



Application of Digitalization

& Automation in the Development of Global Smart Ports in South Korea

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June 12th, 2024





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History of Korean Port Development

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(1) Port Development Timeline

Within 70 years after the Korean War, South Korea has developed its ports from a basic local transport infrastructure to now the hub of a global logistics network.

	Before the 60s	60s	70s	805	905	2000s~Current
Cargo	10 mln ton ('45)	15 mln ton ('66)	35 mln ton ('76)	150 mln ton ('86)	295 mln ton ('96)	1.1 bln ton ('15)
Economic Status	 Post-war recovery Focus on primary industries 	 Growth of labor- intensive manufacturing industry Increase in exports 	 Pursuit of heavy & chemical industrialization 	 Industrial restructuring Industrial rationalization 	 Market opening Drastic technological development Increase in IT investment 	 Global competition Diversification of trade structure Slowdown in growth of economy & trade volume
Functions of the Ports	• Basic transport infrastructure		 A support facility for heavy & chemical industry 	 A support facility for export and import 	 A support facility for export & import A facility for connection with the regional maritime network 	 A support facility for global logistics network
Focus of Port Development	Local ports for economic development		elopment	• Local & regional hub ports		 Global ports Development of Port Distripark
Major Source of Financing	• UNKRA, FOA Grants, ICA support	• Grants & loans	• IBRD Loans	• IBRD, ADB loans • Independent budge	 Private investment Special transport account 	 Expansion of private investment

In 70 years, South Korean Ports developed from a basic local transport infrastructure to the hub of global logistics network

History of Korean Port Development

(2) Four Representative Port Distriparks in Korea (1/2)

Among four representative port distriparks in Korea, Busan Port is the best transshipment port as well as its distripark is a manufacturing center, and Incheon Port Distripark is the closest to China with high accessibility to metropolitan areas.

Busan New Port Distripark

Overview & Current Status

- 68 companies in North Distripark, Ungdong Distripark operating
- Best Trans-shipment port, where major carriers use for China-origin US-bound T/S cargo

Competitiveness

- World's manufacturing center
- Good access to European Route, North American Route and China

Incentives for Foreign Businesses

- 50 year maximum rental period
- Affordable rental fees
- Tax benefits
- High-value creation through diverse business models
- Simplification of IM/EX customs clearance

Source: 해양수산부, Samil PwC Analysis



Europe

Incheon Port Distripark

Overview & Current Status

- The closest Korean port to China, and the 2nd largest container handling port in Korea
- (Container Cargo Volumes) 3.19 mn TEUs
- (Total Cargo Volumes) 158 mn RTs
- 98(30%) Refrigerated Warehouse

Accessibility

- (Kyung-in Exp.) Within 20 mins.
- (OuterRing Exp.) Within 30 mins.
- (Airports) Within 15~30 mins

Nearest Industrial Zone

- (Kyung-in Exp.) Within 20 mins.
- (OuterRing Exp.) Within 30 mins.
- (Airports) Within 15~30 mins



Busan

Gyeonggi-do

13.6mil.

Daejeon

Jeonju

Mokpo

Seoul

9.5mil

Incheon

3.0mil.

History of Korean Port Development

(2) Four Representative Port Distriparks in Korea (2/2)

Yeosu Gwangyang Port Distripark is mostly handling petrochemicals, steels and containers etc., and Ulsan Port Distripark, which ranks first in liquid cargo volume, designates areas according to the business type and characteristics of resident companies.

Yeosu Gwangyang Port Distripark

Overview & Current Status

- (Total Cargo Volume) 300 mn tons
- (Containers) about 2.12 mn TEUs
- (Number of Port of Facilities) 4 piers, 110 berths

Accessibility

- (Airports) 5 airports within 1 hour
- (Railways) Within 2 hours
- (Highways) Connect all major cities

Major Products

- Petrochemicals 142 million tons (52% of the total imports and exports)
- Steels 93 million tons (34% of the total imports and exports)
- Containers 18 million TEUs





Ulsan Port Distripark

Overview & Current Status

- The port opened in '63 and became no.
 1 in liquid cargo volume
- Divided into four zones: Complex Logistics, General Logistics, Manufacturing, Eco zone

Competitiveness

• Since '18, specialized areas have been designated and operated independently according to the business type and business characteristics of the resident company.

Major Products

- 1ST & 3rd Distripark Area: Shipbuilding, petrochemical, plant, and automobile parts manufacturing and export support
- 2nd Distripark Area: Front Oil Hub



(2) Port Distripark Characteristics

The government agency, MOF, established port distriparks in Korea, which can be categorized into two types, and additionally, unlike other countries, Korean port authorities select tenants through a competitive bidding process.

