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Simulating Logistics Changes in South Korea Caused by Trans-Eurasia Logistics Passing through North Korea

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북한 통관 유라시아 횡단 물류에 따른 국내 물류 변화 시뮬레이션 분석

정재운
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Abstract Ever since Korea was geopolitically divided into North and South Korea in the 1940s, South Korea has depended on maritime transportation for global trade and logistics. Now, however, South Korea is preparing to develop a new global route for trans-Eurasia logistics passing through North Korea. Even though there are difficulties to overcome, South Korea expects that a new overland route, shorter than the existing seaways in the Europe–Asia section, will bring more frequent trade with more rapid and cost-effective logistics services in the future. Related to this issue, this study aims to proactively analyze dynamic logistics changes in South Korea when a trans-Korea railway is developed and linked with the trans-China railway and the trans-Siberian railway. This study employed a system dynamics simulation approach to model the logistics system in South Korea. The simulation results indicated that the traffic of the Uiwang inland container depot near the capital area may increase but the traffic of the Port of Busan may decrease. With supplementary research, consequently, follow-up studies on adjusting the traffic capacity in Korea are required to attain successful trans-Eurasia logistics by rail.

Key Words : Trans-Eurasia Logistics, Trans-Korea Railway, Logistics Change, System Dynamics, Simulation

요 약 한국은 1940년대 남북분단 이후 국제 무역 및 물류를 위해 해상운송에 의존해 왔으며, 현재는 북한을 경유하는 유라시아 횡단 물류를 위해 새로운 경로의 개발을 준비하고 있다. 이를 위해 극복해야 할 많은 어려움이 존재하지만, 한국은 아시아와 유럽 구간의 기존 해상경로보다 짧은 새로운 육상경로가 앞으로 더욱 빠르고 비용 효과적인 물류서비스를 통해 더 많은 교역을 가져올 것으로 기대하고 있다. 이와 관련하여 본 연구는 한국종단철도가 개발되어 중국 및 시베리아 횡단철도와 연결된 상황에서의 국내물류 변화를 미리 분석해 보고자 한다. 국내 물류시스템의 모델링을 위해 시스템다이내믹스 시뮬레이션 기법을 사용하였다. 시뮬레이션 결과 수도권과 가까운 의왕 ICD의 물동량은 증가하는 반면, 부산항의 물동량은 감소할 가능성이 있는 것으로 나타났다. 철도를 활용한 유라시아 횡단 물류의 성공을 위해서는 본 연구의 보완과 더불어 국내 물동량 처리 용량의 조정에 관한 후속연구가 필요하다.

주제어 : 유라시아 횡단 물류, 한국종단철도, 물류변화, 시스템다이내믹스, 시뮬레이션

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1. Introduction

A peninsula, as a portal linking the land and sea, has a geographical advantage as a center or bridge of trade, transportation, and culture between neighboring countries [1,2]. When peninsular countries wane, their geographical location becomes a liability prone to occupation by neighboring powers rather than a strategic location [3].

In modern history, the Korean Peninsula was occupied and used as a bridgehead for approximately 35 years until 1945 by Japan, which had military ambitions to expand its territory into Eurasia [4]. Just after the Japanese colonial period ended, the Korean Peninsula was regarded as a buffer zone in the cold war and was divided into North Korea (communist) and South Korea (capitalist), based on the 38th parallel of latitude, by world powers such as China, Russia, and the USA [5]. The division soon carried over into the outbreak of the Korean War, which evolved into a proxy war of the neighboring great powers [6].

In the 1950s just after the Korean War, ruined South Korea was one of the poorest countries in the world; however, as of 2017, South Korea has become the world's 6th-largest exporter and 11th-largest national economy [7,8]. This progress was based on the world's economic assistance in the recovery from the Korean War and the strong desire and efforts of South Korea to escape from poverty with export-driven industrial development policies [9]. This export-driven economic growth required developing the port and shipping industries; as a result, Busan (or Pusan) is ranked as the world's 6th-busiest port [10]. The Port of Busan handles approximately 80% of the total container exports and imports in South Korea [11].

Conversely, approximately half of South Korea's residents (49.5%) live in Seoul and near the city in Incheon and Kyeunggi-do [12]. More than half of manufacturers are located in the capital area including Seoul, and their exports are primarily transported approximately 400 km to the Port of Busan by road or railway [13-15].

The capital area of South Korea is contiguous with North Korea; therefore, if there were a safe overland route connected to North Korea, exports from South Korea to the mainland of Eurasia could be directly transported without detouring to Busan.

