.	Bulk		Full Con.	Bulk		Full Con.	Bulk	
Donghae Port	CNDDG	0	0		0	41,489		0	0		0	0	
	CNDLC	0	0		0	30,098		0	0		0	0	
	CNDXG	0	0		0	0		0	0		0	0	
	CNTSN	0	0		0	3,017		0	0		0	0	
	CNTXG	0	0		0	54,593		0	0		0	0	
	CNYIK	0	0		0	0		0	0		0	0	
	China_Total	-	-	-	-	129,197	129,197	-	-	-	-	-	-
	RUVVO	2,962	178,018		1,248	1,645		374	207		25	87	
	RUVYP	0	0		0	1,705,073		0	0		0	0	
	RUNJK	0	9		0	155,038		0	0		0	0	
	RUZAR	0	44		0	794		0	0		0	0	
	Russia_Total	2,962	178,071	181,033	1,248	1,862,550	1,863,798	374	207	581	25	87	112

Note: CNDDG(Dandong), CNDLC(Dalian), CNDXG(Dalianxingang), CNTSN(Tianjin), CNTXG(Tianjinxingang), CNYIK(Yingkou), RUVVO(Vladivostok), RUVYP(Vostochniy), RUNJK(Nakhodka), RUZAR(Zarubino)
Source: KOREA CUSTOMS SERVICE

solution of bottlenecks. Traffic and logistics facilities in ROK have been expanded as of the following.

2.2.1 Road network

Traffic congestion cost has been ever growing due to concentrated population/industrialization in Metropolitan area and Seoul-Busan axis. Population, business firms and cars in Metropolitan area represent 46.3%, 45.7% and 46.5% respectively, despite it only accounts for 11.8% of the entire national area. Lack of integrated traffic policy considering urban spatial characteristics and circulation pattern led to worsened congestion. Therefore, a national arterial road network has been implemented for the road development. In comparison to 2001, the total extension of roads increased by 13,587km in 2009. As of 2009 the total extension of roads is 104,983km and it has been increasing by an annual average of 1.75% since 2001. The national expressways increased by 1.43 times from 2,637km in 2001 to 3,776km in 2009 (Table2.4).

As for the roads in ROK, it is planned to promote balanced development of the national territory by implementing grid type national arterial road network consisting with seven south-north axes and nine east - west axes. Large traffic areas in between expressways and regions will be connected with an express arterial network and the big city beltway network will be built as part of the arterial traffic network. The total extension of expressways as of present is 3,776km and it will be expanded by stages according to priorities. In order to secure a foundation for long-term development of the national territory, the ROK government has established a composite arterial road network plan that comprehensively includes expressways and national roads.

A long-term highway construction plan to deal with traffic congestion caused by inconsistent development and expansion; 1) 7 South-North axes, 4 East-West and 3

circulation belts to be jointly developed by central and local governments and private investors by 2020 2) Projects to mitigate traffic congestions on a gradual basis in Metropolitan areas including Busan, Daegu, Gwangju and other big cities 3) Gradual construction of bypass near small and medium sized cities to ease the congestion (Long-term estimate: 1,308km).

As shown in Table 2.5 and Table 2.6, the current state of road traffic infrastructure along Korean Peninsula East and West Corridors is investigated respectively.

Table 2.4 Statistics of Road Network of ROK

(Length, km)

	2003	2004	2005	2006	2007	2008	2009
National Expressway	2,778	2,923	2,968	3,103	3,368	3,447	3,776
National Highways	14,234	14,246	14,224	14,225	13,832	13,905	13,820
Provincial Highway	17,485	17,476	17,710	17,677	18,175	18,193	18,138
Country road	45,625	48,262	49,885	49,318	49,535	50,174	50,501
Other roads	17,130	17,371	17,506	17,738	18,109	18,517	18,749
Total	97,252	100,278	102,293	102,061	103,019	104,236	104,983

Source: Korea Expressway Corporation

Table 2.5 Road Infrastructure of Busan-Incheon Corridor (ROK West Corridor)

Country	Length, Km	Lanes	Condition	Traffic, AADT
ROK	447	4/6/8	Good	60,000-158,500

Source: Korea Expressway Corporation

Table 2.6 Road Infrastructure of Busan-Kosong Corridor (ROK East Corridor)

Country	Length, Km	Lanes	Condition	Traffic, AADT
ROK	475	2/4	Good	7,000-70,000

Source: Korea Expressway Corporation

2.2.2 Rail network

In terms of railway, stage 1 of Gyeongbu Rapid-transit Railway (Seoul - Daegu) was opened in 2004 and stage 2 (Daegu - Busan) was opened in 2010. Rapid-transit railway contributed to the formation of a half-day life zone in ROK. The total extension of railways is 3,377.9km as of 2009 and it consists of 240.4km of rapid- transit railway and 3,137.5km of general railway. The rate of double-track railway implementation is 43.9% as of 2009 and is increasing annually. In line with the basic condition of green traffic, the investment is in a trend of both quantitative and qualitative increase. The investment cost increased from KRW 3,376.1 billion in 2004 to KRW 5,183.8 billion in 2009. Investment for railway construction and facility modernization (double- tracking and electrification) since 1998 has been increasing and, as a result, the investment ratio increased significantly by 30% or higher.

Railroad transport in ROK displays worse traffic congestion or bottleneck on Seoul-Busan axis than on any other routes. Particularly such congestion seems most intense at the Seoul-Siheung section where Honam, Gyeongbu, Gyeongin and Gyeongwon Lines are interfaced, which requires the continuous expansion of railroads to address such traffic congestion.

High-speed railway projects have been conducted as follows; 1) Double-tracking typical railroads and linking them with regional lines along with modernization of signaling system 2) Upgrading the speed of existing lines for high speed railway service (Gyeongbu, Honam and connection line) up to 180km(from existing 140km) 3) Making continuous endeavors to develop tilting train and next-generation high speed railway, and to structure the integrated high-tech research institute to advance railroad technologies.

In addition, restructuring the subsidiary companies and enhancing the work efficiency will be implemented with the support of the government for railroad automation project. The efforts will also be made to lay the foundation for the economically-independent management, while developing neighborhood area and complex facilities near the station as a top priority to secure passenger convenience.

As for ROK railways, the stage 2 project of Gyeongbu rapid-transit railway has completed. In addition, Honam rapid-transit railway is under construction with a goal to handle increasing transportation demand resulted by the West Coast development and to encourage local development. In the long run, it is necessary to implement an international railway transport base in order to have the rapid-transit railway network connected to TCR and TSR and therefore ROK performing as a gateway to the continents of Asia and Europe. The ROK government has established a systematic national railway network implementation plan to connect rapid-transit railway with general railway network.

As shown in Table 2.8 and Table 2.9, the current state of railway traffic infrastructure along Korean Peninsula East and West Corridors is investigated respectively.

Table 2.7 Statistics of Railway Network of ROK

Section	Railway Length, Km	Route length, Km		Double-track length,Km	Electrified length, Km	Opening year	
		Passenger	Freight			Date	Section
Total	3,377.9	3,240.5	3,043.9	1,482.7	1,894.8		
Gyeongbu line: Seoul~Busan	441.7	441.7	439.9	441.7	441.7	1905.01.01	Seoul~Choryang
Donghae Nambu line: Busanjin~ Pohang	145.8	145.8	145.8	2.1	4.6	1935.12.16	Busanjin~ Pohang

Source: Korea Railroad Research Institute

Table 2.8 Rail Infrastructure of Busan-Incheon Corridor (ROK West Corridor)

Country	Length, Km	No. of tracks	Gauge, mm	Propulsion	Freight Speed
ROK	480	2/4	1,435	Electric/Diesel	100-160

Source: Korea Railroad Research Institute

Table 2.9 Rail Infrastructure of Busan-Kosong Corridor (ROK East Corridor)

Country	Length Km	No. of tracks	Gauge, mm	Propulsion	Freight Speed
ROK	489		1,435	Electric/Diesel	80-160

Source: Korea Railroad Research Institute

2.2.3 Land BCP

Gyeongeui railway and road (Gyeongeui Line, National Road No. 1, 4-lane road in both directions) and Donghae railway and road (Donghae Line, National Road No. 7, 2-lane road in both directions), which are connecting

between ROK and DPRK, are the most important traffic networks in terms of not only the economic cooperation between ROK and DPRK, but also activation of inter-Korean exchange and implementation of a traffic network connecting to TAR and AH. On September 17, 2003, ROK and DPRK agreed on the details of Gyeongeui and Donghae railway and road connection project as of the following.

Facility Structure

- In case of railway, both Gyeongeui Line and Donghae Line will be connected as single-track railways.
- In case of roads, Gyeongeui Line will be built as a 4-lane road considering Kaesong Industrial Complex and Donghae Line will be built as a 2-lane road.

Border Station

- Border stations will be installed in the ROK and DPRK areas outside the Demilitarized Zone (DMZ) considering special characteristics of the DMZ and successful CIQ function for people and goods using railway and road systems.

