Global Port Infrastructure Sufficiency Index (PISI)

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Background

The PISI is **a port performance indicator** which measures **Punctuality, Safety & Security, and Digitalization**.

PISI

The PISI is developed under the framework of the Korea Maritime Institute (KMI) project launched in 2019 and implemented in collaboration with the UNCTAD and Gyeongsang National University.

The PISI is a proposed port performance indicator articulated around three main components: Punctuality, Safety and Security, and Digitalization.

The presentation sets out the main findings of Phase 2 of the PISI project.

Under Phase 2, the PISI concept was piloted across selected world container port terminals.

The AIS data allowed for assessing Punctuality (vessel time) while the survey questionnaire focused on Safety and Security and Digitalization.

The technical report was published in November 2023 and is available at UNCTAD's website.

Background

PISI has entered the 3rd phase after completing the concept design in the 1st and the pilot test in the 2nd phase.

Phase I

2018 ~ 2020

- Construction of **conceptual design** for the index
- Identification and hierarchization of applicable indicators
- Establishment of **an international cooperation system** for pilot testing

  * UNCTAD, IAPH, IMO, World Bank, WTO, WMU, WEF, GATF, GSF, IAME, ICS, UN-ECLAC, UN-ESCAP, etc.

Phase II

2021 ~ 2023

- Review and revision of the index structure
- Execution of **the initial pilot evaluation** (targeting approximately 50 ports worldwide)
- **Validation and identification** of the need for improvement

Phase III

2023 ~ 2025

- Preparation for **the second pilot evaluation**
- Conduct the second pilot evaluation
- **Preparation of establishing a regular evaluation system**

Port Infrastructure Sufficiency Index

PISI components, Indicators, and sub-indicators

The structure of PISI		
Punctuality (Vessel Time)	**Annual Average Waiting Time of Vessel (AWT)**	
	Annual Average Turnaround Time of Vessel (ATT)	
	Annual Average Berthing Time of Vessel (ABT)	
Safety & Security	**Equipment and Facility**	Physical Equipment / Technology Adoption / Information Security / Maintenance
	Human Factor	Knowledge / Sufficiency / Education and Training
	Management	Investment / Plan / Organization / Monitoring
Digitalization	**Indirect**	National Strategy / Human Capital
	Direct	Functionality / Technology

Port Infrastructure Sufficiency Index

How to measure : Punctuality

Setting coordinates

Extracting ship records
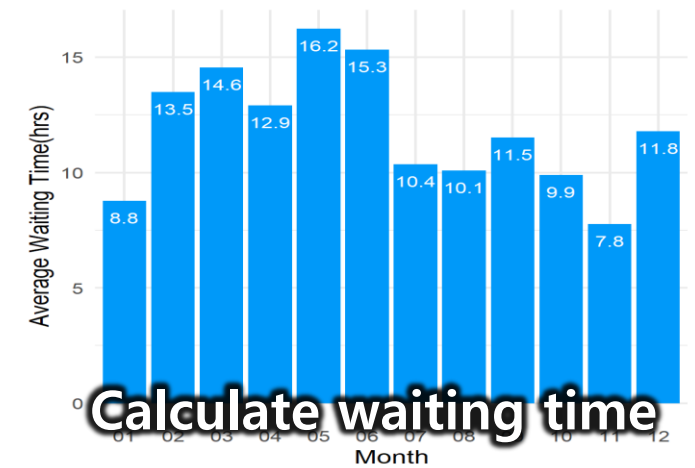
Calculate waiting time

Set up coordinates of port limits, berths, and anchorages
- IHS Markit's Port and Terminal Guide
- Satellite view and ship records in AIS data for berth specification

Extract the ship records incorporating loading/unloading activity

Calculate the average waiting time and berthing time
- Waiting time equals turnaround time minus berthing time

Port Infrastructure Sufficiency Index

How to measure : Safety & Security

- ✔ Consist of three sub-categories : Equipment and Facility(4), Human Factor(3), Management(4)
- ✔ Methodology : 5 levels(Strongly Disagree – Disagree – Neither agree or disagree – Agree – Strongly Agree)

[Evaluation of Safety & Security]

