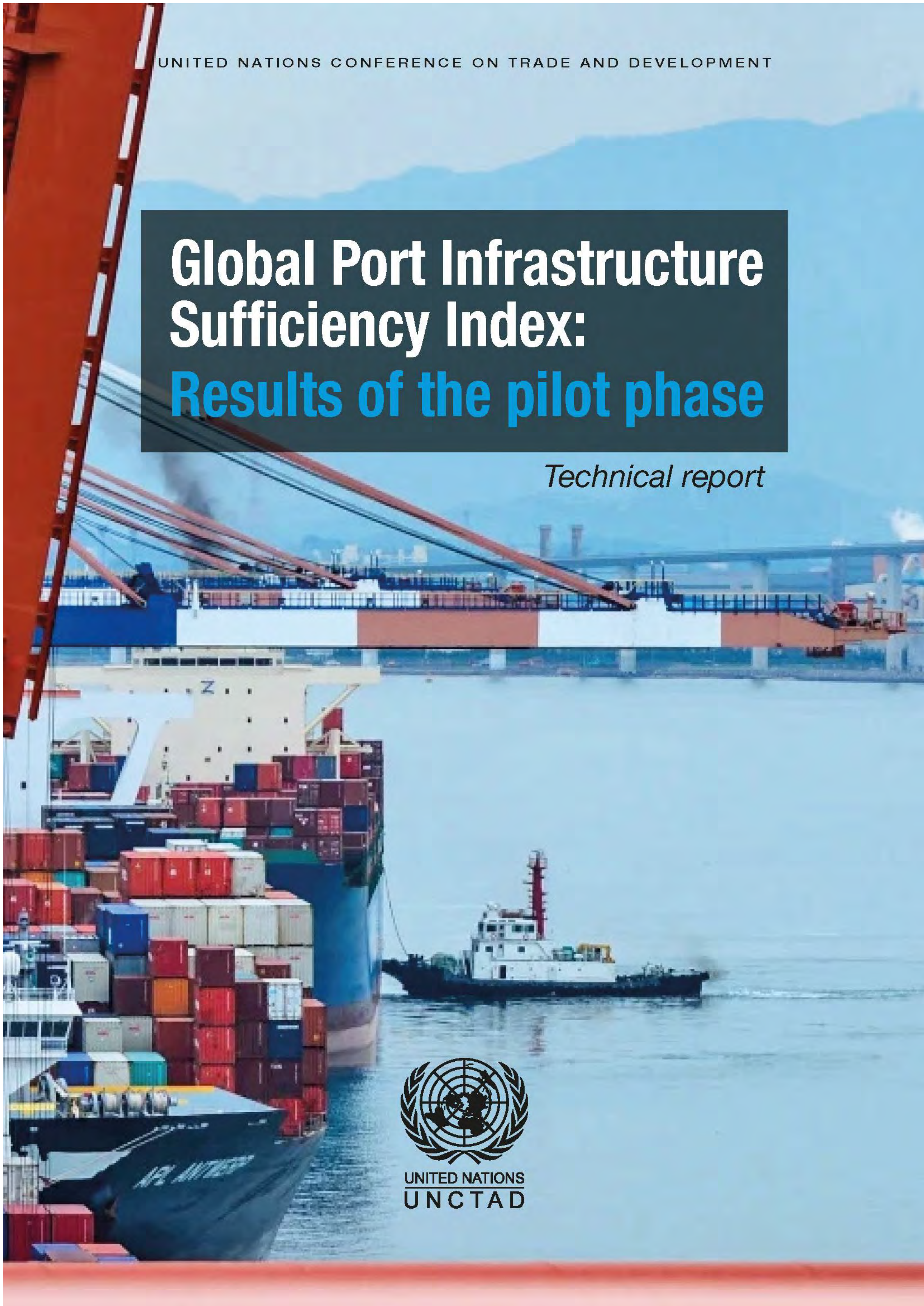
UNITED NATIONS CONFERENCE ON TRADE AND DEVELOPMENT

Global Port Infrastructure Sufficiency Index: Results of the pilot phase

Technical report



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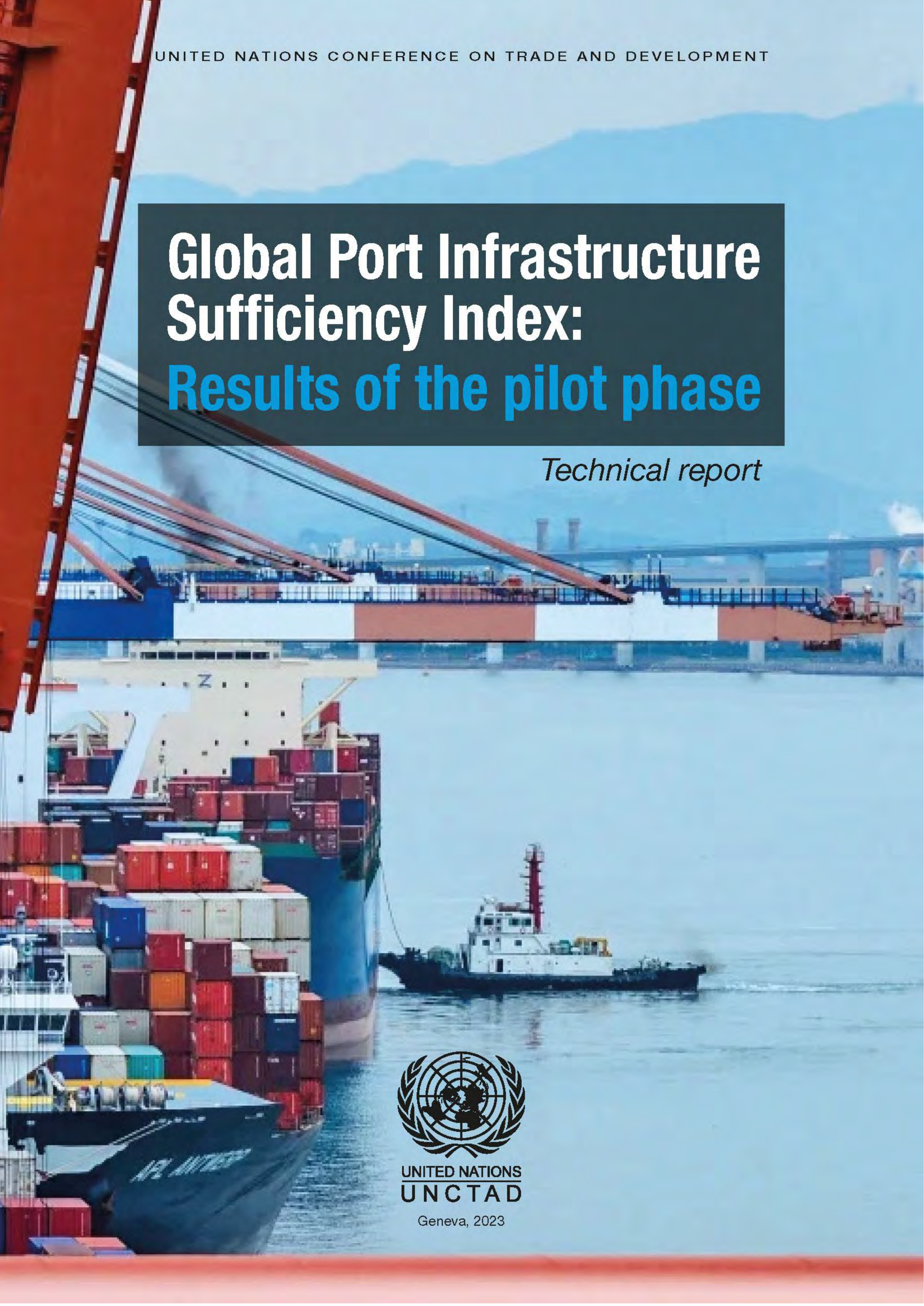

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The project is supported by the Ministry of Oceans and Fisheries of the Republic of Korea. Phase 1 (2019–2020) focused on elaborating the index and its methodology and phase 2 (2021–2023) allowed for the testing and validation of the index.

For further information, please visit the UNCTAD website at https://unctad.org/en/Pages/DTL/TTL/Infrastructure-and-Services.aspx or contact the Transport Section, Trade Logistics Branch, Division on Technology and Logistics, UNCTAD; transport.section@unctad.org.

Ministry of Oceans and Fisheries

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Abbreviations and acronyms

ABT: Annual Average Berthing Time of Vessel
AI: Artificial Intelligence
AIS: Automatic Identification System
ASD: Agenda for Sustainable Development
ATT: Annual Average Turnaround Time of Vessel
AWT: Annual Average Waiting Time of Vessel
CDMA: Code Division Multiple Access
CSR: Corporate Social Responsibility
EDI: Electronic Data Interchange
ERP: Enterprise Resource Planning
ESG: Environmental, Social, Governance
GNU: Gyeongsang National University
GPS: Global Positioning System
IAME: International Association of Maritime Economists
IAPH: International Association of Ports and Harbors
ICS: International Chamber of Shipping
IMO: International Maritime Organization
IoT: Internet of Things
KMI: Korea Maritime Institute
LAN: Local area network
LTE: Long Term Evaluation
MOF: Korea Ministry of Fisheries and Oceans
PCS: Port Community System
PISI: Port Infrastructure Sufficiency Index
PPRN: Port Performance Research Network
RFID: Radio Frequency Identification
SOC: Social Overhead Capital
TEU: 20-foot equivalent units
UMTS: Universal Mobile Telecommunications System
UNCTAD: United Nations Conference on Trade and Development
UNECLAC: United Nations Economic Commission for Latin America and the Caribbean
UNESCAP: United Nations Economic and Social Commission for Asia and the Pacific
WBG: World Bank Group
WCDMA: Wideband Code Division Multiple Access
WMU: World Maritime University
WTO: World Trade Organization

Port Infrastructure Sufficiency Index (PISI)

Results of the pilot phase

1. Purpose of the report

This report was prepared under the framework of the Korea Maritime Institute (KMI) project on a Global Port Infrastructure Sufficiency Index (PISI) which was launched in 2019 and implemented in collaboration with the United Nations Conference on Trade and Development (UNCTAD). The PISI is a proposed port performance indicator articulated around three main components: Punctuality, Safety and Security, and Digitalization.

This report 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 piloting of the PSIS relied on two distinct data and maritime intelligence sources, namely 1) the Automated Identification System data (AIS) on vessel port calls and time spent in ports and, 2) a survey questionnaire elaborated by KMI in collaboration with UNCTAD, the International Association of Ports and Harbors (IAPH) and the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP). The AIS data allowed for assessing Punctuality (vessel time) while the survey questionnaire focused on Safety and Security and Digitalization. The survey was launched in November 2022 and concluded in April 2023.

2. Context and background

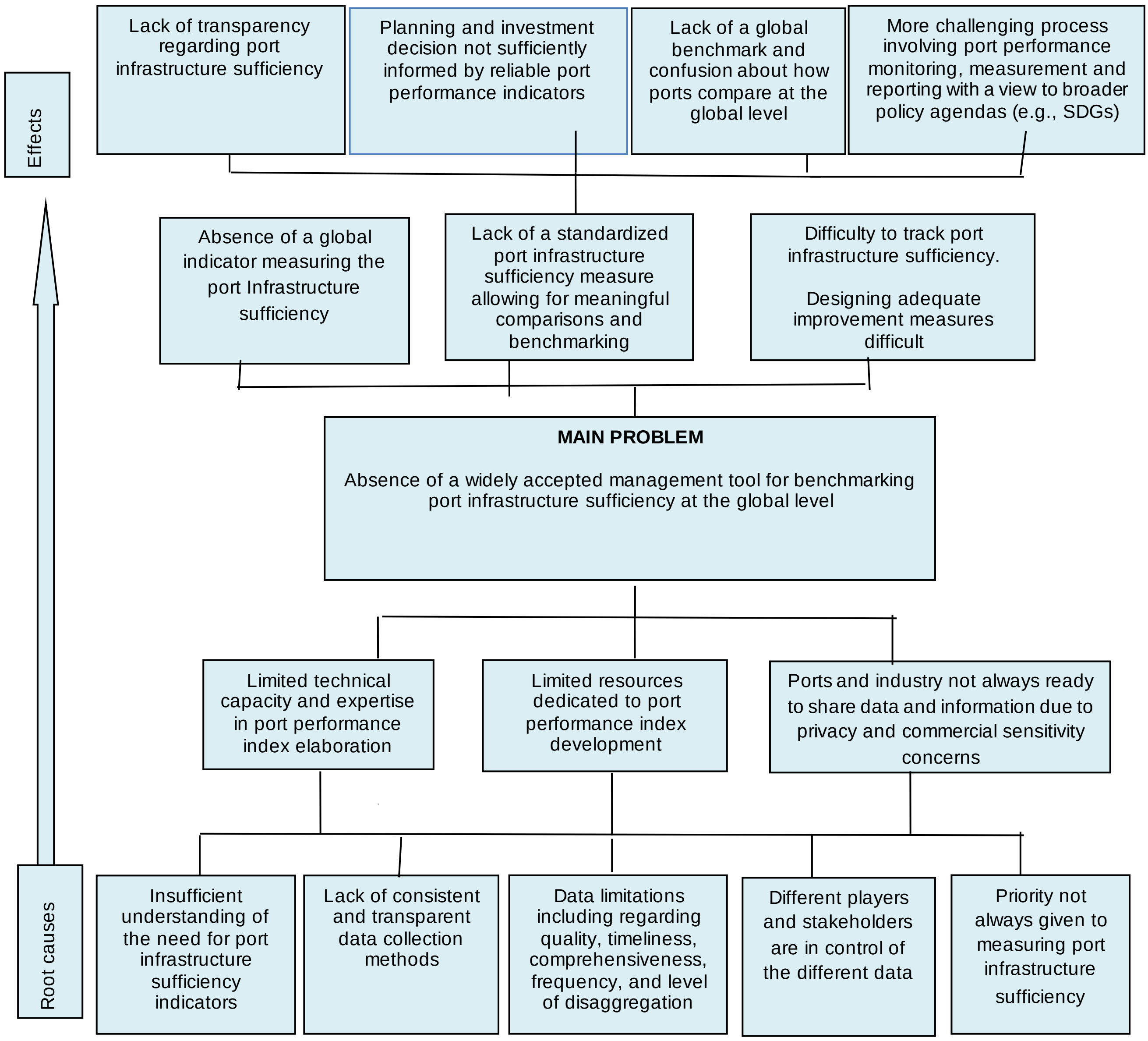
Maritime transport is the backbone of globalized merchandise trade with over 80 per cent of the world merchandise trade by volume being carried by sea. Shipping and ports link global value chains and underpin the global economic interconnectedness. Ports are global strategic assets which over the years have become more than cargo handling centres and emerged as complex, multifunctional centers offering a wide range of services for cargo and users. Many ports are related to wide-ranging value-added industries and serve as critical drivers of social and economic progress in cities, regions, and countries worldwide. According to UNCTAD estimates, in container shipping alone, over 900 ports were servicing global liner shipping networks in 2022. These ports handled 171 million 20-foot equivalent units (TEU) of containerized trade and generated over 800 million TEU of world containerized port traffic.