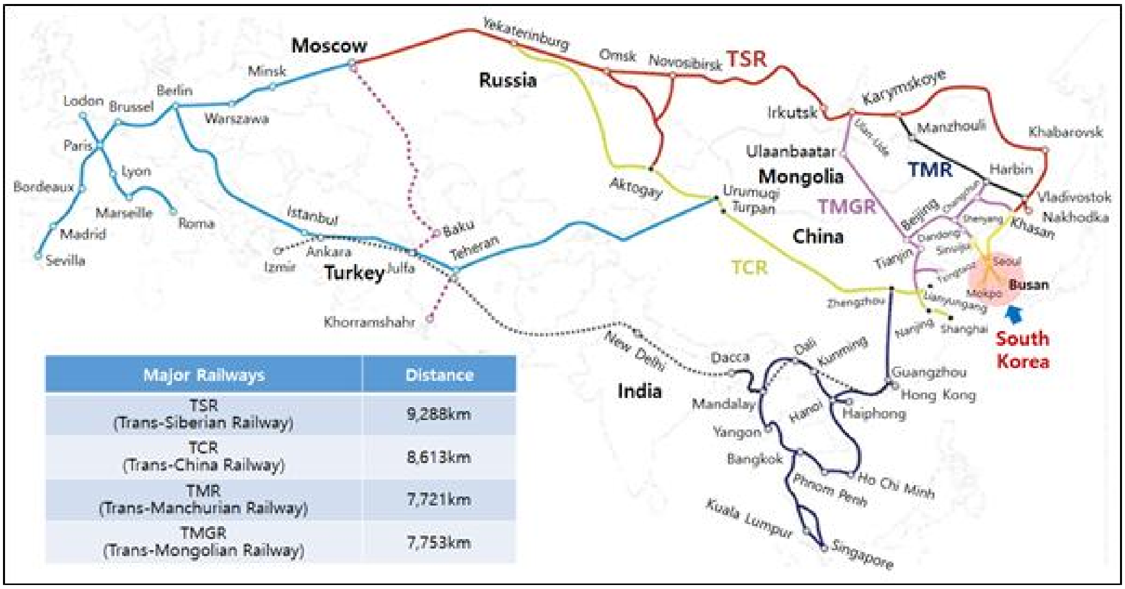
This reasonable conjecture considers a trans-Korea railway (TKR) as an enabler, good for long-distance transportation and available to connect to the trans-China railway (TCR) and the trans-Siberian railway (TSR) throughout Eurasia [16,17].

To realize this new route, South Korea will need to proactively understand and cope with diverse changes inside and outside its borders. This study, in terms of logistics, aims to analyze the dynamics in South Korea after the TKR is connected with the TCR and TSR systems to Europe. For this analysis, the system dynamics simulation approach is employed.

2. Trans-Eurasia Routes from South Korea

Exports from Europe and Asia account for approximately 70% of the world's trade and more than half of the world's gross domestic product (GDP) [18,19]. The leading exporter, China, accounted for 14% of the world's total exports as of 2015 [20]. China has shown steady economic growth since its accession to the World Trade Organization in 2001 [21]. Of the top 10 world's busiest container ports in 2001, 4 were Chinese ports including Hong Kong; however, as of 2017, 7 of the top 10 busiest container ports belonged to Chinese territories [22].

Having the world's 6th-busiest port (Busan), South Korea is the world's 6th-largest exporter [22-24]. In 2013, export-oriented South Korea presented the Eurasia Initiative to link energy and logistics infrastructures across Europe and Asia based on a gradual elimination of world trade barriers to overcome the long-term economic recession [25,26].



Major Railways	Distance
TSR (Trans-Siberian Railway)	9,288km
TCR (Trans-China Railway)	8,613km
TMR (Trans-Manchurian Railway)	7,721km
TMGR (Trans-Mongolian Railway)	7,753km

Fig. 1. Trans-Eurasia Railways from South Korea to Europe ([29], edited)

Located in the huge northern area of Eurasia, Russia has a plan to modernize the old TSR from Moscow to the far eastern area of Vostochny, approximately 9,300 km (the world's longest railway), and this issue is bound with the South Korea initiative to connect to the TSR for a new global market and route linking Eurasian countries [27-30]. For each goal, both countries agreed to cooperate to modernize and extend the TSR to the Korean Peninsula (TKR); this link can transport nearly three times faster and cost-effectively than the existing seaway through the Suez Canal [31].

In the past, North Korea hesitated to participate in this cooperative project but has recently signaled willingness to cooperate with neighboring countries including South Korea and Russia [32-36].