Tracks between Boarder Stations

- Traction by diesel locomotives of ROK

ROK - DPRK Road Connection Status

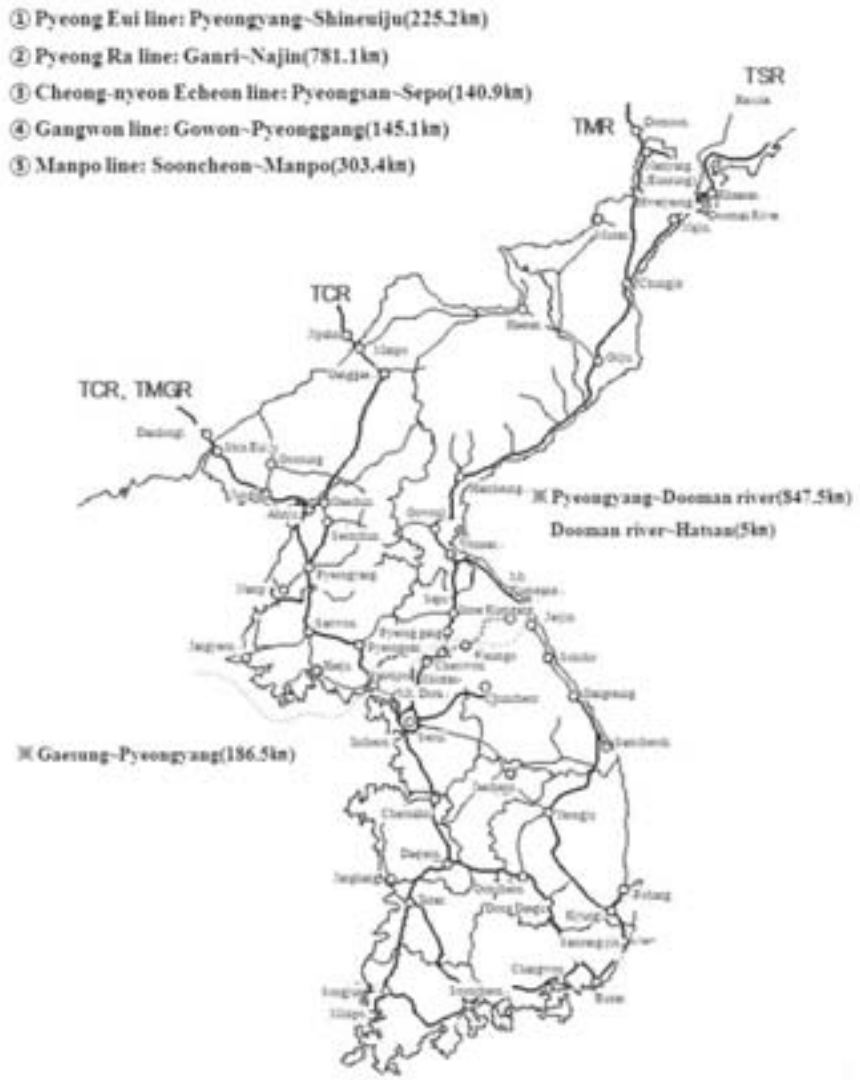
In the ROK– DPRK road network, 13 routes are cut off and this includes 6 routes of national roads. National Road No. 1, as of now, is completed of the 4-lane and 2-lane pavement up to the Joint Security Area and Panmunjeom respectively. As for National Road No. 3, it has been expanded to a 2-lane road to Woljeong-ri and 4-lane road to Yeoncheon for connection of the cut-off sections between Cheolwon and Pyeonggang. In National Road No. 5, a design for a 2-lane road to Saengchang is in progress for connection between Hwacheon and Pyeonggang. In addition, a 2-lane road pavement to Geumgok has completed. As for National Road No. 7, a design for a 2-lane road to the cease-fire line has completed for connection between Ganseong and Jangjin. Of the 13 routes with cut-off roads, 7 routes are of national and lower level roads. One is a regional road and the remaining six are other roads. For the ROK– DPRK road connection, ROK and DPRK agreed on Gyeongeui Line road connection (National Road No. 1, Munsan - Gaeseong) at the 1st and the 2nd Inter-Korean Ministerial Talk in July and August 2000. At the 7th Inter-Korean Ministerial Talk in August 2002, an agreement was reached on the Donghae Line road connection (Songhyeon-ri - Goseong). Gyeongeui Line, of which construction for road connection began in September 2002, measures a total of 12.1km. ROK handles the 5.1km section from the Tongildaegyo Bridge to the Military Demarcation Line (MDL) and DPRK is in charge of the 7.0km section from the MDL to Gaeseong. Pavement of the sections in ROK and DPRK was completed at the end of October 2003 and the end of November 2004 respectively. Donghae Line road connection project covers a total extension of 24.2km. For this, ROK is in charge of the 4.2km section from Songhyeon-ri to the MDL and DPRK is in charge of the 20.0km section from the MDL to Goseong. Pavement of the sections in ROK and DPRK was completed at the end of October 2004 and the end of November in the same year respectively.

Construction of all sections for the 4-lane Gyeongeui Line road and 2-lane Donghae Line road was completed at the end of 2004. The roads are being frequented by the traffic of humans, goods and vehicles since November 2004. For one year in 2004, a total of 30,899 cars used Gyeongeui Line and Donghae Line roads. 15,314 cars drove through Gyeongeui Line and 15,585 cars through Donghae Line. These figures indicate that the roads were used by an average of 2,500 cars a month and around 80 cars a day. However, only two routes of the existing cut-off roads have been connected and connection to other arterial axes in DPRK is insufficient. For example, in Donghae Line, construction for road connection has been carried out only up to the Mt. Geumgang zone and Donghae Line beyond this point lacks in basic conditions as a general motoring road in terms of center lines, lanes and shoulders. Therefore, in the present state, the roads can be used as transportation roads up to the Mt. Geumgang area. For the section north of Mt. Geumgang, such as Tongcheon, Wonsan and Hamheung, usability of the roads as motoring road is low.

ROK - DPRK Railway Connection Status

The government has been promoting restoration of Gyeongeui Line since 1985 in order to connect railway networks between ROK and DPRK. For Gyeongeui Line, working design and deliberation on environmental impact assessment were completed in 1985 and 1994 respectively. In addition, land purchasing has been continuously carried out since. As for Gyeongwon Line restoration project, working design and deliberation on environmental impact assessment were completed in 1991 and 1992 respectively. At present, purchasing of the land for project sites is in progress. In addition, working design for Mt. Geumgang Line was completed and construction plans for Donghae Bukbu Line were established in 1999. The ROK– DPRK railway connection started in full scale after ROK and DPRK had agreed on the Gyeongeui Line railway connection at the 1st and the 2nd Inter-Korean Ministerial Talk in July and August 2000 immediately after the Inter-Korean Summit. In particular, the Gyeongeui Line restoration project was completed on Sep. 16, 2000. As a result, in ROK, construction in the 10.2km section from Munsan and the MDL was completed and therefore railway service to Imjingak Station began in September 2001 and to Dorasan Station in April 2002. For efficiency of construction, the construction for 8km section from Munsan Station to Imjin River bridge was handled by (formerly) Korean National Railroad. For the 4km section from Imjin River bridge to MDL, the ROK Armed Forced was in charge of engineering work and removal of underground utilities and the (formerly) Korean National Railroad handled installation of facilities. At the 7th Inter-Korean Ministerial Talk in August 2002, an agreement was reached on commencement of Gyeongeui and Donghae Line railway construction and, accordingly, a commencement ceremony for construction of the Gyeongeui and Donghae Line railway connection was held jointly by ROK and DPRK on September 18, 2002. At the 8th Inter-Korean Economic Cooperation Committee meeting in March 2004, ROK agreed on providing materials for stations in DPRK necessary for the railway opening. The 27.3km section of Gyeongeui Line between Munsan and Gaeseong was built as a single-track railway and the construction cost was approx. KRW

Figure 2.3 Trans Korean Railway Network



Source: Korea Railroad Research Institute

Table 2.10 East corridor (Donghae Line) Transit Facilities

Classification	Road Transit Facilities	Railway Transit Facilities	Dorasan Logistics Center
Project Period	Sep. 23, 2004 – Jun 12, 2006	Sep. 23, 2004 – Apr. 30, 2006	Jun. 2006 – Sep. 30, 2010
Gross Area	14,055 m^2	6,705 m^2	12,041 m^2
Site Area	60,704 m^2	46,679 m^2	126,590 m^2
Building Scale	1 underground level, 2 ground levels	1 underground level, 2 ground levels	1 ground levels
Key Facilities	3 facilities including transit facility, Transit screening offices, offices of the related organizations	Jejin Station building, transit facility and 1 office building for the related government bureaus	8 facilities including general management building, plant quarantine shed, light cargo gate, management building of yard for common use
Implemented by	Wonju Regional Construction Management Administration	Korea Rail Network Authority	Korea Rail Network Authority
Construction Cost	KRW 54.8 billion	KRW 18.6 billion	KRW 47.7 billion
Completion Date	Jun. 12, 2006	Apr. 30, 2006	Sep. 30, 2010

Table 2.11 West corridor (Gyeongeui Line) Transit Facilities

Classification	Road Transit Facilities	Railway Transit Facilities	Dorasan Logistics Center
Project Period	Sep. 23, 2004 – May 3, 2006	Sep. 23, 2004 – Apr. 30, 2006	Oct. 2005 – Dec. 24, 2007
Gross Area	18,310 m^2	15,825 m^2	19,488 m^2
Site Area	75,178 m^2	38,656 m^2	328,181 m^2
Building Scale	1 underground level, 2 ground levels	1 underground level, 2 ground levels	1 ground levels
Key Facilities	13 facilities including transit facility, Transit screening offices, offices of the related organizations, departure processing office and the 3rd freight warehouse	Dorasan Station building, transit facility and 1 office building for the related government bureaus	25 facilities including container yard, customs shed, animal quarantine mooring, plant quarantine shed, parking lot and railway car inspection facility
Implemented by	Seoul Regional Construction Management Administration	Korea Rail Network Authority	Korea Rail Network Authority
Construction Cost	KRW 42.5 billion	KRW 36.2 billion	KRW 84 billion
Completion Date	May 3, 2006	Apr. 30, 2006	Dec. 24, 2007

Photograph 2.1 Donghae Line immigration (Jejin Station, East corridor)

Photograph 2.2 Gyeongeui Line immigration (Dorasan Station, West corridor)

90.3 billion (1USD = 1200 KRW). As for Donghae Line, KRW 91.2 billion was invested in a 25.5km single-track railway construction. At the 4th meeting of the Working Level Committee for the Inter-Korean Railway and Road Connection in April 2004, the basic agreement on railway operation between ROK and DPRK was initialed. With the basic agreement, together with vehicle operation agreement, a basic system for railway connection was secured.

