



IAPH-KMI Port Forum

Smart Port Transformation Strategy For Container Terminals

Hyeryeong Lee
Senior Researcher
Korea Maritime Institute(KMI)

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Why Ports Are Pursuing Smart Transformation

The world is moving toward smart ports — **deployment is gaining momentum globally.**

Reliability & Predictability

- Reduce variation across people, shifts, and operating conditions
- Embed operational know-how in systems for consistent and predictable performance

Safety

- Detect emerging faults before failure through continuous condition monitoring
- Reduce opportunities for human error and improve incident traceability through standardized digital records

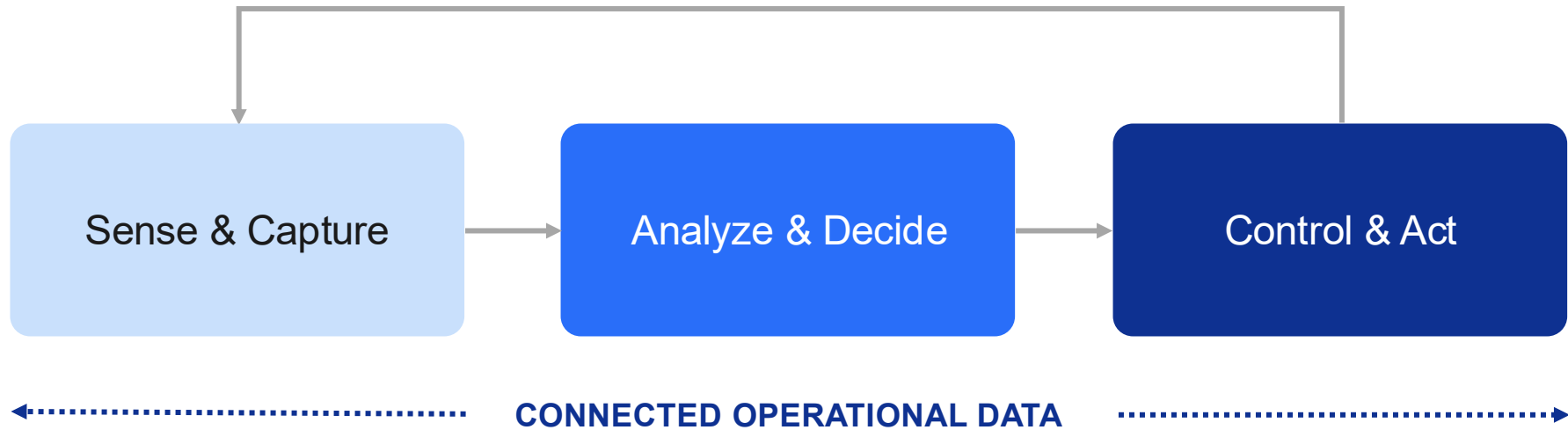
Productivity & Efficiency

- Sense changing conditions and select better operating alternatives
- Reduce empty travel, waiting, and rehandling—and unlock capacity from existing assets

Stakeholders' priorities differ — **but they all point in the same direction: smarter port operations.**

What Is a Smart Port

Smart port is an intelligent port that uses **data** to control and continuously improve port logistics flows.



Where Smart Technologies Are Applied

Smart transformation spans three application domains: **asset management**, **terminal operations**, and **port-logistics interfaces**.

1 Asset management

Data-driven monitoring, predictive maintenance, and lifecycle management of facilities and equipment

2 Terminal Operations

Data-driven coordination and optimization within the terminal

3 Port-Logistics interfaces

Data exchange and coordination across terminal boundaries
(Vessel-terminal · Port-terminal · Terminal-Hinterland)

Three Key Enablers for Smart Port Transformation

Technology provides the means, institutions enable its adoption, and people put it into practice.

Smart transformation requires **all three to work together**.

THE MEANS

Technology

Technological capabilities to collect, connect, analyze, and act on operational data

- Sensing & monitoring
- Connectivity & system integration
- Analytics, prediction & optimization
- Control, automation & decision support

THE ENABLING CONDITIONS

Institutions & Governance

Rules, support, and agreements that make technology trusted, adoptable, and usable

- Safety standards, certification, liability, cyber security
- Incentives and adoption support
- Data ownership, sharing, managing

THE HUMAN CAPABILITY

Workforce & Organization

People and organizations capable of operating, improving, and sustaining the system

- New competencies
- Reskilling and redeployment of existing workers
- Labor-management alignment and acceptance

Greenfield vs Brownfield — Same Goal, Different Constraints

Greenfield can design the target operating model from the outset; **brownfield** must prioritize and phase the transition around existing facilities, equipment, systems, and workforce.