Conversely, China has another Eurasia initiative called "One Belt One Road Initiative" to enforce a China-centered economic network in Eurasia [37,38]. The grand plan of China can be merged with the Eurasia Initiative of South Korea in some areas to create additional benefits [39].

At the base of these grand plans is an expectation for a so-called 21st century new silk road renaissance where interconnected trans-Eurasia railways play the role as a catalyst to reinforce the diverse cooperative networks of Eurasian countries in economy, trade, transportation, and culture [40,41].

For seamless trans-Eurasia transportation, multifaceted collaboration is required, and diverse collaborative projects are underway or have been negotiated with Eurasian countries (e.g., China - Russia - Latvia and South Korea - North Korea - Russia) [42,43].

The backbone of trans-Eurasia railways from/to South Korea is composed of the TKR, TCR, and TSR linked with branches or local lines such as the trans-Manchurian railway and the trans-Mongolian railway (See Fig. 1).

3. Baseline Simulation Model for Shipping Logistics in South Korea

To address logistics problems composed of diverse objects and their dynamic activities, discrete event and system dynamics simulation modeling approaches are generally used [44]. The discrete event simulation

(DES) approach is employed for operational and tactical issues, and system dynamics (SD) approaches are preferred in strategic issues [45,46].

This research employs the SD approach, which is more abstractive and deductive than DES or agent-based modeling approaches focusing on individualized objects [47]. Building a complex model such a trans-Eurasia logistics system requires considering numerous factors (e.g., transportation routes, modes, and agents). In this case, model abstraction or summarization is an alternative approach to reduce the complexity of the problem.

In terms of the modeling scope, this study focuses on the logistics dynamics of containerized cargo inside South Korea caused by trans-Eurasia logistics. It abstracts the area outside of South Korea.

To analyze the logistics dynamics inside South Korea caused by trans-Eurasia logistics, this study builds and compares the following two models: a baseline model (the existing seaway model) and a trans-Eurasia railway model. The handling of containers (containerized cargo) is reproduced in the two models. The models are built and simulated by the Powersim Studio S/W package [48].

3.1 Baseline Data for Modeling

To characterize the logistics dynamics in South Korea after the TKR is developed and connected to the TCR and TSR for trans-Eurasia logistics, this study first builds a maritime transportation model as a baseline model to compare with the trans-Eurasia railway model.

As previously mentioned, approximately 80% of South Korea's total container throughput is handled in Busan; therefore, this study regards the container handling data of Busan as helpful to represent and simplify the global shipping model of South Korea. From this perspective, this study builds the baseline model using the Busan container statistics information. Tables 1 and 2 show the container handling numbers in Busan (outer ports) from 2003 to 2016 as retrieved from the Port-MIS of the Busan Regional Office of Oceans and Fisheries [49].

Table 1. Container Traffic by Handling Type

(Unit: TEU)

Year	import	Export	T/S	Total
2003	3,029,640	3,005,855	4,250,615	10,286,110
2004	3,285,750	3,308,282	4,790,949	11,384,981
2005	3,309,136	3,269,941	5,178,518	11,757,595
2006	3,429,111	3,373,998	5,207,629	12,010,738
2007	3,752,716	3,690,938	5,811,049	13,254,703
2008	3,853,094	3,784,885	5,807,714	13,445,693
2009	3,266,677	3,301,949	5,372,338	11,940,964
2010	3,913,580	3,922,659	6,276,331	14,112,570
2011	4,402,706	4,305,252	7,352,417	16,060,375
2012	4,381,541	4,426,368	8,147,329	16,955,238
2013	4,424,024	4,509,214	8,748,237	17,681,475
2014	4,596,200	4,657,522	9,429,146	18,682,868
2015	4,713,141	4,650,051	10,105,112	19,468,304
2016	4,801,032	4,819,238	9,835,630	19,455,900

* Retrieved from the Port-MIS of the Busan Regional Office of Oceans and Fisheries [49]

Table 2. Container Traffic by Shipping Region

(Unit: TEU)

Year	FEA	NA	Japan	SEA	Europe
2003	3,123,182	2,209,392	1,565,538	921,287	922,384
2004	3,451,606	2,428,494	1,789,670	1,005,872	1,085,790
2005	3,643,094	2,549,187	1,823,398	941,502	993,532
2006	3,857,326	2,457,201	1,996,373	991,436	863,542
2007	4,285,517	2,578,731	2,085,079	1,121,076	1,024,665
2008	4,244,773	2,511,353	2,144,289	1,177,109	921,176
2009	3,669,423	2,122,950	1,911,167	1,190,131	859,226
2010	4,396,267	2,451,110	2,258,947	1,355,135	1,027,471
2011	5,161,104	2,673,733	2,418,002	1,424,439	1,168,025
2012	5,444,090	2,821,406	2,594,137	1,704,364	1,222,798
2013	5,770,321	2,875,037	2,758,222	1,855,477	1,287,529
2014	6,094,943	3,014,966	2,803,959	1,833,684	1,514,759
2015	6,241,524	3,353,186	2,754,560	1,874,535	1,560,295
2016	6,223,175	3,352,696	2,810,959	2,027,781	1,440,337

