

THE LEADING CONTAINER PORTS OF THE WORLD 2025

A DNV and Menon Economics Publication





A DNV and Menon Economics Publication

Authors:

DNV team: M. Shahrin Osman, Aruna Coimbatore Meenakshi Sundaram, Ann Iren Holm Rise, Amitava Kumar Ghosh, Piyush Raj, Jacob Tam Jun Hui, Malini Mohan Das, Aalen Church Dsouza, Shreshth Srivastava
Menon team: Erik Jakobsen, Kaja Haug, Sophie Emilie Sundt, Øyvind Vennerød

This study is being funded by:

DNV
Menon Economics
PSA International (inaugural edition)

Design:

Ludwig Holmen

Photos: iStock

CONTENTS

| | |
|---|-----------|
| EXECUTIVE SUMMARY | 4 |
| THE CONTAINER PORT INDUSTRY | 6 |
| THE LEADING CONTAINER PORTS OF THE WORLD | 10 |
| INDICATORS FOR CONTAINER PORTS RANKING | 14 |
| ENABLERS | 16 |
| CONNECTIVITY & CUSTOMER VALUE | 22 |
| PRODUCTIVITY | 28 |
| SUSTAINABILITY | 34 |
| OVERALL IMPACT | 42 |
| REGIONAL BENCHMARKING | 48 |
| APPENDIX A: LIST OF OBJECTIVE INDICATORS OF 20 PORTS | 64 |
| APPENDIX B: METHODOLOGY AND DATA SOURCES | 65 |

EXECUTIVE SUMMARY



Maritime transport remains the backbone of international trade, with container ports alone handling over 80% of global non-bulk merchandise trade, underscoring their central role in sustaining large-scale economic activity. These global container ports are undergoing a period of remarkable transformation, propelled by surging trade volumes, rapid technological advancement, and intensifying climate imperatives. In 2024, worldwide container ports throughput soared to an unprecedented 931.8mTEU, marking a 7.8% rebound after several years of subdued growth. Asian ports continue to set the pace, with Chinese terminals alone accounting for more than 40% of global container traffic. Shanghai established a new world record, processing 51.5 million TEUs, driven by its strategic location in China's manufacturing heartland and strong integration with China's export economy. In comparison, Singapore achieved 41.1 million TEUs, supported by its status as a key transshipment hub. In the United States, ports remain key economic engines, supporting 30.8 million jobs and contributing \$5.4 trillion to the country's GDP, accounting for 26% of national output. Meanwhile, emerging economies such as India, Türkiye, and Vietnam have posted double-digit growth in container volumes, driven by supply chain diversification and nearshoring strategies.

Significant geopolitical disruptions have tested the resilience of global supply chains. The Red Sea crisis, for example, led to a 56% decline in vessel transits, with most large container ships rerouting around the Cape of Good Hope, which extended Asia-Europe and Asia-US East Coast transit times by up to two weeks. This disruption primarily affected mainline container vessels, while regional feeder vessels were largely unaffected as they generally operate outside the high-risk corridor. The Cape route increased both shipping costs and operational complexity, highlighting the vulnerability of critical maritime corridors.

Port authorities are instrumental in shaping the growth and development of container ports. By defining long-term visions, leading critical infrastructure development, and implementing forward-thinking regulations, they establish the framework necessary for sustainable growth and innovation. Such governance creates an enabling ecosystem where terminal operators and ancillary service providers can concentrate on optimising productivity, streamlining opera-

tions, and elevating customer experience. The collaboration between visionary port authorities and agile operators is indispensable, driving continuous advancement and ensuring ports remain adaptable and competitive in a rapidly evolving global landscape.

The inaugural Leading Container Ports (LCP) report presents the first robust, data-driven benchmark of container port performance worldwide. This comprehensive study evaluated 160 ports, with the top 20 distinguished through a meticulous assessment based on 35 indicators categorised under five fundamental pillars: Enablers, Connectivity & Customer Value, Productivity, Sustainability, and Overall Impact. The key differentiator of the report is its unique blending of numerical data and industry expertise. It is also the industry's first report to rank ports' performance using a wide range of indicators covering productivity, connectivity, service levels, and sustainability. Senior executives from the world's 20 leading shipping companies, responsible for over 90% of the world's containerised cargo, played a pivotal role in shaping the findings. Their expert insights and subjective evaluations complement the objective metrics, ensuring the final rankings reflect both hard data and the nuanced realities of day-to-day global shipping operations.

Singapore emerges as the world's leading container port, ranking first across all five pillars, primarily driven by its aggregated indicator scores. The outcome is underpinned by world-class infrastructure, transparent governance, and efficient mainline-mainline and feeder-mainline connectivity. The local port authority, the Maritime and Port Authority of Singapore (MPA), has played a significant role by spearheading pioneering investments in alternative-fuel bunkering, establishing green shipping corridors, and implementing emissions-reduction measures. Central to Singapore's strategy is Tuas Port, a highly automated facility that began operations in 2022 and, once fully complete by the 2040s, will handle over 65 million TEUs annually, making it the world's largest. These initiatives have reinforced Singapore's leadership, ensuring the port remains at the forefront of global maritime innovation.

Shanghai, the world's busiest container port, ranks second overall. Its strong infrastructure is supported by a strategic location, deep-water terminals, and integration with China's manufacturing base. The port's development is guided by

| RANK | ENABLERS | CONNECTIVITY & CUSTOMER VALUE | PRODUCTIVITY | SUSTAINABILITY | OVERALL IMPACT | OVERALL RANK |
|------|-----------------------|-------------------------------|-----------------|----------------|-----------------|-----------------|
| 1 | SINGAPORE | SINGAPORE | SINGAPORE | SINGAPORE | SINGAPORE | SINGAPORE |
| 2 | SHANGHAI | SHANGHAI | NINGBO-ZHOUSHAN | SHANGHAI | SHANGHAI | SHANGHAI |
| 3 | ROTTERDAM | NINGBO-ZHOUSHAN | SHANGHAI | ROTTERDAM | NINGBO-ZHOUSHAN | NINGBO-ZHOUSHAN |
| 4 | NEW YORK & NEW JERSEY | BUSAN | QINGDAO | LOS ANGELES | BUSAN | BUSAN |
| 5 | ANTWERP-BRUGES | QINGDAO | BUSAN | HAMBURG | SHENZHEN | ROTTERDAM |

the Shanghai Municipal Commission of Transport, with Shanghai International Port Group (SIPG) operating the terminals. Major investments in automation, such as the fully automated Yangshan Phase IV terminal and the expansion of Xiaoyangshan North Operation Area, have helped Shanghai surpass 51 million TEUs in 2024, making it the first port to reach this milestone. Shanghai leads in connectivity, ranking highest on the Liner Shipping Connectivity Index and serving over 700 ports worldwide. Sustainability initiatives, including comprehensive shore power, LNG and methanol bunkering, and green shipping corridors with Los Angeles and Hamburg, further highlight Shanghai's environmental and operational impact.

Ningbo-Zhoushan, the fastest-growing global hub and a key node in China's Belt and Road Initiative, ranked third overall. In 2024, it handled 39.3 million TEUs, a 26% increase over the past three years. The Ningbo Municipal Port Bureau has driven integration and infrastructure investment, creating China's largest cargo-handling complex with extensive deep-water berths for ultra-large vessels. Upgrades such as automated terminals, expanded rail links, and streamlined customs have boosted efficiency and connectivity. With over 300 routes linking 600 ports worldwide and sustainability initiatives such as smart port systems and low-carbon operations, Ningbo-Zhoushan has cemented its role as a critical hub of international trade.

Following next is Busan, ranking fourth overall. Busan stands as Northeast Asia's logistics powerhouse, serving as a key transshipment hub linking Chinese, Japanese, and Korean markets. The Busan Port Authority has driven this transformation through ambitious infrastructure development and operational innovation, including the ongoing Jinhae New Port project with 66 planned berths designed for 30,000 TEU-class vessels, which will boost capacity to 39.66 million TEUs by 2045. Strategic investments in terminal automation and digital solutions such as the blockchain-based Chain Portal platform have enabled real-time terminal monitoring and vehicle booking systems, significantly reducing truck waiting times and improving efficiency.

