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Improving Efficiency of Truck Flows in *Uiwang* ICD and its Surrounding Areas

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Title: Improving Efficiency of Truck Flows in *Uiwang* ICD and its Surrounding Areas

Abstract

Uiwang ICD is a pivotal logistics infrastructure playing the role as a gateway for Korean international trade and a central logistics hub to serve the Seoul Metropolitan Areas (SMA). There is an increasing demand for *Uiwang* ICD to enhance its role as a key import and export logistics center in the SMA, optimizing logistics processing efficiency in anticipation of future demands, and ensuring seamless operations not only within *Uiwang* ICD but also in the surrounding areas. Hence, there is a pressing requirement for new development strategies and operational plans to enhance traffic flows and facilitate the expansion of railway infrastructure. *Uiwang* ICD lacks dedicated roads for freight trucks, and the railway lines established and roads within the ICD are neither fully separated nor elevated, resulting in inefficient container cargo truck operations and an increased risk of safety incidents. The concentration of truck traffic leads to insufficient parking space in the ICD, exacerbating traffic congestion. This congestion not only affects *Uiwang* ICD itself but also extends to its surrounding areas. The study aims at identifying and understanding traffic flow challenges at *Uiwang* ICD and its surroundings, while proposing solutions to enhance the efficiency of truck movements. The emphasis is placed on improving the intermodal transportation system, with the specific goal of addressing traffic congestion issues within and around *Uiwang* ICD. The ultimate objective of this study is to suggest diverse strategies, including road system improvement, traffic rerouting, advanced technology integration, site expansion, and modal shift promotion (from road to rail transport) for improving efficiency of container cargo truck flows in and around *Uiwang* ICD.

Keywords: Uiwang Inland Container Depot (ICD), container cargo trucks, efficiency of truck movement (truck flow), traffic congestion, container yards, integration of advance technology, expansion of site, modal shift, rail transportation, road transportation.

INTRODUCTION

Background

Uiwang ICD stands as a pivotal logistics infrastructure, serving as both a gateway for Korean international trade and a central logistics hub supporting the Seoul Metropolitan Areas (SMA). With the escalating volume of cargo managed by *Uiwang* ICD, there arises a growing need for an expanded and more efficient logistics processing framework, integrating with industrial complexes. There is an increasing demand for *Uiwang* ICD to enhance its role as a key import and export logistics center in the SMA, optimizing logistics processing efficiency in anticipation of future demands, and ensuring seamless operations not only within *Uiwang* ICD but also in the surrounding areas. Hence, there is a pressing requirement for new development strategies and operational plans to enhance traffic flows and facilitate the expansion of railway infrastructure.

Furthermore, under the Build-Operate-Transfer (BOT) contract, the privately invested project, *Uiwang* ICD, is set to be transferred to the Korea Railroad Corporation (KORAIL) upon the contract's expiration in 2023. Before the contract terminates, it is imperative to outline a new development and operational strategy for *Uiwang* ICD to propel it towards further growth. The new plan should not only augment the role of *Uiwang* ICD as a logistics hub in the SMA but should also align with the national long-term logistics plans, considering various stakeholders. This new plan should comprehensively address aspects such as strengthening logistics functions, rearranging facilities, expanding support functions, improving transportation systems and traffic flow, rationalizing operational processes, exploring new business opportunities, and proposing measures for facility and site expansion, all while taking into account the anticipated future demand for *Uiwang* ICD.

When focusing on the aspects of improving transportation systems and traffic flows for *Uiwang* ICD, there are several issues popped up. *Uiwang* ICD lacks dedicated roads for freight trucks, and the railway lines established and roads within the ICD are neither fully separated nor elevated, resulting in inefficient container cargo truck operations and an increased risk of safety incidents. Especially, during peak hours from 7 a.m. to 1 p.m., the concentration of truck traffic leads to insufficient parking space within the ICD, exacerbating traffic congestion. This congestion not only affects *Uiwang* ICD itself but also extends to its surrounding areas. Unauthorized parking and traffic congestion have also become significant issues around Uiwang ICD perimeter due to the insufficient availability of suitable parking spaces. This congestion problem is exacerbated by the entry and exit of a number of heavy-duty trucks for container cargo transportation.

Purpose of study

The objective of this study is to identify and comprehend traffic flow challenges at *Uiwang* ICD and its surroundings, while proposing solutions to enhance the efficiency of truck movements. The emphasis is placed on improving the intermodal transportation system, with the specific goal of addressing traffic congestion issues within and around *Uiwang* ICD. The study aims to recommend various strategies, including improvement of road system, traffic rerouting, integration of advanced technology, expansion of site, promotion of modal shift (to rail transport), and exploration of any other potential scopes for improvement efficiency of truck flows.