* Retrieved from the Port-MIS of the Busan Regional Office of Oceans and Fisheries [49]

The data in Table 1 are categorized according to the purpose of the cargo transportation in Busan: import, export, and transshipment (T/S). Table 2 shows the container traffic of the five busiest regions trading with

Busan: Far East Asia (FEA), North America (NA), Japan, Southeast Asia (SEA), and Europe.

As of 2016, the container traffic in FEA and Europe accounted for approximately 40% of the total container traffic in Busan. Their transportation mode can be switched from seaway to railway using the TKR, TCR, and TSR.

However, there are four inland container depots (ICD) in South Korea. Of these, the Uiwang ICD covering the capital area is the busiest and 96% of the total traffic of the Uiwang ICD is handled in the section connected to Busan via railway or road [50].

This characteristic of inland container transportation is helpful for making a simple model, as shown in Fig. 2.

Fig. 2. Major Sections for Inland Container Transportation in Souht Korea ([50], edited)

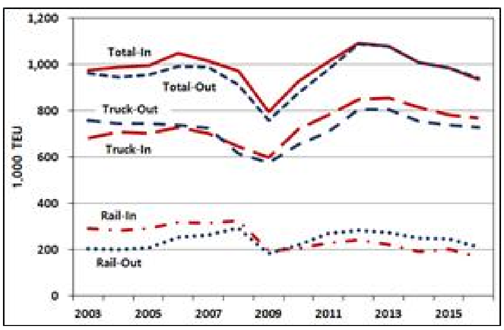


Fig. 3. Container Traffic of the Uiwang ICD [51]

Fig. 3 presents the annual container traffic of the Uiwang ICD from 2003 to 2016. The data are composed of carrying-in and carrying-out by truck (Truck-In, Truck-Out) and rail (Rail-In, Rail-Out). Total carrying-in and carrying-out containers are marked as Total-In (Truck-In + Rail-In) and Total-Out (Truck-Out + Rail-Out) on the graph.

3.2 Developing a Baseline Simulation Model

Disconnected via North Korea, South Korea delivers a portion of the FEA export containers from Busan to China, Russia, and Europe along the TCR and TSR after shipping through seaways, as depicted in Fig. 4.

Based on the existing logistics process and data (including Tables 1 and 2 and Fig. 3), this study developed a baseline simulation model (Model 1) for the global and domestic container logistics of South Korea (See Fig. 5).

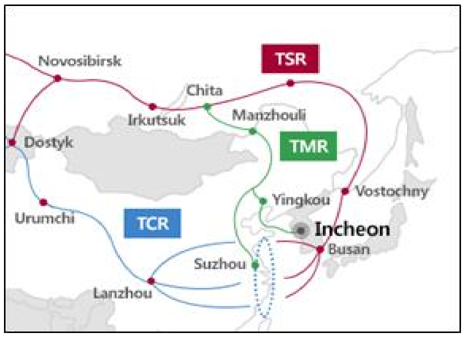


Fig. 4. Trans-Eurasia Railways without the TKR [53]

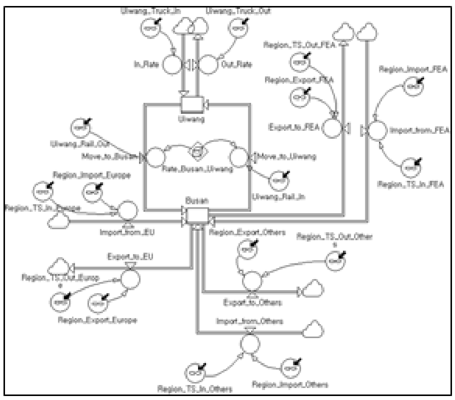


Fig. 5. Baseline Model without the Trans-Eurasia Railways (Model1)

