

EXECUTIVE SUMMARY

A Study on Legal and Institutional Improvement Measures to Promote the Adoption of Smart Port Technologies

Da-Ye Lee · Bo-Kyung Kim · Min-Jeong Park · Moo-Hong Kang

1. Research Purpose and Methodology

1) Background and purpose

- The transition to smart ports has emerged as an essential strategy for maintaining port competitiveness.
- As external factors change, including the slowdown in cargo throughput growth, vessel upsizing, expanding implementation of Industry 4.0 technologies, and a declining labor force, the need to enhance port productivity and efficiency through the application of smart port technologies has increased.
- While legal and institutional improvements are required to ensure the smooth implementation of emerging industries, research on establishing a legal and institutional framework

for the adoption of smart ports remains insufficient.

- The adoption of new technologies brings fundamental changes to industrial structures and work practices, necessitating improvements to legal and institutional environments to accommodate these changes.
- While foreign ports and other domestic industrial sectors have pursued legal and institutional reforms in response to new technology adoption, research in the domestic port sector remains comparatively limited.
- The purpose of this study is to identify potential issues that may act as constraints on smart port technology adoption and to proactively propose improvement measures.
- This study contributes to smart port transition by examining the prospects for smart port technology adoption, deriving anticipated changes and potential issues, and exploring preemptive improvement measures.

2) Methodology

- This study conducts systematic research encompassing prospects for technology adoption, identification of anticipated changes and issues, and proposals for improvement measures.
- Smart port-related R&D projects conducted during the latest five years (2020–2024) were examined based on NTIS data, and smart port technologies under development in Korea were categorized.

- Expert surveys using the Delphi method were employed to forecast the timing of domestic port adoption for smart port technologies under development.
- Based on the forecasted smart port technology adoption timeline, this study identified anticipated changes and potential legal and institutional issues associated with technology implementation through literature review and expert surveys.
- This study proposed improvement measures to address the identified legal and institutional issues.

2. Results

1) Prospects for Smart Port Technology Adoption and Port Environment Changes

- By reviewing major national policies and the status of R&D projects, the direction and trends of smart port technology development in Korea are identified.
- Major national policies related to smart port development have established key implementation tasks including automated port development, optimization and intelligence of port operations, and optimization of maritime-port-land logistics.
- Analysis of smart port-related R&D trends confirmed that 19 types of technologies across five areas are under development: cargo handling and transport, operations and control, maintenance, environmental sustainability, safety and security.

- Through expert surveys, this study forecasted the adoption timeline for smart port technologies under development and established a hypothetical smart port model incorporating technologies expected to be adopted before 2030 as the subject of analysis.
- Expert surveys were conducted to forecast the adoption timeline for smart port, achieving consensus on the expected adoption timing for 16 out of 19 technologies.
- Considering the opening timeline for Phase 1-1 of Jinhae New Port, which aims to become a world-class smart mega port, this study defines a hypothetical smart port applying 12 technologies expected to be introduced before 2030 as the subject of analysis.

〈Summary Table 1〉 Expected Timeline for Smart Port Technology Adoption

Smart port technologies	2026	2027	2028	2029	2030 +
[Cargo Handling and Transport]					
Automated Container Handling Equipment (Cranes)					
Autonomous Terminal Vehicles					
Automated Non-Container Cargo Handling Systems					
Next-Generation Automated Cargo Handling Systems					
Automated Transport System for Transshipment Cargo					
[Operations and Control]					
Smart Container					
Automated Vessel Berthing Support System					

Smart port technologies	2026	2027	2028	2029	2030 +
Berth Optimization System					
Smart Logistics System Integrating Land, Port, and Maritime Transport					
[Maintenance]					
Predictive Safety Diagnostics System for Port Equipment					
Smart Maintenance and Management System for Port Facilities					
Port Facility Lifecycle Management System					
[Environmental Sustainability]					
Port Carbon Emissions Management Platform					
Unmanned Shore Power Supply System					
[Safety and Security]					
Automated Hazardous Cargo Detection and Management System					
Integrated Port Security System					

Source: Author

- The transition to smart ports is expected to entail a paradigm shift across overall port activities, including equipment, operations and control, and maintenance.
 - (Cargo Handling and Transport) Automated equipment based on remote control and autonomous driving will expand, along with the separation of manned and unmanned workspaces and expanded electrification equipment.
 - (Operations and Control) Data-driven operation systems will be strengthened through advancement of TOS and ECS, integrated

management of automated equipment, expanded data connectivity, and AI and IoT-based decision-making.

- (Maintenance) The maintenance system will transition to a predictive maintenance approach based on drones, sensors, IoT, and AI.
- (Environmental Sustainability) Growing Need for Carbon Emissions Calculation and Management in Ports.
- (Safety and Security) The necessity to strengthen cybersecurity systems will increase with the expansion of digital operations.

2) Potential Legal Issues Following the Adoption of Smart Port Technologies

- This study examined the current legal and institutional framework for smart port technology adoption to identify the necessity and rationale for institutional improvements.
- A wide range of port-related laws, such as the *Harbor Act*, the *Special Act on Port Safety*, and the *Act on Fostering and Supporting the Port Technology Industry*, are in place and are also linked with legislation in related fields, including industrial safety, personal data protection, and the environment.
- The existing institutional framework shows limitations in accommodating new technologies and changing environments, confirming the need for institutional improvements that align with port technology development and adoption.
- Through expert consultation, the study identified 23

potential legal and institutional issues arising from the adoption of smart port technologies.