Bearing in mind the strategic importance of ports, adequate monitoring and measurement of their performance is crucial when aiming to improve trade competitiveness, reduce maritime transport costs, increase port user satisfaction, and enable sustainable and resilient maritime transportation systems.

The 2030 Agenda for Sustainable Development (ASD), the Sustainable Development Goals (SDGs) and the 2015 Paris Climate Agreement (Paris Agreement) have emphasized the need for all economic sectors, including maritime transport to monitor and measure performance and track progress towards the achievement of relevant economic, social, and environmental targets. In this context, indicators measuring the performance of the maritime transport sector with multidimensional metrics spanning a range of factors (e.g., efficiency, cost-effectiveness, productivity, profitability, connectivity, access, social inclusiveness, and environmental sustainability) are becoming ever more important for maritime business and its users, as well as for governments and policy makers.

Developing SMART performance indicators i.e., indicators that are Specific, Measurable, Achievable, Relevant and Timely, depends on the availability and the quality of the input data and statistics. Therefore, addressing existing maritime transport data gaps and measuring the sector's performance requires investing in acquiring, compiling, making available and managing relevant data. Key problems and gaps underpinning the need for global SMART port performance indicators including port infrastructure sufficiency measures are summarized in Figure 1.

Figure 1. Mapping the factors driving the need for a global port infrastructure sufficiency indicator



3. UNCTAD-KMI collaboration on port performance measurement

In 2019, KMI, supported by the Ministry of Oceans and Fisheries of the Republic of Korea (MOF), initiated a collaborative effort to advance the work on port performance measurement. The aim was to evaluate the feasibility of a global port infrastructure sufficiency index and associated metrics that could be easily implemented and widely accepted by global ports and terminals.

Against this background, KMI and MOF have elaborated the PISI to help evaluate port infrastructure sufficiency worldwide, with a special focus on container ports and terminals. The proposed index is articulated around quantitative and qualitative factors and is designed to be simple and user-friendly. It is intended as a research tool and a port management instrument that can help governments, ports and other relevant stakeholders refine their understanding of port performance and ways in which it can be upgraded to enhance competitiveness, user and customer satisfaction while, at the same time, supporting the attainment of broader sustainable development objectives that are being increasingly mainstreamed in transport and trade through global policy processes such as the ASD 2030, climate action and digitalization uptake. The PISI is expected to help fill an important research and data gap since no such global index is currently available.

The project was supported by UNCTAD drawing upon its established expertise in maritime transport. For over five decades, UNCTAD has been working with developing countries to improve their maritime transport and trade performance. In addition to its research and analysis, intergovernmental machinery, technical assistance and capacity-building work, UNCTAD leveraged its historical time series on maritime statistics and its annual *Review of Maritime Transport* (RMT). Additionally, UNCTAD shared insights and provided guidance to help determine the feasibility of the PISI and ensure its validation by the target audience and wide-ranging stakeholders spanning ports, terminals, policy makers and public authorities responsible for port development and management.

UNCTAD considers that a workable PISI will help close a persistent data and information gap in port performance management and serve as a policy tool that informs decisions, policies, and actions by relevant stakeholders, including port service providers, infrastructure developers and managers, users, financiers, and investors as well as governments and regulators.

4. Introducing the PISI

Key features and value-added

The PISI is an index calculated by KMI based on two sets of data, namely the input provided by container port terminal operators and port authorities through a survey questionnaire and the AIS data obtained from IT-enabled data sources such as VesselsValue. For the pilot phase, KMI focused on these two main channels to gather the required input data. Going forward, KMI expects to leverage additional data sources depending on availability, ease of access and quality.

The PISI is articulated around various indicators which, together, are expected to measure the level of port infrastructure sufficiency. These indicators capture the following three dimensions: 1) Punctuality (vessel time/vessel turnaround time) which assesses the sufficiency of the seaside infrastructure, 2) Safety and Security, including of infrastructure, facilities, and equipment, and 3) Digitalization, ICT infrastructure capabilities and yard- and gate-related infrastructure.

The PISI aims to support strategic decisions by container terminal and port operators, policy makers, maritime transport industry, and other supply chain stakeholders. Other stakeholders such as investors, infrastructure developers, equipment manufacturers and lending institutions can also make use of the PISI and the information it generates. The PISI can help assess and improve performance in terms of Environmental, Social and Governance (ESG) criteria, the Corporate Social Responsibility (CSR), sustainable development goals and climate action.

The PISI values and scores calculated for the participating container terminals and ports can serve as a benchmark for governments and regulators to define standards, norms, good practices, thresholds, control, and audit levels. They can also inform governments' decisions on budget and resource allocation, ensure alignment with global processes on sustainable development and climate action, and influence their capacity to attract funding.

To summarize, key expected achievements of the PISI project include the following:

- Enhance port performance measurement and gain better insight into the areas that may require improvements to ensure more sustainable and resilient port and maritime supply chain systems.
- Establish a reliable and verifiable global port metric assessing the sufficiency of port infrastructure.
- Enable sound port planning and investment decisions that are better informed and underpinned by a globally verifiable port infrastructure sufficiency indicator.
- Strengthen and promote more research and collaboration among government (e.g. Republic of Korea), the port industry (e.g. IAPH), research institutions (e.g. KMI), academia (e.g. the World Maritime University (e.g. WMU) and the International Association of Maritime Economists (e.g. IAME)) development partners such as UNCTAD, the World Bank Group (WBG), the United Nations regional commissions (e.g. UNESCAP), and entities with regulatory mandates such as the International Maritime Organization (IMO) and the World Trade Organization (WTO).

The main contribution of the PISI can be summarized by some of its unique features. First, it is formulated by a specialized maritime research centre, namely KMI, in collaboration with the international community including institutions such as UNCTAD. KMI and the MOF of the Republic of Korea have existing national experience in the field of port performance measurement. In 2019, KMI evaluated a total of 30 Korean commercial ports using a national version of the PISI. The national index consisted of 17 indicators spanning various aspects, namely Punctuality (vessel time), Safety, Environment, and Digitalization. Following the national port performance evaluation, KMI and the MOF concluded that a comprehensive evaluation system for port performance, productivity, efficiency, and service quality combined in one single index was required, given the ongoing global trends shaping the port industry.

Second, it leverages UNCTAD's extensive network of partners to ensure that the methodology adopted is sound and adequate. Relevant network partners include research institutions and data providers (e.g., VesselsValue), academia (WMU, IAME, the Port Performance Research Network (PPRN)), intergovernmental organizations (e.g., WTO, World Bank Group (WBG)), UN-sister organizations (Economic Commission for Latin America and the Caribbean (UNECLAC) and UNESCAP), the shipping and the port industries (e.g., IAPH and the International Chamber of Shipping (ICS)). In addition, Korea's Gyeongsang National University (GNU) joined the project in 2020 as one of initial project members moved from KMI to GNU.

Third, the PISI is global in scope and is based on hard data and objective criteria. It is underpinned by a methodology that is transparent and captures both the core operational port performance aspects and the emerging cross-cutting trends spanning safety and security, technology, and digitalization. While during the pilot phase, the PISI focused on container port terminals, in the future and once the concept has been proven, the scope could be widened to cover other types of terminals and ports. Access to PISI scores will be free of charge and cater to wide-ranging stakeholders depending on which perspective of the PISI is emphasized and on the purpose of the terminal and port evaluation.

PISI project phases

Phase 1 (2019–2020): Elaborating the PISI and its methodology

KMI elaborated the PISI drawing upon the successful national experience in the field of port performance measurement. In collaboration with UNCTAD and other partners, KMI conducted a substantive assessment of the methodology, the components and the approach underpinning the proposed PISI.

Under Phase 1, UNCTAD established and chaired an international Advisory Board tasked with reviewing and validating the proposed PISI. In addition to the virtual meetings, KMI, UNCTAD and the Advisory Board members discussed the PISI in more detail during the in-person workshop held in June 2019 in Geneva and at the international conference held in November of the same year in Seoul. Phase 1 concluded with a final report and generated input into the future communication plan for the rolling out of the final PISI following its testing and validation during Phase 2.

The structure of the PISI is set out in Table 1. The PISI features three main components: 1) Punctuality; 2) Safety and Security; and 3) Digitalization. Punctuality captures the operational efficiency of ports and terminals by tracking time spent in port. Safety and Security aspects are assessed by looking at the level and the adequacy of safety and security aspects affecting infrastructure and equipment, labour and human resources, and management processes. Key themes include knowledge, education and training, plans, management, physical infrastructure, and investment levels, among others. Finally, the PISI includes a component on digitalization and technology uptake by terminal and port operators. These areas are examined by including metrics pertaining to the regulatory and enabling framework such as the presence of national and port strategies that seek to promote digitalization. Other relevant metrics considered include human resource capabilities in the digital field, and the functionality aspects (e.g., type of operating systems, speed, and frequency of communications) and investments dedicated to technology.

Table 1. PISI components, indicators, and sub-indicators

Punctuality (Vessel Time)	Annual Average Turnaround Time of Vessel (ATT)	
	Annual Average Waiting Time of Vessel (AWT)	
	Annual Average Berthing Time of Vessel (ABT)	
Safety and 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

Phase 2 (2021–2023): Pilot phase — PISI testing and validation.

Initiated in 2021, Phase 2 focused on piloting the proposed PISI across a selected number of major world container ports and terminals. It concluded in October 2023 with the publication of the joint KMI-UNCTAD report on the main results and findings of the PISI pilot phase.

Testing and validating the questionnaire as a data collection tool is a crucial step under the PISI project as the aim is to establish an PISI data collection survey questionnaire to be rolled out annually to gather data required to calculate the PISI values. As was the case in the present report, responses to future PISI questionnaires will also be anonymized and presented in an aggregated format.

Against this background, a survey questionnaire developed by KMI in collaboration with UNCTAD was elaborated to collect input data from the targeted ports and terminals. The questionnaire sought to ascertain whether, as formulated, the questions were able to generate the relevant input data and information that are considered essential to calculating the PISI values.

Questions were structured around three core thematic areas: 1) quantitative data relating to terminal and port operations such as the waiting time of vessels in the terminal and port area, 2) a qualitative assessment of the safety and security levels at terminals and ports, and 3) an assessment of the digitalization levels and technology uptake, including investment technology.

The questionnaire was launched on 11 November and was open for a duration of five weeks through an online questionnaire (Survey Questionnaire 2022). As the response rate was not satisfactory, the duration was extended until mid-April 2023. UNCTAD reached out to 50 global container ports and terminals based on the list prepared by KMI in collaboration with IAPH. In addition, the questionnaire was circulated among the port members of the UNCTAD Port Management Programme of the TrainForTrade and was translated into French and Spanish to ensure wider coverage. The questions were further disseminated through personal contacts and networks of UNCTAD and KMI staff. Additionally, the IAPH and UNESCAP have helped to facilitate the roll out of the survey across the wide-ranging world container ports and terminals.

5. Phase 2 main results and findings

Punctuality (vessel time) component: Results of AIS-based analysis

Punctuality (vessel time) dimension of the PISI is assessed based on AIS data sourced from VesselsValue. The initial objective was to assess the top 50 world container ports and terminals. However, three of these top 50 ports were excluded for the purposes of the analysis due to their geographical location and the overlapping AIS data coverage which may result in duplication. Data analysis focused on the top 47 leading world container ports by container throughput. As shown in Table 2, the 47 ports used for analysis, are spread across East Asia (15 ports), Europe (10 ports), North America (7 ports), Southeast Asia (6 ports), Latin America and the Caribbean (3 ports), Middle East (2 ports), Southern Asia (2 ports), and Africa (2 ports).

The data covers 2021 and features information regarding port turnaround, waiting, and berthing time. Data was extracted through Geo Fencing for the target ports and terminals. The analysis of was based on data capturing a total of 165,000 recorded events (i.e., arrival, berthing and departure). While the AIS data sourced from VesselsValue was relied upon, lack of clarity in some cases, regarding the number of port calls, required the use of IHS Markit's Port and Terminal Guide to address issues arising from the Geo Fencing.

For analytical purposes, the AIS data was modified to meet certain criteria. The minimum turnaround time was set to 3 hours or more. Turnaround time of less than 3 hours was excluded from the analysis as such a short timeframe is probably not linked to cargo handling activities. In addition, cases exceeding 366 hours (i.e., 14 days) were also note included since they probably reflect other potential port activities such as repair work. Instances where berthing time was less than 1 hour were also filtered out as they potentially relate to a vessel's passage that does not involve cargo handling work.

Table 2. Profile of the 47 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

From the perspective of services rendered to consumers at a port, schedule uncertainty is recognized as a major risk, especially in the case of container terminals. Since container and liner shipping operates according to set schedules, their operations also take into account the reliability of schedules at their port of call. Among other factors, liner operators may decide to cancel or skip calling at a port to improve their schedule reliability as was the case, for example, during the 2021-2022 global logistics crunch. They could also aim to optimize their port calls by closely coordinating operations with the port terminal operators.

The turnaround time required for a containership to enter and leave a port line can be a major factor in evaluating the level of port services. Shipping companies prefer highly productive ports that allow for fast loading and unloading of cargo. Liner operators prefer to arrive at the port on time, berth without delays, and depart after quick loading and unloading operations. Thus, for a containership, minimal waiting and berthing time at port constitutes a major port competitive advantage. The analysis of the AIS data relating to the 47 ports has helped to clarify the time it takes for a containership to call at a port.