Factors		Description	Strongly Disagree	Disagree	Neither agree nor disagree	Agree	Strongly Agree
Equipment & Facility	Physical Equipment	The safety and security of facilities(equipment) such as CCTV, fence, light, or sensor at port area are well equipped.	①	②	③	④	⑤
	Technology Adoption	The latest technologies and equipment related to safety and security are being introduced.	①	②	③	④	⑤
	Information Security	The information security system of port is well established.	①	②	③	④	⑤
	Maintenance	Periodic inspection and maintenance of equipment and facilities are being performed.	①	②	③	④	⑤
Human Factor	Knowledge	Personnel of safety and security have specialized knowledge.	①	②	③	④	⑤
	Sufficiency	Safety and security personnel are adequate for the size of the terminal(port).	①	②	③	④	⑤
	Education & Training	Education and training of safety and security for personnel(workers) is conducted regularly.	①	②	③	④	⑤
Management	Investment	Investments in safety and security are being made sufficiently.	①	②	③	④	⑤
	Plan	An emergency plan for safety and security accidents is well established, and members(workers) are familiar with the plan.	①	②	③	④	⑤
	Organization	There is an organization of emergency response for safety and security incidents.	①	②	③	④	⑤
	Monitoring	Supervision and monitoring of compliance with safety and security regulations at terminal(port) are well established.	①	②	③	④	⑤

Port Infrastructure Sufficiency Index

How to measure : Digitalization

- ✅ Divide into two groups : Indirect(5) and Direct(6)
- ✅ Methodology : 5 levels(Very Low – Low – Middle – High – Very High)

[Evaluation of Digitalization]

Group	Factors		Description	No	Yes				
					1 (Very Low)	2 (Low)	3 (Mid.)	4 (High)	5 (Very High)
Indirect (Context, enabling framework, soft infrastructure, etc.)	National Strategy	National Digitalization Strategy	National strategy or related policy level of digitalization		①	②	③	④	⑤
		National Port Digitalization Strategy	National strategy or related policy level of digitalization for port		①	②	③	④	⑤
	Human Capital	IT Education	IT education level of citizen		①	②	③	④	⑤
		IT Capabilities	Citizen's capability level of IT usage		①	②	③	④	⑤
		IT Training & Education Opportunities	Education circumstance and infrastructure level of IT in nation		①	②	③	④	⑤
Direct (Hardware, IT tools and technology, etc.)	Functionality	Communications Infrastructure	Infrastructure level of data communication through wireless in port (see Apx. 1)		①	②	③	④	⑤
		Information of Status	Information (location, status, etc.) provision level of resources such as facility, equipment, etc. in port. (see Apx. 2)		①	②	③	④	⑤
		On-time of Information	Information (location, status, etc.) provision frequency of resources such as facility, equipment, etc. in port. (see Apx. 3)		①	②	③	④	⑤
		Operating System	Levels of operations and systems (TOS, etc.) in terms of port operations(see Apx. 4)		①	②	③	④	⑤
		Investment	Investment level of technology in the port sector compared to other SOC sectors (choose 3 if similar to other SOC sectors)		①	②	③	④	⑤
		Technology	The level of technology being utilized within the port (see Apx.5)		①	②	③	④	⑤

Port Infrastructure Sufficiency Index

Target Ports of the Pilot Project

- About 50 global major container ports based on throughput, location, etc.
- According to the total throughput of container port in 2021
  * World's top 50 ports takes more than 62% of the total container throughput in the World
- Africa(2), East Asia(15), Europe(10), Latin America and the Caribbean(3), Middle East(2), North America(7), Southeast Asia(6), Southern Asia(2)

[General Information of 47 Target Ports]

| Region	Number of Ports	Average port calls (Container ships)	Average container port traffic (2021, '000 TEU)
Africa	2	2,540	5,970
East Asia	15	6,983	16,357
Europe	10	3,205	6,698
Latin America and the Caribbean	3	1,735	3,849
Middle East	2	1,686	4,626
North America	7	1,651	7,024
Southeast Asia	6	5,996	13,742
Southern Asia	2	1,601	3,841
Overall average	47	4,236	10,306

Port Infrastructure Sufficiency Index

Pilot Project Result : Punctuality by Region

✓ As a result, ATT is 0.87 minutes per TEU, ABT is 0.64 minutes per TEU, AWT is 10.05 hours per vessel

- ✓ Europe : ATT 1.06 min, ABT 0.72 min, AWT 11.8 hours
- ✓ East Asia : ATT 0.78 min, ABT 0.61 min, AWT 6.1 hours
- ✓ Southeast Asia : ATT 1.20 min, ABT 0.73 min, AWT 16.8 hours
- ✓ Middle East : ATT 0.52 min, ABT 0.43 min, AWT 4.0 hours