- Based on expert consultation, 23 potential legal and institutional issues arising from the adoption of smart port technologies were identified.
- The identified issues include 'Absence of Cybersecurity Management Guidelines,' 'Insufficient Inspection Standards for New Types of Port Equipment,' and 'Unclear Feasibility of the Routine Use of Drones for Facility Maintenance Purposes.'
- By examining institutional improvement cases that facilitated smooth technology adoption in overseas ports and in other sectors in Korea, six types of improvement measures were derived.
- Institutional improvements were implemented in the forms of legal and institutional framework revision, inspection and certification system establishment, safety and risk management, operational and procedural efficiency enhancement, and education and infrastructure support.

3) Legal and Institutional Improvement Measures for Smart Port Technology

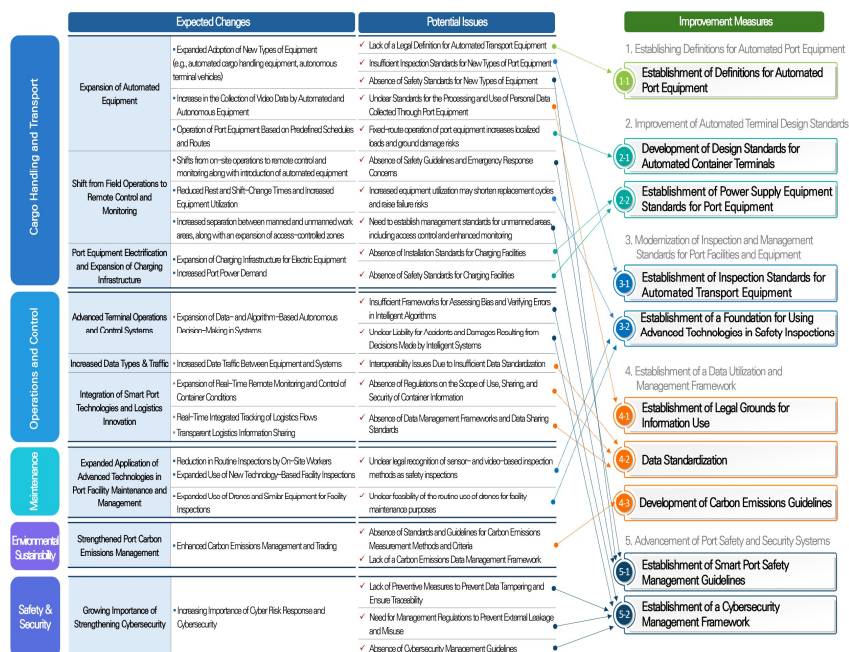
- This study established basic directions for legal and institutional improvement measures aligned with policies aimed at developing legal and institutional frameworks responsive to environmental changes.

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- Establishment of directions for legal and institutional improvements related to smart port technology adoption, aligned with the basic policy directions and principles aimed at building flexible legal and institutional frameworks in response to environmental changes.
 - In formulating the basic directions for legal and institutional improvement measures related to the adoption of smart port technologies, consideration is given to: reviewing improvement targets in line with the objectives and nature of the improvements; establishing a flexible framework that does not constrain future technological development; and promoting a smooth transition to smart ports that accommodates complex changes beyond simple technology adoption, including operational systems and value creation.
 - This study presented 10 improvement measures based on comprehensive consideration of the previously identified potential issues, legal and institutional improvement types from other cases, and basic directions for legal and institutional improvement.
 - The study proposed establishing legal definitions that serve as management standards for registration and inspection of newly adopted automated port equipment.
 - As improvement measures for design standards that reflect automated terminal characteristics, the study proposed establishing design standards for automated container terminals. It also proposed revising the *Design Standards for Harbors and*

Fishing Ports and Special Act on Port Safety to accommodate expanded adoption of power supply facilities for electrified equipment.

- To modernize inspection and management standards for port facilities and equipment, the study proposed improvement measures to include automated transport equipment as subjects of installation inspection with dedicated inspection standards, and to enable the application of advanced technologies such as drones for port facility safety inspections.
- To establish the data utilization and management foundations that determine smart port competitiveness, the study suggested measures such as establishing legal grounds for personal information and location data utilization, promoting port data standardization, and developing standards for port carbon emission calculation.
- To enhance smart port safety and security systems, this study proposed measures including establishing safety management guidelines that reflect smart port equipment and operational characteristics, and creating institutional foundations for strengthening port cybersecurity.

〈Summary Figure 1〉 Legal and Institutional Improvement Measures
Related to Smart Port Technology



Source: Author

3. Policy Recommendations

- Establishment of a Smart Port Legal and Institutional Framework Roadmap
- To support systematic smart port development, it is necessary to establish a roadmap that ensures legal and institutional acceptance in alignment with domestic laws and policies on smart port promotion and technology development.

- Development of an Inter-ministerial and Stakeholder Collaboration Platform
 - The transition to smart ports requires coordination with policies across various ministries including transportation, environment, industry, and information and communications. Participation is essentially required from diverse stakeholders including terminal operators, port authorities, port technology companies, and other experts.
- Incorporation and Implementation of Legal and Institutional Improvement Tasks in the Port Technology Industry Development Plan
 - To secure policy implementation capacity, legal and institutional improvement tasks should be included in the Port Technology Industry Development Plan to be established under the *Act on Fostering and Supporting the Port Technology Industry*.
- Establishment of a Virtuous Cycle Linking Smart Port Technology Demonstration, Institutionalization, and Feedback
 - A virtuous cycle system should be established that promotes necessary legal and institutional enactment and revision based on new technology demonstration results, while continuously monitoring and supplementing the operation of adopted legal and institutional frameworks.
- Enhancement of Social Acceptance during the Smart Port Transition Process

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- In addition to technological preparation, policies should be pursued concurrently to enhance social acceptance, including improving professional workforce training systems and facilitating smooth job transitions.