To assess a port or terminal's performance relating to Punctuality, KMI calculated each of the turnaround, berthing and waiting time of vessels calling at the 47 ports under consideration. The AIS data records the position of a ship at a specific time based on the global positioning system (GPS). Information about time spent in port was extracted and analyzed for each port and vessel by using Geo Fencing. The latter matches information about the location of ports based on the AIS data.

To assess Punctuality, the three port time windows were determined as follows.

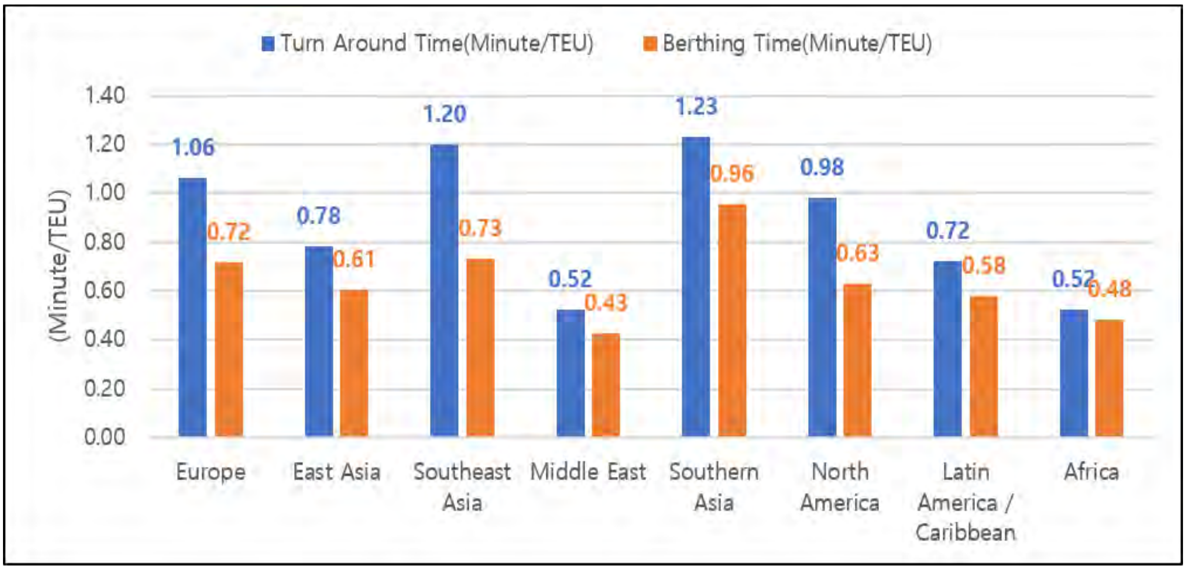
1) Turnaround time: refers to the time staring when a vessel enters the port line and ends when the vessel leaves this line. The annual average turnaround time (minutes) per TEU is estimated by dividing the total turnaround time for all ships per year by the annual cargo volume.
2) Berthing time: refers to the time starting when the vessel arrives at berth and ending when the vessel leaves the berth. The annual average berthing time (minutes) per TEU is estimated by dividing the total berthing time for all ships per year by the annual cargo volume.
3) Waiting time: refers to the difference between the turnaround time and the berthing time. The average waiting time (hours) per vessel is estimated by dividing the total waiting time for all ships per year by the total annual number of vessels.

Vessel time (punctuality) by region

Ports in the Middle East feature the fastest turnaround and berthing times with an annual average of 0.43 minutes to handle one TEU. Meanwhile, South Asian ports showcase the longest berthing times with 0.96 minutes to process one TEU or about twice as long as the average berthing time in the Middle East. Turnaround time in South Asian ports is also the longest with an annual average turnaround time of 1.23 minutes per TEU. Southeast Asia showed the second highest time of 1.20 minutes (Figure 2).

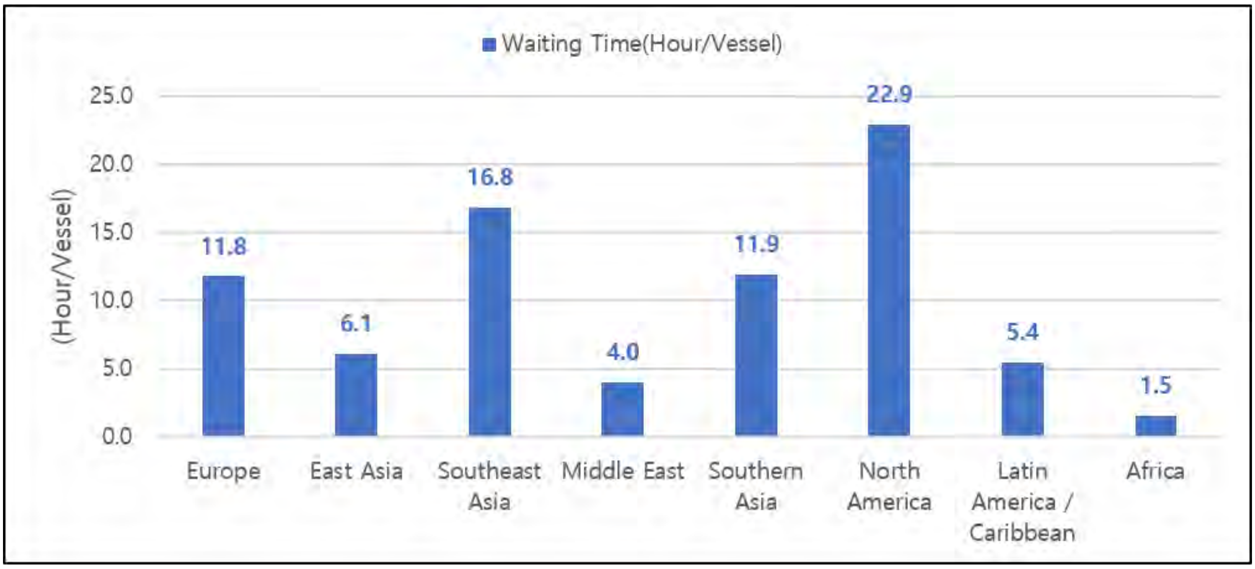
Berthing time is linked to the container terminal productivity levels. Many factors influence port productivity levels including equipment such as the number of the cranes used to handle cargo. While more analysis is required to explain the regional berthing times differences, it can be argued that endowment in terms of cargo handling equipment and automation plays an important role (Figure 2).

Figure 2. Annual Average Turnaround and Berthing Time by region



African ports have the lowest waiting time of 1.5 hours per vessel, while North American ports have the highest average waiting time of 22.9 hours per vessel. The waiting time at the container terminal reflect among other factors, potential imbalance in port capacity supply and demand. The performance of the North American ports largely reflects the effect of the unprecedented port congestion faced in 2021 (Figure 3). Results for African ports may be skewed as they are based on a limited number of ports (2 African ports in an overall sample of 47 ports).

Figure 3. Annual Average Waiting Time by region



Southeast Asian ports exhibit an average port waiting time of 16.8 hours, the second highest after North American ports. The waiting time in Southern Asia was 11.9 hours, in line with the overall sample average (11.1 hours). While the turnaround time of Southeast and Southern Asian ports Asia are comparable, Southeast Asian ports have a relatively higher waiting time while Southern Asian ports have a higher berthing time. To improve service levels, it may be necessary to increase berth productivity by investing, for example, in additional cargo-handling equipment. While equipment can play a role in driving port productivity levels, more analysis is required to identify the determinants of port efficiency and productivity. This will also help to better understand the factors that cause port waiting and turnaround times to increase and identify the required response measures to alleviate delays.

Vessel time (punctuality) by port size

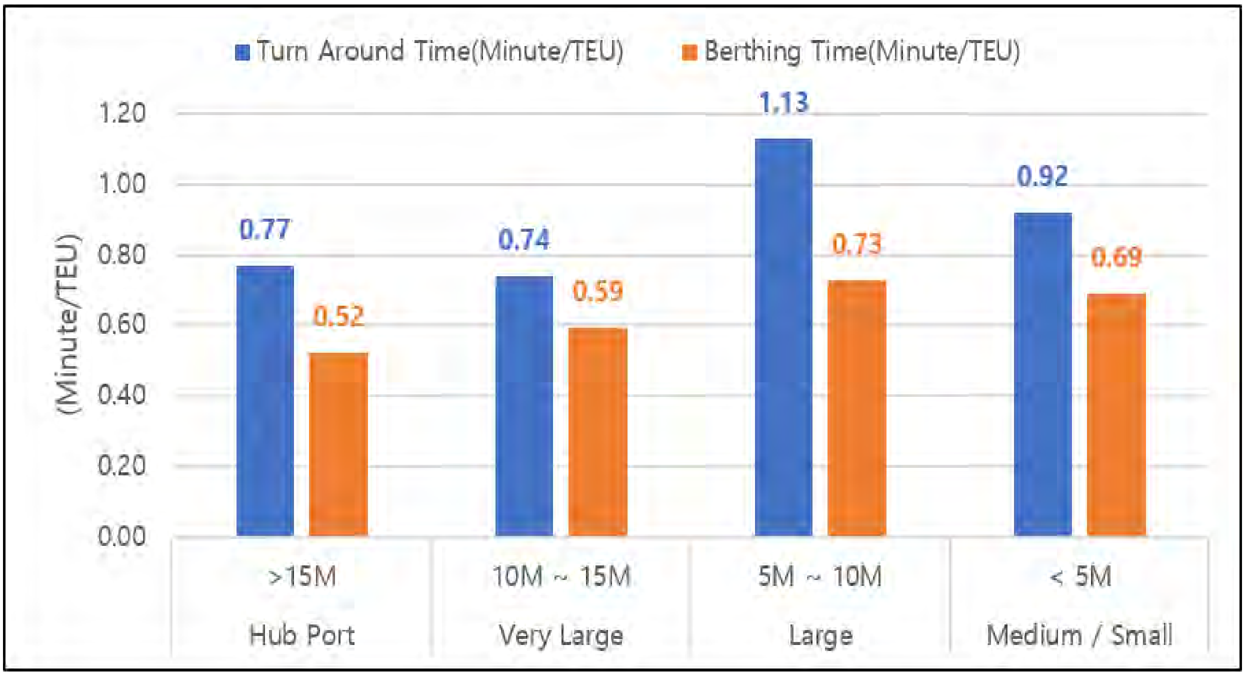
Over time, container ports evolved in tandem with changes global logistics and trade flows. Today, container ports are divided into feeder and hub ports located on major East-West and North-South shipping routes with each port type having distinct roles and characteristics. The size, facilities, and cargo handling equipment of container terminals have also developed differently.

In this context and for the purposes of the present analysis, the 47 ports assessed were divided into four categories based on their port cargo throughput volume. Ports are Hub Ports if their annual handling volume exceeds 15 million TEU. They are Very Large if volume handled ranges between 10 and 15 million TEU and Large if the volume is between 5 and 10 million TEU. Medium and Small Ports handle less than 5 million TEU.

Based on this categorization, Very Large Ports that handle 10 to 15 million TEUs per year, have shown the lowest average turnaround time (0.74 minutes per TEU). These are followed, in ascending order by the Hub Ports (0.77 minutes per TEU), the Medium and Small Ports (0.92 minutes per TEU), and the Large Ports which exhibit the longest turnaround time (1.13 minutes per TEU) (Figure 4).

Large Ports show the longest berthing time (0.73 minutes per TEU), a trend likely to be caused by the average cargo volume handled at once in each individual port call (Figure 4). The average cargo volume handled at one port call is 2,806 TEU in the case of Hub Ports and 1,873 TEU in the Large Ports. Probably and in addition to the exceptional conditions created by the COVID-19 pandemic and the global logistics crunch of 2021, a growing size of port calls probably requires Large Ports to spend more time preparing for the servicing of vessels and the processing of a relatively large volume of cargo at once, assuming berth productivity remains unchanged.

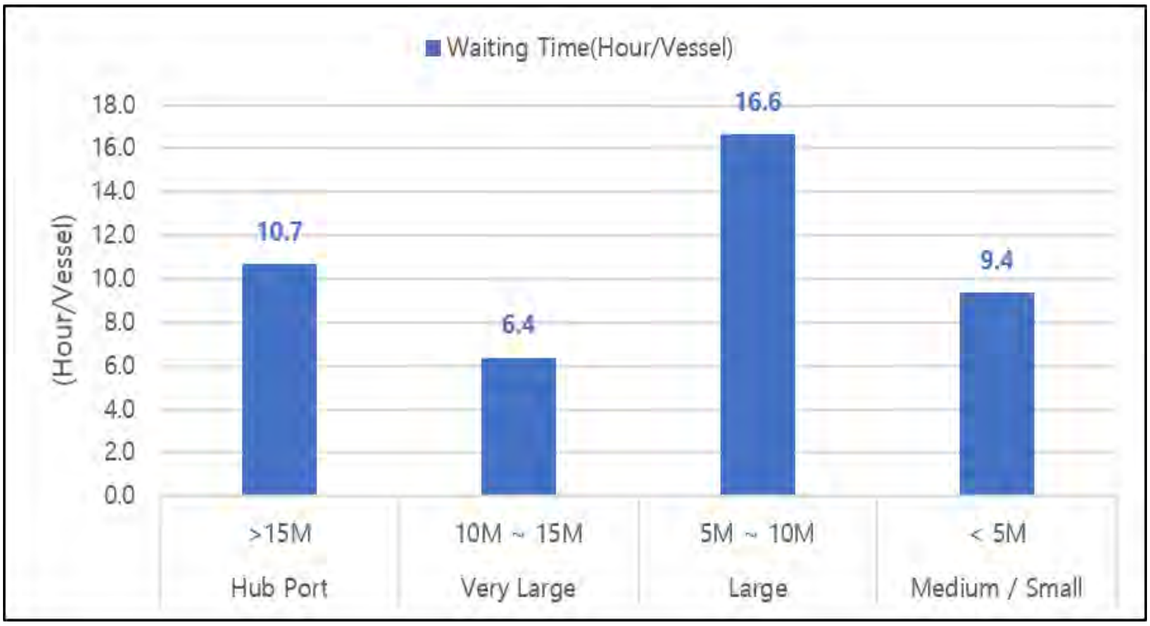
Figure 4. Annual Average Turnaround Time and Berthing Time by port sizes



The longest waiting time is recorded at Large Ports (16.6 hours per ship) with the time spent at these ports being significantly higher than the average waiting time spent at Hub and Very Large Ports. There seems to be a weak correlation between the waiting time, the annual vessel calls and the average cargo traffic (Figure 5).