- ✓ Southern Asia : ATT 1.23 min, ABT 0.96 min, AWT 11.9 hours
- ✓ North America : ATT 0.98 min, ABT 0.63 min, AWT 22.9 hours
- ✓ Latin America/Caribbean : ATT 0.72 min, ABT 0.58 min, AWT 5.4 hours
- ✓ Africa : ATT 0.52 min, ABT 0.48 min, AWT 1.5 hours

[Annual Average Turn-around Time, Berthing Time, and Waiting Time by Region]
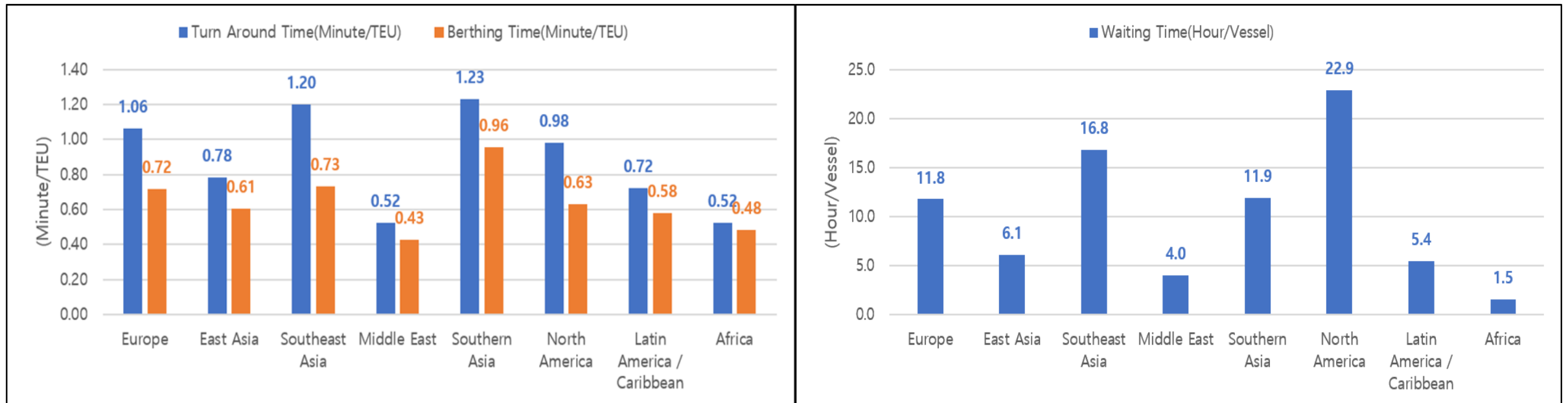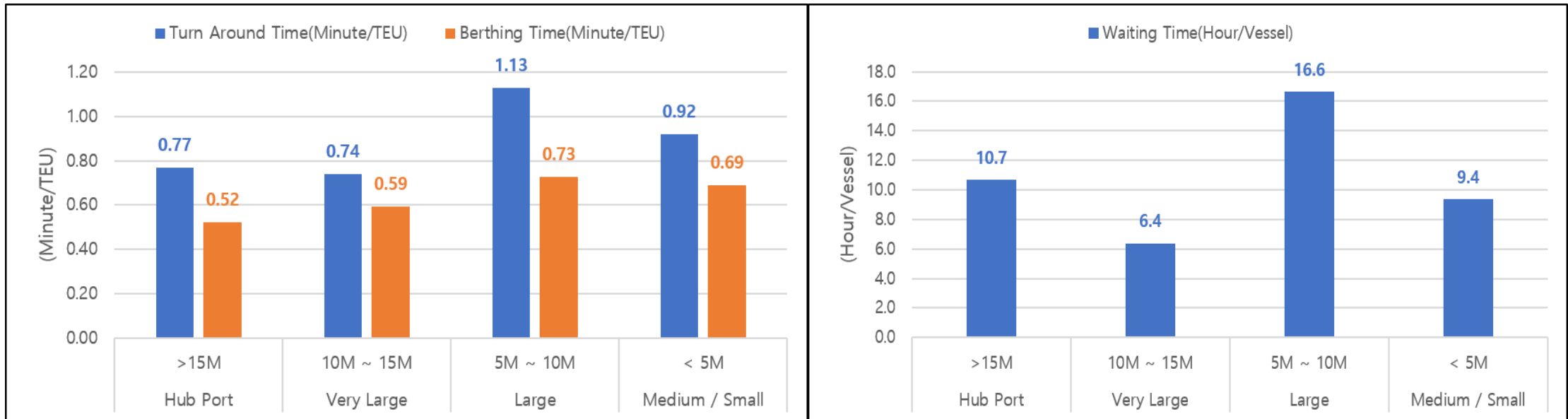
Port Infrastructure Sufficiency Index