Table 3. Variables and Equations in Model1

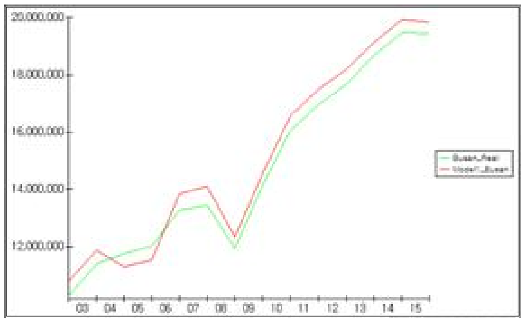
Variables	Equations
Busan	250000
Export_to_EU	INTEGER(Region_Export_Europe +Region_TS_Out_Europe) /1<<yr>>
Export_to_FEA	INTEGER(Region_Export_FEA +Region_TS_Out_FEA)/1<<yr>>
Export_to_Others	INTEGER(Region_Export_Others+Region_TS_Out_Others) /1<<yr>>
Import_from_EU	INTEGER(Region_Import_Europe +Region_TS_In_Europe) /1<<yr>>
Import_from_FEA	INTEGER(Region_Import_FEA +Region_TS_In_FEA)/1<<yr>>
Import_from_Others	INTEGER(Region_Import_Others+Region_TS_In_Others)/1<<yr>>
In_Rate	INTEGER(Uiwang_Truck_In) /1<<yr>>
Move_to_Busan	INTEGER(Uiwang_Rail_Out *(RND_Rate_Uiwang))/1<<yr>>
Move_to_Uiwang	INTEGER(Uiwang_Rail_In *RND_Rate_Uiwang)/1<<yr>>
Out_Rate	INTEGER(Uiwang_Truck_Out) /1<<yr>>
Rate _Busan_Uiwang	NORMAL(1,0.05,0.1)
Region_Export_Europe	DB Connected
Region_Export_FEA	DB Connected
Region_Export_Others	DB Connected
Region_Import_Europe	DB Connected
Region_Import_FEA	DB Connected
Region_Import_Others	DB Connected
Region_TS_In_Europe	DB Connected
Region_TS_In_FEA	DB Connected
Region_TS_In_Others	DB Connected
Region_TS_Out_Europe	DB Connected
Region_TS_Out_FEA	DB Connected
Region_TS_Out_Others	DB Connected
Uiwang	30000
Uiwang_Rail_In	DB Connected
Uiwang_Rail_Out	DB Connected
Uiwang_Truck_In	DB Connected
Uiwang_Truck_Out	DB Connected

Table 3 presents the variables and equations (values) used in Model 1, which was developed in Powersim Studio. The variables Busan and Uiwang in Table 3 represent the container handling traffic in each area as the variable stock calculated by Equation (1) [52]. The variables flows (in and out) mean the transported containers from and to each area at time t.

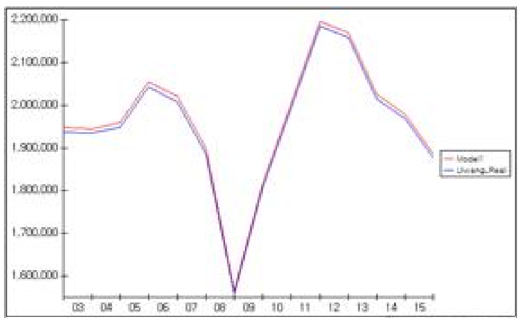
$$Stock(t) = \int_{t_0}^{t} [Inflow(s) - Outflow(s)]ds + Stock(t_0). \quad (1)$$

For efficient modeling, variables using real data were connected with the DB (database). (See the Appendix for the DB including additional data not presented in Section 3.1.)

To identify the modal shift effect following trans-Eurasia railway transportation with Europe and FEA from/to South Korea, other regions were summarized as others in Model 1.



(a) Represented Result of the Port of Busan (Total)



(b) Represented Result of the Uiwang ICD (Total)

Fig. 6. Represented Results of Model 1

Table 4. Fitting Result of Model 1

	R-squared	p-value
(a) Port of Busan	0.9899	0.00
(b) Uiwang ICD	0.9999	0.00

In addition, the capacities of the Port of Busan and the Uiwang ICD are not limited to understand overflowing processes.

The capacity of the container equipment ability in the Uiwang ICD is approximately 45,000 TEU, and as of October 2016, approximately 75% or 33,000 TEU was stored there [54]. The initial value of the stored containers in the Uiwang ICD was set to 30,000 TEU. In the case of the Port of Busan, the maximum storage capacity is approximately 505,000 TEU [55]. The initial storage of containers was set to 250,000 TEU in the model.

To evaluate the validity of Model 1, the simulated results of Model 1 were compared to the real data. Fig. 6 shows graphs of the represented results of Model 1 ((a) Uiwang ICD: domestic area and (b) Port of Busan: domestic and overseas area) and the real data of total container handling in the Port of Busan and the Uiwang ICD.