UIWANG INLAND CONTAINER DEPOT (ICD)

Overview

Uiwang ICD is an inland container depot situated in the Seoul Metropolitan Area (SMA), established as one of the five major regional logistics bases through the efforts of the logistics infrastructure investment coordination committee of Korea. Positioned at 175 *Obong-ro*, *Uiwang* City, *Gyeonggi-do*, it spans approximately 753,000 square meters. The facility comprises Terminal 1 and Terminal 2, operational since July 1993 and January 1997, respectively. *Uiwang* ICD is equipped with an annual container handling capacity of 1.37 million TEU.

Table 1. Facilities in Uiwang ICD (2014)

Classification	Total	Terminal 1	Terminal 2
Site Area	752,680 sqm	491,668 sqm	261,012 sqm
Container Yard (CY)	387,932 sqm	254,622 sqm	133,310 sqm
Container Freight Storage (CFS)	10,712 sqm (3 bldgs)	4,629 sqm (2 bldgs)	6,083 sqm (1 bldg)
Operation Building/Office	14,358 sqm (8 bldgs)	6,797 sqm (5 bldgs)	7,561 sqm (3 bldgs)
Vehicle Maintenance Garage	1,795 sqm (1 bldg)	1,795 sqm (1 bldg)	-
Container Garage	1,226 sqm (1 bldg)	1,226 sqm (1 bldg)	-
Refrigeration Power Facility	72 facilities	-	72 facilities
Railway Track	6,262 m (11 tracks)	3,720 m (8 tracks)	2,542 m (3 tracks)
Gas Station	6,254 sqm	6,254 sqm	-
Car Parking Lot	531 spaces	323 spaces	208 spaces
Truck Parking Lot	238 spaces	146 spaces	92 spaces

Source: Internal document from *Uiwang* ICD Corporation, Ltd.

Table 2. Loading/unloading Equipment in Uiwang ICD (2014)

Classification	Usage	Count
Transfer Cranes	rail transportation	3
Reach Stackers	yard work	47
Tractors	road transportation	652
Trailers	road transportation	1,800

Source: *Uiwang* ICD Co., Ltd. (http://www.uicd.co.kr/)

Uiwang ICD was established through a build-operate-transfer (BOT) contract, representing one form of public-private partnership (PPP). Operated by Uiwang ICD Co., Ltd., the company received capital investments from the Korea Railroad Corporation (Korail) and sixteen major shipping and freight transportation companies. *Uiwang* ICD Co., Ltd., holds a 30-

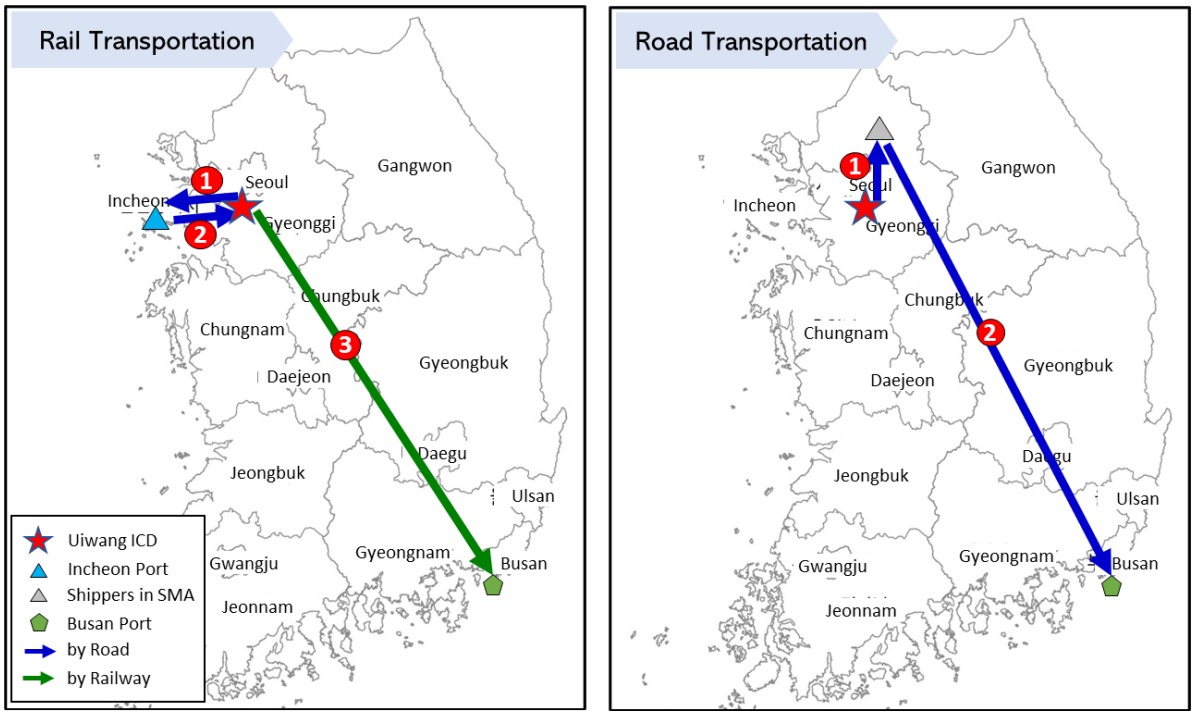
year concession from Korail for the management and operation of the facility, with the project scheduled to revert to Korail in June 2023 upon the conclusion of the concession period.

