



Ports 5.0: the next revolution in sustainable ports

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Intelligence



Human-centric



Ports
5.0



Resilience

Sustainable

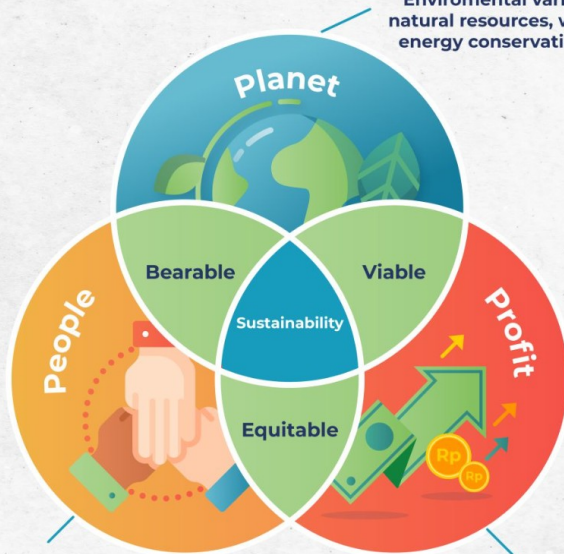


Sustainability Initiatives



The Triple Bottom Line of Sustainability

Environmental variables relating to natural resources, water & air quality, energy conservation, and land use.



Social variables dealing with community, education, equity, social resources, health, well-being, & quality of life.

Economic variables dealing with the bottom line, cash flow.





Sustainable Port

- ▮ **Environmental Impact:** Ports are significant sources of pollution due to heavy machinery and ship emissions; addressing these impacts is crucial for sustainability.
- ▮ **Adoption of Green Technologies:** Incorporating cleaner fuel options, renewable energy sources, and advanced waste management systems to reduce environmental footprint.
- ▮ **Regulatory Compliance:** Navigating through stringent environmental regulations and standards to maintain operations while promoting sustainability practices.
- ▮ **Gender Perspective:** closing the gap between genders.
- ▮ **Social Responsibility:** the port activity has a direct impact on the city, and both need to grow.

GLOBAL PORT SUSTAINABILITY RESEARCH EVOLUTION: TRENDS & FINDINGS (2015–2025)

EVOLUCIÓN DE LA INVESTIGACIÓN GLOBAL EN SOSTENIBILIDAD PORTUARIA: TENDENCIAS Y HALLAZGOS (2015–2025)

PERIOD (PERÍODO)

MAIN TOPICS & KEY FINDINGS (TEMAS PRINCIPALES Y HALLAZGOS CLAVE)

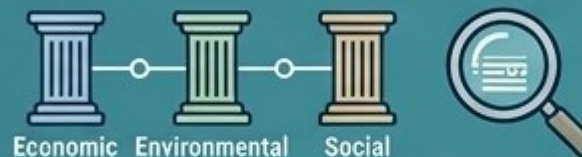
2015–2017

Rising interest in port sustainability measurement, indicator development, and first systematic reviews.



2018–2019

Consolidation of the three pillars (economic, environmental, social). Notable increase in systematic studies.



2020–2022

Focus on carbon emission reduction, energy efficiency, and implementation of green port policies.



2023–2024

Evaluation of multifaceted challenges: integration of economic, environmental, and social criteria via MCDM.



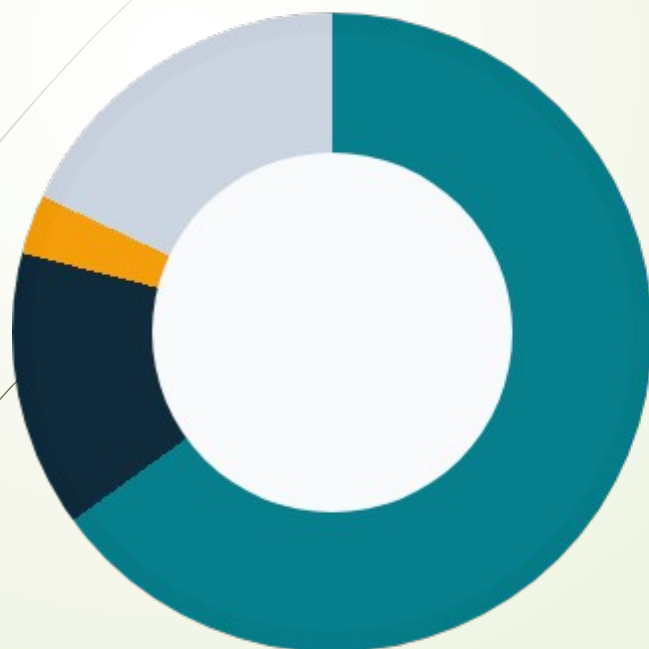
2025

Emerging priorities: digitalization, sustainable infrastructure, security, and port community building.



Structural Bias in ESG Literature

Despite the discourse on balance, corporate and scientific applications present a critical asymmetry:



65% Environmental Focus

Historically predominant and over-managed dimension.

14% Economic Focus

Moderate integration into development strategies.