Pilot Project Result : Punctuality by Port(Terminal) Size

✅ For Hub Ports, ATT is 0.77 hours per vessel, ABT is 0.52 hours per vessel, AWT is 10.7 hours per vessel

✅ For Very Large Ports, ATT is 0.74 hours per vessel, ABT is 0.59 hours per vessel, AWT is 6.4 hours per vessel

✅ For Large Ports, ATT is 1.13 hours per vessel, ABT is 0.73 hours per vessel, AWT is 16.6 hours per vessel

✅ For Medium/Small Ports, ATT is 0.92 hours per vessel, ABT is 0.69 hours per vessel, AWT is 9.4 hours per vessel

[Annual Average Turn-around Time, Berthing Time, and Waiting Time by Port Size]

Port Infrastructure Sufficiency Index

Pilot Project Result : Punctuality by Vessel Size

- ✅ For Greater than 8,000TEU, ATT is 46.6 hours per vessel, ABT is 39.5 hours per vessel, AWT is 7.2 hours per vessel

- ✅ For Less than 8,000TEU, ATT is 35.8 hours per vessel, ABT is 24.2hours per vessel, AWT is 11.6 hours per vessel

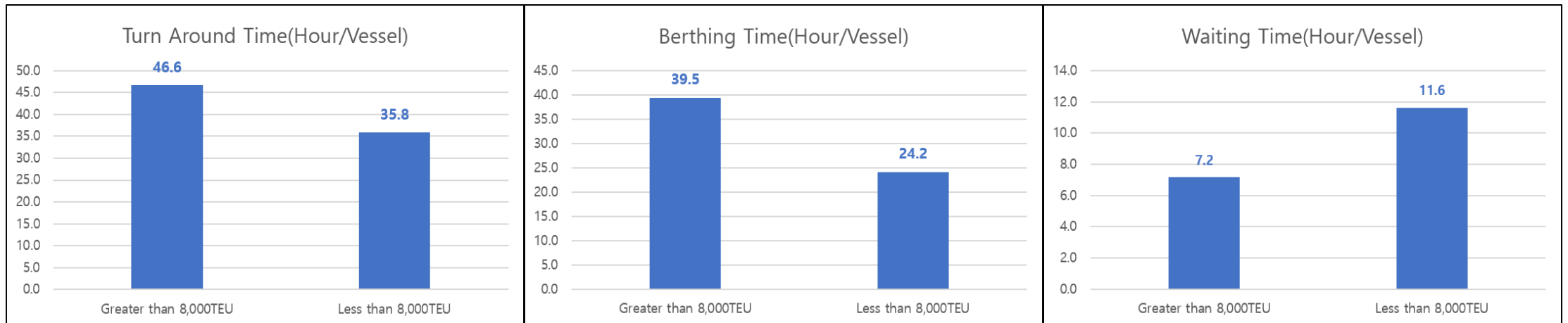## [Annual Average Turn-around Time, Berthing Time, and Waiting Time by Vessel Size]

Turn Around Time(Hour/Vessel)

Berthing Time(Hour/Vessel)

Waiting Time(Hour/Vessel)

Port Infrastructure Sufficiency Index

Pilot Project Result : Port Time and Waiting Time Ratio by Vessel Size

✔ Annual Average Waiting Time Ratio is 28.5%

  ✓ For Greater than 8,000TEU, Waiting Time Ratio is 15.4%
  ✓ For Less than 8,000TEU, Waiting Time Ratio is 32.5%

[Port Time and Waiting Time Ratio by Vessel Size]

	Turn Around Time (Hour/Vessel)	Berthing Time (Hour/Vessel)	Waiting Time (Hour/Vessel)	Waiting Time Ratio (%)
> 8,000 TEU	46.6	39.5	7.2	15.4
< 8,000TEU	35.8	24.2	11.6	32.5
Average	38.9	27.8	11.1	28.5

Port Infrastructure Sufficiency Index

Pilot Project Result : Safety & Security and Digitalization

- ✅ A total of 26 ports responded to the questionnaire
  - ✓ 11 of the 26 respondent ports were in Asia (42.3%), ten were in East and Southeast Asia (38.5%), the other one was in South Asia (3.8%)
  - ✓ Seven respondent ports were from Europe (27.0%)
  - ✓ Four respondents ports were in Africa (15.4%)
  - ✓ Three respondent ports were from the Latin America/Caribbean region (11.5%)
  - ✓ The other one was in Africa (3.8%)
- ✅ Respondent ports were spread across Africa, Asia, Europe, North America, and Latin America and the Caribbean (LAC) with more than half of respondents (62.0%) being in developing regions