Major Functions

The primary objective of *Uiwang* ICD is to enhance the distribution structure of international trade container cargo, aiming to reduce logistics costs and bolster national logistics competitiveness. It serves as an inland container port with multiple functions, including customs clearance, railway and road transport for import/export container cargo. Additionally, the facility acts as a supply and demand base for empty containers within the Seoul Metropolitan Area.

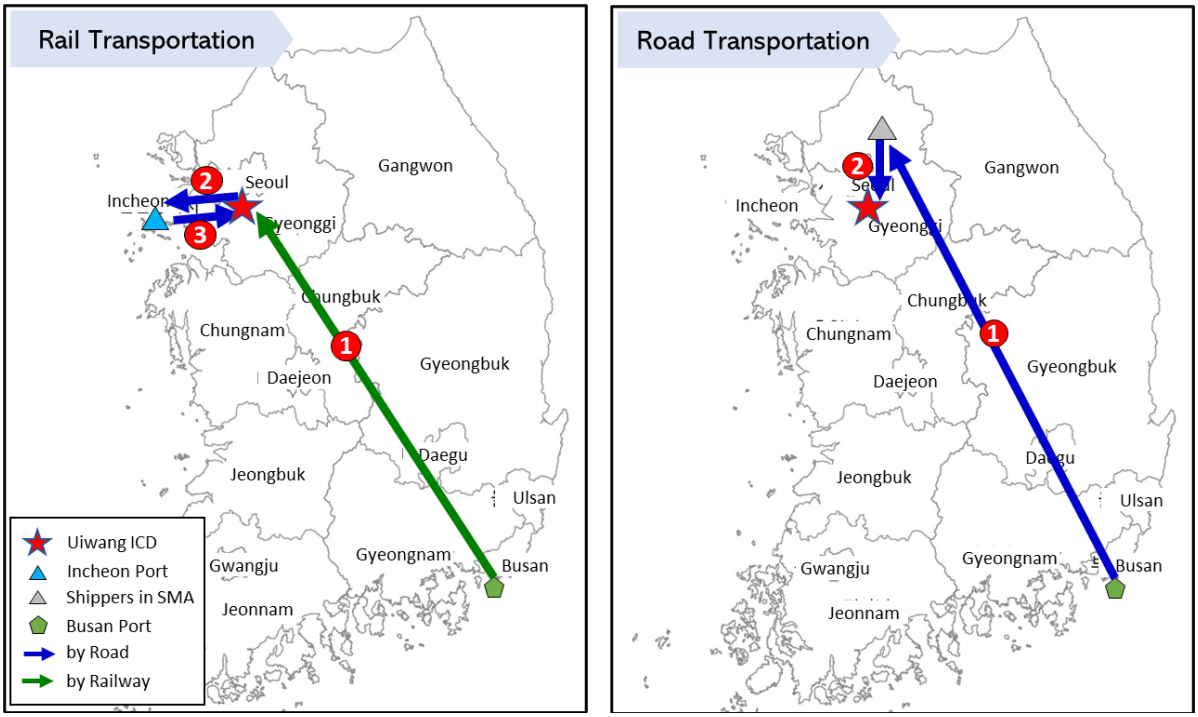
Rail transport is utilized for longer distances between *Uiwang* ICD and import/export ports, while road transport is employed for shorter distances between *Uiwang* ICD and shippers in the SMA. *Uiwang* ICD streamlines customs clearance processes, allowing shippers to handle them on-site, saving both time and costs compared to traditional port clearance procedures.

Strategically located near major consumption points with convenient transportation options, *Uiwang* ICD functions as a vital container cargo redistribution hub. It addresses the logistical challenge of empty container management, offering storage closer to export shippers in the SMA. This proximity reduces the need to transport empty containers back to distant port terminals, resulting in significant savings in traffic and transport costs. In essence, *Uiwang* ICD effectively serves as a supply/demand base for empty containers in the SMA, optimizing transportation efficiency.



Source: Kwon, et al.(2016), *A Study on Development Plan for the Uiwang ICD and its Surrounding Areas*, Korea Transport Institute & Korea Ministry of Land, Infrastructure and Transport, <Figure 2-4>, p.23.

Figure 1. Transportation Route for Export Containers (Representative Example)



Source: Kwon, et al.(2016), ibid., <Figure 2-5>, p.23.

Figure 2. Transportation Route for Import Containers (Representative Example)

Container Cargo Handling Performance

Uiwang ICD has consistently managed an average annual throughput of one million TEU over the last decade, except for 2009 when cargo volumes dipped due to the repercussions of the global economic crisis. Assessing the facility's annual container handling capacity of 1.37 million TEU, it is evident that *Uiwang* ICD has been operating at an efficiency rate of approximately 73%. This utilization rate would reflect the effectiveness of the depot in handling container traffic relative to its designed capacity.