Model 1 showed a good representation of the existing logistics system of South Korea ((a) Uiwang ICD: 99.99%, (b) Port of Busan: 98.99%) (See Table 4).

4. Trans-Eurasia Railway Model of South Korea

To characterize the change that occurred before and after the modal shift to a trans-Eurasian railway passing through North Korea, this study assumes that the existing container traffic of FEA and Europe from/to Busan shifts to the trans-Eurasia railway connected with the TKR from the seaway.

Fig. 7 shows a virtual TKR map spread on border areas passing through North Korea connected with South Korea (southward), China, and Russia (northward) [56,57].

With this assumption, Model 2 added a modal shift module to Model 1 in which the traffic (import, export, T/S-in, and T/S-out) of Europe and FEA would shift from seaway to railway according to various scenarios (rates). Fig. 8 is a schematic of Model 2.

Fig. 7. TKR Connected with the TCR and TSR [56]

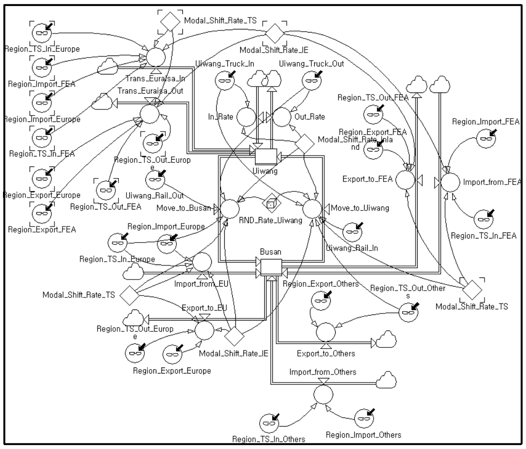
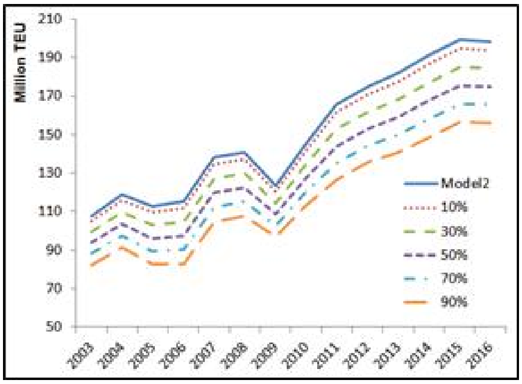


Fig. 8. The Trans-Eurasia Railway Model (Model 2)

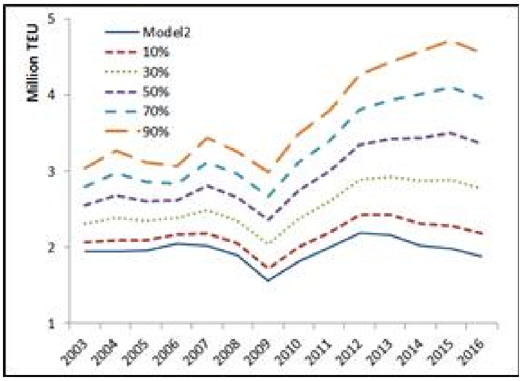
Table 5. Variables and Equations Added to Model 2

Variables	Equations
Export_to_EU	INTEGER((Region_Export_Europe)*(1-Modal_Shift_Rate)+ Region_TS_Out_Europe*(1Modal_Shift_Rate_TS))/1<<yr>>
Export_to_FEA	INTEGER(Region_Export_FEA*(1-Modal_Shift_Rate)+ Region_TS_Out_FEA*(1-Modal_Shift_Rate_TS))/1<<yr>>
Export_to_Others	INTEGER(Region_Export_Others*(1-Modal_Shift_Rate)+ Region_TS_Out_Others*(1-Modal_Shift_Rate_TS))/1<<yr>>
Import_from_EU	INTEGER(Region_Import_Europe*(1-Modal_Shift_Rate)+ Region_TS_In_Europe*(1-Modal_Shift_Rate_TS))/1<<yr>>