[Geographical regions of respondent ports]

Latin America and the Caribbean 12%
North America 4%
Africa 15%
Asia 42%
Europe 27%
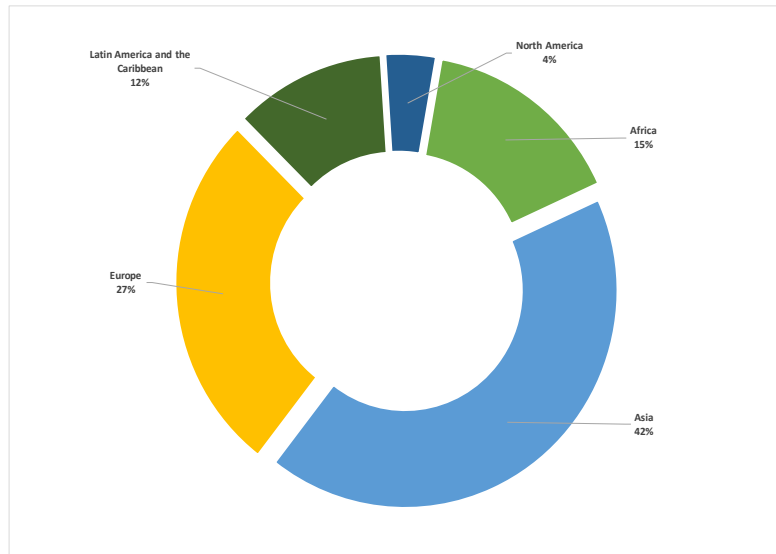
[Development status of respondent ports]
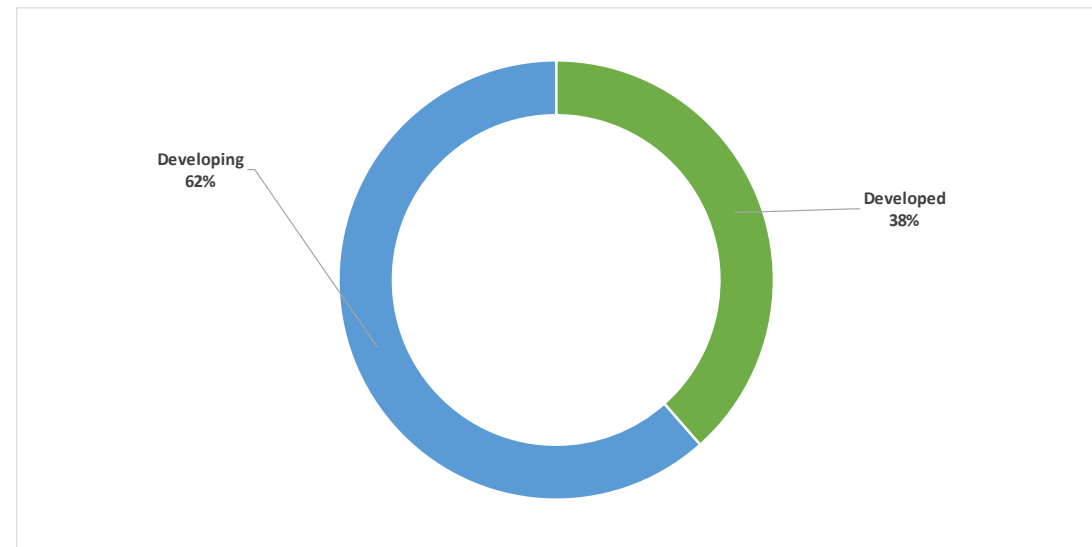
Developing 62%
Developed 38%

Port Infrastructure Sufficiency Index

Pilot Project Result : Safety & Security and Digitalization

✔ Respondent included port authorities, port management companies/port corporations, state owned companies managing ports, port operators, and container terminal operators

- ✓ Over half of respondent ports (54%) were port authorities
- ✓ 19% were terminal operators while 12% were port operators
- ✓ The remaining respondents were either port management companies (11%) or State-owned port managing enterprises (4%)