Table 3. Container Cargo Handling Volume of Uiwang ICD (Unit: thousand TEU)

	2005	2007	2009	2011	2012	2013	2014	2015
Road	474	423	396	493	564	584	563	536
Railway	501	580	382	502	528	495	445	449
Total	975	1,003	778	995	1,092	1,079	1,008	985

Note: counting inbound and outbound containers as one container
Source: Internal document from *Uiwang* ICD Corporation, Ltd.

The modal distribution of transportation, particularly between road and railway, has historically maintained a relatively balanced ratio of around 50 to 50. However, recent trends indicate a notable shift, with the share of road transportation on the rise while railway transportation continues to decrease. On the other hand, *Uiwang* ICD has been steadily

increasing its share of the national container traffic volume by railroad, underscoring its pivotal role in Korea's rail transportation network. In 2015, the nationwide container rail transportation performance amounted to 885.3K TEU, with *Uiwang* ICD handling 448.7K TEU, constituting approximately 51% of the total share. This reinforces *Uiwang* ICD's significance as a key hub within Korea's rail transport infrastructure.

Table 4. Container Cargo Transportation Volume by Railway (Unit: TEU)

	2012	2013	2014	2015
Nationwide	1,138,929	1,097,492	944,693	885,309
Uiwang ICD	527,731 (46.34%)	495,464 (45.15%)	444,583 (47.06%)	448,716 (50.68%)

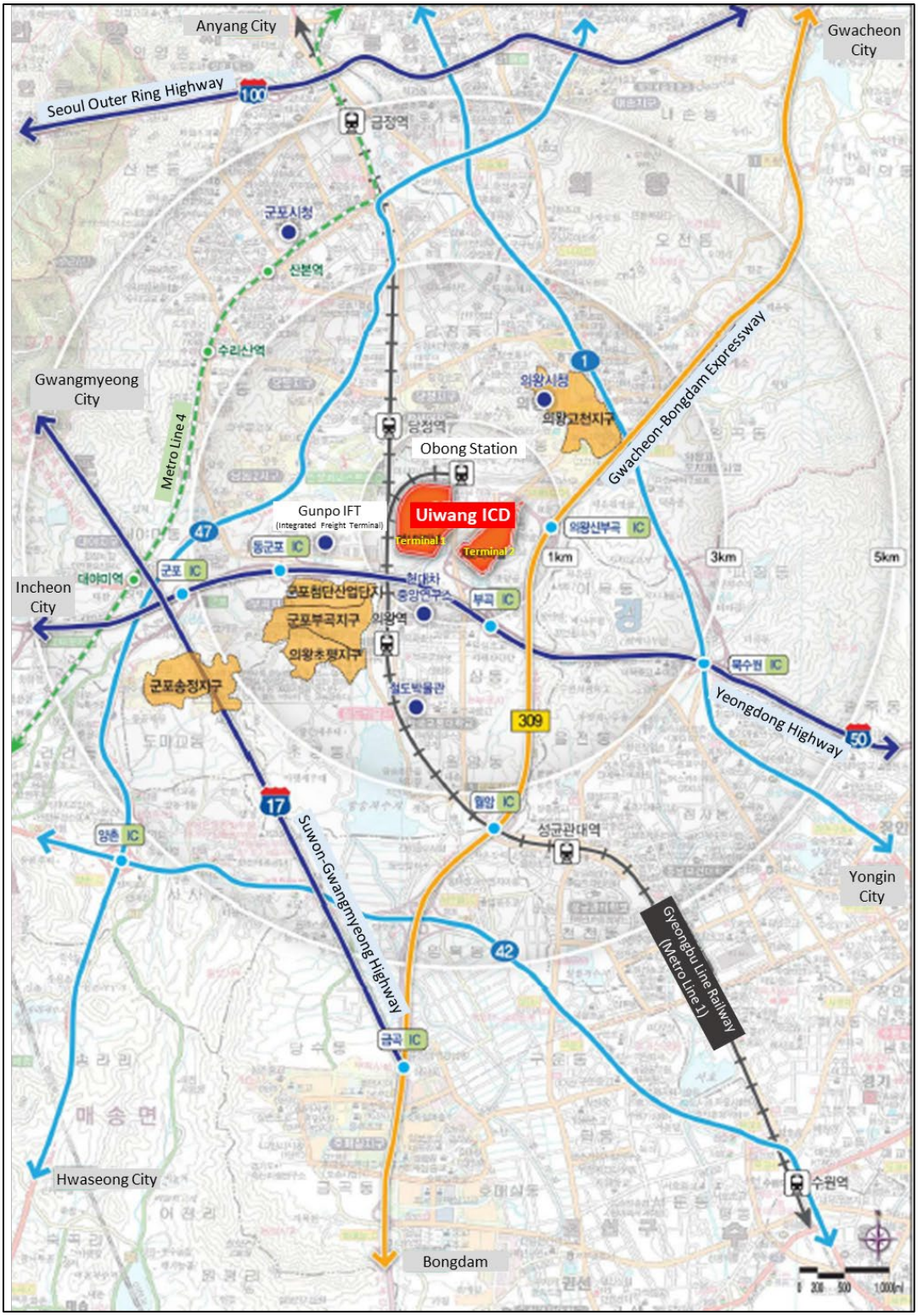
Source: Internal document from *Uiwang* ICD Corporation, Ltd.