Rotterdam is ranked among the top five leading ports globally and is Europe's largest container port. The port features developed infrastructure and access to European inland waterways. The Port of Rotterdam Authority has demonstrated leadership through sustained investment in alternative fuel infrastructure, onshore power supply, and digital twin technology, consistently receiving high scores for its performance as a maritime gateway in Europe. These efforts have positioned Rotterdam as a model for sustainable and techno-

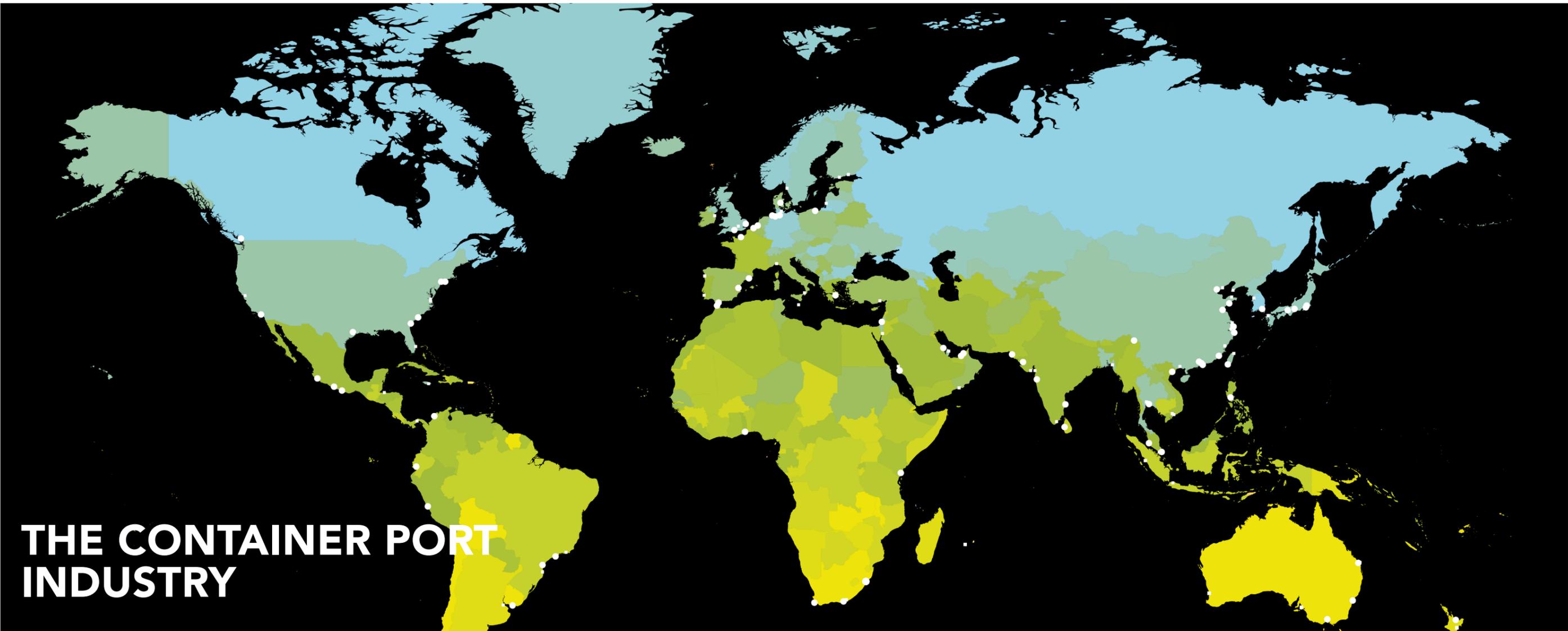
logically advanced port operations on the continent.

It is noteworthy that Singapore, Shanghai, and Rotterdam also consistently rank among the top three in the Leading Maritime Cities rankings, reflecting their continued dominance and influence at both port and city levels. This alignment further reinforces the comprehensive leadership of these hubs across infrastructure, connectivity, and innovation.

Unlike the Leading Maritime Cities (LMC) report, this report provides additional, detailed benchmarking for 14 key regions, offering a nuanced perspective on port performance across diverse geographic, economic, and regulatory contexts. Regional benchmarking is especially significant, as ports tend to compete most intensely within their own markets. This approach highlights the distinctive strengths and challenges ports face in similar environments, enabling them to benchmark their performance against direct competitors, identify best practices, and pursue targeted improvement strategies.

The report's regional benchmarking highlights standout ports shaping maritime trade in their respective regions. Durban is noted for resilience and strategic investment in Africa, while Lome is emerging as a key West African transshipment hub. Savannah leads the Central and Gulf of America (Gulf of Mexico) region in infrastructure and connectivity, and Colon-Cristobal excels in transshipment in Panama. Mundra leads the Indian subcontinent in terms of automation and productivity, with Colombo serving as the region's primary transshipment gateway. Tanger Med is redefining Mediterranean logistics with rapid growth fuelled by its strategic geographic location at the crossroads of the Strait of Gibraltar, serving as a critical entry point to Europe. In the Middle East, Dubai's Jebel Ali leads the ranking, while Khalifa Port in Abu Dhabi is recognised for its environmental leadership. Oceania's leader, Sydney, is recognised for its connectivity and sustainability, while Melbourne is recognised for its overall impact and efficiency.

While the report celebrates the achievements of the overall leaders, it also reveals that excellence in a single indicator, or even within a single pillar, is insufficient for top-tier status. Several ports emerged as indicator-level champions yet did not secure a place among the top five overall, or in some cases, even within their respective pillars. This underscores the importance of a holistic approach. True global leadership in the container port sector requires balanced strength across infrastructure, connectivity, operational efficiency, sustainability, and economic impact. Ports may excel in one area, but true competitiveness and resilience come from integrating strengths across all pillars.



THE CONTAINER PORT INDUSTRY

2024/2025 – SNAPSHOT

The following snapshot provides an overview of how global container ports performed and adapted during 2024 and the first half of 2025, a period marked by both growth and disruption. It captures the surge in throughput that signalled renewed momentum in international trade, while highlighting the strategic role ports play as critical nodes in global supply chains. A sharp rebound in container traffic, with global throughput reaching record levels, driven by sustained demand and evolving trade patterns. The continued dominance of Asian ports, the resilience of U.S. terminals amid strong consumer demand, and the rise of emerging economies leveraging nearshoring and diversification strategies. How geopolitical tensions and crises, such as the Red Sea disruption, reshaped routing, increased costs, and tested the adaptability of port infrastructure and operations. The role of hub-and-spoke systems, automation, and green infrastructure in strengthening connectivity and competitiveness. The contribution of container ports to national and global economies reinforces their importance beyond logistics.

By examining these developments, this snapshot illustrates how external shocks and strategic responses have influenced global container trade flows, underscoring the need for foresight and resilience in a volatile maritime landscape.

In 2024, global container ports evolved as critical nodes in international supply chains. Entering the year with renewed momentum, total throughput across global ports rose 7.8% to a record 938.1mTEU, a sharp rebound after years of sluggish growth. This surge reflects the sustained demand for container port services, underscoring their strategic importance in facilitating global commerce.

Asian ports maintained their dominance, with Chinese terminals alone handling over 40% of the world's container traffic. Leading the charge, Shanghai processed 51.5 million TEUs, followed by Singapore with 41.12 million, Ningbo-Zhoushan with 39.3 million, and Shenzhen with 33.39 million TEUs. Shanghai's leadership in throughput is driven by its strategic location within China's economically dynamic Yangtze River Delta, serving a vast and highly industrialised hinterland that supports a massive export-oriented manufacturing base. Singapore leverage advanced infrastructure, automation, transshipment capabilities, and strong integration with global shipping networks to sustain its high throughput levels. These massive volumes create economies of scale, reducing global shipping costs and enhancing supply chain efficiency for manufacturers, retailers, and consumers worldwide.

In the United States, strong consumer demand and strategic frontloading drove a surge in container volumes. U.S. ports support approximately 30.8 million jobs and contribute \$5.4 trillion to the GDP, accounting for around 26% of the total national economic output. Similar patterns are evident across other developed economies, where the five largest ports globally handle goods representing more than 1.4% of global economic output. This concentration of activity highlights how well-managed ports can drive regional prosperity and national competitiveness.

Meanwhile, emerging economies such as India, Türkiye, and Vietnam gained traction through supply chain diversification and nearshoring trends. These shifts reflect a broader reconfiguration of global trade flows, influenced by geopolitical developments and cost optimisation strategies. The Red Sea crisis, for instance, brought contrasting fortunes to regional terminals, disrupting traditional routes while prompting adaptive strategies and innovations in rerouting.

A key strategic model underpinning modern port operations is the hub-and-spoke system, which enables the efficient redistribution of cargo across global networks. Singapore illustrates this approach, handling more than 75% of its total throughput as transshipment and about 20% of global transshipment volumes. This model allows smaller feeder vessels to connect smaller

regional ports with major deep-sea services, creating network effects that enhance global connectivity and reduce unit transportation costs.

Market demand dynamics continued to reshape the container port landscape. North American ports experienced 12% year-on-year growth in imported container volumes in 2024 compared to 2023, driven by evolving consumption patterns and proactive inventory strategies. Asia-Pacific ports accounted for 61% of global export container volumes, with primary destinations being North America and Europe via mainstream Trans-Pacific and Asia-Europe trade corridors. These traffic patterns reflect the economic relationships that container ports facilitate, connecting production centres with consumption markets across vast oceanic distances. Ports that embraced automation, green infrastructure, and diversified trade routes emerged stronger, while those exposed to chokepoint vulnerabilities, particularly due to geographic constraints and disruptions such as the Red Sea crisis affecting ports like Jeddah, faced mounting pressure. The Red Sea crisis forced many vessel reroutings around the Cape of Good Hope, adding significant transit time and costs, reinforcing a critical lesson that in a volatile global landscape, port choice and infrastructure foresight are more consequential than ever.

GLOBAL CONNECTIVITY AND TRADE FLOWS

Ports with diversified hinterland access and robust intermodal connectivity gained strategic importance in 2024, while those reliant on single trade corridors faced operational strain. The year was marked by geopolitical disruptions and infrastructure failures that tested the resilience of global maritime logistics.

A series of attacks by Houthi rebels in the Bab al-Mandab Strait and Southern Red Sea, over 190 incidents by October 2024, culminated in a drone strike on the MSC Orion, triggering a 56% year-on-year decline (2024 vs 2023) in vessel transits through the Red Sea. Shipping companies rerouted vessels via the Cape of Good Hope, adding 10–14 days to Asia–Europe transit times and increasing carbon emissions, particularly on Far East–Europe routes. Arrivals around the Cape surged by approximately 89% compared to pre-crisis levels, and global containership demand rose by about 12%.