Border Crossing (Jejin and Dorasan) Stations and Transit Facilities

Jejin and Dorasan Stations are Infrastructure of ROK at Border Crossing Points. The Jejin and the Dorasan station are located in Korean Peninsula East Corridor 6 and

West Corridor 5 respectively.

Jejin and Dorasan Stations are close to Mt. Kumgang and Kaesong Industrial Park in DPRK respectively. Infrastructure of ROK at Border Crossing Points aim to revitalize the special zone for economic cooperation. It will be a key role to the success of special economic zone project. In the long term view, Kaesong Industrial Park, Mt. Kumgang Tourism Business and Trans-Korean Railway/road will become powerful driving-force of the 'Inter Korean Economic Community' in the future.

Currently two border crossing stations secure the Inter-Korean Transit Office Facilities including container yard (Table 2.10 and Table 2.11).

Gyeongeui and Donghae railway/road connection project was completed now. In such a process, a bilateral or multilateral talk was held to connect the missing link. Road infrastructure was accomplished earlier, accelerating Kaesong industrial zone development from 2003 and promotes the Mt. Kumgang tourism project in 2004. Road infrastructure further revitalized the Mt. Kumgang tour to increase the tourist up to 300,000 annually. That is, inter-Korean infra project apparently led to promoting the borderland development project.

2.2.4 Ports

In terms of ports, cargo handling capacity and container processing capacity of both new and existing facilities has increased. In comparison to 2001, the total cargo handling capacity and container processing capacity increased by 3.3 million tons and 11,090,000 TEU respectively in 2009. There are 30 trade ports (14 nationally managed ports and 16 regionally managed ports) and 25 coastal ports currently in operation. As trade ports, 9 in the West Coast, 13 in the South Coast and 8 in the East Coast are equipped with 757 berths and 793,015 tons of cargo handling capacities as of the end of 2009.

In the area of logistics, inland container depots (ICD) have increased to alleviate the burden of containers piling up in ports in addition to improving cargo handling capacities. Composite logistics depots are under construction in each of the 5 zones. At present, logistics complexes are being developed and operated in 22 locations nationwide.

2.3 Performance Review of Corridors

The transportation and logistics system of the Northeast Asian region include the major transportation systems of railways, roads, marine and air transportation and the logistics centers connecting these systems. In spite of the differences in the political and economic systems and the geographical barriers, the Northeast Asian countries have begun to build the basic structure for the transportation and logistics system. While the land transportation by rail and road is still incomplete, most of the transportation depends on the marine and air transportation means.

The land transportation network of the Northeast Asian region is based on the 2-vertical and 2-horizontal axes. The 2-vertical axes are Busan (Korea) - Khabarovsk (Russia) and Dalian (China) - Khabarovsk (Russia). The 2-horizontal axes are Busan (Korea)-Dalian (China) and The Tumen River area – Chita (Russia). The hub cities of the lines are Busan, Dalian, Rajin, and Vladivostok.

The transportation and logistics system of the Northeast Asian region has been developed to a basic level, however, is still suffering from various problems based on the superannuated system, unbalanced infrastructure, unreasonable route layout, and the bottlenecks in the corridors.

As a whole, the infrastructure of the transportation and logistics system of the Northeast Asian region fall behind and the system efficiency is lower compared with those of the EU and the North American.

The transportation and logistics system of the Northeast Asian region show many unreasonable route layout, based on the unbalanced demand between the regions/countries and/or insufficient transportation infrastructure.

In addition, the transportation infrastructure in this region has many bottlenecks, formed by different railway gauges, old transition systems, bottlenecks at border points, biased air route allotment for national-flag airlines, complicated customs clear system, etc.

To find the solution for these problems, the GTI program of UNDP "Integrated Transport Infrastructure and Cross-Border Facilitation Study for the Trans-GTR Transport Corridors" is very important and timely for the development of GTR.

The cooperation for transportation in the Northeast Asian region has long been processed on two-party basis. However, recent trend shows multi-party cooperation initiatives including the ROK, DPRK and Russia for TKR-TSR connection and the GTI (Greater Tumen Initiative) based on the TRADP (Tumen River Area Development Programme), since early 1990s. In addition, the ministers' meeting of Korea, China, and Japan, since 2006, is a new development for the integration of the transportation and logistics system of the region.

In addition, various MOU and committee was signed in fields of transportation and logistics as following: Memorandum of Understanding on Cooperation in the field of Construction, Transport and Logistics between Mongolia and ROK(2011), Agreement of sea-land intermodal freight vehicle transportation between ROK and China (2010), Statement of intent between the aviation and railway accident investigation board (ARAIB) of the Republic of Korea and the Japan transport safety board (JTSB) maters of aviation and railway safety (2009), ROK-DPRK-Russia Railway Ministerial Meeting(2006), ROK-DPRK-Russia conference of the supreme representative(2004), Korea-Russia Transportation Cooperation Committee, member (2001,2002).

Rajin-Khasan project is the project for which the consultation between ROK-DPRK and Russia has been advanced in the past. Rajin-Khasan project refers to the trial effort for TKR-TSR project, But ROK cannot participate this project by ROK-DPRK relations strained. 'Rajin' is the strategic area in the Northeast Asia which is expected to attract the logistics cooperation among the DPRK, ROK and China and/or Russia. Recently, Chinese Government has been driving the 5-Point 1-Line Coastal Economic Belt Construction Initiative and the Chang-Ji-Tu Development Zone Initiative, along the Yalu and Tumen Rivers in the

Liaoning and Jilin Provinces. These initiatives are not limited to the 3 Northeast provinces of China, but underline cooperation and exchanges with the neighboring countries which are DPRK, Russia, Mongolia, ROK and Japan, in trading and economy, science and technology, and resources. For this, international transportation routes account for a significant part. The projects as the construction of the new bridge between Sinuiju and Dandong, and entrustment of the right for operating the Rajin harbor have been actively driven to construct transportation routes between DPRK and China.

In order to realize the project "Integrated Transport Infrastructure and Cross-Border Facilitation Study for the Trans-GTR Transport Corridors", a multilateral approach should be proposed to design and develop infrastructure facilities and operations in GTR. Based on the multilateral approach, a phased approach should be adopted. For the first phase, small and medium-scale localized project can be implemented. In the second phase, large-scale projects with heavy financial requirements can be built. In each phase, priority projects with importance can be selected. Low-cost and government-led pilot projects need to be implemented at the early stage and then we will be developed to the high-cost and large scale private projects that will attract the international investment.

3 Future Development Potential

3.1 Review of on-going/planned economic Development Projects likely to impact future traffic

China has been ROK's largest trade partner since 2004. In addition, it is necessary to respond to an increase of intra-trade among Korea, China, Russia and Japan and within the Northeastern Asian regions. Since large-scale transnational development projects are promoted around GTI areas and most of the related infrastructures have been implemented, it is necessary for Korea to prepare for a rapid increase in the new freight traffic demand in the future.

Gyeongeui railway and road (Gyeongeui Line, National Road No. 1, 4-lane road in both directions) and Donghae railway and road (Donghae Line, National Road No. 7, 2-lane road in both directions), which are connecting between ROK and DPRK, are the most important traffic networks in terms of not only the economic cooperation between ROK and DPRK, but also activation of inter-Korean exchange and implementation of a traffic network connecting to TAR and AH. Closely relevant with traffic demand triggered by Kaesong Industrial Complex and tourism development in Kaesong area, Gyeongeui railway and road, especially, are considered capable to handle the traffic demand generated in the initial stage of development. However, as the scale of development increases, the capacity will be exceeded at a certain point in time and this will result in traffic congestion. To solve this problem, it is necessary to establish short, mid and long-term plans for expansion of the existing connection infrastructures, new transportation means and connection methods. The plans as such must be established on the basis of analysis of the capacity of traffic facilities in DPRK and the estimated traffic demand between ROK and DPRK.

Kaesong industrial zone development, Mt. Kumgang tourism and Inter-Korean railway project that symbolize the inter-Korean economic cooperation serve the driving force in building the inter-Korean economic community. Railway and road connection projects between the two Koreas, among others, that aim at revitalizing the special zone for economic cooperation are more than important infrastructure, the key to the success of special economic zone project.