The MOF Set Two Types of Port Distriparks

- The Ministry of Oceans and Fisheries(MOF) designated port distripark areas as Type 1 or Type 2 for development every five years, in accordance with Article 41 of the Port Act
- There are eight Type 1 port Distriparks and four Type 2 areas
 nationwide

Туре	Criteria	Tenant Companies	[Port Distripark Location Map]
Type 1	 Cargo handling capacity (over 10 mn tons) Port facility size (docks of over 2,000 TEU capacity) Land acquisition (area of over 300,000m²) 	Logistics companies for cargo assembly, processing, manufacturing	
Type 2	 Cargo handling capacity (over 10 million tons) Development site (over 100,000m²) Permanent population (over 10,000 people) 	residential /commercial, or facilities related to medical care and welfare	• Type 1 &2 • Type 1

Category Details With one or more valid bidders, the bidder Distripark with the highest price above the bidding Supply standard price is determined as the successful Method bidder (1)Participants Bidding Biddina Payment of Registration Process Presentation Deposit Application Distripark On-site 6 bidding and Supply **Evaluation &** opening bid Notification Agreement 8 Acquisition Disposal **Occupancy Agreement** Agreement

While there are no bidding process in other countries, the authorities of Korean port distriparks adhere to a special method of selecting tenants through competitive bidding.

Source: 해양수산부, Samil PwC Analysis

Tenant Companies Selected through Bidding

(1) Definition of Digitalization & Automation
(2) Political Support for Digitalization & Automation
(3) Digitalization of Ports
(4) Automation of Ports

(1) Definition of Digitalization & Automation

A smart port is established through the digitalization of port resources for connectivity and intelligentization and the mechanical automation of port-handling equipment.

Definition and Examples of Digitalization and Automation in Ports



(2) Support Policy for Digitalization & Automation

As digital transformation expands globally through the 4th Industrial Revolution technology, the idea of "smart port" is spreading, and the Korean government also plans to expand the global market for the shipping and port logistics industry with support in various fields.

Details Category [Support Details] Policy • As one of the new growth 4.0 strategies, the Ministry of Oceans and Fisheries National R&D investment in cranes established the strategy to promote domestic smart ports, foster related industries, Overview and transport equipment and ensure economic security by 2031. R&D _____ Establishment of smart port R&D Vision • A global smart port created by our company around the world roadmap Goal • (Technology-based) Securing technology and price competitiveness: 90% domestic market share, 10% global market share, parts localization rate 65% ('31) Support for overseas expansion • (Market-based) Securing domestic and international port technology markets: feasibility study expenses Expanding to 8 times the domestic size (KRW 3.9 trillion) ('31) Financial • (Policy-based) Institutionalization of industry development system: Creation of a Creating a smart port equipment virtuous cycle ecosystem between market and industry start-up and investment ecosystem Securing domestic Advancement of Promotion Securing through parent fund and policy 3 and overseas port industrial dev. Strategies technology base technology markets finance support system •Secure technology capacity •Secure domestic market •Establish training system Promoting the enactment of laws •Strengthen industries linkage •Strengthen policy Law. Support overseas expansion on fostering and supporting the communication •Secure technology workforce Startup financial support port technology industry

Smart Port Technology Industry Development and Market Expansion Strategy ('23.01)

(3) Digitalization of Ports | Blockchain Portal

Introduced as the best practice of port digitalization by the World Bank and IAPH in 2021, the Chain Portal is the third-generation PCS (Port Community System) used in the Port of Busan, based on real-time data collection and information sharing made possible with blockchain.

Real-time Information Sharing among Terminals Using Blockchain Technology

 In 2020, the Busan Port Authority (BPA) developed an integrated information-sharing blockchain platform for the port stakeholders to facilitate trade and container transportation



Services provided through a mobile app, AllCON-e

Major Objective	 For enhanced efficiency and productivity of the port logistics stakeholders in trade and container transport 						
	 ✓ For the support port information 	 For the support of private businesses through disclosure of port information 					
Charact- eristics	 An information-sharing platform with enhanced information security through the use of blockchain technology 						
	✓ Provision of fun as group ordering	ctions for efficient cont ng and transshipment m	t ainer transport , such nonitoring				
Before & After	Classification	Classification Before Chain Portal					
enhanced data-	Cost	350 KRW per 1Kbyte (EDI* interchange fee)	None				
among Busan terminals	Time consumption	3-10 hours	1 minute				

*EDI: Electronic Data Interchange

[Back-up] History of Port Community Systems used in Busan

Starting from the use of Port-MIS developed by the Ministry of Oceans and Fishers in 1996, the Busan Port Authority has gradually developed its PCS to enhance data reliability and enable real-time responses.