In March 2024, a Maersk-operated vessel collided with the Francis Scott Key Bridge in Baltimore, U.S., causing its collapse and temporarily shutting down the Port of Baltimore. This incident disrupted logistics across the U.S. East Coast, highlighting the fragility of critical infrastructure and its role in maintaining regional trade continuity. The closure forced cargo rerouting and strained alternative ports, compounding delays and increasing costs.

The Panama Canal faced its worst drought in decades, resulting in a nearly one-third reduction in daily transits in 2024 versus 2023. Container vessels were forced to carry lighter loads due to draft restrictions, and some services shifted to the Suez Canal or land-bridge alternatives. By mid-year, the canal introduced a new booking system and water-saving measures, gradually restoring capacity. However, schedule reliability remained low, and full recovery is projected into 2025.

Despite these challenges, several regions demonstrated resilience. Australian ports, notably Melbourne and Port Botany (Sydney), reported nearly 9% year-over-year growth in TEU activity (2024 vs. 2023), benefiting from strategic infrastructure investments. In Northern Europe, easing inflation and stable consumer demand supported steady trade flows. The Mediterranean region saw improved connectivity and a rebound in regional exports, signalling renewed vitality.

Asian ports continued to dominate global throughput rankings. Shanghai crossed the symbolic 50 million TEU mark in 2024, while Ningbo-Zhoushan and Shenzhen posted double-digit growth, driven by strong intra-Asian and trans-Pacific demand. Among Asian ports, Southeast Asia had the fastest growth of 8.5% in 2024, driven by the dynamism of their local economies and factory migration from China. U.S. West Coast ports rebounded sharply, with Long Beach and Los Angeles experiencing growth exceeding 20% year-on-year (2024 vs 2023), partly due to rerouted volumes and pre-tariff stockpiling.

Infrastructure expansion remained a key theme. The Port of Savannah completed its CB-1 berth realignment, enabling simultaneous handling of four 16,000-TEU vessels and adding 1.5 million TEUs in annual capacity. In Europe, the Freeport of Riga finalised a €12.5 million modernisation project, enhancing access for 340-meter vessels and integrating military mobility standards. Meanwhile, the Port of Neom in Saudi Arabia has advanced the construction of its container terminal, part of a broader logistics

hub designed to reshape the dynamics of Red Sea trade. Overall, container port performance in 2024 underscored the strategic value of resilience, adaptability, and investment.

DIGITALISATION, AUTOMATION AND INNOVATION

In 2024, leading container ports made significant strides in digital maturity, embracing technologies that redefined operational standards and logistics coordination. The adoption of AI-driven terminal operating systems, predictive analytics for berth planning, and digital documentation platforms became increasingly widespread. Automation at port gates, such as autonomous vehicle entry systems and optical character recognition (OCR) for container tracking, has helped reduce turnaround times and mitigate labour dependency, particularly in high-throughput terminals.

This momentum reflects a broader shift toward smart port ecosystems, where digitalisation, automation, and innovation converge to enhance resilience and efficiency. Ports worldwide are implementing layered transformation strategies that integrate digital twins, AI-powered scheduling, autonomous vehicles, and Port Community Systems (PCS) to streamline cargo flows and improve stakeholder coordination.

Several ports stood out as global leaders in this transformation. Qingdao Port in China continued to set the benchmark as the world's first fully automated container terminal. In 2024, it expanded its use of AI-enabled Terminal Operating Systems (TOS), which processed thousands of real-time data points to optimise crane scheduling, stack positioning, and routing for Automated Guided Vehicles (AGVs). These enhancements significantly reduced turnaround times and improved overall throughput, reinforcing Qingdao's reputation for operational precision.

At Shanghai Yangshan Port, innovation was driven by the deployment of intelligent crane control systems supported by private 5G networks and real-time 4K video feeds. Operators managed remote-controlled cranes from centralised control rooms, leveraging AI-driven path-optimisation and collision-avoidance systems to ensure safe and efficient yard operations. This integration of high-speed connectivity and machine learning positioned Yangshan as a model for intelligent terminal management.

Meanwhile, Singapore's Tuas Port illustrates smart logistics, powered by advanced automation, AI, and data-driven digital platforms. Automated cranes and driverless electric vehicles operate seamlessly through a centralised control system that enables real-time decision-making, predictive maintenance and end-to-end visibility. Supported by 5G connectivity, digital twins, and advanced analytics, optimise berth planning, cargo flows, and energy use.

In Europe, the Port of Rotterdam has advanced its digital infrastructure by utilising digital twins and IoT-enabled quay walls. These technologies allowed the port to simulate vessel movements, optimise berth allocation, and improve infrastructure utilisation. Rotterdam also made progress toward hosting autonomous ships, aligning with its long-term "Port 4.0" vision that emphasises automation, data integration, and predictive logistics.

In the United States, all ten of the largest container ports adopted

some form of automation. While some terminals reported slower performance from automated equipment compared to conventional systems, others highlighted gains in safety, capacity, and workforce upskilling. Technologies such as automated gate systems, Optical Character Recognition, and semi-automated cranes are now standard features across major U.S. ports.

Australia's Port of Brisbane and Port of Melbourne have launched Smart Port programs, focusing on AI-driven cargo handling, autonomous internal transport, and predictive maintenance. This demonstrates how mid-sized ports can leverage modular innovation for a scalable impact.

Across the board, Port Community Systems (PCS) emerged as critical enablers of digital transformation. These platforms centralised data exchange among stakeholders, reduced manual errors, and improved coordination. By integrating AI, IoT, and blockchain, PCS helped ports achieve both operational efficiency and sustainability goals.

Despite these advances, challenges remain. High initial investment costs, integration complexity, and workforce adaptation continue to pose barriers. However, ports are increasingly adopting phased digitalisation strategies, enabling incremental upgrades and scalable solutions that align with long-term transformation goals. The shift toward smart port ecosystems is no longer aspirational; it is becoming a defining feature of competitive maritime infrastructure.

GREEN TRANSFORMATION AND REGULATORY EVOLUTION

Environmental performance continued to gain traction as a competitive differentiator in 2024, though widespread implementation remained uneven. Ports faced mounting pressure not only from regulators and shipping companies, but also from cargo owners, financial institutions, and local communities to reduce emissions and demonstrate climate leadership.

In response, several container terminals are accelerating decarbonisation efforts, beginning with the electrification of cargo handling equipment. Cranes, yard tractors, and straddle carriers are increasingly powered by electricity rather than diesel, helping reduce local air pollution and lower their carbon footprints. In October 2024, the Port of Los Angeles, backed by a record \$412 million U.S. Environmental Protection Agency grant, committed to deploying 425 battery-electric cargo-handling units and 250 zero-emission drayage trucks, marking one of the largest zero-emission transitions in port history.

Beyond equipment upgrades, ports are investing in infrastructure to support the use of alternative fuels and cleaner vessel operations. Onshore Power Supply (OPS) systems are being deployed to enable ships to connect to the electrical grid while berthed alongside, eliminating the need to run auxiliary engines and reducing emissions at berth. Leading European ports, including Rotterdam, Antwerp-Bruges, and Hamburg, have advanced plans for bunkering facilities that can support green ammonia, hydrogen, and e-methanol. Shanghai Port has launched its first methanol bunkering vessel in 2025 and signed long-term supply agreements for green methanol, positioning itself as a regional leader in alternative fuel infrastructure.

Regulatory momentum intensified globally with the International Maritime Organization (IMO) setting a clear target

for net-zero greenhouse gas emissions from international shipping by or around 2050. This ambitious target drives the sector's decarbonisation efforts, in which ports play a critical role by providing the necessary infrastructure to accelerate it. In Europe, the Fit for 55 package and FuelEU Maritime regulation mandate progressive reductions in greenhouse gas intensity for vessels calling at EU ports, starting with a 2% cut in 2025 and scaling up to 80% by 2050. The inclusion of maritime emissions in the EU Emissions Trading System (ETS) added a financial dimension to environmental compliance, with CO₂ costs for large container vessels reaching up to \$400,000 per voyage on Far East–Europe routes.

Ports also played a proactive role in establishing green and digital shipping corridors; collaborative trade routes that prioritise low-emission technologies, digital transparency, and scalable innovation. These corridors serve as testbeds for decarbonisation and digital integration, aligning stakeholders across the maritime value chain. In East Asia, ports such as Singapore and Busan made notable progress in LNG bunkering, digital emissions tracking, and green corridor partnerships, attracting participation from shipping lines and regional governments. The Singapore–Rotterdam corridor expanded to include 26 global partners, piloting bio-LNG and methanol bunkering, and launching digital port call optimisation tools.

Despite these advancements, global progress remains uneven. While Europe and East Asia lead the decarbonisation charge, other regions still lay foundational groundwork. Some ports have begun aligning with ESG reporting standards and exploring green financing mechanisms. Hapag-Lloyd secured \$4 billion in green financing for 24 new dual-fuel container ships, reflecting growing investor appetite for sustainable maritime assets. In the U.S., the Green Ports Funding Tracker was launched to help port authorities navigate federal grants under the Inflation Reduction Act and Infrastructure Investment and Jobs Act.

Assessments indicate that the enabling conditions for zero-emission shipping improved in 2024; however, significant work remains to translate commitments into widespread operational change. The year highlighted the importance of coordinated investment, regulatory clarity, and scalable innovation to ensure that container ports evolve not only as gateways of trade but as engines of climate resilience.