One may speculate that berth inefficiency caused by the need to service diverse vessel sizes may contribute to longer waiting times. In the case of Small-scale ports, ships of a certain size usually enter the port, whereas in the case of a large-scale port, if ships of various (different) sizes enter the port, a part of the berth may not be utilized, which can lead to a decrease in efficiency. Larger ports, in particular Hub Ports, normally also receive a combination of large main-haul vessels and smaller feeder vessels. The latter tend to have to wait to ensure they connect to the services provided by the larger vessels, thus potentially increasing the average waiting time in these hub ports. Additional analysis is required to determine the precise factors causing the extended waiting times at Large and Very Large Ports.

Figure 5. Annual Average Waiting Time by port sizes

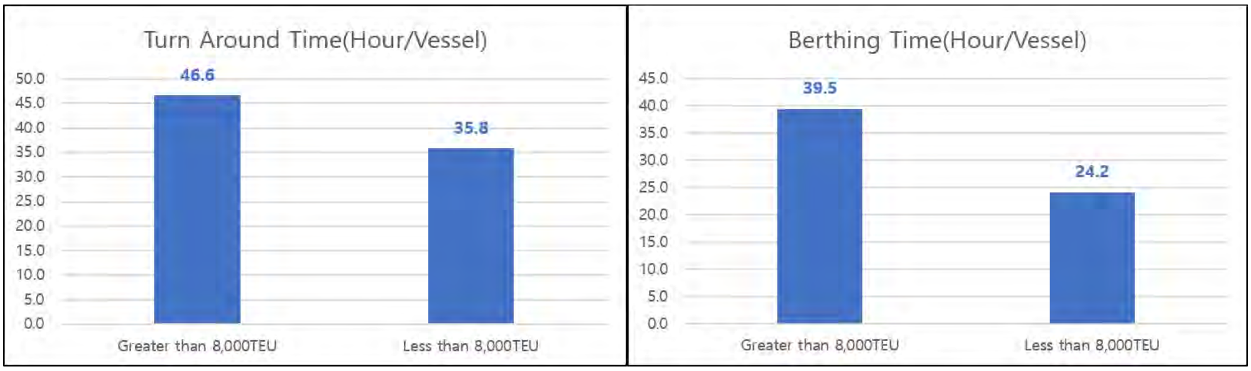


Vessel time (punctuality) by vessel size

Over the years, containerships have been growing in size and their servicing by ports is recognized as an important port performance indicator. Bearing this in mind, for the present analysis, vessel sizes are divided into two categories: below 8,000 TEU and above 8,000 TEU. The analysis focused on calculating the average turnaround, berthing, and waiting times per ship, respectively. Assessing punctuality indicators using vessel sizes instead of cargo volume is useful as the AIS data does not inform about the volume of cargo carried onboard each containership. Going forward, efforts will aim to obtain additional data and information regarding the cargo volume carried on boards ships.

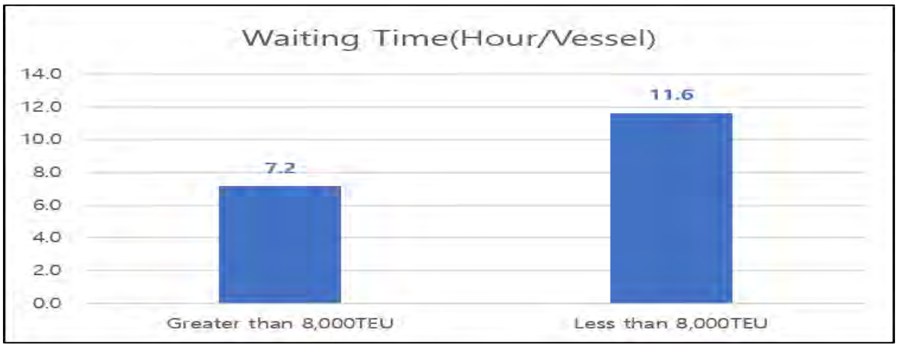
The turnaround time for vessels of less than 8,000 TEU averaged 46.6 hours per vessel while that for vessels larger than 8,000TEU stood at 35.8 hours per vessel (Figure 6). Berthing time averages 39.5 hours per ship of more than 8,000 TEU and 24.2 hours for ships of less than 8,000TEU.

Figure 6. Annual Average Turnaround Time and Berthing Time by vessel sizes



Containerships of more than 8,000 TEU averaged 7.2 hours per ship, whereas those of less than 8,000TEU faced a longer waiting time averaging 11.6 hours per ship (Figure 7).

Figure 7. Annual Average Waiting Time by vessel size



The preferential allocation of berths in some terminals in the case of larger ships may have a role to play in driving these performances. The AIS data has also shown that for larger ships, the proportion of waiting time in the overall turnaround time is 15.4%. For small and medium-sized ships this share jumps to 32.5% (Table 3), suggesting that larger containerships tend to wait less in ports compared to smaller vessels.

Table 3. Port time and Waiting Time Ratio by vessel sizes

	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

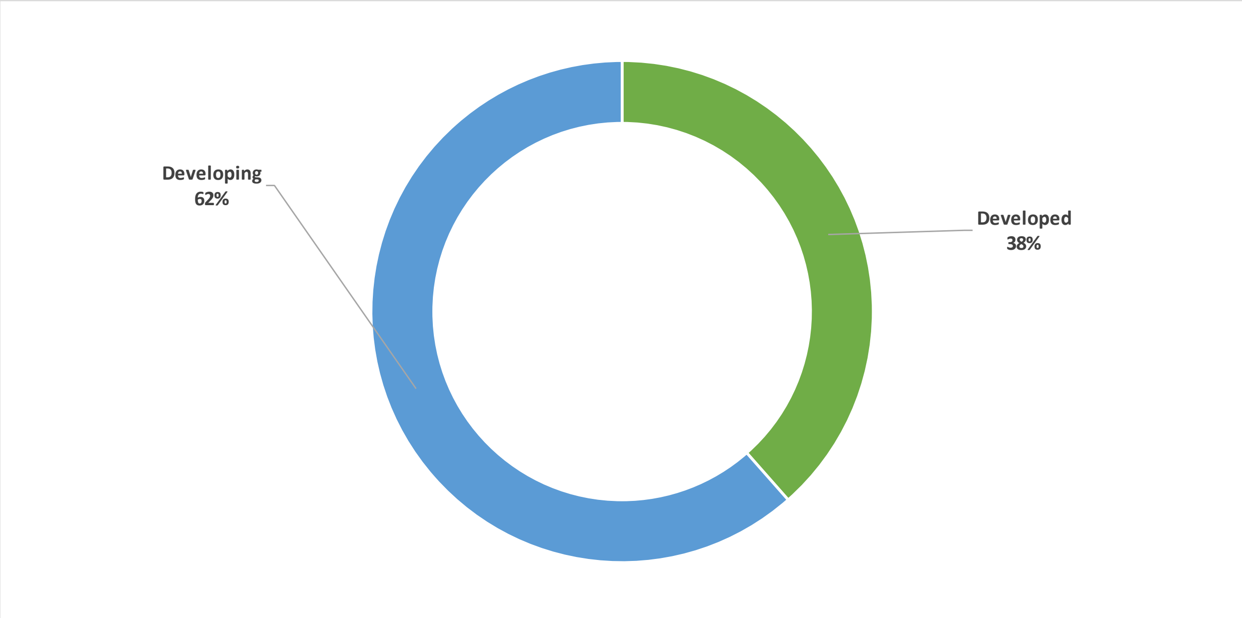
Safety and Security and Digitalization components: Results of the Survey Questionnaire

While AIS data on containership movements and positioning was used to assess the Punctuality component of the PISI, the Safety and Security together with the Digitalization elements were assessed based on input and feedback received in response to the survey questionnaire as set out below.

Profile of the survey respondents

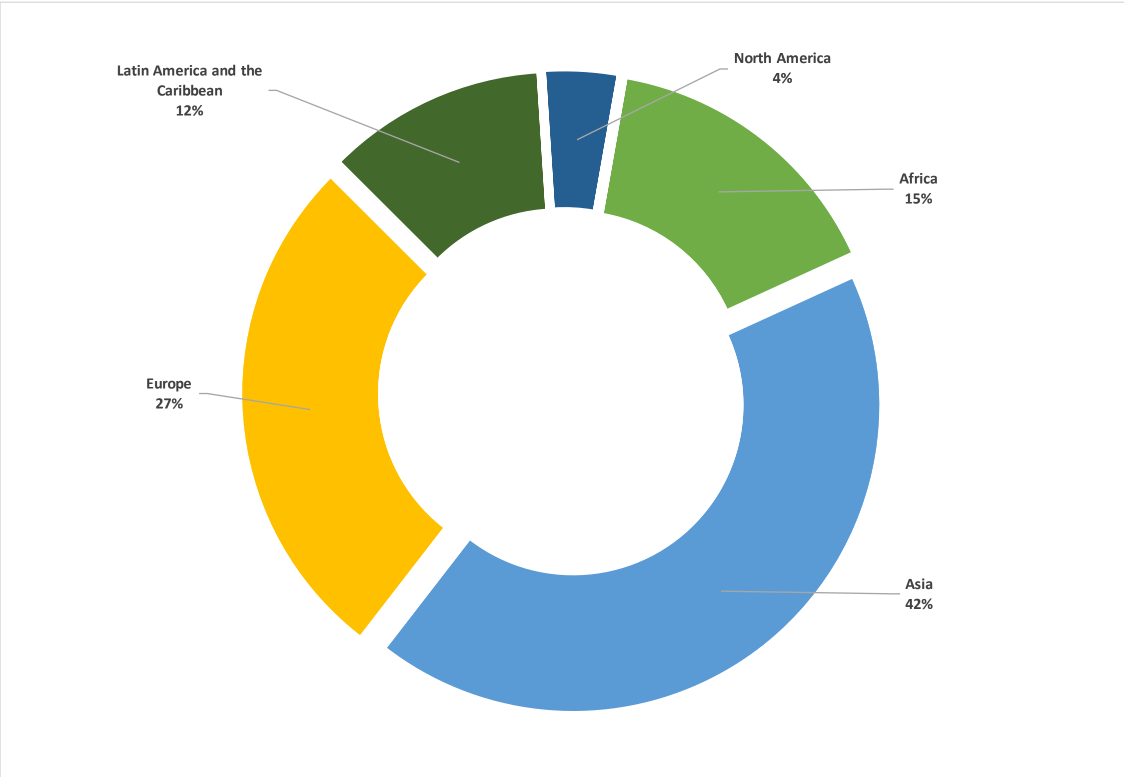
A total of 33 responses to the survey questionnaire were received with only 26 completed survey questionnaires being deemed valid for analysis. The distribution of respondent ports in terms of level of development, region, governance structure and size of traffic are summarized figures 8, 9, 10 and 11 below. Respondent ports were spread across Africa, Asia, Europe, North America, and Latin America and the Caribbean (LAC) with more than half of respondents (61.5%) being in developing regions.

Figure 8. Development status of respondent ports



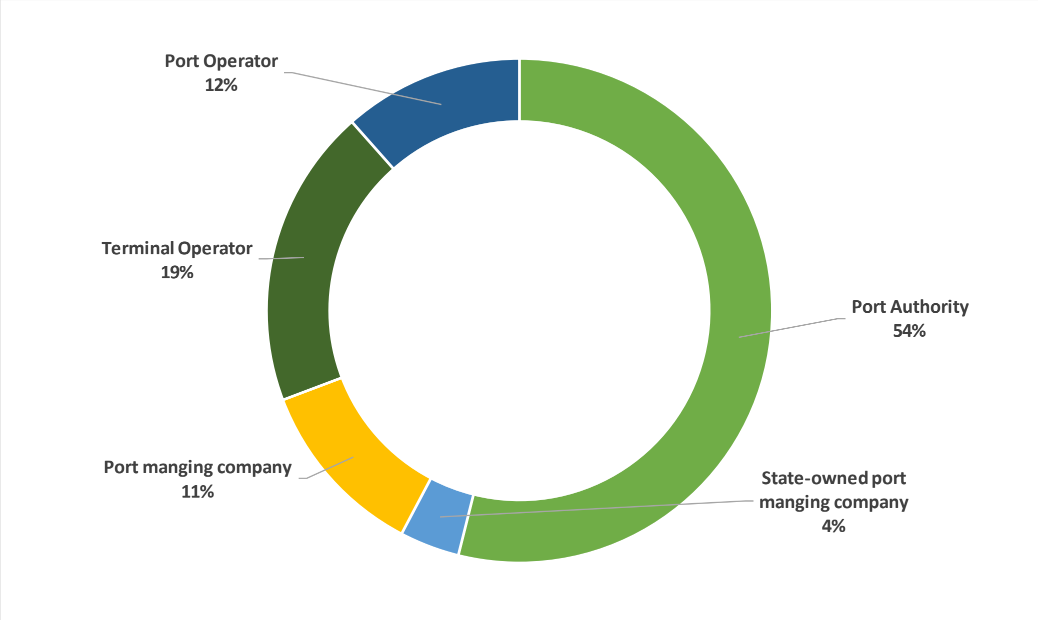
As reported on Figure 9, 11 of the 26 respondent ports were in Asia (42.3%). Of these, ten were in East and Southeast Asia. The remaining port was South Asian. Three respondent ports were from the LAC region (11.5%), and four in Africa (15.4%). One respondent port was in North America (3.8%) while seven respondents (27%) were from Europe.