	PORT-MIS	BPA-NET	CHAIN PORTAL
Functions	Port operation, civil service	Port operation, civil service, port statistics	VBS, terminal monitoring, big data
Development Year	1996 (1 st Generation)	2012 (2 nd Generation)	2020 (3 rd Generation)
Managed by	Ministry of Oceans and Fisheries	BPA	BPA
Data source	Reported Data (Reliant on faithful reporting)	Reported data + EDI	Real-time container status (transfer) information
Data reliability	Low	Medium	High

(3) Digitalization of Ports | Integrated Mobile Application

The Busan Port Authority has developed a real-time information-sharing mobile application, which is unique in that it is a unified system used by all terminals and relevant stakeholders.

AllCON-e, a Mobile App for Truck Drivers

BPA developed a mobile application as part of the Chain Portal to provide **real-time port logistics information to truck drivers**.



Electronic Receipt of Delivery (e-slip)

BPA created a unified system of issuing an electronic receipt of delivery **for all terminal operators and truck drivers at Busan Port.**



Expected to introduce to all Busan terminals by July 2024

Less time consumed at terminal gates to receive the receipt of delivery

Contributes to environment protection by consuming less paper & less idling time

(3) Digitalization of Ports | Digital Twin

The Busan New Port Terminal has implemented a digital twin port logistics platform, which integrates real-time data collected from the sea, port, and the Distripark to optimize the logistics flows across all segments.

Digital Twin in Busan Port

Digital Twin

Implementation of real-world devices, equipment, and objects in a computergenerated virtual world



- With the BPA consortium, the **Busan New** Port Terminal has implemented a digital twin port logistics platform.
- When applied to port logistics, it **enables** the real-time sharing and analysis of data across all segments of land and sea transport, which allows for the optimization of port logistics flows through simulation.

Integrated Data Platform

5G-based Digital Twin Smart Port Logistics Platform

- on digital twin data
- Optimization measures for terminal \checkmark operation & backhaul logistics based on changes in ship arrival times, etc.

Sea	Port	Distripark
- Real-time ship operation data - Entry and departure data - Geographic Information System (GIS) data	 Data from the Terminal Operating System (TOS) Data from the monitoring service of cargo handling equipment 	- Truck operation data - Traffic information

Effect of Digital Twin Platform

1. Improves Port Safety

- Provides optimal ship entry/exit routes, times
- Alleviates terminal & logistics congestion and reduces collision risks

2. Enhances port productivity

• With high simulation accuracy, predicts and prevents disruption of operations due to changes of ship arrivals to the port

3. Connects Port Processes

 Real-time data sharing between shipping companies, port operators, and inland transportation providers

4. Establishes a Green Port

 Improved accuracy in predicting entry/exit times leads to reduction of air pollution emissions from ships caused by waiting time & idling fuel consumption

Integrated analysis and simulation based

(4) Automation of Ports | Automated Port Levels

Most container terminals in Korea rely on manned driving equipment, except for the terminals at Busan and Incheon New Port, which partially use automated equipment for yard operations.

Port Operation Levels

Mechanization

 ✓ A phase of mechanizing terminal work from human-centered manual work, which took place in the 80-90s.

- Semi-automation

 A stage of automating part of the terminal work—gate work mostly automated and can be divided into stage 1 &2 depending on the degree of yard work

Automation

- 1st level: Main line work is automated through remote control, and all terminal work itself is automated
- 2nd level: Ship arrival and departure work
 are also unmanned and automated

Comparison of Container Terminals Automation by Region/Country

- Most container terminals in Korea are first-generation container terminals and use manned equipment in all areas of the terminal
- The container terminals at Busan New Port and Incheon New Port are semiautomated, using automated yard cranes (ATC) for yard work.

Region/	Automati	Ship	Transfer	Equipment	Main Terminal
Country	on Status	unloading	Operation	Work	
South	Semi-	Man driving	Manned driving	Remote driving	 PNC, HJNC, PNIT, HPNT,
Korea	automated	electric power	diesel power	electric power	BNCT etc.
Europe/ Oseania/ Asia	Automated	Man driving electric power	Completely unmanned electric power	Remote driving electric power	 (Netherland) ECT (Germany) CTA (Australia) VICT (China) Ocean Gate
Europe/ America/ Asia	Fully automated	Remote driving electric power	Completely unmanned electric power	Completely unmanned electric power	 (America) LBCT, Trapac (Netherland) APMT (China) QQCTN

(4) Automation of Ports | Automated Port Cases in Korea (Busan)

Busan New Port is Korea's first fully automated port across all sections, utilizing remote-controlled container cranes and unmanned automated guided vehicles, and it is also a carbon-neutral port, operating without any internal combustion engine equipment.