THE LEADING CONTAINER PORTS OF THE WORLD

PORTS – STRATEGIC NODES IN GLOBAL SUPPLY CHAIN

Container ports have transformed into critical lifelines of global trade, far beyond their traditional role as mere cargo transfer points. Today, they function as dynamic gateways that enable the movement of goods across continents, harmonise international trade flows, and strengthen supply chain resilience. Their significance has grown in tandem with the increasing complexity and scale of global commerce, making them indispensable to both national economies and multinational logistics networks.

Maritime transport remains the backbone of international trade, with container ports alone handling over 80% of global non-bulk merchandise trade, underscoring their central role in sustaining large-scale economic activity. Efficient port operations are crucial for maintaining seamless cargo flows, minimising transit times, and reducing costs. Without them, supply chains would suffer severe disruptions, causing delays, inventory shortages, and economic inefficiencies.

Modern ports have evolved into integrated logistics hubs that link sea, rail, and road transport. This multimodal connectivity ensures seamless cargo transitions, supporting just-in-time deliveries, e-commerce fulfilment, and global distribution networks.

Ports now offer value-added services, including warehousing, packaging, and customs clearance, thereby creating end-to-end logistics ecosystems. Their ability to streamline operations and accelerate delivery makes them vital to contemporary supply chains.

A port's strategic importance is no longer defined solely by geography. Today, infrastructure quality, digital integration, skilled labour, connectivity and innovation ecosystems are key factors determining global competitiveness. Leading examples include Singapore and Rotterdam. Singapore leverages its prime location and advanced infrastructure to serve as a key transshipment hub, while Rotterdam, Europe's largest port, combines scale, connectivity, and automation to maintain its edge. The rise of ultra-large container vessels (exceeding 20,000 TEUs) further highlights the need for ports equipped to handle these giants efficiently.

Looking ahead, ports face a dual challenge. First, scaling capacity to meet growing demand, and second, adapting to shifting trade dynamics. With global maritime trade expected to double by 2050, ports must become more efficient, expand infrastructure, digitise operations, and embrace sustainable practices. The surge in e-commerce and consumer expectations for faster delivery drives investments in automation, data-driven logistics, and smart infrastructure. By 2032, the global port infrastructure

market is projected to reach \$290.86 billion, reflecting the scale of transformation underway.

In an era marked by geopolitical uncertainty, climate change, and shifting trade routes, the strategic importance of container ports is expected to continue increasing. Their future will depend on agile management, sustained investment, and technological innovation. Ports that embrace these imperatives will remain critical nodes in global supply chains and play a defining role in shaping the future of international trade.

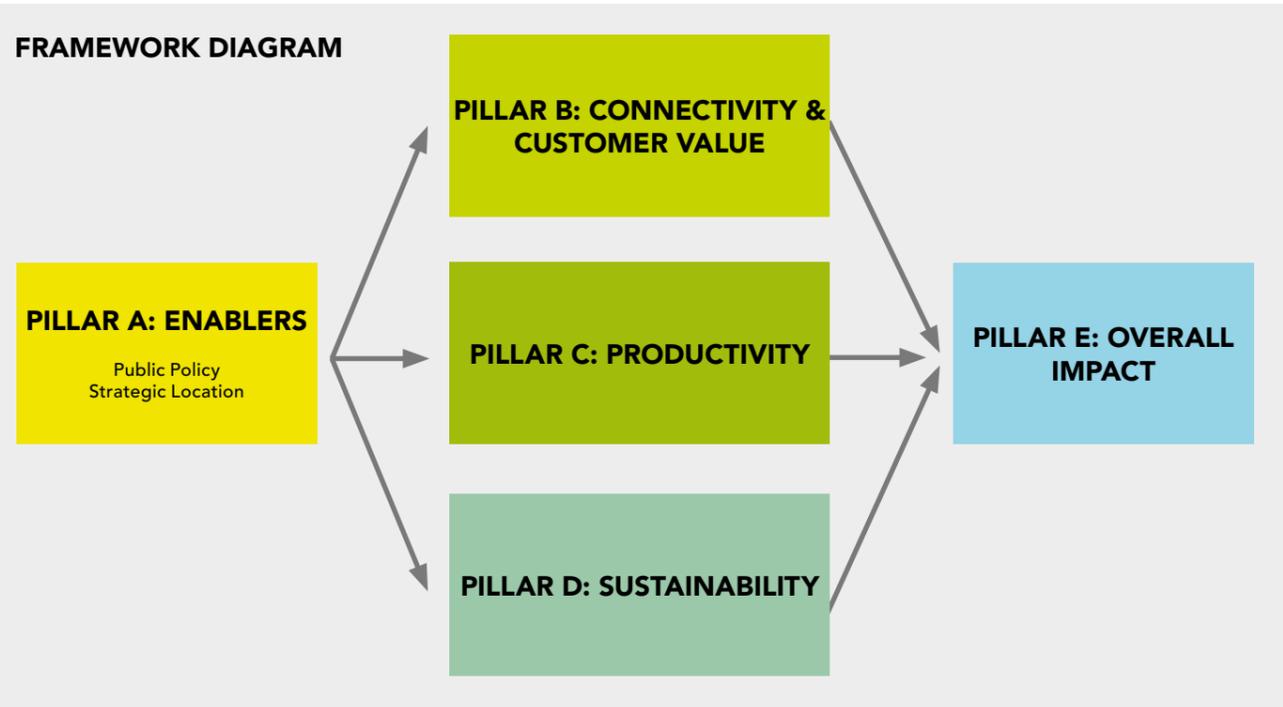
PORT ECOSYSTEM – ADAPTING TO COMPETITION, SCALE & SUSTAINABILITY

The modern container port landscape is defined by complexity, scale, and strategic transformation. Operational excellence, while still critical, is no longer sufficient on its own. Port authorities and their ecosystem, including terminal operators and ancillary service providers, must now navigate a multidimensional competitive environment shaped by evolving trade dynamics, technological disruption, and sustainability imperatives. This report's methodology reflects reality, applying a holistic framework that integrates quantitative metrics and qualitative insights to assess port performance globally.

Grounded in established models of industrial competitiveness, the analytical approach recognises that ports operate within broader economic, technological, and policy ecosystems. Sustainable advantage stems from the interplay between operational capabilities, strategic positioning, and external regulatory environments. Ports must adapt across three critical dimensions: rising service expectations, the need for scalable and flexible infrastructure, and increasing pressure to meet environmental and social standards.

To address these challenges, the benchmarking framework employs a five-pillar structure:

1. **Enablers:** Foundational elements such as governance, investment, and institutional capacity.
2. **Connectivity & Customer Value:** Network reach, service quality, and integration with logistic ecosystems.
3. **Productivity:** Operational efficiency, technological adoption, and resource utilisation.
4. **Sustainability:** Environmental performance, social responsibility, and long-term resilience.
5. **Overall Impact:** Economic contribution, market influence, and regional significance.



This structure is further enriched by analytical dimensions illustrated in the framework diagram above.

Port competitiveness is shaped by a range of interconnected factors that extend beyond operational metrics. A strategic location plays a pivotal role, as ports situated near major shipping routes and economic centres benefit from reduced inland transportation costs via trucks and rail, faster cargo movement and higher service frequency, enabling more efficient distribution and quicker access to key markets. Their proximity to dense trade corridors enhances their attractiveness to shipping lines and logistics providers. Infrastructure investment is another critical enabler of leading performance. Ports that have invested in advanced physical assets such as cranes, berths, bunkering facilities, and safety systems are better positioned to deliver reliable, efficient, and sustainable services. These investments not only support productivity but also align with long-term environmental goals.

Equally important are cluster factors, which refer to the surrounding ecosystem of maritime services, logistics providers, and shipping companies. Ports embedded in vibrant clusters benefit from innovation spillovers, collaborative dynamics, and access to specialised talent, all of which contribute to long-term competitiveness. Public policy also plays a defining role in shaping the operating environment. Regulatory frameworks, digitalisation mandates, and green transition policies influence how ports evolve and compete. Strategic public investments in port infrastructure can catalyse growth, improve resilience, and align port development with broader economic and environmental objectives.

By integrating these elements, the framework ensures a balanced evaluation, recognising that excellence in one area cannot offset deficiencies in another. Equal weighting across pillars reflects the need for comprehensive strength rather than isolated superiority.

Ultimately, this multidimensional framework offers port authorities terminal owners, and operators actionable insights into their competitive positioning. By understanding perfor-

mance across all critical dimensions, both quantitative and qualitative, internal and external, ports can identify strategic priorities, benchmark against global leaders, and develop integrated responses to the complex challenges shaping the future of maritime logistics.

BENCHMARKING BASED ON OBJECTIVE & SUBJECTIVE INDICATORS

The “Leading Container Ports of the World” report introduces a global benchmarking initiative that ranks the top 160 container ports. The methodology combines objective performance data with subjective assessments to provide a comprehensive view of port competitiveness and performance evaluations.

Objective indicators used in this benchmarking initiative were sourced from a combination of well-recognised maritime datasets, including the DNV AIS Master Model, DNV Alternative Fuel Insights (AFI) platform, Lloyd’s Top 100 ports, and other internationally recognised databases. These sources provide robust, high-resolution data on vessel movements, fuel infrastructure, port activity, and environmental performance. The indicators span throughput volumes, connectivity metrics, operational efficiency, and sustainability outcomes, forming the quantitative backbone of the five-pillar analytical framework.