Rail transportation is recognized as a more sustainable option, offering increased efficiency and environmental benefits. Trains can accommodate heavier loads over longer distances, making modal shifts to rail contribute to decreased truck traffic and a reduction in greenhouse gas (GHG) emissions. Given the recent trend of an increasing share in road transportation and a continuous decrease in railway transportation, it becomes imperative to explore and implement policies and strategies that promote a shift towards rail transport. This is particularly crucial in the context of developing a new plan for the future development and improvement of *Uiwang* ICD. Such initiatives align with broader sustainability goals, aiming to enhance efficiency, reduce environmental impact, and contribute to a more sustainable and resilient transportation system.

TRANSPORTATION SYSTEM AND TRAFFIC FLOWS

Connected and Integrated Transportation System of *Uiwang* ICD

The primary transportation networks linking *Uiwang* ICD and its surrounding areas are predominantly road and rail systems. Near to *Uiwang* ICD, there are major arterial road networks, including highways, national roads, and local roads. The interchanges (ICs) associated with these roads are situated near the ICD, and major expressways are accessible within a 5-kilometer radius. Additionally, various local roads are interconnected with both terminals of the ICD, forming a comprehensive and accessible transportation infrastructure around the facility.



Source: Kwon, et al.(2016), op.cit., <Figure 2-1>, p.13.

Figure 3. Connected and Integrated Transportation Network of Uiwang ICD

Obong Station is situated to the northern side of the ICD, and it is connected to *Uiwang* ICD via railway lines for the transportation of container cargo. Despite this connectivity, a significant limitation exists as most of the tracks at Terminal 1 and *Obong* Station fall short of an effective length of 600 meters. This deficiency contributes to congestion and operational inefficiency within the system.

Table 5. Railway Lines within Uiwang ICD (Clearance length and number of train cars)

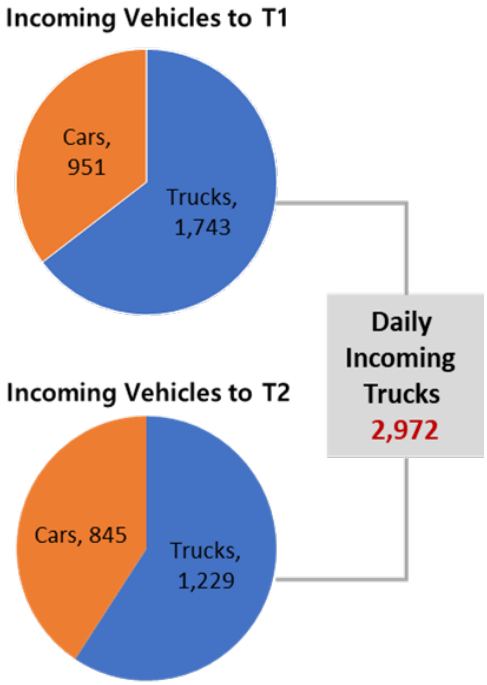
Terminal 1		Terminal 2	
Container Line 1	517m (36 cars)	Container Line 1	650m (46 cars)
Container Line 2	517m (36 cars)	Container Line 2	650m (46 cars)
Container Line 3	559m (39 cars)	Container Line 3	650m (46 cars)
Container Line 4	501m (35 cars)		
Container Line 5	501m (35 cars)		
Container Line 6	538m (38 cars)		
Container Line 7	481m (34 cars)		
Container Line 8	481m (34 cars)		

Source: Korea Railroad Corporation (2011), *A study on how to improve Uiwang ICD facilities and operations preparing for changes in the transportation environment of railway containers*.

Truck Flow for Inbound/Outbound Freight Trucks at *Uiwang* ICD

An observation-based survey was undertaken to analyze the truck traffic volume at *Uiwang* ICD, specifically counting the vehicles entering Terminal 1 and Terminal 2 during the second week of April 2015. The daily count of trucks traversing *Uiwang* ICD was recorded at 2,972, with 660 vehicles moving between Terminal 1 and Terminal 2, constituting approximately 22% of the total. The majority of these inter-terminal movements, particularly involving container cargo trucks, contribute significantly to traffic congestion around Terminal 1 and Terminal 2 of *Uiwang* ICD. This congestion has adverse effects on local traffic and the surrounding areas.