Figure 9.Geographical regions of respondent ports



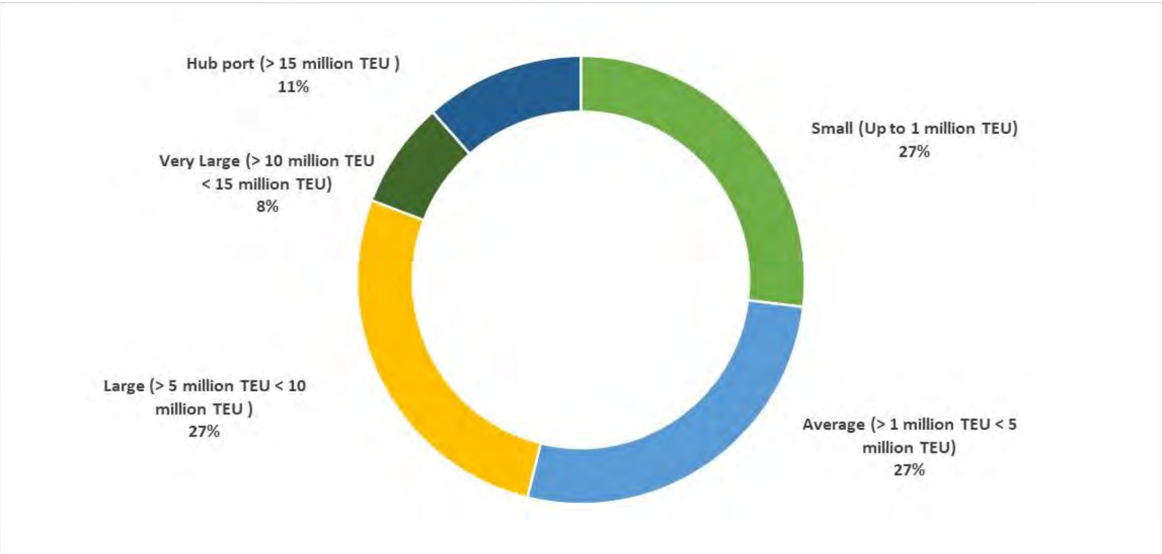
Respondent included port authorities, port management companies/port corporations, state owned companies managing ports, port operators, and container terminal operators (Figure 10). Over half of respondent ports (54%) were port authorities, 19% were terminal operators while 12% were port operators. The remaining respondents were either port management companies (11%) or State-owned port managing enterprises (4%).

Figure 10. Respondent ports by governance structure



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 (Figure 11). Cargo throughput handled by respondent ports ranged between a low of less than 100,000 TEU and a high of more than 20 million TEU. Less than one-third (26.9%) can be considered, for the purposes of this analysis, as average-sized ports with volumes handled ranging between more than 1 million and less than 5 million TEU. Over one-third (34.5%) were large ports handling more than 5 million and less than 15 million TEU. A total of 11.5% respondent ports are linked to hub ports handling over 15 million TEU annually. Over one-quarter (26.9%) were small ports handling hundreds of thousands of containerized cargoes and not exceeding 1 million TEU. The size of operations and the function of the port or terminal as a hub, a gateway, or a small port in a developing country, has necessarily an impact on the dimensions being assessed through the questionnaire. Figure 11 features a more granular breakdown by port and terminal TEU throughput sizes.

Figure 11. Distribution of respondent ports by size and container port traffic



Overall, there is some heterogeneity in the ports sample generated by the survey questionnaire. While not large enough to be fully representative of container port terminals worldwide, the sample does provide some variation that could help understand while still nuancing the results.

As part of the survey questionnaire, targeted ports were asked to rank certain aspects of their port operations, digitalization, technology, safety, and security while using a scale from 1 to 5. When no response was provided to a given question, the average was calculated based on a sample of total valid responses which could be less than 26. Furthermore, when no response was provided, the cell was marked as Not Available.

Summary of the responses to the survey questionnaire

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. 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 (Table 4).

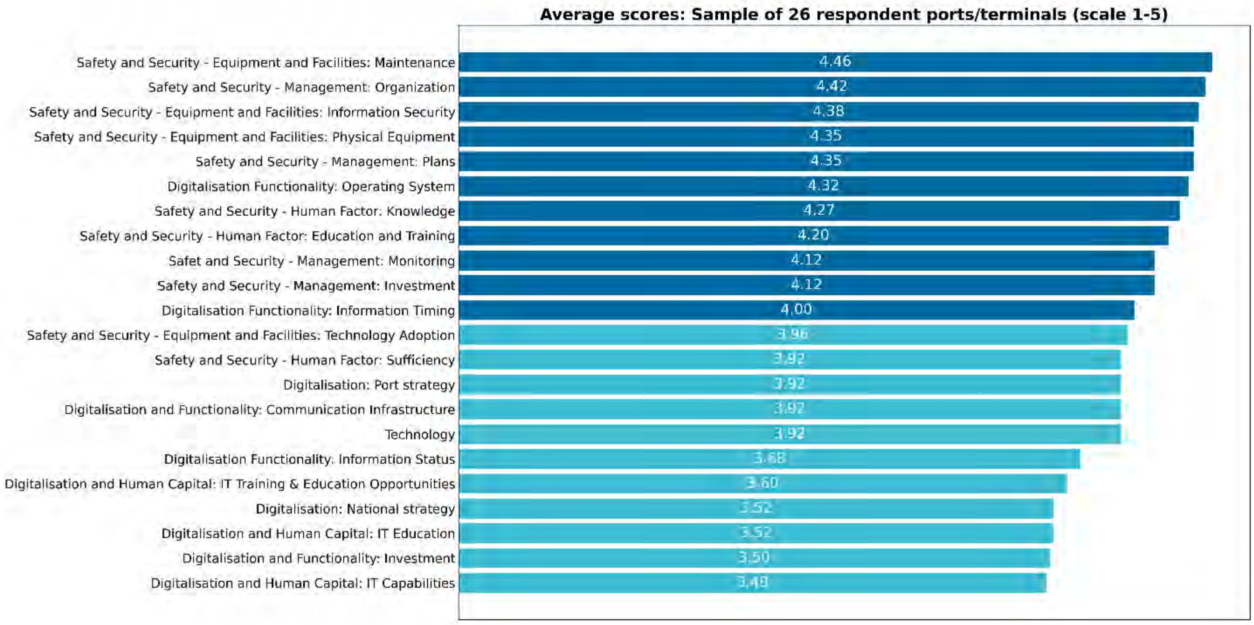
As shown in Figure 12, the average score across the 26 respondent suggests that ports have generally taken the required measures or have ensured that requisite enabling conditions were implemented or were available to safeguard and secure operations (infrastructure and equipment, management, and human factor) and to ensure digitalization and technology uptake. 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 Management. Average scores tend to be lower in other cases, indicating that respondent ports agree less with the statements. They are either neutral or disagree that requisite measures and actions required to promote digitalization and technology were available at their ports or terminals.

Table 4. Summary results and average scores across 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	**3.7**
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**

Figure 12. Average scores of the 26 respondent ports across the 22 PISI indicators



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.

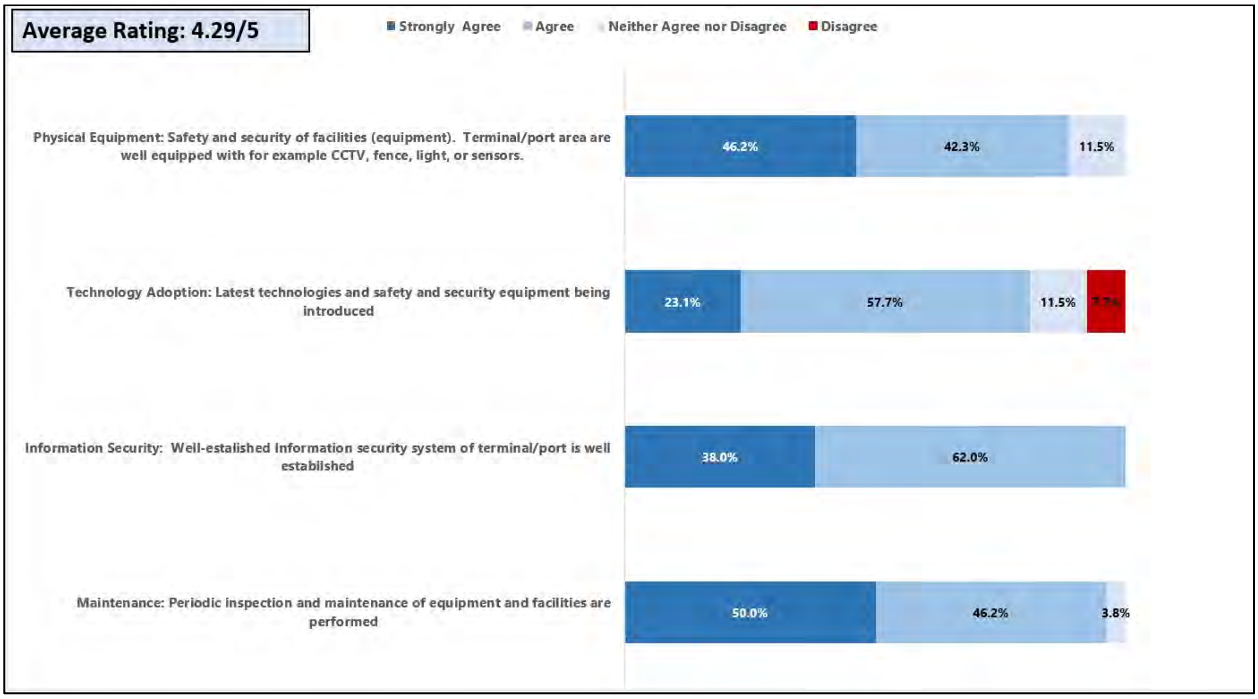
Responses to the survey questionnaire and their statistical distribution

A. <u>Safety and Security</u>

1. **Question on Safety and Security:** *Equipment and facilities and more specifically physical equipment relating to safety and security of facilities (equipment)*

As shown in Figure 13, almost all respondent ports (88.5%) agreed that the terminal or port area were well equipped with, for example CCTV, fences, lights, or sensors. These are necessary for the safety and security of physical equipment and facilities. A large majority (80.8%) confirmed that the latest technologies and safety and security equipment were being introduced. Only 7.7% indicated that relevant technology adoption was not in place. All respondent ports (100%) agreed that the information security systems of terminals and ports were well established. Almost all respondent ports (96.2%) agreed that periodic inspections and maintenance of equipment and facilities were being performed. A small share (3.8%) was neutral and did not agree nor disagree with the statement.

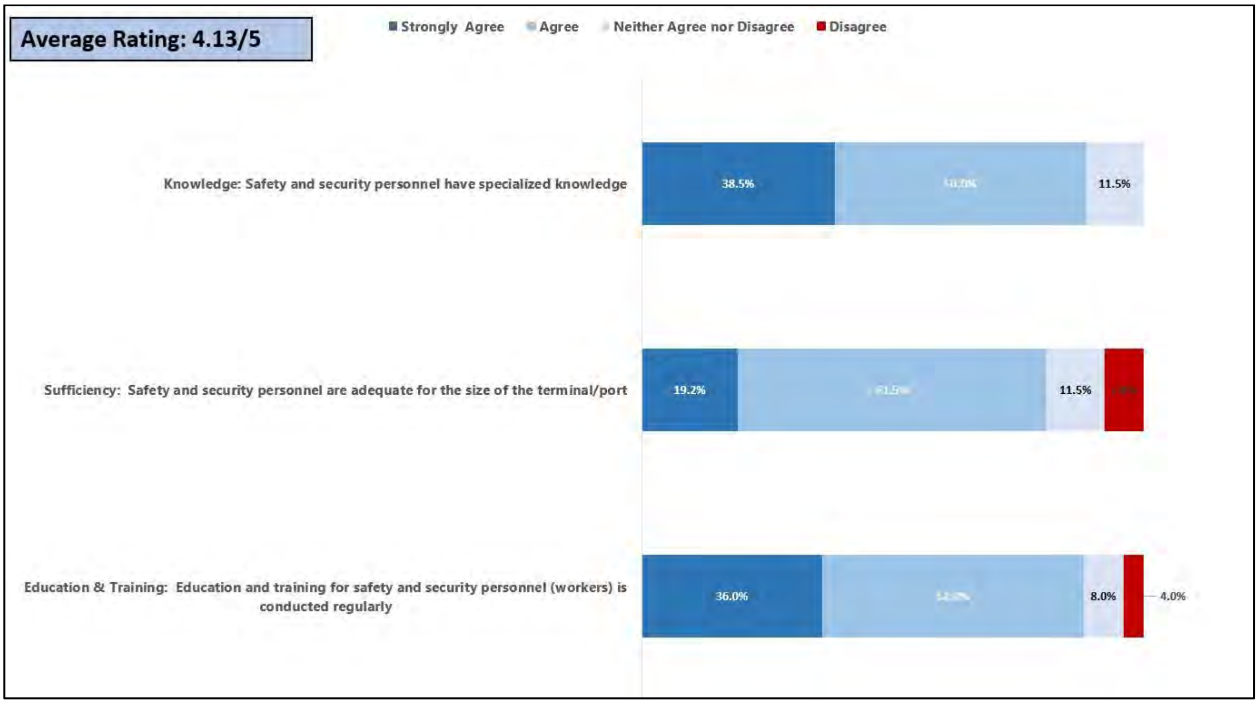
Figure 13. Safety and Security: Equipment and Facilities



2. **Question on Safety and Security:** *Human factor as it relates to the knowledge of the port/terminal safety and security personnel as well as the sufficiency of this knowledge and access to training and education*

A large majority (88.5%) of respondent ports agreed that the port/terminal safety and security personnel were knowledgeable and had the required expertise (Figure 14). The remaining respondents were neutral and did not agree nor disagree with the statement. A large majority (80.7%) agreed that the port/terminal safety and security personnel was adequate for the size of the terminal/port and therefore sufficient. Only 7.8% of respondent ports expressed their disagreement with the statement while 11.5% were neutral and did not agree nor disagree. An overwhelming majority (88%) agreed that port safety and security personnel and workers were receiving education and training activities on a regular basis. Only 4% disagreed and 8% neither agreed nor disagreed.