To complement these metrics, subjective insights were gathered through the Leading Container Ports of the World 2025 survey. This survey focused on input from industry experts from the world’s top 20 shipping companies, operating across diverse geographies and trade routes. These industry leaders provided qualitative evaluations based on their operational experience and strategic engagement with ports worldwide.

Respondents were asked to assess ports on various themes, including competitiveness, digitalisation, green transformation, and innovation. They also ranked their top three ports across categories such as connectivity, productivity, sustainability, and overall impact. A scoring system was applied to these rankings,

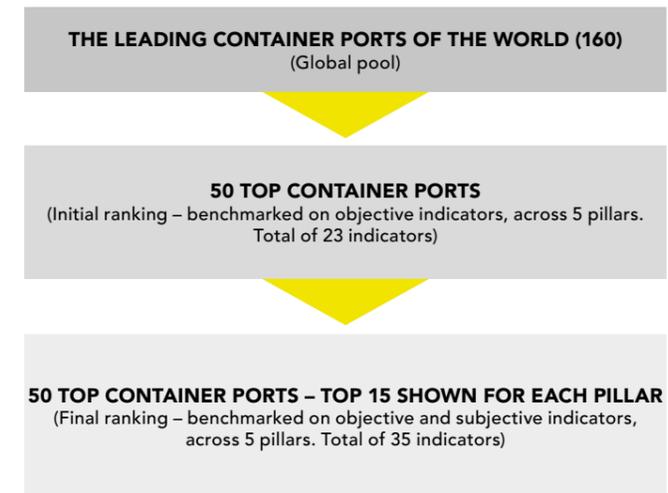
with first-place selections receiving five points, second-place selections three points, and so on. The aggregated scores formed the subjective component of the final ranking.

The global benchmarking initiative began with an analysis of 160 container ports. These were ranked using 23 objective indicators across five pillars. The top 50 ports advanced to a second round, where subjective indicators were added. In this round, ports were assessed on 35 indicators in total, forming the final global top-50 ranking. For the regional benchmarking, only objective indicators were used to identify the top five ports in each of the 14 regions.

This dual methodology ensures that the ranking reflects measurable performance, strategic relevance, and operational reputation among the industry’s most influential stakeholders. It highlights ports that are not only leaders today but are also investing in the capabilities needed to thrive in an increasingly complex and competitive maritime landscape.

Appendix B of this report provides detailed information about the composition of the expert panel and the scoring methodology.

The ranking approach is illustrated as follows:



INDICATORS FOR CONTAINER PORT RANKING

In its inaugural edition, the Leading Container Ports of the World report employs a structured, transparent ranking model, combining objective and subjective indicators to evaluate and benchmark the top 160 container ports worldwide. The model is built around five equally weighted pillars: Enablers, Connectivity & Customer Value, Productivity, Sustainability, and Overall Impact, each contributing 20% to a port's final score in the global ranking.

Within each pillar, most indicators are assigned equal weight. For instance, if a pillar includes five indicators, each will carry equal weight within that pillar. However, there are two exceptions:

- In the Connectivity & Customer Value pillar, the four indicators related to customer satisfaction will be combined and considered as one indicator.
- In the Sustainability pillar, emissions per TEU and port call will also be combined and treated as one indicator.

In total, the ranking framework comprises 35 indicators, of which 23 are objective. These objective indicators are derived from various internationally recognised and validated data sources, ensuring consistency, comparability, and reliability across ports. The complete list of indicators is presented in

the tables below, and further details on data sources and methodology are provided in the appendices.

The subjective assessment is based on the operational perceptions and evaluations of industry experts from the world's top 20 shipping companies, each of whom is actively engaged across major global trade routes and port networks. Their insights were collected through the Leading Container Ports of the World 2025 survey, which focused on ports they interact with regularly and assessed from the perspectives of performance, strategy, and service quality. This approach ensures that the subjective indicators capture the real-world experience and operational relevance, representing the views of both decision-makers and practitioners throughout the global maritime logistics network.

It is important to note that while some ports not included in the final sample may perform well on individual indicators or within specific pillars, they may not demonstrate consistent performance across all five pillars. As such, they do not qualify for inclusion in the top 50 container ports featured in this report.

ENABLERS

| INDICATOR | DESCRIPTION | SOURCE |
|--|---|--|
| Strategic location: Proximity to economic activity | The proximity of the port to key industrial, commercial, and consumer hubs. | Official national statistics agencies |
| Berth Length | Total length of berths available for mooring vessels. | DNV Research |
| Transparency & Corruption | Level of openness and integrity in governance, focusing on transparency, ethical practices, and the absence of corruption. | UNCTAD |
| Strategic location: Infrastructure for Multi-modal connectivity (Sea/air) | Global Survey: Which ports offer the most advanced and effective infrastructure for multi-modal connectivity (i.e. seamless integration of sea, rail, road and air transport)? | The Leading Container Ports of the World 2025 Survey |
| Public policy: Labor Union management relationship | Global Survey: Which ports demonstrate the most stable and constructive relationships between port authorities, terminal operators, and labour unions (i.e. within the operational port environment)? | The Leading Container Ports of the World 2025 Survey |

CONNECTIVITY & CUSTOMER VALUE

| INDICATOR | DESCRIPTION | SOURCE |
|--|---|--|
| Number of customers among the top 15 | Number of top global shipping lines or cargo owners served by the port. | DNV AIS Master Model, DNV Analysis |
| Strategic location/connectivity: Liner Shipping Connectivity Index | Port's integration into global shipping networks based on ship calls, capacity, and direct connections. | UNCTAD |
| No. of Mainline services | Number of direct long-haul shipping services calling at the port | Econdb |
| Future plans for scalable expansion | Global Survey: Which ports have the most credible and well-developed plans for scalable capacity expansion and long-term infrastructure investment? | The Leading Container Ports of the World 2025 Survey |
| Customer satisfaction: Responsiveness & Ease in business dealings | Global survey: Which ports are recognised for being responsive and easy to work with, particularly in terms of communication, coordination, and commercial processes (e.g. booking, scheduling, documentation, and customer support)? | The Leading Container Ports of the World 2025 Survey |
| Customer satisfaction: Accuracy & Timeliness of Information | Global Survey: Which ports provide the most accurate, timely, and transparent operational information to customers and stakeholders (e.g. vessel schedules, berth availability, cargo status, or delays)? | The Leading Container Ports of the World 2025 Survey |
| Customer Satisfaction: Value-added services offered | Global Survey: Which ports offer the most comprehensive and integrated value-added services beyond core cargo handling (e.g. warehousing, customs brokerage, tracking systems, or data integration platforms)? | The Leading Container Ports of the World 2025 Survey |
| Customer Satisfaction: Reliability of Port Infrastructure | Global Survey: Which ports are known for the reliability, technical quality, and availability of their physical infrastructure (e.g. quay structures, cranes, terminal systems, yard equipment)? | The Leading Container Ports of the World 2025 Survey |

PRODUCTIVITY

| INDICATOR | DESCRIPTION | SOURCE |
|---|--|--|
| Berth Utilisation | Percentage of available berth capacity occupied by vessels. | DNV AIS Master Model + Seaweb |
| Berth Productivity | Efficiency of cargo handling at a berth, typically expressed as the number of containers moves per hour per meter of berth length. | DNV AIS Master Model + DNV Analytics |
| Ability to handle peak volume | Port's capacity to manage high traffic periods. | DNV AIS Master Model + DNV Analytics |
| Just-in-time effectiveness | Global Survey: Which ports are most effective in supporting Just-in-Time logistics—specifically by minimising vessel dwell time and managing port congestion (e.g., disruptions caused by equipment breakdowns, labour strikes, etc.)? | The Leading Container Ports of the World 2025 Survey |
| Leading in digitalisation and automation processes | Global Survey: Which ports have the strongest capabilities in the adoption of digital technologies and automated processes for port operations? | The Leading Container Ports of the World 2025 Survey |

SUSTAINABILITY

| INDICATOR | DESCRIPTION | SOURCE |
|---|---|--|
| Emissions per TEU | CO ₂ emissions normalised by TEUs handled. | DNV AIS Master Model, Lloyds 100 ports and Drewry |
| Emissions per Port call | CO ₂ emissions normalised by port calls. | DNV AIS Master Model |
| Availability of alternative fuels | Capacity of alternative fuel bunker vessels. | AFI (Alternative Fuel Insights) |
| Onshore power supply | Power/capacity of shore power. | AFI (Alternative Fuel Insights) |
| No. of Green Vessel calls | Number of alternative fuel-capable vessels calling the port. | DNV AIS Master Model |
| No. of Green Shipping Corridors announced | Number of green shipping corridors announced by the port. | Global Maritime Forum |
| Leading in sustainable environmental processes | Global Survey: Which ports are at the forefront of implementing environmentally sustainable technologies and practices (e.g. shore power, energy-efficient terminals, emissions reduction, circular waste systems)? | The Leading Container Ports of the World 2025 Survey |
| Leading multi-fuel bunkering port | Global Survey: Which ports have the strongest capabilities and infrastructure to be best positioned as a leading multi-fuel bunkering port (e.g. LNG, methanol, ammonia, hydrogen, or biofuels)? | The Leading Container Ports of the World 2025 Survey |

OVERALL IMPACT

| INDICATOR | DESCRIPTION | SOURCE |
|---|--|--|
| Market Share (Throughput) | Port's share of total container volume. | Lloyds 100 ports and Drewry |
| Market Share (Vessel Call) | Port's relative share (%) of vessel calls. | DNV AIS Master Model |
| Growth rate (% of Throughput) | Percentage change in container volume handled over three years (2021-2024). | Lloyds 100 ports and Drewry |
| Growth rate (Absolute Throughput) | Change in total container volume handled (TEU). | Lloyds 100 ports and Drewry |
| Volume of TEU handled | Total number of containers processed annually, measured in TEUs. | Lloyds 100 ports and Drewry |
| Volume of Transhipment TEU handled | Number of containers transferred between vessels without inland movement. | Econdb |
| Number of vessels calls | Total vessel arrivals at the port during the year. | DNV AIS Master Model |
| Number of yearly ULCV calls | Annual arrivals of vessels above 20,000 TEU. | DNV AIS Master Model |
| Global centres for ports and logistics | Global Survey: Looking ahead three to five years from now: Which ports do you consider will be the leading container ports in your region? | The Leading Container Ports of the World 2025 Survey |

ENABLERS

SUMMARY



The Enablers pillar underpins a container port's ability to facilitate global trade. Port authorities play a pivotal role in shaping the enabling conditions. By setting strategic direction, overseeing investment in physical and multimodal infrastructure, and upholding high standards of governance and transparency, they ensure that ports remain attractive to global shipping lines and investors. Effective port authorities act as convenors, bringing together private shipping companies, port operators, and local authorities to coordinate long-term planning and investment.