Import_from_FEA	INTEGER(Region_Import_FEA*(1-Modal_Shift_Rate)+Region_TS_In_FEA*(1-Modal_Shift_Rate_TS))/1<<yr>>
Import_from_Others	INTEGER(Region_Import_Others*(1-Modal_Shift_Rate)+Region_TS_In_Others*(1-Modal_Shift_Rate_TS))/1<<yr>>
In_Rate	INTEGER(Uiwang_Truck_In*(1-Modal_Shift_Inland))/1<<yr>>
Modal_Shift_Rate_IE	0
Modal_Shift_Rate_Inland	0
Modal_Shift_Rate_TS	0
Move_to_Busan	INTEGER(Uiwang_Rail_Out*(RND_Rate_Uiwang)*(1-Modal_Shift_Rate)+Region_TS_In_Europe*Modal_Shift_Rate_TS+Uiwang_Truck_Out*Modal_Shift_Inland)/1<<yr>>
Move_to_Uiwang	INTEGER(Uiwang_Rail_In*RND_Rate_Uiwang*(1-Modal_Shift_Rate)+Region_TS_Out_Others*Modal_Shift_Rate_TS+Uiwang_Truck_In*Modal_Shift_Inland)/1<<yr>>
Out_Rate	INTEGER(Uiwang_Truck_Out*(1-Modal_Shift_Inland))/1<<yr>>
Trans_Euraisa_In	INTEGER((Region_Import_Europe+Region_Import_FEA)*Modal_Shift_Rate+(Region_TS_In_Europe+Region_TS_In_FEA)*Modal_Shift_Rate_TS) /1<<yr>>
Trans_Euraisa_Out	INTEGER((Region_Export_Europe+Region_Export_FEA)*Modal_Shift_Rate+(Region_TS_Out_Europe+Region_TS_Out_FEA)*Modal_Shift_Rate_TS)/1<<yr>>



(a) The Port of Busan



(b) The Uiwang ICD

Fig. 9. Total Container Traffic Change According to the Modal Shift Rate

Table 5 presents the variables and equations (values) in Model 2 added to Model 1. Model 2 simulates the container handling traffic according to the modal shift rate of the export, import, and T/S traffic of Busan from/to Europe and FEA.

Fig. 9 shows the simulated results of the modal shift from seaway to railway in the regions of Europe and FEA by 10%, 30%, 50%, 70%, and 90%.

This result indicates that the container handling traffic in the Port of Busan decreases but the handling of containers at the Uiwang ICD increases as the modal shift rate increases when the trans-Eurasia railway connected with the TKR is operated nearly three times faster and cost-effective than the existing seaway through the Suez Canal.

The Port of Busan will still be important to transport exports and to handle transshipment after the operation of the trans-Eurasian railway; however, its handling traffic will vary depending on the modal shift rate.

In addition, the Uiwang ICD needs to enlarge its capacity to accept increased traffic due to such a modal shift.

5. Conclusion

This study examined the domestic logistics changes caused by a modal shift from the existing seaway to trans-Eurasia railways for faster and cheaper global trade to and from South Korea, which has operated a port-centric logistics system for the last seven decades.

If South Korea operates the TKR with North Korea, many exports for Eurasian countries will be directly delivered via the TKR without a detour to Busan. This means that there may be a change in the role of the busy Port of Busan in South Korea.

Handling this issue, in which South Korea hopes to connect to the TCR and TSR, requires close cooperation with North Korea and other neighboring countries. To satisfy this prerequisite, this study assumed that a trans-Eurasia railway linking with the TCR and TSR was connected to South Korea through North Korea via the TKR.

Based on this assumption, this study built a simulation model to characterize the container traffic change in the Port of Busan (the busiest sea port in South Korea) and the Uiwang ICD (the busiest inland depot in South Korea) for various modal shift scenarios (rates) of Europe and FEA traffic ranging from 10% to 90%.

The simulations indicate that the handling traffic of the Port of Busan decreases, while the traffic of the Uiwang ICD increases.

With supplementary research, consequently, follow-up studies on a domestic adjustment or redesign of the logistics infrastructure and operating assets is required for the secure trans-Eurasia logistics of South Korea in the future.

Even though this simulation model did not consider all the individual factors (variables) related to trans-Eurasia logistics, it efficiently represented reality using variables that were abstracted and summarized via an SD simulation modeling approach.

In addition, this study helps envisage the dynamic logistics changes in South Korea caused by operation of the TKR and provides insight for relevant studies to develop a Eurasian logistics strategy focusing on South Korea in the future.