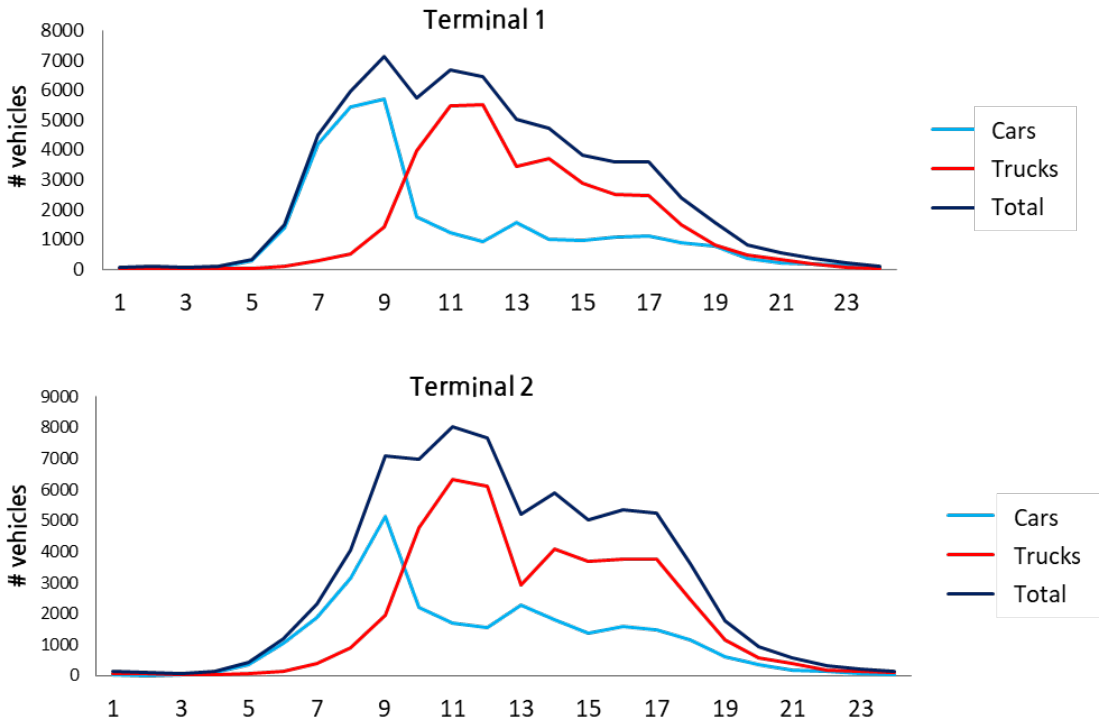
In an additional observation conducted for the month of April 2016, data analysis focused on the movement of vehicles entering and exiting *Uiwang* ICD by time zone. The analysis revealed a concentration of movement primarily between 7 a.m. and 2 p.m. Consequently, there is an observed increase in waiting times for terminal entry and exit during these specific time windows. The data indicates that passenger cars



Note: Observation results from Apr 13-17, 2015.
Source: Kwon, *et al*.(2016), op.cit., <Figure 2-12>, p.36.

Figure 4. Daily Incoming Vehicles of Uiwang ICD (for Terminal 1 and 2)

are particularly concentrated between 7 a.m. and 9 a.m., suggesting their predominant use by workers commuting to and from their workplaces. Conversely, cargo trucks exhibit a concentration in both inbound and outbound movement from 9 a.m. to 1 p.m., which includes the lunchtime period. This concentration has led to complaints from nearby residents due to heightened traffic congestion on the surrounding roads.



Note: Survey data collected during the month of April 2016.
Source: Kwon, et al.(2016), ibid., <Figure 2-14>, p.38.

Figure 5. Container Cargo Trucks Traffic to/from Uiwang ICD by Time Zone

The heightened concentration of truck inflow at specific times not only contributes to increased fatigue among truck drivers but also results in traffic congestions and operational inefficiencies. The prolonged waiting times and congestion lead to severe fatigue, ultimately impacting the working conditions for truck drivers and contributing to a shortage of drivers. Addressing this issue requires the formulation of strategic measures to rectify the uneven distribution of entry and exit times for container cargo trucks.

Main Truck Traffic Issues

Traffic issues related to container cargo trucks of *Uiwang* ICD are distinguished between congestion within the ICD and surrounding traffic congestion outside the ICD. Furthermore, its internal traffic problems within the ICD are categorized into issues related to movement within each terminal and between Terminal 1 and Terminal 2.

Congestion within terminals is attributed to inefficiencies in the current entry and exit processes and routing of trucks. After passing through the main gate, a thorough inspection of the containers takes place. This container inspection process contributes to significant inefficiencies in the vehicle flow as trucks are required to turn around if anomalies are detected. Moreover, the designated loading and unloading locations for occupying companies within the ICD, along with individual operational schedules, result in a lack of integrated operations. This leads to congestion and traffic jams within the terminal, involving not only cargo vehicles but also passenger cars.

Road transportation within the ICD is handled by vehicles owned by occupying companies and external contracted vehicles. The high proportion of external contracted vehicles entering frequently exacerbates congestion due to the narrow roads and insufficient parking space within the ICD compared to the number of trucks. The shortage of parking space for container cargo trucks not only contributes to congestion within the container yard (CY) but also impacts the surrounding road networks. Additionally, the inadequate separation of entrance and exit at the Terminal 2 intensifies traffic congestion in fact.