[Respondent ports by governance structure]
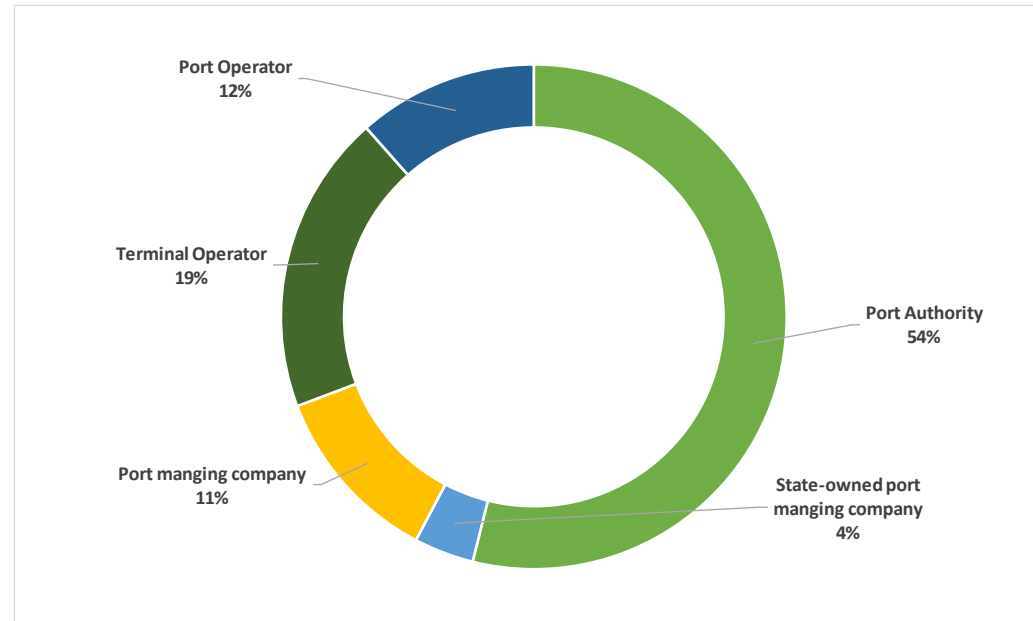
Port Operator
12%

Terminal Operator
19%

Port Authority
54%

Port manging company
11%

State-owned port
manging company
4%

Port Infrastructure Sufficiency Index

Pilot Project Result : Safety & Security and Digitalization

✔ Respondent ports varied in size whether in terms of physical size (number of berths, handling capacity and water draft) or cargo handling operations and throughput

- ✓ For Average Ports, less than one-third (26.9%) can be considered
- ✓ Over one-third (34.5%) were large ports
- ✓ A total of 11.5% respondent ports are linked to hub ports
- ✓ Over one-quarter (26.9%) were small ports

[Respondent ports by Port Size]
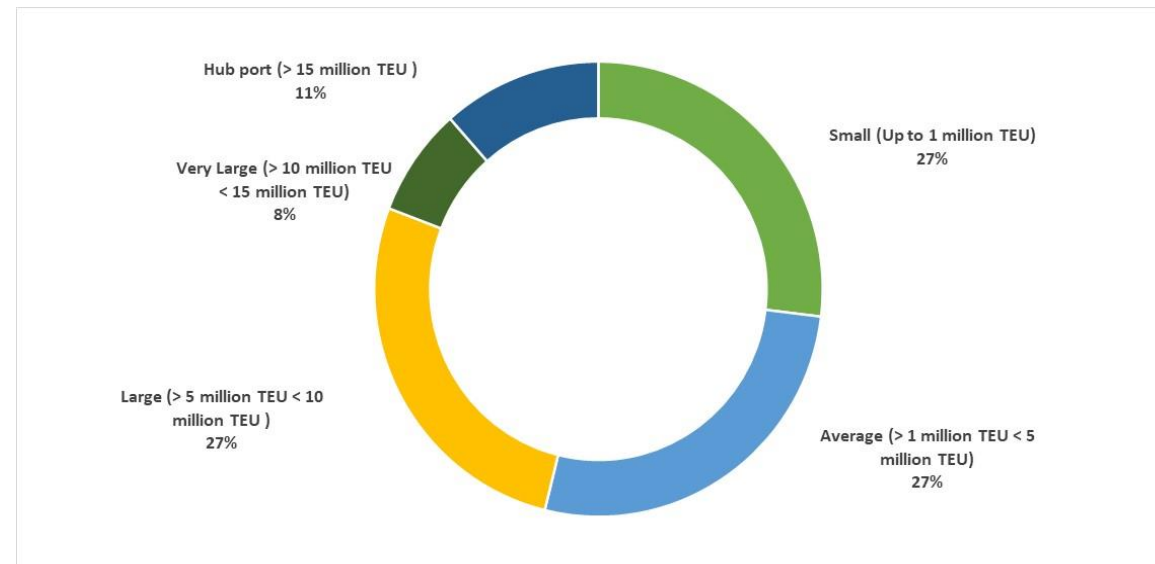
Hub port (> 15 million TEU)
11%