This spirit of collaboration is vital for fostering robust labour relations, harmonising the interests of a broad range of stakeholders, and implementing policies that drive sustainable growth and operational excellence. Industry experts consistently emphasise that investment in port infrastructure is inherently a long-term undertaking, requiring shared commitment and risk among all parties involved. Without such alignment, the sector faces significant capacity bottlenecks, threatening the efficiency of global supply chains and hindering the smooth flow of international commerce.

Consequently, this pillar encompasses five critical dimensions: strategic proximity to economic activity, physical infrastructure capacity (measured by berth length), governance quality (reflected in transparency and anti-corruption measures), multimodal connectivity infrastructure, and labour relations. Together, these factors create the enabling environment

that allows ports to attract investment, secure long-term commercial partnerships, and adapt to evolving market demands.

Singapore maintains a leading position in the Enablers pillar, ranking highly across key areas such as berth length, multimodal connectivity, labour relations, and transparency. The Maritime and Port Authority of Singapore (MPA) is instrumental in developing and implementing strategies that support Singapore's status as a global port leader. The MPA oversees maritime regulation, infrastructure development, and the advancement of innovation, ensuring efficient integration of sea, air, and road transport. Industry experts frequently note Singapore's well-structured tripartite arrangements that bring together labour, regulatory, and government stakeholders. This coordinated approach, led by the MPA and PSA, the terminal operator, reflecting Singapore's reputation for effective port management and sustained prominence in global maritime logistics.

Shanghai secured the second spot among the world's leading container ports by leveraging its prime location in China's manufacturing heartland and robust infrastructure. Ranking third in berth length and second in both multimodal connectivity and labour relations, Shanghai demonstrates how close integration with a vast economic hinterland and purposeful policy support can create powerful enabling conditions. As the gateway to the productive Yangtze River Delta, the port accesses key production



"Global container fleet capacity is expanding three to four times faster than port infrastructure can accommodate. Governments and port operators demonstrating genuine commitment to both new infrastructure development and expansion of existing facilities will emerge as the competitive winners in an increasingly capacity-constrained environment."

ENABLERS

| | Proximity to Economic Activity | Berth length | Transparency & corruption | Q: Infrastructure for multi-modal connectivity | Q: Labor union management relationship |
|-----------------------|--------------------------------|--------------|---------------------------|--|--|
| SINGAPORE | 17 | 1 | 1 | 1 | 1 |
| SHANGHAI | 11 | 3 | 31 | 2 | 2 |
| ROTTERDAM | 13 | 4 | 2 | 3 | 10 |
| NEW YORK & NEW JERSEY | 1 | 16 | 17 | - | - |
| ANTWERP-BRUGES | 12 | 5 | 13 | 11 | 16 |
| LOS ANGELES | 3 | 15 | 17 | 4 | 8 |
| BUSAN | 48 | 7 | 23 | 8 | 6 |
| SHENZHEN | 18 | 2 | 31 | 6 | 3 |
| LONG BEACH | 3 | 11 | 17 | - | - |
| KAOHSIUNG | 10 | 20 | 16 | 13 | 4 |
| HOUSTON | 2 | 43 | 17 | - | - |
| JEBEL ALI (DUBAI) | 43 | 10 | 14 | 11 | 10 |
| NINGBO-ZHOUSHAN | 14 | 6 | 31 | 5 | 7 |
| HAMBURG | 39 | 19 | 5 | - | - |
| OAKLAND | 3 | 23 | 17 | - | - |

centres and consumer markets. The Shanghai Municipal Port Authority, jointly with SIPG as primary terminal operator, have driven this progress by enacting clear regulatory standards, investing strategically in infrastructure, and promoting stakeholder collaboration, ensuring multimodal connectivity, ongoing investment, and sustained global prominence.

Rotterdam claimed third position, representing European excellence in port governance and institutional quality. Ranking fourth in berth length and third in multimodal connectivity, Rotterdam benefits from its strategic position as Europe's primary maritime gateway and its extensive integration with continental road, rail, and inland waterway networks. The port's second rank in transparency reflects the Netherlands' strong governance standards and regulatory predictability, essential factors for attracting long-term infrastructure investment and maintaining stakeholder confidence.

New York & New Jersey ranked fourth, distinguished by their unmatched proximity to economic activity (rank 1). Serving the largest consumer market and business cluster in North America, the port benefits from direct access to the Greater New York metropolitan area and extensive rail and highway connections to the U.S. interior. Despite facing labour relations challenges common to major North American ports, its strategic location and infrastructure capacity ensure

continued prominence.

Los Angeles completed the top five, sharing the top position for proximity to economic activity alongside Long Beach and Oakland. As the leading gateway for trans-Pacific trade, Los Angeles benefits from California's vast economy and serves as a critical node connecting Asian manufacturing centres with North American markets. Its fourth ranking in multimodal connectivity reflects substantial investments in rail and highway infrastructure designed to move cargo efficiently to distribution centres across the western United States.

The Enablers pillar assessment reveals that sustained leadership requires a balanced approach to excellence across governance, infrastructure, and stakeholder management. While Asian ports dominate through scale and integration with manufacturing ecosystems, European and North American ports leverage regulatory quality, transparent governance, and sophisticated intermodal networks to maintain competitiveness. The data indicate that enabling conditions extend beyond mere physical infrastructure and include institutional capacity, policy alignment, and collaborative ecosystems. These factors are predominantly facilitated by port authorities, which work to minimise friction, attract investment, and strengthen long-term resilience.

EXPERT ASSESSMENT

Industry experts from the world's top 20 shipping companies were asked to evaluate ports based on two subjective indicators within the Enablers pillar: infrastructure for multimodal connectivity and the quality of labour-management relationships. These assessments reflect the operational experience and strategic perceptions of the ports with which they regularly engage.

INFRASTRUCTURE FOR MULTIMODAL CONNECTIVITY

This indicator measures the effectiveness with which a port integrates sea, air, road, and rail transport to facilitate seamless cargo movement. This indicator captures not only the physical presence of intermodal infrastructure but also its quality of integration, accessibility, and operational efficiency. Figure 1 presents the scores given by the experts.

Singapore emerged as the clear leader, ranking first, recognised for its integration of maritime operations with air freight facilities at Changi Airport, and highway networks that provide rapid access to industrial zones and distribution centres. The Maritime and Port Authority of Singapore (MPA) has thoughtfully cultivated these multimodal linkages as part of its strategy to remain a premier logistics hub.

Shanghai ranked second, benefiting from China's aggressive infrastructure development and the Yangtze River Delta's comprehensive transport networks. The port's connectivity extends inland via the Yangtze River, China's extensive rail network, and a sophisticated highway system, enabling efficient cargo distribution across one of the world's most economically dynamic regions. Rotterdam secured third place, leveraging its unparalleled access to European inland waterways, particularly the Rhine-Meuse-Scheldt delta, as well as extensive road and rail connections that reach deep into continental Europe. Los Angeles followed in fourth position, supported by the Alameda Corridor rail expressway and highway infrastructure that facilitates cargo movement

to inland distribution hubs. Ningbo-Zhoushan ranked fifth, reflecting China's ongoing investments in connecting coastal ports with inland economic centres through rail and highway expansion.

LABOUR UNION MANAGEMENT RELATIONSHIP

This indicator assesses the quality of collaboration between port operators and labour organisations, a critical factor influencing operational continuity, productivity, and the ability to implement technological innovations. Strong labour-management relationships reduce the risk of disruptions, facilitate workforce adaptation to automation, and enhance overall operational predictability. Singapore once again led this indicator, ranking first (see Figure 2), reflecting the MPA's and PSA's collaborative approach towards workforce management, transparent communication, and alignment between management and labour on long-term strategic objectives.

Shanghai ranked second, demonstrating China's and SIPG coordinated approach to port labour management within its state-influenced industrial framework. Shenzhen claimed third place, benefiting from labour relations dynamics similar to those in Shanghai while maintaining operational agility in Southern China's manufacturing hub. Both Hong Kong and Kaohsiung shared fourth place, reflecting their respective approaches to labour relations shaped by regional labour market dynamics and institutional frameworks.