Gyeongeui railway and road connection project was completed and the cargo train between Munsan and Pongdong began running beginning in Dec 2007. In such a process, a bilateral or multilateral talk on connection of TKR and TRS among ROK, DPRK and Russia was held, and the two Koreas agreed in 2002 on connection of Donghae railway and road as a result of the effort to cooperate among the two Koreas and Russia. Road opening, which was relatively free from political issue, was accomplished earlier, accelerating Kaesong industrial zone development project from 2003 and Mt. Kumgang tourism project was converted to an overland travel from cruise tour beginning in 2004, which further revitalized the Mt. Kumgang tour to increase the tourist up to 300,000 annually. That is, inter-Korean railway project apparently led to promoting the borderland development project.

Despite of successful completion of the trans-Korean railway project, Gyeongeui line stopped its operation regretfully in December 2008 due to political deadlock between the two Koreas. Kaesong Industrial Zone still depends on individual logistics network, instead of joint logistics system. Difficulty in securing the economical efficiency under the unique situation between ROK and DPRK was what already expected from the beginning. However it's necessary to maintain the virtuous circle for special zone for economic cooperation and infrastructure between the two Koreas as a breach to deal with the deadlock between the two Koreas. When it comes to DPRK infrastructures, low-cost and government-led pilot projects need to be implemented at the early stage and then they will be developed, on a long-run, to the high-cost and large scale private projects that will attract the international investment. It's the strategy to modernize the DPRK's infrastructures system and create the virtuous circle of international logistics business so as to sharpen the international competitiveness.

3.2 Traffic and Transport Demand Forecasting

In this study, transportation demand for the integrated traffic network in the Korean peninsula is forecast and the set of transportation demand is divided into 4 areas within GTI region (a. ROK - DPRK, b. ROK - China/ Russia, c. DPRK - China/ Russia and d. transit shipment to China/ Russia) as shown in Figure 3.1. The arterial traffic networks for which transportation demand is estimated are Korean Peninsula West Corridor 5 and Korean Peninsula East Corridor 6.

This study assumes the economic growth rate of DPRK according to a scenario to maintain status quo and an optimistic scenario. Under the two scenarios, the annual average GDP increases in DPRK are assumed to be 5% and 10% respectively between 2011 and 2020 and 7% and 15% respectively between 2021 and 2025. For demand forecast,

Figure 3.1 Transportation demand set of 4 areas within GTI region (a. ROK - DPRK, b. ROK - China/ Russia, c. DPRK - China/ Russia and d. transit shipment to China/ Russia)

Source: Author

Figure 3.2 Freight O/D in 10 zones of ROK and DPRK

Source: Author

estimation curves are applied through a regression model in relation to the time-series data collected.

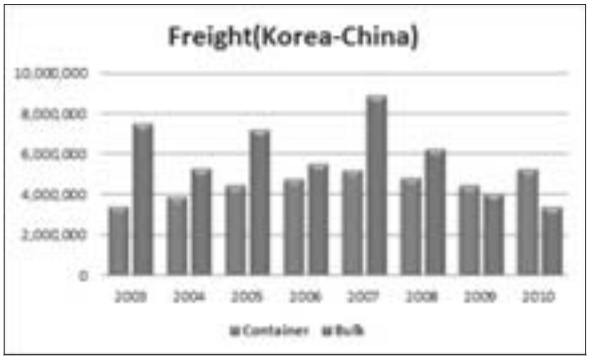
Of the demand for freight traffic in the GTI-linked zones, the traffic demand to Korean Peninsula West and East Corridor of GTI is estimated according to the quo and the optimistic scenario (as of 2015, 2020 and 2025) as follows. The freight traffic demand in the GTI-linked zones is divided into ROK - DPRK, Korea - China/ Russia, DPRK - China/ Russia, Korean Port - transit shipment to Russia/ China and demand for Changchun - Jilin – Tumen project. Each of the demand generated is equivalent to the total amount of traffic demand prior to division by transportation means.

ROK - DPRK Freight Traffic Demand

Based on the O/D of Mr. Seong (2005, ROK), estimations are calibrated considering the latest environments. As for specific demand, a scenario of cooperation for exchange between ROK – DPRK is taken into consideration.

To estimate freight demand between ROK and DPRK, freight O/D in 10 zones of ROK and DPRK used in previous studies are calibrated and used (Figure 3.2). Assuming an increase in exchange between ROK and DPRK and completion of the Gaeseong Industrial Complex development plans according to the scenario to maintain status quo, the annual freight demand between ROK and

Figure 3.3 Results of freight traffic estimation between ROK and China (Note: Korea is ROK)



Unit : ton

yy	Container
2010	5,268,517
2015	6,626,945
2020	7,790,578
2025	8,954,211

Source: Author

Figure 3.4 Results of freight traffic estimation between ROK and Russia (Note: Korea is ROK)

Unit : ton

yy	Container
2010	907,960
2015	1,438,089
2020	1,726,299
2025	2,014,510

Source: Author

Figure 3.5 Results of freight transit traffic estimation between ROK and China (Note: Korea is ROK)

Unit : ton

yy	Container
2010	9,282,754
2015	12,816,153
2020	15,693,449
2025	18,570,746

Source: Author

DPRK in 2025 is estimated as 124.53 million tons. Assuming a trend of increase in exchange between ROK and DPRK, development of Gaeseong Industrial Complex and an additional development of 4 special zones of economic cooperation between ROK and DPRK according to the optimistic scenario, the annual freight demand between ROK and DPRK in 2025 is estimated as 197.78 million tons. The estimation of Freight Traffic between ROK and DPRK is as follows for quo and optimistic scenario respectively.

Korea - China/ Russia Freight Traffic Demand

On-the-sea freights O/D by zone (Korea - the Three Northeastern Provinces, Hebei, Beijing/ Tianjin, far-east Russia, etc.) is used. For transport demand, estimation targeted only the import - export freight excluding transit shipment.

As shown in Figure 3.3, freight traffic volume of ROK-China increased steadily for 10 years despite world economic crisis in 2008. In the GTI-linked zones, the freight traffic demand to West and East Corridor is estimated according to the freight traffic data of 10 years old as follow. The freight demand between ROK and China will increase about two times for 15 years. The freight demand of transportation between ROK and China in 2025 is estimated to be 20.05 million tons.

Similar with China, freight traffic of ROK-Russia volume increased steadily for 10 years despite world economic crisis in 2008 (Figure 3.4). The freight demand will increase about two times for 15 years. The freight

Figure 3.6 Results of freight transit traffic estimation between ROK and Russia (Note: Korea is ROK)

Unit : ton

yy	Container (Bulk)
2010	1,945,739
2015	2,834,560
2020	3,792,712
2025	4,750,865

Source: Author

Table 3.1 Traffic demand of Korean Peninsula West and East Corridor in the GTR (2025)

Unit: Mil. ton

2025 year	ROK-DPRK	ROK-China	DPRK -China	Transit (China)	Transit (Russia)	ChangJiTu	Total
Total demand	124.53 (quo) 197.78 (optimistic)	20.05 (ROK - Dongbei) 10.22 (ROK - Russian Far East)	9.93 (DPRK - Jilin / Heilongjiang) 8.11 (DPRK - Liaoning)	-	-	-	172.83 (quo) 246.09 (optimistic)
Demand of West Corridor	104.86 (quo) 146.09 (optimistic)	20.05 (ROK - Dongbei)	8.11 (DPRK - Liaoning)	18.85	-	-	151.87 (quo) 193.09 (optimistic)
Demand of East Corridor	19.67 (quo) 51.70 (optimistic)	10.22 (ROK - Russian Far East)	9.93 (DPRK - Jilin / Heilongjiang)	-	4.98	1.36	46.16 (quo) 78.19 (optimistic)

Source: Author

demand of transportation between ROK and Russia in 2025 is estimated to be 10.22 million tons.

DPRK - China/ Russia Freight Traffic Demand

Trade volumes by region in DPRK - China (DPRK - the Three Northeastern Provinces, Beijing, Tianjin, Hebei, Shandong peninsula) is used. The demand for freight traffic of DPRK - Jilin / Heilongjiang in 2025 is estimated to be 9.93 million tons. And the demand for freight traffic of DPRK – Liaoning in 2025 is estimated to be 8.11 million tons.

Transit Shipment to China/ Russia

The estimation targeted transit shipment between Korea ports and the China/ Russia.

As shown in Figure 3.5, freight traffic volume of ROK-China increased steadily for 10 years despite world economic crisis in 2008. In the GTI-linked zones, the freight traffic demand to West and East Corridor is estimated according to the freight traffic data of 10 years old as follow. The freight demand between ROK and China will increase about two times for 15 years. The freight demand of transportation between ROK and China in 2025 is estimated to be 18.85 million tons.

Similar with China, freight traffic of ROK-Russia volume increased steadily for 10 years despite world economic crisis in 2008 (Figure 3.6). Especially, freight traffic volume for transit increased rapidly between ROK and Russia. The freight traffic demand will increase about two times for 15 years. The freight demand of transportation between ROK and Russia in 2025 is estimated to be 4.98 million tons.