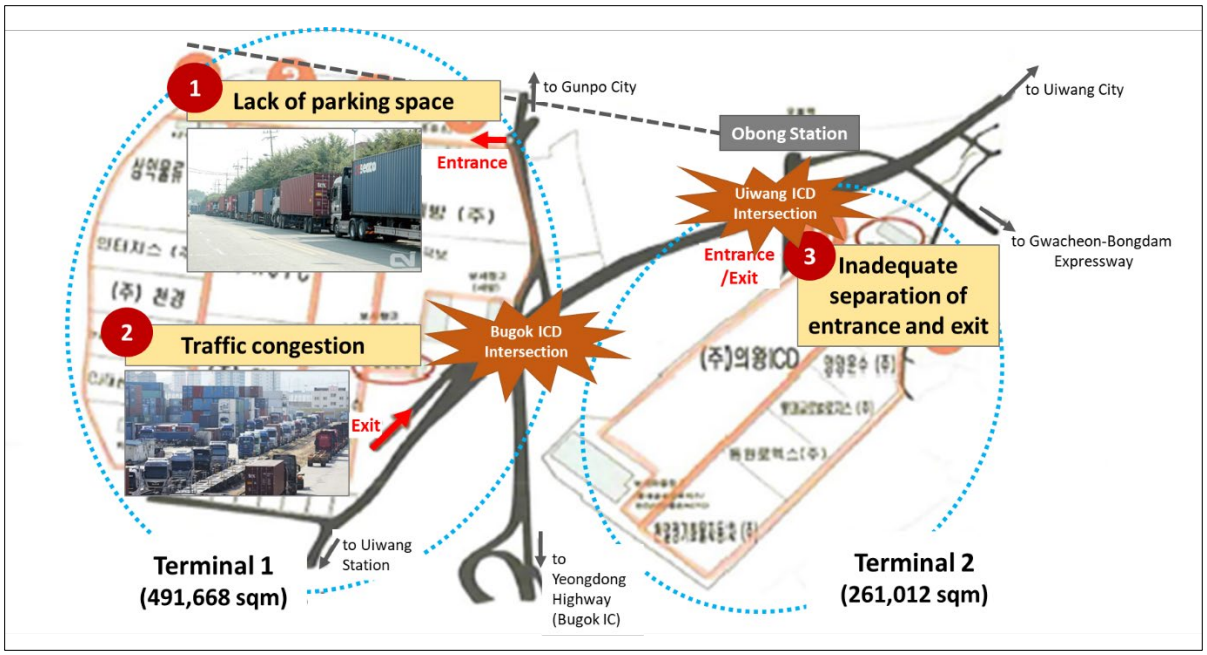


Figure 6. Main Traffic Issue Points in Uiwang ICD

Furthermore, as the container loading space has reached its limits, the shortage of parking space for trucks has intensified, leading to chronic congestion within *Uiwang* ICD. For these reasons, the ongoing need for the expansion of *Uiwang* ICD continues to be emphasized.

The persistent congestion of traffic within the ICD has broader implications beyond cargo vehicle congestion. The reduced turnover rate of on-site trucks for railway transportation results in delays in railway handling operations. Specifically, the intersection of the main thoroughfare for heavy duty container cargo trucks and railway lines is causing severe traffic congestion during the loading and unloading operations, significantly reducing the efficiency of cargo handling.

The movement of freight vehicles between terminals within *Uiwang* ICD is contributing to an exacerbation of traffic congestion on surrounding roads. As previously noted, the daily average of trucks entering *Uiwang* ICD is 2,972 vehicles, with 660 of them, approximately 22.2%, moving between Terminal 1 and Terminal 2. The movement of these container cargo trucks not only impacts the entry roads to Terminal 1 and Terminal 2 but also worsens traffic congestion on the surrounding roads.

To address this issue, it is imperative to consider future redevelopment and expansion of the existing *Uiwang* ICD into one unified site. This expansion would absorb the movement between terminals through internal pathways, thereby improving the overall traffic conditions in the vicinity as well. Evaluation and consideration of such a solution are believed to warrant for effective resolution.

The passage of large container cargo trucks within the ICD and their movement between Terminal 1 and Terminal 2 have led to a continual increase in traffic congestion on surrounding roads. As the role of the ICD expands, and with anticipated additional traffic due to future developments in the surrounding area, it is crucial to explore solutions to disperse traffic around the crucial *Bugok* ICD intersection, located at the center of the ICD.

POTENTIAL STRATEGIES TO IMPROVE EFFICIENCY OF TRUCK FLOWS IN *UIWANG* ICD AND ITS SURROUNDING AREAS

Improvement of Current Road Systems around the ICD

The area most significantly impacted by traffic due to container cargo trucks through Uiwang ICD are *Bugok* ICD Intersection, situated between Terminal 1 and Terminal 2, and *Uiwang* ICD Intersection at the entrance of Terminal 2. Hence, it is crucial to explore strategies to alleviate traffic congestion, with one potential solution being the elevation or three-dimensional expansion of the Intersections.