Very Large (> 10 million TEU
< 15 million TEU)
8%

Small (Up to 1 million TEU)
27%

Large (> 5 million TEU < 10
million TEU)
27%

Average (> 1 million TEU < 5
million TEU)
27%

Port Infrastructure Sufficiency Index

Pilot Project Result : Safety & Security and Digitalization

- ✅ The survey questionnaire focused on the following aspects
  - ✓ Safety and Security, Management, Human Factor, National and Port level plans supporting digitalization (investment, management, skills and human capabilities, infrastructure, etc.) and Technology

- ✅ The Main survey results are captured by the average scores which reflect the rating assigned by respondent ports to each question using a scale of 1 to 5, where 1 means that the respondent strongly disagrees with the statement and 5 means that the respondent strongly agrees with the statement

[Summary results of the PISI sub-indicators]

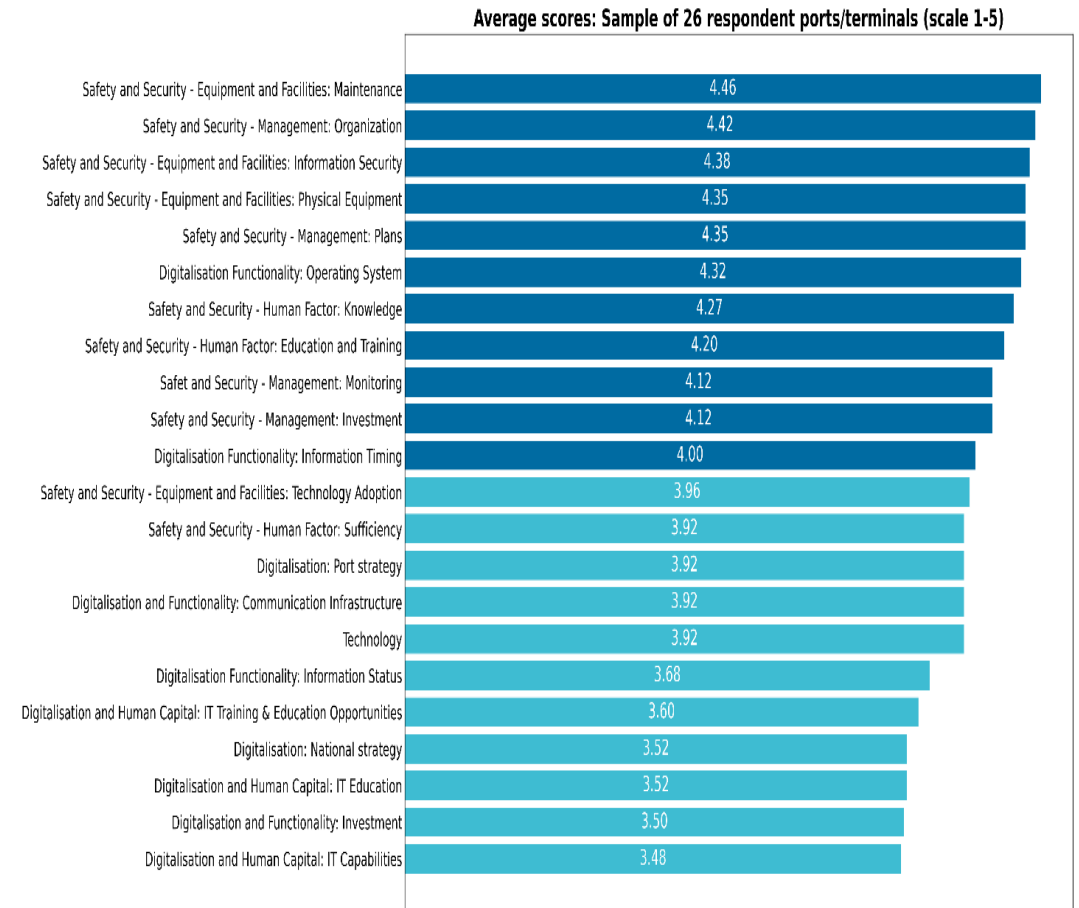|	
Average Score of Safety and Security	**4.23**
Average Score of Equipment and Facilities	4.29
Physical Equipment	4.35
Technology Adoption	3.96
Information Security	4.38
Maintenance	4.46
Average Score of Human Factor	4.13
Knowledge	4.27
Sufficiency	3.92
Education and Training	4.2
Average Score of Management	4.25
Investment	4.12
Plans	4.35
Organization	4.42
Monitoring	4.12
Average Score of Digitalization	**3.70**
Average Score of National Strategy (Combined national and port levels)	3.72
National level strategy	3.52
Port strategy	3.92
Average Score of Human capital	3.53
IT Education	3.52
IT Capabilities	3.48
IT Training and Education Opportunities	3.6
Average Score of Functionality	3.88
Communication Infrastructure	3.92
Information Status	3.68
Information Timing	4.00
Operating System	4.32
Investment	3.50
Average Score of Technology	3.92
Total Average Score	**3.98**