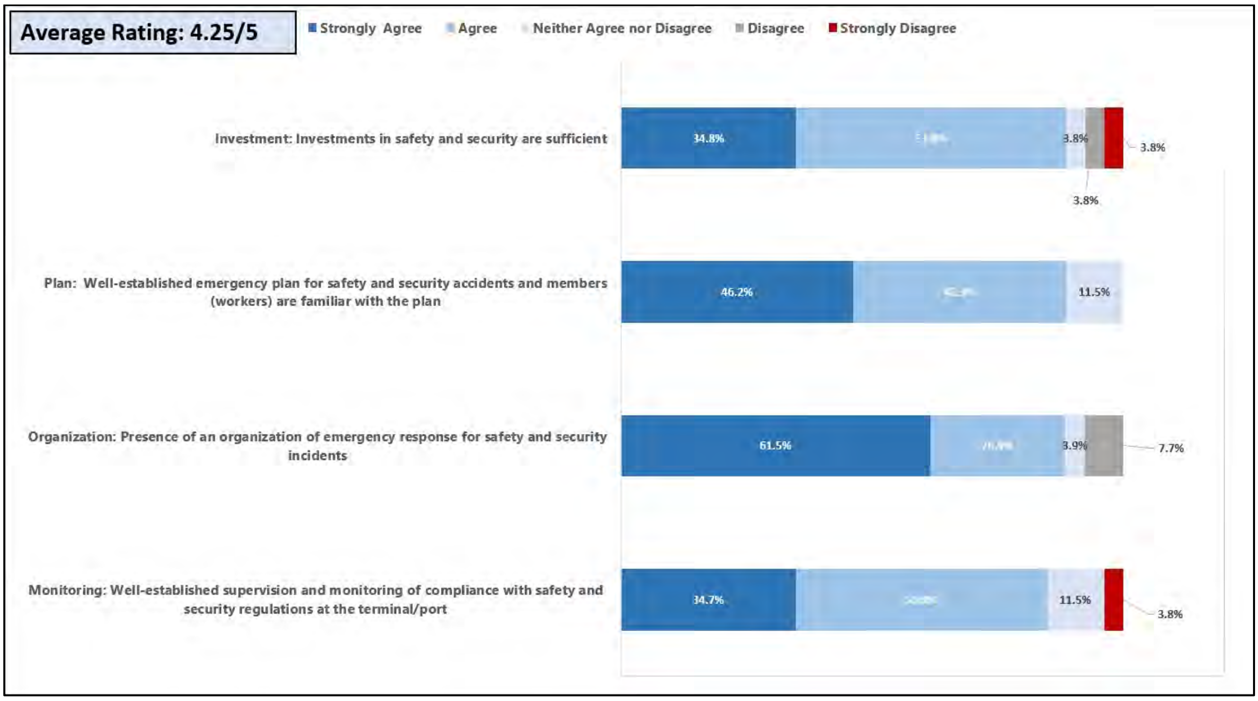
Figure 14. Safety and Security: Human Factor



3. **Question on Safety and Security:** *Management, including investment, plans, organization, and monitoring*

A significant majority of respondent ports (88.6%) agreed that investment levels in safety and security were sufficient while 7.6% disagreed and 3.8% were neutral (Figure 15). A total of 88.5% agreed that emergency plans for safety and security, including in the face of accidents were well-established and terminal/port workers and personnel were familiar with such plans. The remaining 11.5% did not agree nor disagree. A large majority (88.4%) agreed that they had in place a system to organize the emergency response in the face of safety and security incidents. The remaining 7.7% disagreed and therefore did not have such an organization in place. A small share (3.9%) did not agree nor disagree. Over a majority (84.7%) of respondents agreed that a monitoring system ensuring supervision and oversight was in place and aim to ensure compliance with safety and security regulations at the terminal/port. A few (3.8%) respondent ports did not have such monitoring systems while 11.5% did not agree nor disagree.

Figure 15. Safety and Security: Management



B. <u>Digitalization</u>

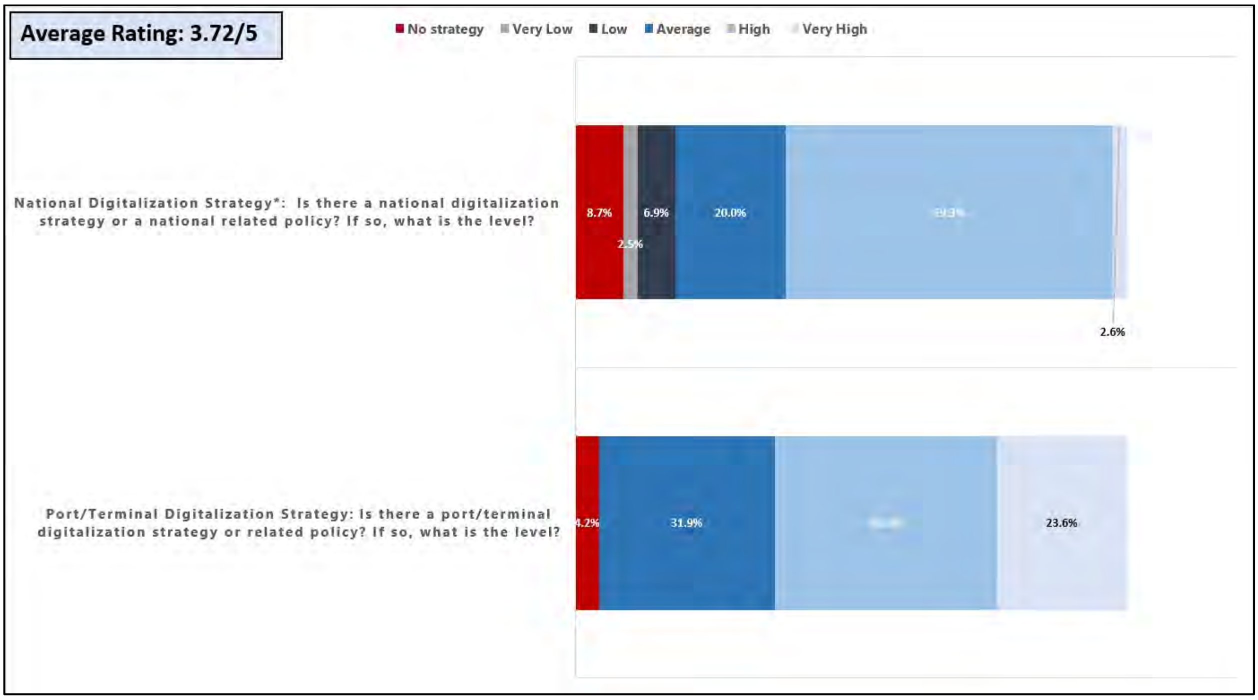
4. **Question on digitalization and the enabling context**, *including legislation and policies at national and port or terminal levels*

Figure 16 features the responses to the question on the digitalization policy and legislative enabling framework. A few respondents (8.7%) indicated that there was no national digitalization strategy or related policy in place while 4.2% indicated that there was no port/terminal digitalization strategy or related policy. Meanwhile, 91.3% confirmed the presence of national strategies and 95.8% said that port level strategies were implemented.

Of the 91.3% respondents that confirmed the presence of national level strategies and policies promoting digitalization and who had also indicated the levels of these strategies and policies, 61.9% felt that these were of High and Very High levels, 20.0% felt that the level was average and 9.4% considered the levels to be Low and Very Low.

Among the 95.8% of respondent who confirmed the presence of port/terminal level strategies and policies promoting digitalization and who had also specified the levels of these strategies and policies, 31.9% felt that these were considered Average Levels while 40.3% assigned a High-Level rating. One quarter or 23.6% considered these to be at a Very High Level.

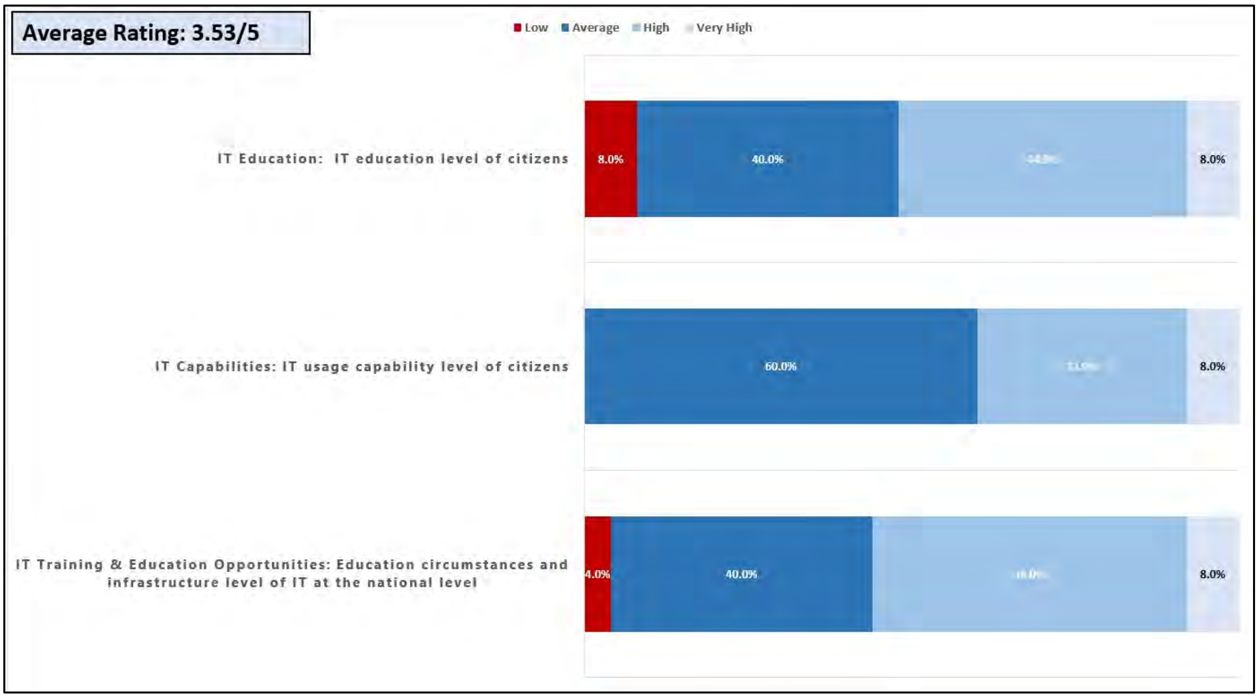
Figure 16. Digitalization: National and port strategies and policies



5. **Question on digitalization and the enabling context:** *Human capital*

Over half (52.0%) of respondent ports rated the national level of IT-related education as High and Very High. A few (8.0%) felt that the national IT education level was Low while 40.0% gave an Average rating (Figure 17). More than half of the respondent (60.0%) felt that IT usage capability at the national level was at Average. One third of respondent ports (32.0%) rated the IT usage capability level as High while 8.0% gave a Very High-level rating. As regards training opportunities, the majority (56.0%) felt that these were at High and Very High levels. Over one third (40.0%) rated these opportunities as Average and a few (4.0%) felt that these were still at Low levels.

Figure 17. Digitalization: Human capital



1. **Question on digitalization for functionality (communications infrastructure)** *and more specifically, regarding the infrastructure level of data communication through wireless in the port or terminal. For ease of reference Levels 1 to 5 are set out in Table 5.*

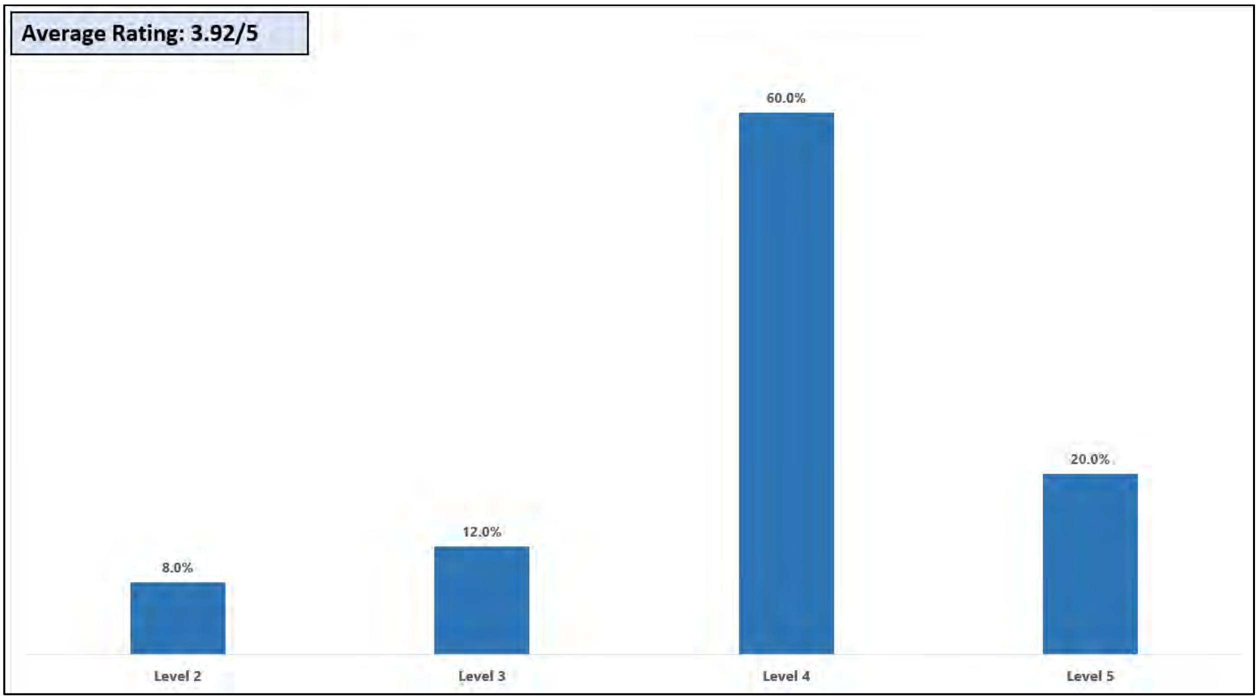
More than half (60.0%) of respondent ports indicated that the level of such infrastructure hovered around Level 4 (4G – LTE: Long Term Evaluation).

One-fifth (20.0%) indicated Level 5 (5G), while 12.0% noted Level 3 (3G, WCDMA: Wideband CDMA/UMTS: Universal Mobile Telecommunications System). A few (8.0%) referred to Level 2 (2G, CDMA: Code Division Multiple Access). Level 1 (1G) is clearly outdated. Taking all responses together and the various levels identified, the Average Level for the 26 respondent ports was estimated at 3.92 (Figure 18), that is somewhere between Level 3 and Level 4.