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Appendix

DB 1. Region_Export_[field name]

(Unit: TEU)

	Europe	FEA	Others	Total
2003	295,507	919,345	1,791,003	3,005,855
2004	339,106	1,016,331	1,952,845	3,308,282
2005	305,148	1,016,808	1,726,141	3,269,941
2006	327,452	1,087,693	1,724,485	3,373,998
2007	401,059	1,201,053	2,088,826	3,690,938
2008	356,641	1,249,639	2,178,605	3,784,885
2009	306,809	941,178	2,053,962	3,301,949
2010	383,081	1,074,901	2,464,677	3,922,659
2011	419,302	1,138,617	2,747,333	4,305,252
2012	409,817	1,194,749	2,821,802	4,426,368
2013	435,659	1,282,044	2,791,511	4,509,214
2014	490,548	1,339,717	2,827,257	4,657,522
2015	520,383	1,266,118	2,863,550	4,650,051
2016	542,388	1,315,883	2,960,967	4,819,238

* Retrieved from the Port-MIS of the Busan Regional Office of Oceans and Fisheries [49]

** All regions except Europe and FEA were summarized as others

DB 2. Region_Import_[field name]

(Unit: TEU)

	Europe	FEA	Others	Total
2003	308,677	753,649	1,967,314	3,029,640
2004	386,024	831,645	2,068,081	3,285,750
2005	373,188	828,102	1,793,682	3,309,136
2006	335,607	932,035	1,797,168	3,429,111
2007	383,717	1,021,901	2,347,098	3,752,716
2008	358,499	975,494	2,519,101	3,853,094
2009	334,109	799,350	2,133,218	3,266,677
2010	380,481	1,018,444	2,514,655	3,913,580
2011	441,550	1,161,106	2,800,050	4,402,706
2012	458,426	1,110,818	2,812,297	4,381,541
2013	469,735	1,118,658	2,835,631	4,424,024
2014	534,244	1,126,253	2,935,703	4,596,200
2015	534,711	1,109,865	3,068,565	4,713,141
2016	526,014	1,150,829	3,124,189	4,801,032

* Retrieved from the Port-MIS of the Busan Regional Office of Oceans and Fisheries [49]

** All regions except Europe and FEA were summarized as others

DB 3. Region_TS_In_[field name]

(Unit: TEU)

	Eureope	FEA	Others	Total
2003	210,543	995,364	969,420	2,175,327
2004	237,384	1,075,167	1,095,489	2,408,040
2005	201,292	1,203,691	1,031,964	2,606,042
2006	104,334	1,244,167	1,103,812	2,620,585
2007	121,540	1,342,212	1,464,176	2,927,928
2008	116,054	1,251,076	1,549,373	2,916,503
2009	132,322	1,202,094	1,382,205	2,716,621
2010	147,980	1,468,194	1,567,510	3,183,684
2011	180,855	1,730,735	1,856,718	3,768,308
2012	206,675	1,910,172	2,012,179	4,129,026
2013	219,561	2,011,298	2,191,725	4,422,584
2014	273,676	2,169,255	2,293,570	4,736,501
2015	255,104	2,318,246	2,491,027	5,064,377
2016	182,039	2,209,096	2,540,467	4,931,602

* Retrieved from the Port-MIS of the Busan Regional Office of Oceans and Fisheries [49]

** All regions except Europe and FEA were summarized as others

DB 4. Region_TS_Out_[field name]

(Unit: TEU)

	Europe	FEA	Others	Total
2003	107,657	454,824	1,512,807	2,075,288
2004	123,276	528,463	1,731,170	2,382,909
2005	113,904	594,493	1,595,961	2,572,476
2006	96,149	593,431	1,604,969	2,587,044
2007	118,349	720,351	2,044,421	2,883,121
2008	89,982	768,564	2,032,665	2,891,211
2009	85,986	726,801	1,842,930	2,655,717
2010	115,929	834,728	2,141,990	3,092,647
2011	126,318	1,130,646	2,327,145	3,584,109
2012	147,880	1,228,351	2,642,072	4,018,303
2013	162,574	1,358,321	2,804,758	4,325,653
2014	216,291	1,459,718	3,016,636	4,692,645
2015	250,097	1,547,295	3,243,343	5,040,735
2016	189,896	1,547,367	3,166,765	4,904,028

* Retrieved from the Port-MIS of the Busan Regional Office of Oceans and Fisheries [49]

** All regions except Europe and FEA were summarized as others

DB 5. Uiwang_[field name]

(Unit: TEU)

	In	Out	Total
2003	974,591	962,822	1,937,413
2004	989,529	945,663	1,935,192
2005	994,840	954,498	1,949,338
2006	1,049,688	992,785	2,042,473
2007	1,016,517	990,411	2,006,928
2008	973,748	912,397	1,886,145
2009	796,340	760,771	1,557,111
2010	927,874	877,928	1,805,802
2011	1,011,706	979,762	1,991,468
2012	1,093,589	1,090,665	2,184,254
2013	1,079,776	1,078,470	2,158,246
2014	1,007,646	1,007,873	2,015,519
2015	984,377	985,013	1,969,390
2016	936,441	941,349	1,877,790

* Retrieved from the Uiwang ICD [51]