Demand for Chang-Ji-Tu

An increase in the gross economy of Jilin Province according to the Changchun - Jilin - Tumen development plan (gross economy of Jilin Province to double in 2012, to quadruple in 2020) is taken into consideration. Of the freight volume to be generated by the Changchun - Jilin - Tumen development, approx. 11.46% is to Korea.

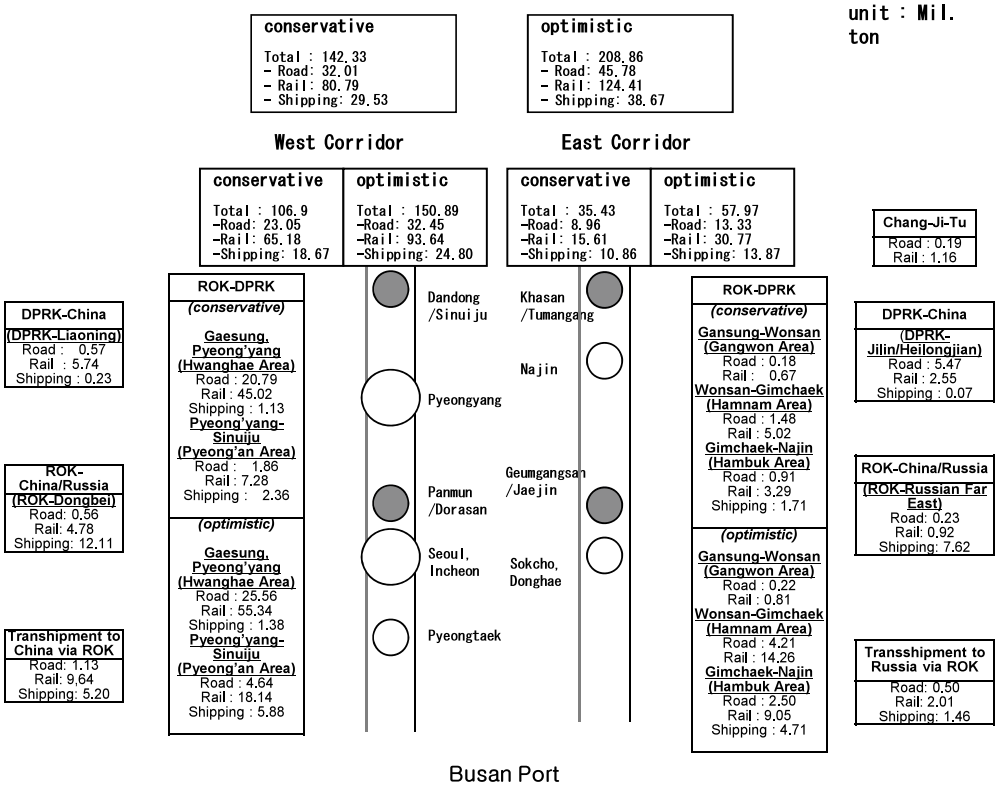
In the GTI-linked zones, traffic demand to Korean Peninsula West and East Corridor of GTI is estimated

Figure 3.7 Traffic demand to Korean Peninsula West and East Corridor

2020

Freight Traffic Demand of Korean Peninsula West and East Corridor related to the GTR (ROK)

unit : Mil. ton



according to the quo and the optimistic scenario as follows.

The traffic demand to Korean Peninsula West Corridor in 2025 is estimated to be 151.87 million tons according to the scenario to maintain status quo and 193.09 million tons according to the optimistic scenario (Table 3.1). The traffic demand to Korean Peninsula East Corridor in 2025 is estimated to be 46.16 million tons according to the scenario to maintain status quo and 78.19 million tons according to the optimistic scenario (Figure 3.7).

3.2 Special Issue Analysis: ROK-DPRK transport infrastructure and services

3.2.1 Inter-Korean Transit

Roles of Inter-Korean Transit Office

Inter-Korean Transit Office is operating 'overland route transit sites' designated to allow transit between ROK

and DPRK according to the 'Inter-Korean Exchange and Cooperation Act.' As a result of the ROK - DPRK railway and road connections and commencement of overland tours to Mt. Kumgang, a temporary transit office was established in February 2003 to process Inter-Korean transit operations. On November 20, 2003, the official Inter-Korean Transit Office was installed.

Inter-Korean Transit Office handles transit management, such as screening and quarantine of people visiting DPRK, civil affairs in relation to the transit, support for customs clearance of goods carried in and out between ROK and DPRK and contact and cooperation with DPRK in relation to train operation. The office maintains a cooperative system to work jointly with the Ministry of Unification, Ministry of Justice, Korea Customs Service, Ministry of Ministry of Health and Welfare, Ministry for Food, Agriculture, Forestry and Fisheries, Food and Drug Administration and Cultural Heritage Administration at the northernmost end of the Gyeongeui Line and Donghae Line roads and railways. Inter-Korean Transit Office is also serving as a gateway to the ROK - DPRK cooperation districts within DPRK, such as Kaesong Industrial Complex and Mt. Kumgang.

Inter-Korean Transit Procedures

The procedures and methods of inter-Korean transit are different from those applied to departure to or arrival from foreign countries. In general, one requires going through departure process by carrying a passport at the airport to depart from a country. However, to visit DPRK, visitors need to obtain an approval on the visit to DPRK in advance and have a certificate for visit to DPRK issued by the Minister of Unification instead of a passport (Table 3.2). As for screening, customs clearance and quarantine, the same procedures as of immigration apply.

Table 3.2 Differences between Immigration and Border Passage

Classification	Immigration	Border Passage
Differences	· Travel between countries, international trading · Visa and passport required · Handled by Immigration Office (Ministry of Justice)	· Travel between ROK and DPRK by affiliate persons, internal trading by the Korean race · Visitor's pass or certificate for stay and certificate for visit to DPRK required · Handled by Inter-Korean Transit Office (Ministry of Unification)
Same Procedures	· Screening, customs clearance, quarantine	

For the people of ROK to visit DPRK, it is required to obtain an approval on a visit to DPRK from the Ministry of Unification by submitting an application for the visit and then to obtain a certificate for visit to DPRK. In particular, to visit the Kaesong Industrial Complex, visitors must apply for a visitor's pass or a certificate of stay, which are certificates necessary for a visit to DPRK, on the OK System (online transit application system) operated by the Kaesong Industrial District Management Committee (KIDMAC).

Following the application, an approval for a visit to DPRK is checked on the inter-Korean exchange and cooperation system (http://www.tongtong.go.kr) of the Ministry of Unification. On the day of leaving border, visitors are to present their certificates for visit to DPRK to the Inter-Korean Transit Office, receive screening and leave the border. In DPRK, the visitors are to receive screening upon entry by presenting their visitor's pass or certificate of stay. In general, visitors can apply for a education and information program for visit to DPRK and a visitor's pass or a certificate of stay when applying for an approval on the visit to DPRK.

To visit DPRK on a car, visitors must apply for a certificate for visit to DPRK and then apply for an approval on the vehicle operation prior to submitting their transit plans. For a visit to the Kaesong Industrial Complex, an electronic vehicle operation certificate (RFID card) is issued when an application for vehicle operation is made on the inter-Korean exchange and cooperation system and screening is carried out automatically with the electronic certificate. That is, visitors on a car can swiftly pass through screening when they attach the electronic certificate (RFID card) on the front part of their vehicles.

Transit Facilities and Status

a. Transit Facilities

Following the ROK - DPRK railway and road connections, an one-stop service system was established in relation to all transit affairs including screening, customs clearance and quarantine to be carried out on people, vehicles and goods (freights) moving between ROK and DPRK by continuously expanding the related infrastructures to ensure convenience of the people visiting DPRK.

Inter-Korean Transit Office is operating Gyeongeui Line Road and Railway Transit Office in Munsan, Gyeonggi-do as a transit site for the western region to Kaesong and Pyongyang, etc. and Donghae Line Road and Railway Transit Office in Kosong, Kangwon-do as a transit site for the eastern region to Mt. Kumgang, etc.

Railway and road transit facilities for Gyeongeui Line Transit Office and Donghae Line Transit Office (including Dorasan Station and Jejin Station respectively) were completed in 2006. In addition, Gyeongeui Line Dorasan Logistics Center and Donghae Line Logistics Center were completed in December 2007 and September 2010 respectively. The scale of Inter-Korean Transit Office including Gyeongeui Line Transit Office and Donghae Line Transit Office is 675,988m^2 in site area and 51 buildings with a floor space of 86,424m^2.

For the Gyeongeui Line Transit Office in Munsan, Gyeonggi-do, road transit facilities were built for successful passage of vehicles and people in between ROK and DPRK, railway transit facilities were installed for ROK - DPRK train operation and Dorasan was opened for swift customs clearance and quarantine of goods (freight) and to supplement the insufficient logistics infrastructures in DPRK. The facility scale is 442,015m^2 in site area and 39 buildings with a floor space of 53,623m^2.

The Donghae Line Transit Office located in Kosong, Kangwon-do consists with road transit facilities, railway transit facilities and a logistics center over a site measuring

233,973 m^2. There are 12 buildings with a total floor space of 2,801 m^2.

b. Overland Route Transit Status

In 2010, 126,107 people and 81,414 vehicles traveled through the Gyeongeui overland route because the commuting traffic to and from the Kaesong Industrial Complex increased as the number of people staying within the complex decreased. As for Donghae overland route, 3,051 people and 1,027 vehicles traveled through it, which decreased from the previous year.