GOAL

Data-driven control and continuous improvement of port logistics flows

GREENFIELD

Design around the target operating model

- Every element is open — the operating model can be defined at the planning stage
- Co-design layout, infrastructure, technology, systems, and workforce as one package
- Validate interfaces and optimize lifecycle performance before operations begin

BROWNFIELD

Transform within existing operations

- Legacy equipment, workforce, and contracts set the boundary conditions
- Define the value to be created, and prioritize investments accordingly
- Phase implementation to preserve interoperability and operational continuity — while operations continue

Why Horizontal Transport — and Why ATT

Horizontal transport is one of the key determinants of **terminal performance** — and a case where **all three transformation enablers** come into play.

A Critical Operational Link

Horizontal Transport connects quay and yard operations; its performance affects container terminal productivity

A Cross-cutting Transformation Case

It clearly shows why technology, institutions, and workforce must be prepared together.

Smart port transformation



Terminal Operation



Horizontal Transport



ATT(Autonomous terminal tractor)

Key Enabler 1 — Technology

Technology strategy is not equipment selection alone — it is finding the system that fits the terminal's own objectives, constraints, and operating environment.

The choice spans **deployment scope, system architecture, and how the equipment will live with the existing operation** — not just which machine to buy.

Define goals and development scope

- Clarify target outcomes and automation level
- Set deployment scale, budget, and allowable downtime
- Assess technology maturity, safety, reliability, and total cost

Integrate digital systems

- Connect vehicles, FMS, and TOS
- Ensure reliable real-time data exchange and fail-safe operation
- Secure interoperability across equipment and systems

Prepare the operating environment

- Assess the terminal's suitability for the new equipment
- Identify additional infrastructure needs for charging, and vehicle localization and navigation
- Plan for operational risks and contingencies, such as mixed-traffic, and data failures

Key Enabler 2 — Institutions & Governance

Governments should identify institutional gaps early, establish appropriate rules and guidance, and maintain governance mechanisms for coordination, learning, and stakeholder acceptance.

The goal is **timely and proportionate intervention** that enables innovation while closing critical gaps with the right instruments.

Diagnose the gaps

- Map the demand for technology, emerging trends, and existing rules
- Identify barriers to testing, adoption, and deployment
- Prioritize gaps by urgency, safety, and operational impact

Design the response

- Choose regulation, standards, public guidance, or industry-led rules
- Set timelines in line with expected deployment
- Avoid both overregulation and insufficient safeguards

Govern the transition

- Engage regulators, port authorities, operators, suppliers, and workforce representatives
- Coordinate rules, support measures, operational needs, and acceptance
- Update the framework based on pilot and operational feedback

Key Enabler 3 — Workforce & Organization

Workforce planning should define the roles and capabilities required by the new operating model, build the talent pipeline to supply them, and manage a realistic transition for the existing workforce.

The objective is to **build the workforce required by the new operating model** while managing **a fair and feasible transition from the existing one**.

Design future work and roles

- Identify changes in operating and maintenance tasks
- Define new roles, responsibilities, and staffing needs
- Decide which capabilities to retain in-house or source externally

Build the capability pipeline

- Identify the skills and occupations required by industry
- Combine recruitment, training, qualifications, and industry-education partnerships
- Develop the talent and technical-service base needed for deployment

Manage transition and acceptance

- Assess the impact on existing roles and the feasibility of reskilling or redeployment
- Align workforce transition with the pace of technology deployment
- Engage workers and labor representatives early

Strategic Principles for Smart Port Transformation

A smart port transformation strategy should define the value to be created, choose a pathway that fits the terminal's starting conditions, and align technology, institutions, and workforce

Smart port transformation requires strong public-private collaborations.

Given the global port industry and technology markets, this cooperation must also extend internationally.

PRINCIPLE 01

Define the destination

- Clarify the value and operational outcomes sought
- Define the target operating model
- Set priorities, scope, and acceptable trade-offs

PRINCIPLE 02

Design the pathway

- Assess the terminal's starting conditions, gaps, and constraints
- Prioritize and phase investment and implementation
- Align technology, institutions, and workforce

PRINCIPLE 03

Coordinate implementation

- Involve relevant stakeholders in planning and implementation
- Align policy, technology, skills, and investment with operational needs
- Strengthen international cooperation



Thank You

Korea Maritime Institute (KMI)
Hyeryeong Lee · hrlee@kmi.re.kr