3% Social Focus

Critically underrepresented and lacking deep theorization.

Source: Alamoush et al. (2021). Only 17% of studies genuinely address the Triple Bottom Line.

"Focusing sustainability solely on the environmental pillar undermines the structural viability of the whole logistics ecosystem."

Barriers to investment in sustainability in the port sector

Lack of ESG Skills



Weak Government Policies



Trade Policy Gaps



Low ESG Confidence



Low Public Awareness



Greenwashing Focus



High Resource Use



High Initial Costs



No Measurement Tools



Implementation Hurdles



Firm Size Limits



Inconsistent Pressure



Singapore Port: Utilizes automated systems and AI for predictive maintenance and efficient cargo handling, serving as a model of efficiency and sustainability.



Port of Rotterdam: Embraces digital twins and smart logistics solutions to enhance operational transparency and reduce environmental impact.



Port of Los Angeles: Implements green initiatives like electrification of cargo handling equipment and use of alternative fuels to lead in sustainability efforts.



Hamburg Port: City – port – academia, work together to solve problems: Integration.



MaLmö – Copenhagen Port: The sustainability department has a key role in the organization and it is part of all projects.

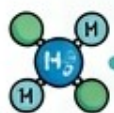


CHILE'S PUBLIC PORTS: ADVANCING SUSTAINABLE INITIATIVES

1. DECARBONIZATION AND ELECTRIFICATION



- Electrification of all terminal equipment
- Full transition to electric vehicle fleets



- Implementation of Shore-to-Ship Power (Cold Ironing)
- National Green Hydrogen Hubs & Pilotproject



3. CIRCULAR ECONOMY AND WASTE



- Improved waste strategy (Segregation & Recycling)
- Reuve reduction of plastic pollution (in-water and shores)
- Reusent reuse and repurposing of dredged materials
- Implementation of Sustainable Procurement Policies



2. ENERGY EFFICIENCY AND RENEWABLES



- Renewabl use of renewable energy (PPAs)
- Comprehensive Smart Lighting systems
- Predictive operational planning (AI-based)
- Inveitnent investments in port-specific solar and wind energy



4. SOCIAL RESPONSIBILITY AND GOVERNANCE



- Professional Training & Inclusion (Local Communities)
- Full Cender Parity and Diversity (Workforce and Leadership)
- Digital Community Engagement Platforms (Transparency)
- Trpsarent Sustainability and GRI Standfiance



Synthesis: Navigating with the Complete Ecosystem



2. Governance is the Enabler

Clear national policies (Resolution 1099) level the playing field against size and cost asymmetries.



1. Sustainability is Indivisible

Resolving the 65% environmental component without the 3% social aspect creates civil friction and judicial paralysis (San Antonio Case).



3. Digitalization as Accelerator

Smart Ports do not just move boxes faster; they make visible, measure, and manage the Triple Bottom Line impact.

Are we designing ports solely for the ships of tomorrow, or are we building logistics ecosystems for the societies of the future? ✨

An aerial photograph of a large port area. In the foreground, a large blue and white cargo ship is docked at a pier with several yellow cranes. To its right, another large ship is docked. The water is filled with many smaller boats. The port is surrounded by city buildings and infrastructure. The text "Ports 5.0: the next revolution in sustainable ports" is overlaid in white. An orange arrow points to the right on the left side of the image.

Ports 5.0: the next revolution in sustainable ports

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Thanks for your attention!

ROADMAP

1 FOVI 22 - TRANSFORMACIÓN DIGITAL (AUTOMATIZACIÓN y PCS)



SISTEMA NERVIOSO DIGITAL

2 FOVI 23 - SOSTENIBILIDAD (DESCARBONIZACIÓN y ENERGÍAS LIMPIAS)



PUERTO VERDE, BAJA HUELLA

3 FOVI 24 - LOGÍSTICA COLABORATIVA (SINERGIAS y COMPARTICIÓN DE DATOS)



PLATAFORMAS COMPARTIDAS

4 FOVI 25 - RESILIENCIA DE LA CADENA (MODELOS PREDICTIVOS y CONTINGENCIA)



CONTINUIDAD OPERATIVA

FONDEF - EXTERNALIDADES URBANAS
(MITIGACIÓN y PLANIFICACIÓN)



RUIDO,
CONTAMINACIÓN,
CONGESTIÓN

EXTENSIÓN E
TRANSFORMACIÓN Y
(PORTUARIA PORTUARIA)

PASEO HUMANO Y COMUNITARIO

PASEO HUMANO
Y COMUNITARIO

TECNOLOGÍA
(FOVI 22/24)

RESISTENCIA
(FOVI 25)

PLANETA
(FOVI 23/FONDEF)

ECOSISTEMA
PORTUARIO 5.0:
MODELO DE
SÍNTESIS

PERSONAS
(FOVI 26)

VIABLE,
NEUTRO,
RESPONSABLE

FOVI 26 - PUERTOS
CENTRADOS EN EL HUMANO
(EN ELABORACIÓN)



SEGURIDAD y
ACEPTABILIDAD SOCIAL