Full Automation of Busan New Port [Fully Automated Dock Overview] **Key Points** Korea's first fully automated port for all sections of the wharf, and has introduced unmanned remote container cranes and unmanned automated guided vehicles (AGV, Automated Guided Vehicle) 2 A carbon-neutral port with no internal Transfer combustion engine equipment, and is also External Vehicle Quay Crane Yard Crane Vehicle a fully automated port centered on TIT domestic technology **Berth Area Transfer Area** Yard Area **Gate Area Automation** Economic Ripple Effect Yard Area Category **Berth Area Transfer Area** Level Production Added Value Traditional Х Х \bigcirc **Employment** Partially Inducement Inducement Docks (Manual Crane) (Yard Tractor) (Remote Crane) Inducement 442 million 145 million \cap $\left(\right)$ \cap **USD** USD New Port Dock Fully (Remote Crane) (AGV) (Automated)

2,386 ppl

(4) Automation of Ports | Domestication of port equipment

The Ministry of Oceans and Fisheries and the Busan Port Authority are striving to realize a domestically driven, technology-focused automated port through domestic procurement of port equipment.

Current Domestication Efforts by the MOF

Key Background and Necessity

Self Reliance	Domestication reduces this dependency in maintenance and procurement of parts, ensuring a more self-reliant operational framework
Economic Impact	Utilizing domestically produced equipment can decrease the outflow of foreign currency by substituting imports with local products, thereby supporting the national economy
Technological Progress	MOF is providing regulatory and policy support to facilitate the development and adoption of domestically produced equipment in ports across the country

Strategies for Domestication

Collaboration with domestic industries	MOF is working closely with South Korean companies to develop advanced port equipment, including automated container cranes and eco-friendly transport systems
Investment in R&D	Significant funds are being allocated to R&D projects aimed at creating innovative and competitive domestic port equipment
Regulatory Support	The MOF is providing regulatory and policy support to facilitate the development and adoption of domestically produced equipment in ports across the country

BPA: Third Call for Port Equipment Supply

Current Situation

- ✓ The third round of bidding for the production and installation of domestic port equipment for the 2-6 phases of the Busan New Port West Container Terminal is scheduled to take place in June 2024
- The current circumstances require the port authority to invest and place orders with local companies, rather than relying on operators
- ✓ The U.S. port operators expressed significant interest in this bidding process as the BPA delegation provided explanation
- This interest stems from their current situation, which necessitates either banning or avoiding the use of Chinese equipment



The current situation is controversial; Busan port authority is very driven, while there is skepticism about future demand

(4) Automation of Ports | Automated Port Cases in Korea (Incheon, Ulsan)

In addition, Incheon Port has launched a new plan for establishing a fully automated port, set to open in 2027, and Ulsan Port has also continuously provided R&D support to develop innovative port logistics infrastructure.

Incheon New Port Full Automation Plan Launched

Incheon New Port is a 'semi-automated' terminal that has introduced technology to remotely control yard cranes and stack them in the equipment yard.

[Fully Automated Incheon New Port Plan Overview]

Industry-academia Cooperation of UPA

Ulsan Ports are not as automated as Busan or Incheon; however, Ulsan Port Authority continue to provide R&D-related support through industry-academia cooperation.

[Industry-academia Cooperation Details]



Evaluation & Implications

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III Evaluation & Implications

Overall Evaluation and Implications

Korean ports are demonstrating progressive advancements in digitalization and automation, while the Korean port distriparks epitomize a harmonious blend of private and public sector collaboration.

Korea's Port Distripark	 The level of infrastructure development is the most significant factor determining the competitiveness of ports Over the past 70 years, the Ministry of Oceans and Fisheries has made various efforts to increase the level of Korea Ports The Korean-style port distripark is a unique model based on the support of the government and port authorities, and it plays a practical role in enhancing the competitiveness and attractiveness of ports
Digitalization of Ports	 Each country and port pursues different strategies regarding digitalization of ports Korea is pursuing digitalization based on a blockchain portal involving the port community and follows an approach that provides specific digital items (e.g., Eslip) according to the needs of stakeholders
Automation of Ports	 Korean ports may be perceived as having lagged slightly behind their competitors in terms of automation However, addressing stakeholder issues makes now the most opportune time for automation At the same time, the pursuit of agendas such as the use of domestically produced cranes underscores a forward-looking approach aimed at fostering the future growth of the port industry ecosystem

Korean ports and

their distriparks

represent the

synergy of

private sector

innovation and

public sector

strategic vision

Thank you