Port Infrastructure Sufficiency Index

Pilot Project Result : Safety & Security and Digitalization

[Summary results of the PISI sub-indicators]

✔ Summary of the responses to the survey questionnaire

- ✓ The higher the average score the more likely are the respondent ports to have implemented the requisite safety and security and digitalization measures
- ✓ The average scores tend to be higher for 'Safety and Security: Equipment and Facilities' and 'Safety and Security: Management'
- ✓ Average scores tend to be lower in other cases, indicating that respondent ports agree less with the statement
- ✓ The level of development does not seem to affect the scores or the ability of a respondent port or terminal to perform above the average score for the sample.
- ✓ Also, port size measured in volume of cargo handled does not seem to have a major influence on the score and whether the terminal or ports have implemented measures, strategies and decisions promoting the three components captured by the PISI.

Average scores: Sample of 26 respondent ports/terminals (scale 1-5)

Indicator	Score
Safety and Security - Equipment and Facilities: Maintenance	4.46
Safety and Security - Management: Organization	4.42
Safety and Security - Equipment and Facilities: Information Security	4.38
Safety and Security - Equipment and Facilities: Physical Equipment	4.35
Safety and Security - Management: Plans	4.35
Digitalisation Functionality: Operating System	4.32
Safety and Security - Human Factor: Knowledge	4.27
Safety and Security - Human Factor: Education and Training	4.20
Safet and Security - Management: Monitoring	4.12
Safety and Security - Management: Investment	4.12
Digitalisation Functionality: Information Timing	4.00
Safety and Security - Equipment and Facilities: Technology Adoption	3.96
Safety and Security - Human Factor: Sufficiency	3.92
Digitalisation: Port strategy	3.92
Digitalisation and Functionality: Communication Infrastructure	3.92
Technology	3.92
Digitalisation Functionality: Information Status	3.68
Digitalisation and Human Capital: IT Training & Education Opportunities	3.60
Digitalisation: National strategy	3.52
Digitalisation and Human Capital: IT Education	3.52
Digitalisation and Functionality: Investment	3.50
Digitalisation and Human Capital: IT Capabilities	3.48

Future Works

Tentative schedule for the second pilot

✔ **Stage 1 of Phase 3 of the project** (1 April to 1 June 2024)

UNCTAD and the PISI Advisory Board members review the PISI revised Indicators and improved Survey Questionnaire and provide their feedback and views to KMI.

✔ **Stage 2 of Phase 3 of the project** (1 June 2024 to 28 February 2025)

During this phase, KMI evaluates the punctuality and UNCTAD supports the piloting of the PISI improved Survey Questionnaire and revised Indicators. It calculates the PISI values and scores across the various components for a target of 100 ports/terminals.

✔ **Stage 3 of phase 3 of the project** (1 March 2025 to December 2025)

The final report is prepared and published.

Future Works

Preview of the Phase 3

Refinement of the punctuality measurement algorithm

- Previously, waiting time was measured by the difference between turnaround time and berthing time.
- Now, waiting time is measured by the time ships spend in the anchorage area.

Enhancing the Objectivity and Reliability of the PISI Questionnaire

- Previously, the items in the questionnaire showed high variability depending on the evaluator's subjectivity.
- Now, objectivity is enhanced by providing specific response guidelines for each item.

Expanding the Survey Target Ports

- Previously, 50 global container ports were reached out and 26 were examined.
- Now, we are targeting 100 global container ports and terminals.

Thank you!