In 2011, the commuting traffic decreased as a result of an increase in the number of people staying in the complex for support to production activities of the tenant companies and, thus passage of people and vehicles through the Gyeongeui overland route (115,249 people, 1,414 vehicles) decreased slightly from the previous year. As for the Donghae overland route, 436 people and 198 vehicles traveled, which decreased from the previous year.

Inter-Korean Transit Office is located inside the civilian access control line. 3,834 and 6,062 people visited the office in 2010 and 2011 respectively. The visitors count is displaying an upward trend.

c. ROK - DPRK Freight Train Operation

The basic facilities for train operation between ROK and DPRK were established as the inter-Korean railway track construction on a Gyeongeui Line section (Munsan - Kaesong, 27.3km) and a Donghae Line section (Jejin - Mt. Kumgang, 25.5km) was completed at the end of December 2005. Following an agreement at the 13th meeting of the Inter-Korean Economic Cooperation Promotion Committee in April 2007, the ROK - DPRK railway pilot operation commenced on May 17, 2007. From December 11, 2007, the ROK - DPRK freight trains were operated five days a week excluding Saturdays and Sundays between Dorasan Station in ROK and Panmun Station in DPRK (departing Dorasan Station at nine in the morning, departing Panmun Station in DPRK at two in the afternoon).

In the beginning, a railway car consisting with 12 compartments (one engine car, ten freight cars and one cabin car) was used in the operation. From February 1, 2008, based on an agreement between ROK and DPRK, freight cars were operated only when freights were to be transported. When there were no freights to be transported; only the engine car and cabin car were operated. However, the freight train operation was stopped on November 28, 2008 as a result of the restriction of overland route transit by DPRK.

3.2.2 Possible solution for the bottleneck along the Korean Peninsula West Corridor 5

The current issues of ROK in relation to the ROK– DPRK Railway connected operation are as outlined below. The final destination of transportation by the ROK– DPRK railway connection is mainly in the metropolitan area and Busan Port/Gwangyang Port and therefore domestic railway transport capacity must be taken into consideration. In addition, ROK– DPRK railway connection in the metropolitan area must be via Gyeongeui Line. However, the metropolitan railway is in a radial shape stretching in all directions from downtown Seoul. Therefore, the capacity of not only Gyeongeui Line, but also Gyeongbu Line and Jungang Line is insufficient for ROK– DPRK freight transport.

In case of the Munsan – Susaek section of Gyeongeui Line, there is a possibility of its functions colliding with the metropolitan subway line functions. As for the Seoul – Siheung section of Gyeongbu Line, there are limitations in the capacity even when it is expanded through signal improvement, etc. In order to overcome the issues, the direction of metropolitan railway improvement has been set as of the following.

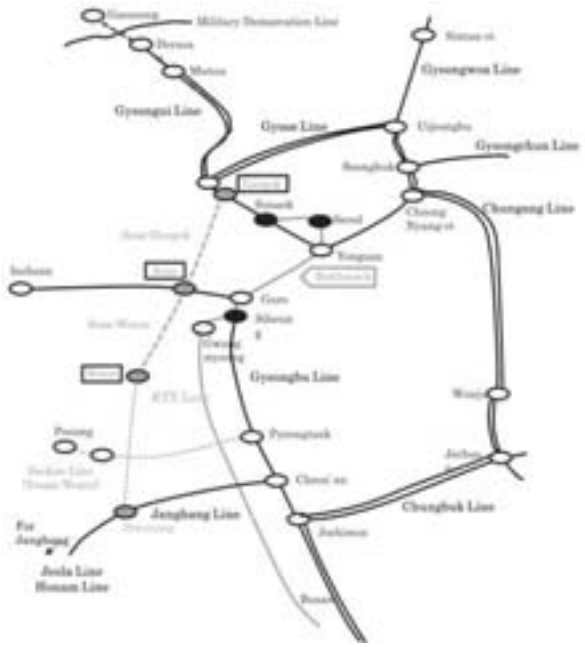
- Bypass Route in the Western Part of Metropolitan Area: Daegok – Sosa – Wonsi – Hwayang
- Bypass Route in the Eastern Part of Metropolitan Area: To use Gyeongeui/Gyeongwon Line via Chungbuk Line – Jungang Line

The Daegok – Sosa route connects Bucheon (Sosa Station, Gyeongin Line) and Ilsan (Neunggok Station, Gyeongin Line) of the currently prompted Sosa – Wonsi route in south – north direction. Linked to the Seohae railway to be built in the future (Wonsi-dong of Ansan – Hwayang and Yeosan of Chungcheongnam), it will function as an arterial railway network in preparation for the expanded exchange between ROK and DPRK. The Sosa – Wonsi route stretches from Sosa of Bucheon through Siheung to Wonsi-dong of Ansani. The route is scheduled for opening in 2015. This route starts from Sosa Station of Gyeongin Subway in Bucheon, passes through Siheung and ends at Wonsi-dong inside Banwol Industrial Complex of Ansan. A total of 12 stations will be installed along the route. After the subway line is completed, the consortium will hand over the title to the government and will recover construction cost and operating cost by operating the line for 20 years. Once the route is opened, it will bypass the metropolitan area and therefore connect between the northwestern and southwestern parts of the metropolitan area. As a result, it will not only provide traffic convenience but also significantly contribute to activating the West Coast axis development project in the future.

In case of the eastern route, it has to bypass a relatively longer distance. It requires improvement work, such as double-tracking in the single-line section. It is considered more effective to use the eastern bypass route as an alternative route in case the international logistics project in the Eurasian continent is completed in a short period of time and to encourage investment in and activation of the western bypass route in a mid to long-term.

This is a possible solution for the bottleneck along the Korean Peninsula West Corridor 5 (Figure 3.8). The solid line from Guro to Seoul in figure represents the bottleneck section. The dotted line is a railway line under construction. This line will be function as the western roundabout route for the metropolitan area. The double line is an existing route currently, and it curves around the eastern region of the metropolitan area. This eastern route travels a long distance around the region, and requires improvements such as double tracks. If the international logistics business of the Eurasia Continent is conducted in early, we can use the eastern roundabout route for short term, and invest in the western roundabout route for long-term basis.

Figure 3.8 Possible solutions for the bottleneck along the Korean Peninsula West Corridor 5



Source: Korea Railroad Research Institute

When connecting railway networks in ROK and DPRK, it will be necessary to (1) restore unconnected sections of the Donghae Line and Gyeongwon Line and (2) develop a bypass route in the metropolitan area and an alternative railway network.

3.3.4 Economic Feasibility of Automatic Variable Gauge System through LCC Analysis

One of issue in GTI region is break of gage at border crossing point (Figure 3.9). At this point, transshipment and transit including bogie change need to time consumption and cost. Variable gauge system (Figure 3.10) resolves the time and cost increasing due to transshipment and bogie change. It prevents damages of freights and provides comfortable operation service to passengers.

When the ROK – DPRK railway is connected with the continental railway, width of track will change in some borders. There will be no problems caused by transshipment when the amount of freights is small. However, when the amount of freights transported increases, it will result in bottleneck effect and therefore cause a number of problems in freight transportation. In Europe, free gauge train (FGT), which can be promptly and safely operated in areas where the width of track changes without bogie exchange or transshipment, is being operated.

Variable gauge system not only resolves the problems of time and cost increasing due to transshipment and transit, but also prevents damages to freights and provides comfortable operation service to passengers. In addition, this is an eco-friendly system more advantageous in handling hazardous and toxic freights. Moreover, using variable gauge system, additional cost for infrastructures, such as transit and bogie exchange facilities, in borders applied with different types of tracks can be reduced.

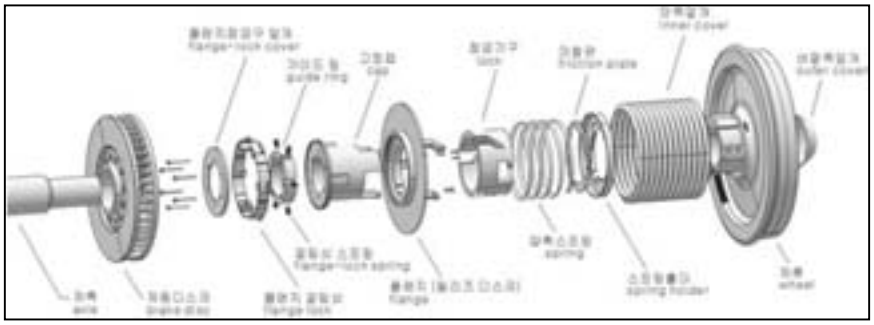
The applicable stations in the East Asian regions are as outlined below. These stations are currently using transshipment and bogie exchange facilities although the transit freight volume is increasing. Therefore, congestion is forecast to occur in these stations.