Table 5. Levels regarding communications infrastructure

Level	Description
Level 1	1G
Level 2	2G (CDMA: Code Division Multiple Access)
Level 3	3G (WCDMA: Wideband Code Division Multiple Access)
Level 4	4G (LTE: Long Term Evaluation)
Level 5	5G

Figure 18. Digitalization: Functionality



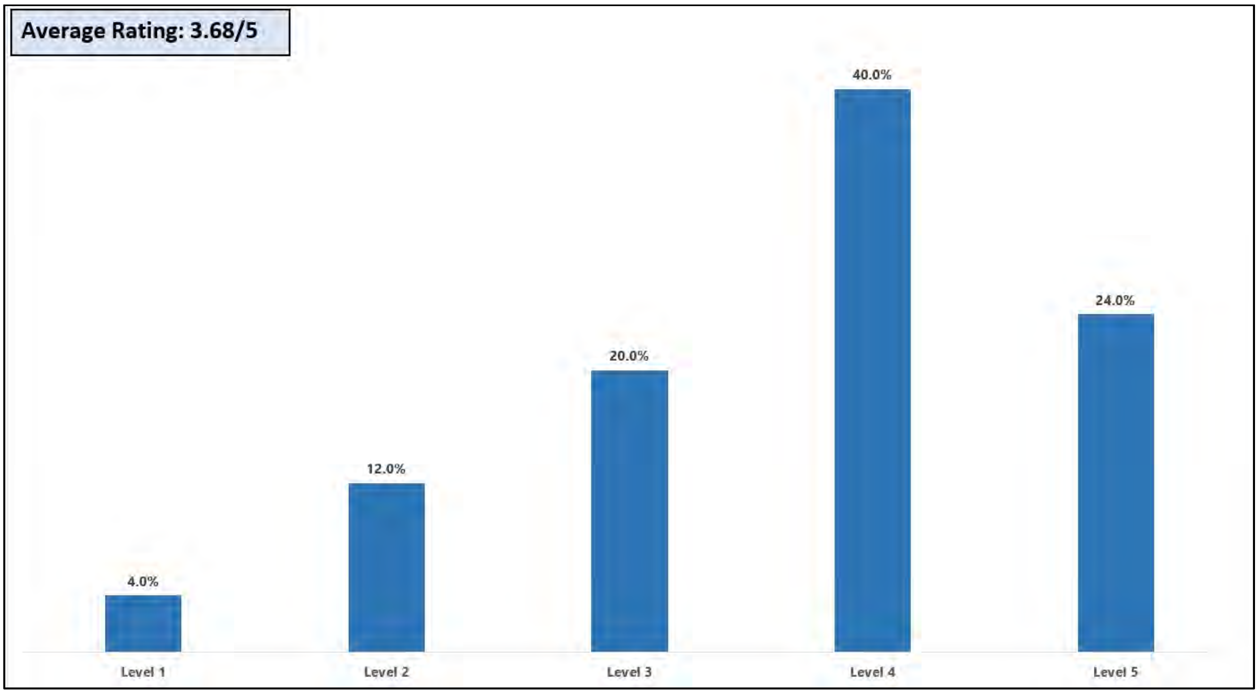
2. **Question on digitalization for functionality (information status)** *and more specifically, regarding information status at the port or terminal*. *For ease of reference Levels 1 to 5 are set out in Table 6 below.*

Less than half (40.0%) of respondent ports indicated that the level of such infrastructure hovered around Level 4 (Figure 19). One-fourth (24.0%) of respondents indicated Level 5, while one-fifth (20.0%) noted Level 3. Others (12.0%) referred to Level 2 and only 4.0% selected Level 1. Taking all responses together and the various levels identified, the average Level for the 26 respondent ports is estimated at 3.68, that is somewhere between Level 3 and Level 4.

Table 6. Levels regarding information status

Level	Description
Level 1	Collection target: cargoes (containers) Collection information: target location
Level 2 ~ Level 4*	Collection target: any possible part of cargoes (containers)/equipment**/truck (internal and external)/employees Collection information: any possible part of the target's location/temperature/humidity/impact(damage)
Level 5	Collection target: whole part of cargoes(containers)/equipment**/truck (internal and external)/employees Collection information: whole part of the target's location/temperature/humidity /impact(damage)
(*): respondent's choice/decision based on collection target and information (e.g., if possible, to collect information regarding the location and impact (damage) of cargo and truck, the respondent can choose Level 3). (**): equipment includes all kind of port equipment such as cranes, transtainers, straddle carriers, yard tractors, rich stackers, top handlers, etc.	

Figure 19. Digitalization: Information status



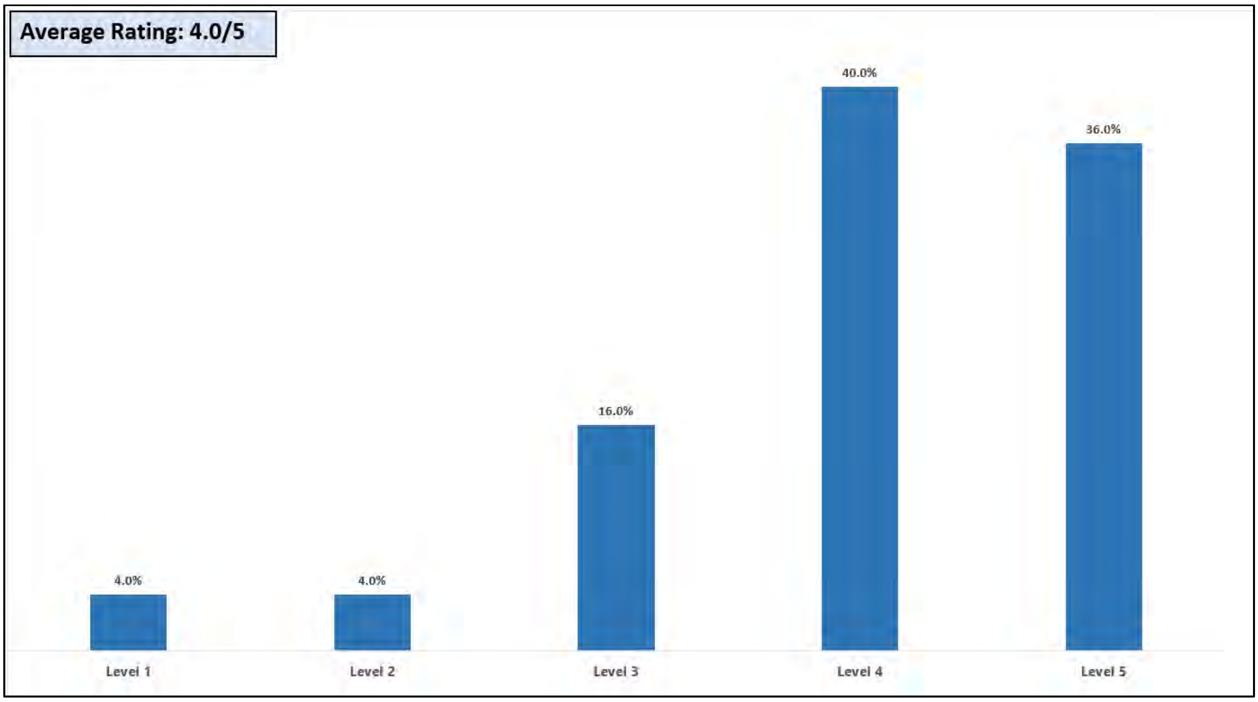
3. **Question on digitalization for functionality (timing of information)** *and more specifically, regarding the frequency at which the information (location, status, etc.) about resources such as facilities and equipment is provided in the port or terminal. For ease of reference, Levels 1 to 5 are set out in* Table 7 *below.*

As shown in Figure 20, less than half (40.0%) of respondent ports indicated that the timing of information was set at Level 4 (Minutely, using real time communication technologies such as LAN, 3G/4G/5G, and WIFI) while over one-third (36.0%) indicated Level 5 (real time, by using real time communication technologies such as LAN, 3G/4G/5G, and WIFI). The remaining respondents (16.0%) noted that information was being communicated at Level 3 (hourly, using non-real-time communication technologies such RFID). The remaining 8.0% said to be relying on Level 2 (daily, using non-real-time communication technologies such as RFID) or Level 1 (weekly) information flows. Taking all responses together, the average Level for the 26 respondent ports is estimated at 4.0. In other words, on average, ports are relying on real time communication using real time communication technologies with information flowing by minute.

Table 7. Levels regarding timing of information

Level	Description	
Level 1	Weekly	
Level 2	Daily	Using non-real-time communication technologies such as RFID.
Level 3	Hourly	
Level 4	Minutely	Using real-time communication technologies such as LAN, 3G/4G/5G, and WiFi
Level 5	Real-time	

Figure 20. Digitalization: Timing of information



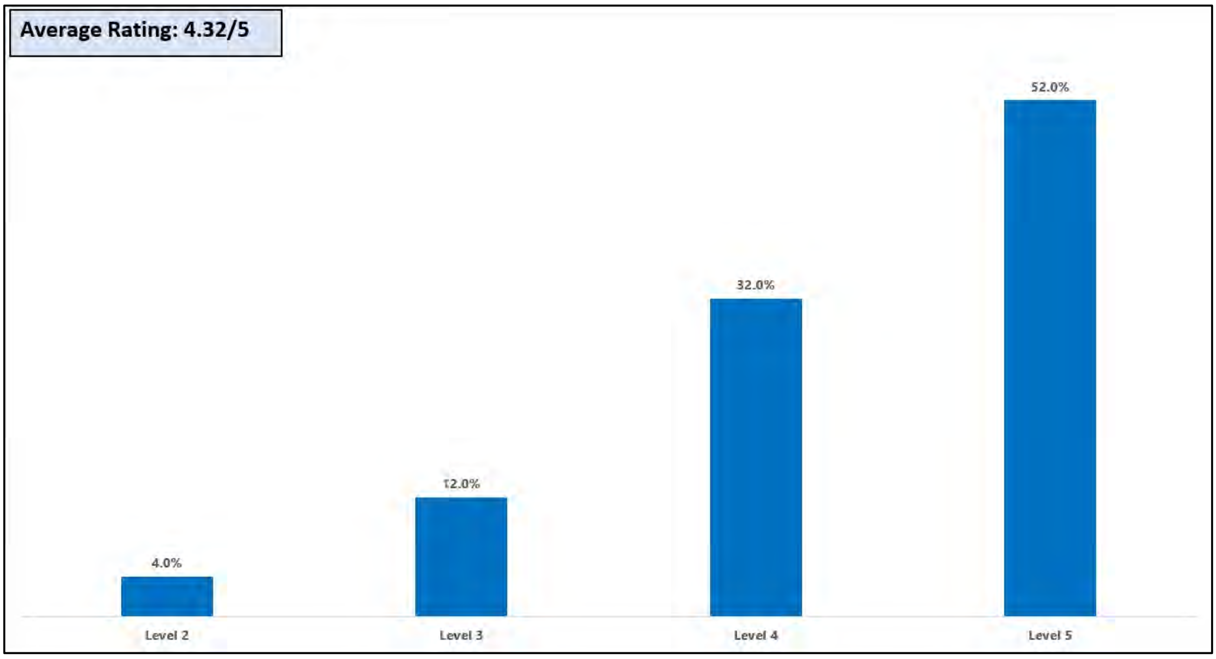
4. **Question on digitalization for functionality (operating system)** *and more specifically, regarding the operating system level of the port or terminal. For ease of reference, Levels 1 to 4 are set out in Table 8.*

For the large majority (84.0%) of respondent ports, the operating system was set at Level 4 and Level 5 (Commercial terminal operating systems such as NAVIS, CLT, TSB, etc.). For some respondents (12.0%), the operating systems stood at Level 3 (In-house developed Terminal operating systems) while for few others (4.0%), Level 2 (Office Automation programs such as MS Excel) and Level 1 (paperwork) were more prevalent. Combining all responses, the average Level for the 26 respondent ports is estimated at 4.32 (Figure 21) (i.e., on average, ports and terminals are using commercial terminal operating systems).

Table 8. Levels regarding operating system

Level	Description
Level 1	Paperwork
Level 2	Office Automation (OA) programs such as MS Excel
Level 3	In-house developed TOS (Terminal Operation System)
Level 4 ~ Level 5	Communication TOS such as Navis, CLT, TBS, etc.
Note: respondent's choice/decision based on specific function and technology (e.g., if technology such as AI, Big Data, or Cloud is in service, the respondent can choose Level 5).	

Figure 21. Digitalization: Operating system



5. **Question on digitalization for functionality (investment)** *and more specifically, regarding the technology-related investment level in the port or terminal compared to other social overhead capital/infrastructure sectors. For ease of reference, Levels 1 to 5 are set out in Table 9 below.*

According to responses received, 41.1% of respondent ports indicated Level 4 investments while another 40.3% noted Level 3 (Figure 22). This means that compared to other infrastructure sectors, for a significant majority of respondent ports (81.4%), technology-related investments in ports and terminals constitute the second and third largest increases in percentage terms. For 9.3% of respondent ports, the level indicated stood at 5 (highest increase in technology-related investments compared to other infrastructure sectors) while for another 9.3%, Level 1 seemed to apply (i.e., the lowest increase in technology-related investment scale in ports/terminals compared to other infrastructure related sectors).

Table 9. Levels of technology-related investment

Level	Description
Level 1	Decrease in % change of technology investment scale among SOC* sectors
Level 2	Lowest increase in % change of technology investment scale among SOC sectors
Level 3	3rd highest increase in % change of technology investment scale among SOC sectors
Level 4	2nd highest increase in % change of technology investment scale among SOC sectors
Level 5	Highest increase in % change of technology investment scale among SOC sectors

Note: respondent's choice/decision based on rate (%) change of technology investment in budget scale.
*: SOC stands for Social Overhead Capital which is often used to mean infrastructure. It is further divided into economic and social overhead capital. Economic overhead capital refers to such things as roads, power transmission systems, telecommunications, etc. Social capital refers to investment in activities such as education, health, police, fire, etc. SOC in the survey means infrastructures for ocean shipping, aviation, rail, road, and pipeline.