These expert assessments highlight the importance of institutional quality and stakeholder alignment in creating sustainable competitive advantages. Ports that cultivate transparent communication, invest in workforce development, and foster collaborative relationships with labour organisations are better positioned to navigate technological transitions, maintain operational reliability, and adapt to shifting market conditions. The convergence of infrastructure excellence and labour-management harmony

creates a powerful enabling environment that attracts shipping lines, cargo owners, and logistics providers seeking predictable, efficient, and resilient port operations.

"Ports with ambitious, credible long-term expansion plans signal to liner operators that they understand trade growth dynamics and are prepared for scalability. This institutional clarity enables shipping companies to align their own fleet deployment strategies and growth investments with ports offering genuine growth potential."

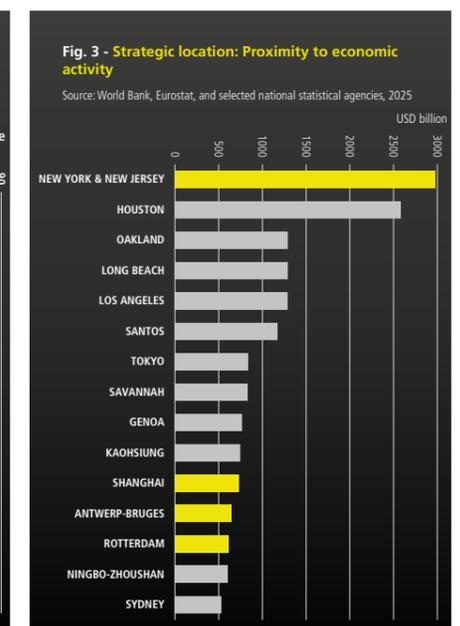
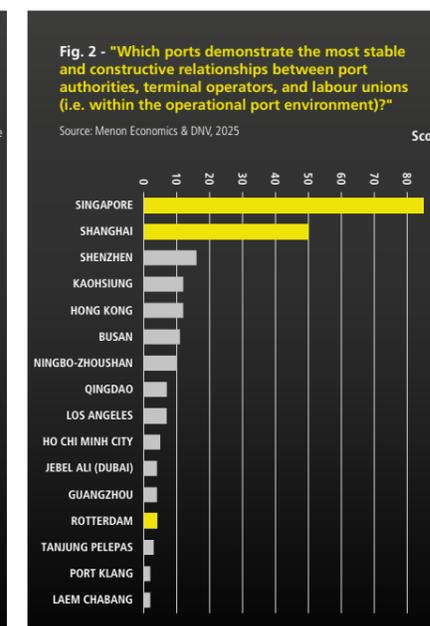
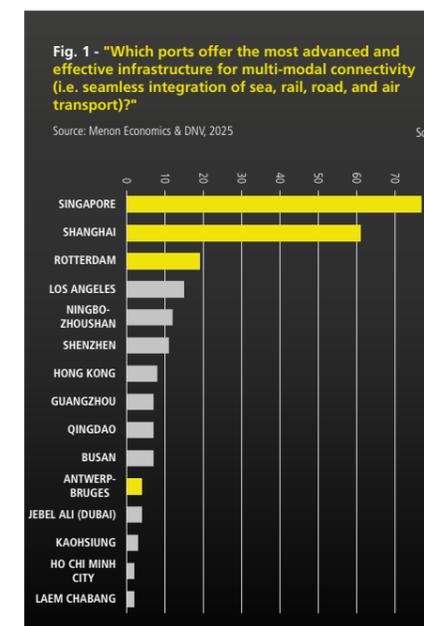
OBJECTIVE INDICATORS' ASSESSMENT

The objective assessment of the Enablers pillar draws on three quantitative indicators that measure fundamental aspects of port capacity, governance, and strategic positioning: proximity to economic activity, berth length, and transparency and corruption levels.

PROXIMITY TO ECONOMIC ACTIVITY

Proximity to major economic centres is a fundamental determinant of port competitiveness, influencing cargo volumes, logistics costs, and service frequency. Ports located near dense concentrations of production, consumption, and trade activity benefit from reduced inland transportation costs, faster cargo turnaround, and stronger integration with supply chains. This indicator measures the proximity of a port to major GDP-generating regions, reflecting its natural advantage in attracting and retaining cargo.

New York & New Jersey lead this category, ranked first globally, serving the largest metropolitan economy in the United States with direct access to over 23 million people and a regional GDP exceeding \$1.8 trillion. The port is ideally



positioned to serve the densely populated Northeast corridor, which includes major business centres, manufacturing zones, and consumer markets.

Houston ranks second (Figure 3), benefiting from its location along the Gulf Coast and proximity to Texas's \$2 trillion economy, which includes major energy, petrochemical, and manufacturing industries. Houston's role as a gateway for energy-related cargo and its access to inland markets via the Mississippi River system reinforce its strategic significance. Long Beach, Los Angeles, and Oakland share third place, collectively serving California's \$3.9 trillion economy, the fifth largest globally if California were a standalone nation. These West Coast ports benefit from their proximity to major population centres, technology hubs, and agricultural production zones, positioning them as critical gateways for trans-Pacific trade.

Among Asian ports, Tokyo ranks seventh, leveraging its position within the Greater Tokyo Area, one of the world's most economically productive regions with a GDP approaching \$2 trillion. Kaohsiung (13th) and Shanghai (14th) also demonstrate strong proximity to major economic zones, though Shanghai's ranking reflects the broader geographic distribution of China's manufacturing base rather than a lack of economic significance. The port serves the Yangtze River Delta, home to over 200 million people and a regional GDP exceeding \$3 trillion, making it one of the most economically integrated port regions in the world.

This indicator highlights a critical advantage for North American and Japanese ports, which are embedded within highly developed, consumption-driven economies. In contrast, Chinese ports, despite serving massive economic hinterlands, are distributed across a larger geographic area, which affects proximity rankings but does not diminish their overall economic significance or cargo-handling dominance. European ports rank relatively low in this aspect due to the continent's fragmented geographic setup, characterised

by many smaller countries and a more distributed economy. This results in less concentrated economic hubs near ports compared to North America and parts of Asia.

BERTH LENGTH

Berth length is a key indicator of a port's capacity to accommodate vessels simultaneously. It reflects the cumulative capacity of the entire terminal to handle large vessels. The range of berth lengths within a terminal determines how many vessels can be moored and service concurrently. Longer berth lengths enable ports to service more vessels concurrently, reduce waiting times, and improve overall throughput efficiency. This indicator is particularly critical as container ships grow larger, requiring deep-water berths and extensive quay infrastructure.

As presented in Figure 4, Singapore ranks first in berth length, with extensive quay facilities designed to accommodate ultra-large container vessels (ULCVs) including vessels exceeding 24,000 TEU. The continued expansion of Tuas Port is expected to significantly increase berth capacity and further strengthen Singapore's infrastructural competitiveness. Shenzhen follows in second place, with extensive berth infrastructure distributed across multiple terminal complexes, including Shekou, Chiwan, Yantian, and Dachan Bay, collectively providing the capacity to handle over 33 million TEUs annually.

Shanghai ranks third, with its Yangshan Deep Water Port and Waigaoqiao terminals providing extensive quay length designed to accommodate ULCVs vessels on key Asia-Europe and trans-Pacific routes. Rotterdam ranks fourth, with Maasvlakte terminals offering state-of-the-art infrastructure designed for automated operations and efficient vessel handling. Antwerp-Bruges completes the top five, benefiting from the recent merger of Antwerp and Zeebrugge ports, which consolidated berth capacity and created Europe's second-largest port complex.

The ranking reveals a clear divide, with Asian ports dominating berth capacity through

aggressive infrastructure expansion driven by China's industrial growth and Southeast Asia's role as a manufacturing and transshipment hub. European ports, while ranking highly, face geographic and regulatory constraints that limit expansion compared to their Asian counterparts. North American ports, despite serving large economies, rank lower in berth length (Los Angeles at 15th), reflecting slower infrastructure development and constrained expansion opportunities due to land availability and environmental regulations.

TRANSPARENCY & CORRUPTION

Transparency and the absence of corruption are critical governance indicators that influence investment decisions, operational predictability, and long-term competitiveness. Ports operating in transparent, well-governed environments attract higher levels of foreign direct investment, benefit from stable regulatory frameworks, and foster trust among shipping lines, cargo owners, and logistics providers. This indicator, derived from Transparency International's Corruption Perceptions Index, assesses the governance environment in which ports operate. Figure 5 presents the scores for the top 15 rank holders.

Singapore ranks first on this indicator, representing Asia's premier transparent governance jurisdiction, where regulatory clarity and efficient public administration create a business environment characterised by trust and predictability. Rotterdam represents European excellence outside the Nordic region, benefiting from the Netherlands' strong rule of law and robust anti-corruption frameworks. European ports generally perform well in terms of transparency measures due to European Union regulatory standards and national governance traditions that prioritise transparency and accountability. Sydney, Melbourne, and Brisbane exemplify Australia's robust governance institutions and transparent regulatory environment, providing a stable foundation for port operations and long-term infrastructure planning.