· Tumangang (DPRK/1,435mm) - Khasan (Russia/1,520 mm) Station
· Erenhot (China) - Zamin Uud (Mongolia)
· Manzhouli (China) - Zabaykalsk (Russia)
· Suifenhe (China) - Grodekovo (Russia)
· Hunchun (China) - Kraskino (Russia)
· Alashankou (Chian) - Druzhba (Kazakhstan)

This study aims at economic analysis necessary in introduction and operation of FGT in the future. For this, LCC (life cycle cost) analysis to predict the total cost incurring in the process of acquisition, operation, maintenance and disposal of FGT is conducted and

Figure 3.9 Break of gauge in GTI region

Figure 3.10 Automatic Variable Gauge Bogies



Source: Korea Railroad Research Institute

Table 3.3 Summary of LCC Analysis Results on Transport of Hazardous Materials by Transport Route and Scenario (1.2 million tons/ year)

Item	Route I TKR - TSR		Route II TKR – TSR – TMR - TSR	
	Scenario I (Bogie Exchange)	Scenario II (Variable Gauge Bogie)	Scenario I (Bogie Exchange)	Scenario II (Variable Gauge Bogie)
Freight Car Return, days	14.6	11.3	18.8	8.9
No. of Freight Cars Owned	1,106	856	1,419	670
Initial Investment Cost to Overcome Track Differences	KRW 176.6 billion	KRW 220.6 billion	KRW 236.1 billion	KRW 172.9 billion
Cost of Operation and Ownership to	KRW 304.0 billion	KRW 147.5 billion	KRW 723.3 billion	KRW 167.8 billion
Overcome Track Differences				
Total Life Cycle Cost of Transportation System	KRW 480.6 billion	KRW 368.1 billion	KRW 959.5 billion	KRW 340.7 billion
Transportation Unit Cost	KRW 13,349/ton	KRW 10,226/ton	KRW 26,653/ton	KRW 9,465/ton
Conclusion	In comparison to scenario I, transportation unit cost is reduced by approx. 23.4% in scenario II.		In comparison to scenario I, transportation unit cost is reduced by approx. 64.5% in scenario II.	

Source: Korea Railroad Research Institute

Table 3.4 Summary of LCC Analysis Results on Transport of Container by Transport Route and Scenario (100 Thousand million TEU/ year)

Item	Route I TKR - TSR		Route II TKR – TSR – TMR - TSR	
	Scenario I (Bogie Exchange)	Scenario II (Variable Gauge Bogie)	Scenario I (Bogie Exchange)	Scenario II (Variable Gauge Bogie)
Freight Car Return, days	14.9	11.6	19.1	9.2
No. of Freight Cars Owned	2,348	1,828	3,001	1,441
Initial Investment Cost to Overcome Track Differences	KRW 238.4 billion	KRW 397.2 billion	KRW 323.9 billion	KRW 313.4 billion
Cost of Operation and Ownership to Overcome Track Differences	KRW 587.6 billion	KRW 278.4 billion	KRW 1,419.7 billion	KRW 255.4 billion
Total Life Cycle Cost of Transportation System	KRW 826.0 billion	KRW 675.7 billion	KRW 1,742.6 billion	KRW 568.8 billion
Transportation Unit Cost	KRW 275,352 /TEU	KRW 225,240 /TEU	KRW 581,215 /TEU	KRW 189,607 /TEU
Conclusion	In comparison to scenario I, transportation unit cost is reduced by approx. 18.2% in scenario II.		In comparison to scenario I, transportation unit cost is reduced by approx. 67.4% in scenario II.	

Source: Korea Railroad Research Institute

therefore the feasibility of using variable gauge bogie in the Northeast Asian regions and GTI-linked zones is analyzed.

The LCC analysis of hazardous materials and container freight transport system is conducted in relation to two transport scenarios to overcome track differences.

- Scenario 1: Bogie exchange with lift jack (currently used method)
- Scenario 2: Automatic variable gauge (FGT)

Key Assumptions by Scenario:

- Freight Group and Transport Quantity:

1) Hazardous Materials (petroleum products and liquefied gas) – 1,200,000 tons/ year

2) Container – 100,000 TEU/ year

- Freight Car Loading Capacity:

1) A tank vehicle capable to load 50 tons

2) Container freight car

- Transport Distance:

1) Route I: TKR (Gyeongbu Line – Gyeongwon Line

– Pyeongla Line) - TSR

Busan – Seoul – Wonsan – Najin – Tumangang – Hasan – Khabarovsk – Chita – Ulan Ude

2) Route II: TKR (Gyeongbu Line – Gyeongwon Line – Pyeongla Line) – TSR –TMR - TSR

Busan – Seoul – Wonsan – Najin – Tumangang – Hasan – Gredekovo – Suifenhe – Manzhouli –Zabaykalsk – Chita – UlanUde

- Operation Method: Shuttle service

As a result of analysis, transport scenario II (automatic variable gauge) is found to be more economically feasible than transport scenario I (bogie exchange). The results of LCC analysis on transport scenarios by transport route and freight type are summarized as Table 3.3 and Table 3.4 (1 USD = 1200 KRW).

In the study, considering 1/2(half) operating labor cost and 20% reduction of variable gauge bogie, it is concluded that economic feasibility is higher when using variable gauge bogie.

4 Measures and Investment Program proposed to improve transport movements along the corridors (Status of ROK - DPRK & Northeast Asia Transportation Plans)

4.1 Constraints for traffic flows along the trans-GTI corridors

See Table 4.1.

4.2 Plans for Revision of the Fourth Comprehensive National Territorial Plan (2006~2020)

A. Establishing a Foundation for Formation of the Northeast Asian Development Community

To establish a foundation for formation of the Northeast Asian development community for economic integration and cooperation in Northeast Asia

- Aiming to lower development gaps between the advanced and underdeveloped regions in Northeast Asia through cooperation especially on traffic, logistics and energy fields.
- Organizing "Northeast Asian Infrastructures Development Organization (provisionally named)" and therefore promoting cooperation for infrastructures development covering a wide area

To strengthen international cooperation for implementation of an integrated traffic and logistics system in Northeast Asia

- Promoting cooperation for connection of the Trans-Korea Railway (TKR: Gyeongeui Line and Donghae Line) and trans-continental railways (TCR, TSR, TMR and TMGR)
- Promoting cooperation for connection of Asian Highway and express road networks in the Korean peninsula according to progress in relationship between ROK and DPRK

B. Expanding Exchange and Cooperation among Sub-cooperation Spheres in Northeast Asia

To implement an international labor division system and establish composite strategies in preparation for integration of regional economics, such as Korea - China - Japan FTA (Free Trade Agreement)

- Reorganizing regional industrial structures centering on competitive industries based on comparative advantages and promoting cooperation and division of roles among the three countries of Korea, China and Japan

To expand exchange and cooperation in the Pan Yellow Sea area, the Pan East Sea area and the Korea - Japan Strait area

- Preferentially strengthening industrial, logistics and tourism cooperation in Pan Yellow Sea area and Korea - Japan Strait area and cooperation among the open regions
- Strengthening industrial cooperation centering on electronic and information and communications industries for Bohai Bay of China as well as Gyeonggi-do and Incheon in the Pan Yellow Sea area
- Extensively promoting cooperation among countries in the Pan East Sea area centering on tourism, natural gas and maritime resources

To promote cooperation among local governments in the sub-spheres in response to the trends of decentralization and globalization in local areas

- Encouraging implementation of infrastructures for systems in response to each country for the fields of tariff, customs and immigration procedures and logistics service in order to promote domestic and overseas investment by establishing a network linking free economic zones
- Implementing a linked network for Incheon, Dalian and Qingdao in the Pan Yellow Sea area
- Implementing a linked network for Busan, Kitakushu and Niigata in the Pan East Sea area

C. Establishing a Peace Belt by Promoting Cooperative Projects in Borderland

To strengthen the foundation for ROK - DPRK exchange and cooperation by developing the borderland as a peace belt, a space of reconciliation and cooperation

D. Developing ROK - DPRK Cooperation for Step-by-step Development of the Special Economic Zones in DPRK

To develop special economic zones where the geo-economic potentials are high and the related infrastructures are established and therefore to promote ROK - DPRK cooperation

- Utilizing and developing Gaeseong Industrial Complex and Mt. Geumgang areas as a stage to try out reciprocal economic cooperation between ROK and DPRK

To expand traffic network and infrastructures for activation of special economic zones in DPRK

- Implementing communications network and power supply network for successful promotion of exchange and cooperation projects
- Expanding expressways, railways and ports connecting between ROK and DPRK in order to secure inland and marine traffic networks necessary in development of special economic zones