Figure 22. Levels of investment

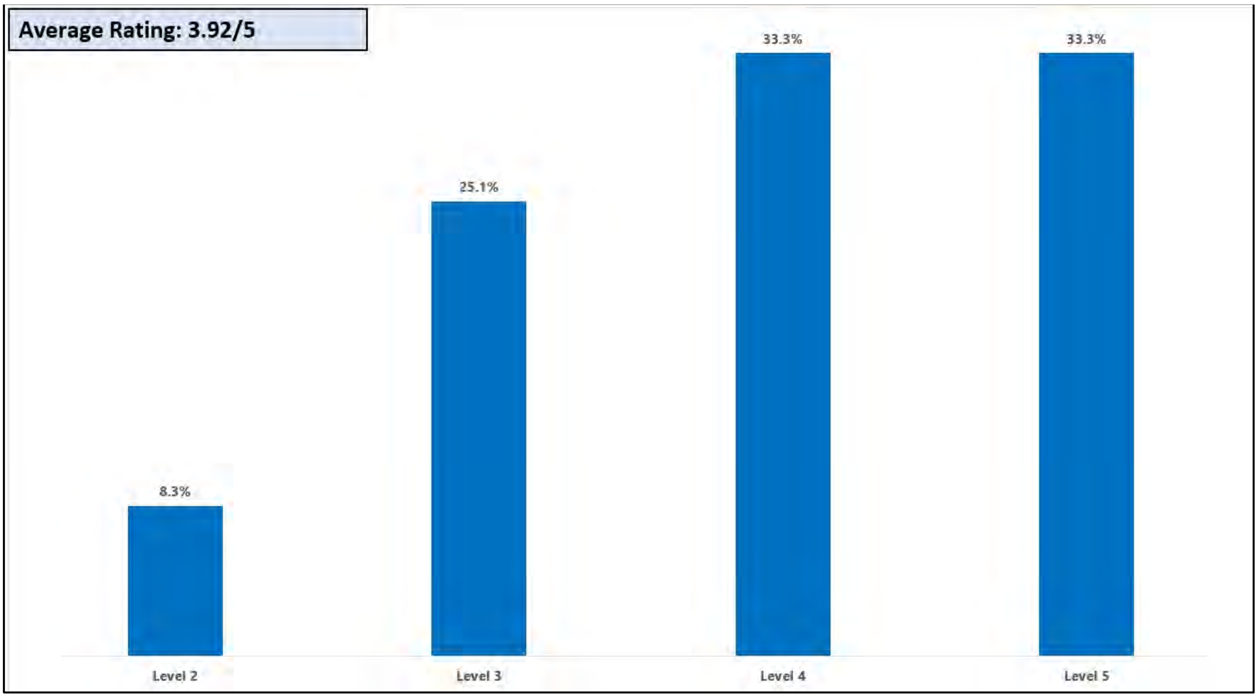
Error! Reference source not found.*11.* **Question on digitalization for overall technology** *and more specifically, regarding the level of technology being utilized within a port or terminal. For ease of reference, Levels 1 to 5 are set out in Table 10 below.*

As shown in Figure 23, one third of respondent ports (33.3%) indicated Level 5 while another 33.3% referred to Level 4. One-fourth of respondents (25.1%) said to be using Level 3 while the remaining respondents (8.3%) referred to Level 2. There have been no reports of Level 1 (i.e., paper-based, and minimal technology use). The average level across the 26 respondent ports is estimated at 3.92 meaning that, on average, ports in the sample seem to have exceeded level 3 and are increasingly using new technology arising from the fourth industrial revolution.

Table 10. Levels of technology used in ports or terminals

<table>
<tr><th>Level</th><th>Description</th></tr>
<tr><td>Level 1</td><td>Paper-based, minimal technology intervention</td></tr>
<tr><td>Level 2</td><td>Internet, ERP (Enterprise Resource Planning), MS Excel, etc.</td></tr>
<tr><td>Level 3</td><td>EDI, PCS, GPS (Global Positioning System)/RFID (Radio Frequency Identification), etc.</td></tr>
<tr><td>Level 4</td><td rowspan="2">A new technology of 4^{th} Industrial Revolution such as IoT, Big Data, Cloud Computing, AI, Drones, Digital Twin, etc.</td></tr>
<tr><td>Level 5</td></tr>
<tr><td colspan="2">Note: respondent’s choice/decision based on the application and usage of technology.</td></tr>
</table>

Figure 23. Digitalization: Technology



6. Concluding Remarks

The PISI aims to track the performance of terminals and ports as regards their economic and operational performance, sustainability principles relating to safety and security together with technology uptake and digitalization. Insights generated through the PISI will help operators of container terminals and ports make sound and informed decisions relating to these port-related aspects. The PISI will be accessible to ports and terminals in all countries as well as to a broad range of policy and industry stakeholders including, port users and customers, regulatory authorities, governments, investors, and port infrastructure developers. For these stakeholders, in particular the ports and their managing and operating entities, the PISI can help identify potential capacity needs and gaps together with the required response and intervention measures.

The analysis on the Punctuality component of the PSIS as captured by port waiting, berthing and turnaround time suggests that it is possible to identify the factors necessary to improve the service level of container terminals and ports. Ports and terminals punctuality performance informs to some extent on the port's productivity and the factors influencing productivity levels including infrastructure, equipment, and technology. The analysis was carried out using the AIS pertaining to the 165,000 port calls of the 47 target ports. Therefore, it can be argued that the main findings of the analysis are reliable and well-supported by the data.

The PISI survey questionnaire and related results relating to Safety and Security and Digitalization provide critical insights for KMI and UNCTAD regarding the next phase of the PISI implementation process. The survey has helped to evaluate and explore the feasibility of the questionnaire as a means for collecting input data necessary to calculate the PISI values. These findings have also helped to determine whether the set of questions that were articulated as part of the questionnaire are fit for purpose and easy to grasp. Overall, responses received highlighted the ease of completing the survey questionnaire and its user-friendliness. However, and despite the relevant information conveyed by the small sample of respondent ports, it is not clear whether the responses received effectively inform about the safety and security, digitalization, and technology levels in ports.

Findings from the pilot phase suggest that to ensure that the PISI is successfully rolled out internationally and meets its objective as a widely accepted indicator measuring sufficiency levels of port infrastructure, focusing on container terminals and ports**,** there will be a need to address the underlying limitations. In this context and going forward, several issues will need to be taken into consideration to refine the use of AIS data and the PISI survey questionnaire.

There is a need to ensure continuous correction to the Geo Fencing when using the AIS ship positioning and port call data. Clarifying the geographical scope of some port calls required the use of the IHS Markit's Port and Terminal Guide. Sometimes, ports can be adjacent to each other, and their areas can overlap making port coordinates more difficult to set. Therefore, and to avoid duplication, such ports were excluded from the analysis. However, this is not ideal and improvements to the Geo Fencing are required to ensure a more comprehensive analysis in the future. A broader port coverage when analysing punctuality performance by region will also improve the accuracy and the reliability of results obtained.

The survey questionnaire used as a data collection tool on safety and security and digitalization needs to be further refined. Finding new ways of encouraging systematic and wider participation by the targeted ports is required. This can only be achieved if the PISI is endorsed and accepted by container terminal and port operators not only in the Republic of Korea but also by the international community. More information sharing and awareness raising about the PISI as a tool for assessing infrastructure sufficiency levels in container terminals and ports worldwide can help incentivize greater participation in an annual PISI data collection survey administered by KMI in collaboration with relevant partners from Government and public authorities, international institutions including UNCTAD as well as the maritime supply chain industry.

Ports and terminal operators need to be further informed about the methodological soundness, the benefits, and the Unique Selling Proposition and Value Proposition of the PISI.

The difficulty in getting an acceptable response rate despite efforts by UNCTAD, KMI and other partners to encourage participation suggests that there may be a need to reconsider the approach or, alternatively, further simply the questionnaire to facilitate participation. Another option would be to identify champions among the port and terminal operators' community to lead the process of incentivizing participation in the survey.

The self-assessment approach strongly shapes the survey outcomes. First, subjectivity is an issue as respondent ports may decide to be conservative in ranking themselves or aspects relating to their activities. This will affect the results and potentially undermine the conduct of meaningful comparisons. Second, as ports are heterogeneous and serve diverse needs, the concept of port sufficiency could take different meanings depending on the port function. For example, the digitalization needs of a hub port will be different from a small port, and likewise the extent of investment and policy resources needed in increasing its digitalization level, given the available resources. A port can therefore be at a lower absolute level of digitalization than another, but still be at a high enough level to fulfil its specific function, which might lead the respondent to self-assess on the upside by assigning a higher overall score to digitalization, for example as compared to other aspects/criteria being measured. Consequently, there may be merit in taking this into account when further assessing and interpreting the results.

As regards the survey questions and the way these were formulated, it was difficult to assess the results pertaining to some areas as these were not expressed in numbers or quantitative scales. Therefore, and for the purposes of the analysis, numbers had to be assigned to each of the choices to allow for a quantitative measure/score to be generated. These relate to the following:

- Safety and Security - Equipment and Facilities:
  1 = strongly disagree, 2 = disagree, 3= neither agree nor disagree, 4 = agree, 5 = Strongly agree
- Safety and Security - Human Factors:
  1 = strongly disagree, 2 = disagree, 3= neither agree nor disagree, 4 = agree, 5 = Strongly agree
- Safety and Security - Management:
  1 = strongly disagree, 2 = disagree, 3= neither agree nor disagree, 4 = agree, 5 = Strongly agree

For comparison, the PISI survey questions relating to Digitalization allowed for responses using a scale ranging from 1 = Very Low, 2 = Low, 3= Mid, 4 = High to 5 = Very High, which made it much easier to assess the position of respondent ports. Responses to the questions on Technology were also assigned numerical levels facilitating therefore, the analysis and the calculation of scores.

Some questions provided a scale where respondent ports had to indicate "neither agree nor disagree." In these cases, and while the response aimed to indicate neutrality, interpreting the exact meaning of the responses received was problematic. The survey questionnaire should be amended to include an additional question to clarify the reason for neutrality and what "neither agree not disagree" could mean in the context of the question raised.

Another difficulty faced when assessing responses to the questionnaire relates to the format or how questions were framed and the responses that were expected. This is specific to the two questions pertaining to national and port strategies on digitalization. The scales provided for the answers did not allow for responses such as "no we do not have a strategy" and "yes, we have a strategy." Therefore, a zero value was assigned to the cases where the respondent ports indicated that they "do not have a strategy." When the response is "yes, we do have a strategy" but no value or score was provided in terms of levels of agreement with the statement, the mention "NA" was added. While these adjustments enabled a more uniform assessment of the responses received and their interpretation, they nevertheless affect the overall results.

Under the Digitalization component, one respondent port noted that as regards the question focusing on the context (National IT level), a question about the port workers' IT literacy was missing. It was commented that it was problematic to assume that the country level of literacy was the same level prevailing at ports and terminals. It was also argued that the question on Hardware, IT tools and technology, etc./Functionality/Investment could be better framed for more clarity and that in a landlord port model, the role of port authorities differed from that of the port terminal operators. Therefore, technological requirements would also differ in scope (e.g., use of terminal operating systems versus port management information system). This aspect should be addressed to refine the survey questionnaire.

Finally, it was not always easy to distinguish the role of the respondent port (i.e., whether a terminal, a port, or an authority). Some of respondent port authorities explained that terminal operators would be in a better position to provide the information sought. In this respect, it is recommended that in the future, dedicated questions be included to clarify the functions and governance structure of the respondent ports. The questionnaire could also be designed to include two versions targeting the terminal operators and the port authorities separately.

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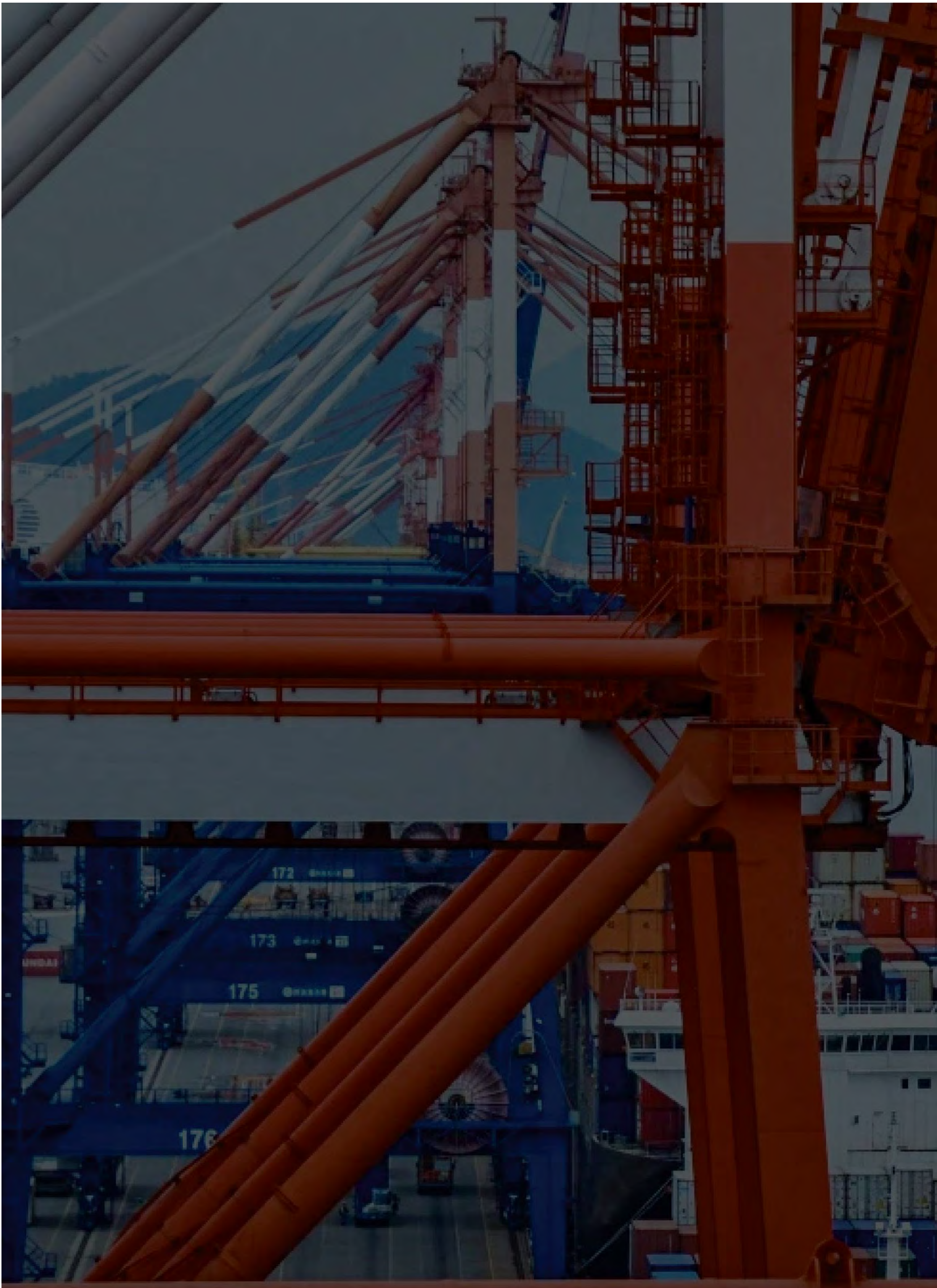
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