A substantial portion, 22%, of container cargo trucks entering or exiting *Uiwang* ICD are trucks moving between Terminal 1 and Terminal 2. Constructing a dedicated road directly connecting these two terminals could be a promising approach to enhance the surrounding traffic system and the overall flow of container cargo truck traffic to and from the ICD. Additionally, reduction of traffic congestion on external roads around *Uiwang* ICD can be achieved through measures such as relocating the ICD entrance and exit points, as well as installing new dedicated ramps.

Internal Movement Efficiency Improvement within the ICD

Reconfiguring vehicular traffic, mainly including container cargo trucks, around the CYs, is a strategy aimed at concurrently enhancing the efficiency of ICD operations and optimizing traffic flow and overall logistics flow. This entails a comprehensive redesign of land use and layout, emphasizing the separation and consolidation of functions within the ICD. Specifically, CYs can be exclusively designated for loading and unloading activities, while administrative and support facilities are centralized in dedicated zones. The goal of this reconfiguration is to streamline and restructure the flow of truck traffic within ICD.

Within the CY operation, a more detailed approach involves segregating empty and fully loaded containers, strategically organizing yards to align with the entire container logistics flow. This optimization enhances the efficiency of traffic flow for freight vehicles within the ICD. Moreover, facilities for such as container inspection, repair, and cleaning can be strategically positioned near the entrance for increased operational efficiency.

In conjunction with these efforts, reconsideration of the realignment of the railway inbound line and exploration of the potential acquisition of additional land for use in vehicle waiting areas and specific office building locations should be considered. Additionally, simultaneous attention is given to the implementation of dedicated roads for container cargo trucks within the ICD, along with an examination of the realignment and elevation of roads and railway lines.

Integration and Optimization of Advance Technology

The establishment and utilization of standard information systems based on advanced technology are crucial components, encompassing the implementation of automated ICD gates and a tracking system for both outbound and inbound container cargo trucks. The deployment of advanced technology plays a pivotal role in managing and controlling access by recognizing outbound and inbound container cargo trucks. Vehicle tracking not only facilitates internal traffic congestion management and regulation within the ICD but also provides guidance for loading and unloading locations within the CYs. This orchestrated technological environment contributes significantly to the seamless flow of traffic, ensuring transportation safety at the same time.

Moreover, the utilization of standard information systems allows for the establishment of a 24-hour loading and unloading system. This strategic implementation aims to alleviate the concentration of container cargo truck traffic during specific periods within the ICD. Ultimately, by harnessing technology, the realization of smooth traffic flow both within and outside the ICD becomes feasible, leading to heightened efficiency and strengthened security of container logistics.

Expanding the Site to Enhance Traffic Management

In response to the anticipated growth in logistics demand, expanding *Uiwang* ICD emerges as a fundamental solution. The integration of Terminal 1 and Terminal 2 within the ICD into one unified site involves redirecting existing terminal-to-terminal traffic, resulting in an estimated 20% reduction in inbound and outbound traffic. This not only minimizes conflicts with through traffic but also optimizes the utilization of the expanded space for administrative facilities, vehicle waiting areas, and rest zones for truck drivers. This strategic approach enhances the overall efficiency of facility placement, including CYs, leading to a more streamlined traffic flow within the ICD.

Advancing Rail Transport Promotion

An assessment of the current state of container inbound and outbound transport at the *Uiwang* ICD reveals a seamless integration of both rail and road transport in the central regions of the SMA. In contrast, the southern and northern regions heavily depend on road transport,

highlighting the *Uiwang* ICD's pivotal role as a primary supply base for empty containers in these areas. To address environmental concerns and foster sustainable transportation, there is a pressing need for a proactive shift from road transport to rail transport.

Policy initiatives promoting the modal shift from road to rail in these northern and southern regions of the SMA are crucial. Plans for expanding the rail network in the SMA should strategically enhance rail transport capacity, taking into account the connectivity between these regions and *Uiwang* ICD. Besides, improving the handling capacity for both rail and road transport at *Uiwang* ICD is paramount for minimizing bottlenecks and reducing time and costs associated with loading/unloading and transshipment. To strengthen *Uiwang* ICD's role as a pivotal logistics hub for import and export in the SMA through expanded rail transport, efforts should also prioritize the modernization and automation of handling equipment.

REFERENCES

1. Korea Railroad Corporation, 2011, *A study on how to improve Uiwang ICD facilities and operations preparing for changes in the transportation environment of railway containers*.
2. Kwon, et al., 2016*, A Study on Development Plan for the Uiwang ICD and its Surrounding Areas,* Korea Transport Institute & Korea Ministry of Land, Infrastructure and Transport.
3. Kwon, Hyeokku and Mina Chae, 2016, "Current status and implications of *Uiwang* ICD interpreted in terms of container traffic volume", *2016 KOTI Logistics Brief*, Vol. 8, No. 3, pp. 5-10.
4. Uiwang ICD Co., Ltd., Internal documents.
5. Uiwang ICD Co., Ltd., webpage, http://www.uicd.co.kr/.

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