Table 4.1 Constraints along the trans-GTI corridors

	Constraint	Importance (How much it restricts the flow)	Timeframe (Reflects the Urgency)	Mitigation measures
Infrastructure				
Rail	- Missing link between ROK and DPRK	Severe	Urgent (2013-)	Reconnection of the missing link (Cheolwon – Pyeonggang & Cheolwon –Neageumgangsan; There are physically no rail.)
	- Improvement of Railway for International Logistic Service	Severe	Urgent (2013-)	Improvement of the railway section (Gaeseong - Sinuiju)
	-Modernization of DPRK's railroad for Korean Peninsula Corridors	Severe	Urgent (2017-)	In the modernization of DPRK infrastructure, low-cost and government-led pilot projects need to be implemented at the early stage and then they will be developed to the high-cost and large scale private projects that will attract the international investment. (Goseong(Gansung) – Najin, Pyeonggang -Wonsan)
	- Difference in gauges and axle load requirements	Moderate	2015-	Need to demonstration run of Automatic Variable Gauge System considering International Logistic Service
Road	- Missing link between ROK and DPRK	Severe	Urgent (2013-)	Reconnection of the missing link (No. 3 road of Cheolwon – Pyeonggang ; There are physically no road.)
	- Improvement for Logistic Service	Severe	Urgent (2013-)	Improvement of the road section(AH1 road; Gaeseong - Pyeongyang)
	-Modernization of DPRK's road for Korean Peninsula Corridors	Severe	Urgent (2017-)	In the modernization of DPRK infrastructure, low-cost and government-led pilot projects need to be implemented at the early stage and then they will be developed to the high-cost and large scale private projects that will attract the international investment. (AH1 road; Pyeonggang – Sinuiju, AH6 road; Goseong(Gansung) – Tumangang, Pyeonggang -Wonsan)
Port	-Modernization of DPRK's port for Korean Peninsula Corridors	Severe	Urgent (2013-)	In the modernization of DPRK infrastructure, low-cost and government-led pilot projects need to be implemented at the early stage and then they will be developed to the high-cost and large scale private projects that will attract the international investment. (Heaju, Nampo, Najin port rehabilitation)
BCP	Insufficient traffic network and infrastructures for activation of special economic zones in DPRK 3C Problem (Commutation, Communication and Customs)	Severe	Urgent (2013)	It is necessary to expand logistics infrastructures by stages according to the step-by-step implementation of projects in special districts for economic cooperation in the ROK - DPRK border areas and to activate the ROK - DPRK joint operation committee to increase efficiency of transit and customs-related operations.
Transport regulation	Not to join OSJD (Organization for Cooperation of Railway) in preparation for the international railway operation	Moderate	Urgent (2013)	Promoting to join OSJD with cooperation of member countries Improving laws and systems to simplify procedures in crossing borders, concluding international agreements (on routes, fares and operating conditions) and implementing railway operation by stages for successful promotion of the TKR-Trans Continental linking project

E. Implementing Integrated Infrastructures for the Korean Peninsula

To secure a foundation for expansion and further development of projects for cooperation in infrastructures development that are being currently implemented on a short-term basis

- Promoting ROK - DPRK cooperation to enhance transportation efficiency of Gyeongeui and Donghae Line railways and roads and to lower marine transportation cost between ROK and DPRK

To implement an integrated logistics network of the Korean peninsula on a mid to long-term basis that compositely links railways, roads, airports and ports between ROK and DPRK

- Implementing and modernizing cross-border railway routes
- Linking major airports, ports, arterial railways and express road networks

F. Establishing Key National Traffic Network for Half-day Life Zone

Roads

To promote balanced development of the national territory by establishing a grid-type arterial road network consisting with seven South - North axes and nine east - west axes

- Connecting areas of large traffic in between expressways and regions with express arterial road networks and implementing metropolitan belt way networks as part of arterial road networks
- Expanding expressways by stages according to priorities from the total extension of 2,923km as of 2004

To establish composite arterial road network plans comprehensively covering expressways and national roads in order to secure a foundation for long-term development of the national territory

Railways

Express railway network

- Completing stage 2 of Gyeongbu Express Railway project and building Honam Express Railway in order to encourage local development and to handle an increase of transportation demand according to the West Coast development
- Implementing an international railway transportation basis so the Korean peninsula can perform as a gateway to Asia and Europe as express railway networks are connected with TCR and TSR

To establish and promote systematic national railway network implementation plans to link express and general railway networks

Implementation of Inland Logistics Base Facilities

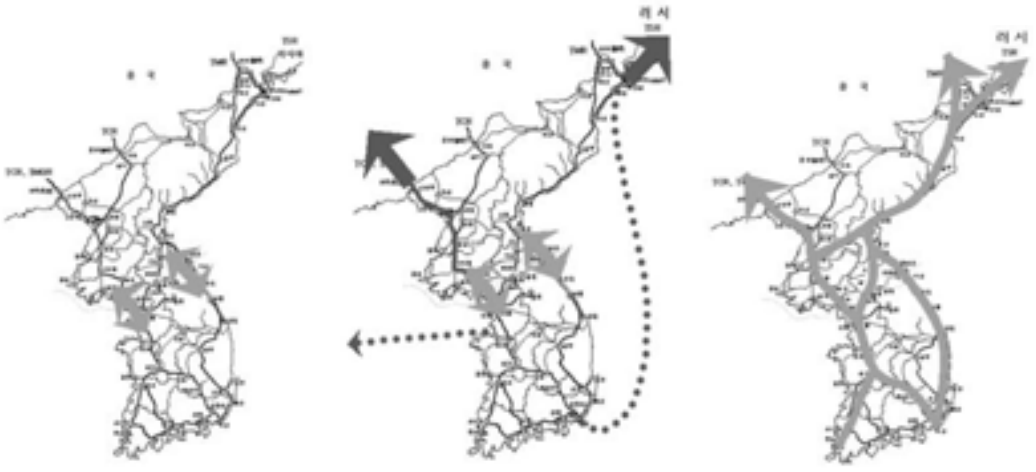
To establish inland logistics bases linked with arterial traffic facilities in order to implement an inland transport system for linked transportation between airports and ports

To expand and activate the functions of composite freight terminals and inland cargo depots (ICD) by each of the five areas nationwide

- SMA: Expanding existing facilities and establishing new logistics bases
- Busan Area: Focusing on activating functions of the facilities
- Jungbu, Yeongnam, Honam: Expanding facilities by stages and activating operation

To develop distribution and logistics complexes by region

Figure 5.1 Roadmap of Inter-Korean Transportation for ROK-DPRK Railway



Phase 1	Phase 2	Phase 3
Connection between ROK-DPRK	Improve DPRK Railroad	Modernize DPRK Railroad
Minimum maintenance of DPRK railroad → create/reinvest profits from transportation business	Improve DPRK railroad → expand transportation business, organize an international consortium	Modernize DPRK railroad to a 'new' railroad → complete Eurasia Land Bridge

5. Future Development of Trans Korean Transportation Infrastructure

The project of Trans Korean Transportation Infrastructure has a mission to restore the disconnected space of the Northeast Asia as well as to build the inter-Korean economic community.

For Korea to realize its future visions, it is important to promote spatial development of the Korean peninsula under the concept of "open territory" rather than "closed and exclusive territory". This means that the concept of national territory needs to be recognized afresh as an "open space" of exchange and cooperation rather than a physical area. If Korea and the Northeast Asia are to form a integrated economic zone in the future, one of the most fundamental conditions is none other than "mutual exchange". Trans Korean Transportation Infrastructure will also revitalize the personal and physical exchange in the territory of Northeast Asia, strengthening the connectivity with the Northeast Asia's economic zone.

For SOC development in the Korean peninsula, a step-by-step strategic approach is required where macroscopic goals are set, such as to achieve economic revitalization in DPRK, ROK - DPRK economic integration, long-term improvement of competitiveness in the Korean peninsula and cooperation for implementation of infrastructures in the Northeast Asia, and to achieve the goals accordingly.

Step one of the approach is to build local infrastructures in the ROK - DPRK border areas. At present, Gyeongeui and Donghae Line railways and roads have been completed. Step two is to expand the infrastructures according to activation of special districts in the border areas and to promote infrastructures development in preparation for the demand for traffic between DPRK and Russia, DPRK and China and through DPRK. A Eurasian logistics project is currently on the way in line with the Najin - Khasan railway renovation and it is necessary to promote additional logistics projects for Northeast Asian regions according to the renovation of Gyeongeui Line. Step three is to increase infrastructures in preparation for the demand of traffic through the Korean peninsula and inside DPRK. In the long run, it is necessary to continuously improve internal capacities of infrastructures in the Korean peninsula at the same time as linked implementation of the Eurasian infrastructures network.

Thus, the paper proposes the implementation strategy in stage for Inter-Korean railway for practical approach as the driving factor in structuring the Inter-Korean economic community and the multilateral railway cooperation. To that end, the measures to modernize the DPRK railway and create the virtuous circle of logistics industry, thereby strengthening the international logistics competition.

It's necessary to work out the phasing strategy to develop the DPRK railway network and suggest the medium & long-term road map for inter-Korean railway (Figure 5.1).

Stage 1 (inter-Korean railway connection stage) is the phase for construction of regional infrastructure at the borderland such as Gaesung and Mt Geumgang. It's the stage completed. Gyeongeui and Donghae line and overland route have been completed.

Stage 2 (DPRK railway restoration stage) is the phase for implementation of infrastructure development stage in preparation for the demand from the trans- Korea. It's the stage currently required. To accomplish the goal, the project among the two Koreas and Russia or the two Koreas and China need to be developed likes Najin-Hasan project and logistics business linking Shimyang - Pyungyang - Seoul – Busan.

Stage 3 (modernization of DPRK railroad) is the stage to improve the infrastructure (double-tracking and high-speed) in preparation for transit and potential DPRK demand. It's the stage to modernize DPRK railway system based on construction of the new line we understand. On a long-run, it's the stage requiring internal improvement for construction of infrastructure network in Northeast Asia and constant infrastructure in Korean Peninsula.

When it comes to modernization of DPRK railway, low-cost and government-led pilot projects need to be implemented at the early stage and then they will be developed to the high-cost and large scale private projects that will attract the international investment.

Moreover, as Trans Korean Transportation Infrastructure contribute to economic and security-related cooperation in Northeast Asia and cooperation in the Northeast Asia, in turn, contributes to the improvement of ROK- DPRK relationship, it will be possible to ultimately look forward to a virtuous cycle leading to unification of Korea and integration of the Northeast Asia.