In contrast, many high-performing Asian ports rank substantially lower on transparency measures despite their operational excellence and throughput dominance. Shanghai, Ningbo-Zhoushan, Qingdao, Shenzhen, Guangzhou, and Hong Kong rank in the mid-to-high range, reflecting broader national governance dynamics rather than port-specific operational issues. While these ports demonstrate world-class operational efficiency and high-quality infrastructure, governance perceptions remain a significant consideration for international investors and shipping lines evaluating long-term partnerships. This divergence stresses that operational excellence and governance transparency, while both critical for port competitiveness, remain distinct dimensions that do not always correlate perfectly. Ports can achieve high throughput and efficiency while operating in environments with lower transparency scores; however, those in highly transparent jurisdictions benefit from enhanced investor confidence and reputational advantages, which support sustained strategic positioning.

The Enablers pillar assessment reveals that port competitiveness requires a balanced portfolio of strengths across physical infrastructure, strategic location, and institutional quality. While Asian ports leverage scale, proximity to manufacturing ecosystems, and aggressive infrastructure investment, European and North American ports differentiate through governance quality, regulatory stability, and sophisticated multimodal networks. The most competitive ports excel across multiple dimensions, creating enabling environments that attract investment, foster innovation, and ensure long-term resilience in an increasingly complex global maritime landscape.



Fig. 4 - Berth length

Source: DNV Research

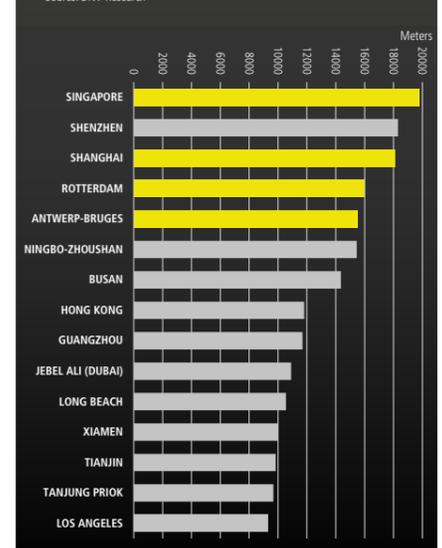
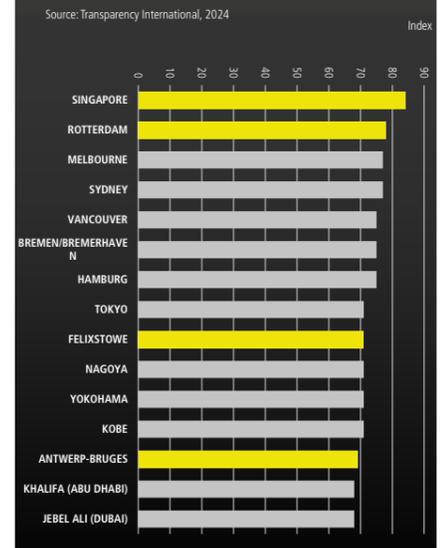


Fig. 5 - Transparency & Corruption: Corruption Perceptions Index 2024

Source: Transparency International, 2024



CONNECTIVITY & CUSTOMER VALUE

SUMMARY



"Port competitiveness increasingly requires operational agility in responding to supply chain uncertainties, combined with proactive value-added service offerings that extend beyond transactional cargo handling. Ports that remain vibrant and adaptable create strategic advantages in volatile trade environments."

The Connectivity & Customer Value pillar assesses a port's capacity to integrate into global shipping networks, deliver high-quality services to customers, and generate value through operational excellence and strategic positioning. Experts consistently identified connectivity and customer value as the most critical factors determining a port's global standing, with customer value also ranking highly in their assessments. Port congestion was repeatedly highlighted as a persistent challenge, with increased wait times and berth delays cited as major obstacles to operational efficiency. As global trade volumes continue to rise and supply chains become more complex, ports that can minimise congestion and deliver reliable, high-quality service will be best positioned to lead in the years ahead.

Therefore, this pillar encompasses both objective metrics, such as the number of top-tier shipping line customers, liner shipping connectivity, and mainline services, as well as subjective assessments of customer satisfaction, including responsiveness, information accuracy, value-added services, and infrastructure reliability. Together, these indicators capture a port's effectiveness in meeting the needs of shipping lines, cargo owners, and logistics providers in an increasingly competitive and demanding maritime environment.

In 2024, Singapore ranked first in the Connectivity & Customer Value pillar, performing well across most indicators. This strong showing reflects Singapore's steady focus

on customer service, network integration, and operational reliability. The port serves all the top 15 global shipping lines by fleet size in TEU as of December 2024, provides a wide range of mainline services, and placed third on the Liner Shipping Connectivity Index. The port's emphasis on transparency, digital integration, and regular communication continues to set a high standard for port-customer relationships.

Shanghai secured second place overall, combining its position as the world's busiest container port with exceptional network connectivity. Ranking first on the Liner Shipping Connectivity Index and second in mainline services, Shanghai's integration with China's manufacturing base and its role as a gateway to the Yangtze River Delta ensure that it remains indispensable to global supply chains. The port's consistent second-place rankings across all customer satisfaction indicators reflect its operational reliability and commitment to service quality, even as it manages unprecedented cargo volumes.

Ningbo-Zhoushan claimed third place, demonstrating rapid ascent in connectivity and customer value. Ranking second on the Liner Shipping Connectivity Index and third in mainline services, the port has emerged as a critical node in China's Belt and Road Initiative and as a key alternative to Shanghai for ULCV calls. At the same time, its customer satisfaction scores indicate room for improvement (ranging from third to ninth across indicators). Its strong network integration and ambitious expansion



CONNECTIVITY & CUSTOMER VALUE

| | Number of top 15 customers | Liner Shipping Connectivity Index | Number of mainline services | Q: Future plans for scalable expansion | Q: Responsiveness & ease in business dealings | Q: Accuracy & timeliness of information | Q: Value-added services offered | Q: Reliability of port infrastructure |
|-------------------|----------------------------|-----------------------------------|-----------------------------|--|---|---|---------------------------------|---------------------------------------|
| SINGAPORE | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 |
| SHANGHAI | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 |
| NINGBO-ZHOUSHAN | 1 | 2 | 3 | 4 | 6 | 3 | 9 | 4 |
| BUSAN | 14 | 4 | 4 | 3 | 4 | 5 | 7 | 6 |
| QINGDAO | 1 | 5 | 6 | 11 | 12 | 15 | 11 | 6 |
| PORT KLANG | 1 | 7 | 5 | 7 | 8 | 13 | 13 | 11 |
| HONG KONG | 1 | 6 | 7 | 16 | 3 | 4 | 3 | 12 |
| JEBEL ALI (DUBAI) | 1 | 12 | 18 | 6 | 12 | 10 | 3 | 9 |
| XIAMEN | 1 | 10 | 10 | - | - | - | - | - |
| KAOHSIUNG | 14 | 11 | 8 | 12 | 9 | 7 | 7 | 8 |
| SHENZHEN | 1 | - | 11 | 9 | 5 | 6 | 11 | 3 |
| MUNDRA | 1 | 17 | 22 | - | - | - | - | - |
| HAI PHONG | 1 | 21 | 24 | - | - | - | - | - |
| LAEM CHABANG | 14 | 14 | 15 | 9 | 10 | 10 | 13 | 14 |
| JAWAHARLAL NEHRU | 1 | 18 | - | - | - | - | - | - |

plans (fourth in future scalability) position it as a rising force in global maritime logistics.

Busan secured fourth place, leveraging its strategic location in Northeast Asia, along with operational excellence and customer-focused service delivery. Ranking fourth on both the Liner Shipping Connectivity Index and mainline services, Busan serves as a critical transshipment hub connecting Chinese, Japanese, and Korean markets with North American and European destinations. Its strong performance in customer satisfaction indicators, particularly third in future expansion plans and fourth in responsiveness, reflects deliberate efforts to enhance service quality and maintain competitiveness amid intense regional competition.

Qingdao completed the top five, leveraging its position as China's leading port for automation and digitalisation. Ranking fifth on the Liner Shipping Connectivity Index and sixth in mainline services, Qingdao combines technological sophistication with growing network reach. However, its customer satisfaction scores (ranging from 6th to 15th) suggest that, despite operational efficiency, there is scope to improve customer engagement, communication, and value-added service offerings.

The Connectivity & Customer Value pillar assessment reveals that market leadership requires more than physical infrastructure and throughput capacity; it demands strategic network positioning, customer-centric operational models, and continuous invest-

ment in service quality and relationship management. Ports that excel in this pillar understand that their competitive advantage lies not only in moving cargo efficiently but in creating seamless, reliable, and responsive experiences that foster long-term partnerships with shipping lines and cargo owners.

EXPERT ASSESSMENT

Industry experts from the world's top 20 shipping companies evaluated ports across five subjective indicators within the Connectivity & Customer Value pillar: plans for scalable expansion, responsiveness and ease in business dealings, accuracy and timeliness of information, value-added services offered, and reliability of port infrastructure. These assessments reflect the operational realities and strategic perceptions of maritime professionals who interact with these ports daily.

FUTURE PLANS FOR SCALABLE EXPANSION

Given the trends of increasing vessel sizes, higher cargo volumes, and shifting customer demands, it is essential for ports to invest in scalability to maintain competitiveness continually. Industry experts emphasise that port capacity constraints and expansion strategies are crucial considerations in carrier network planning. Liner operators seek ports with clearly articulated three- to five-year expansion policies and capacity commitments, as the absence of such growth strategies constitutes a significant operational risk for carriers looking to expand their service offerings. This indicator assesses the extent to which ports offer transparent, credible, and ambitious plans for future capacity expansion, technological advancements, and infrastructure development.

Singapore ranked first (Figure 6), driven by the ongoing development of Tuas Port, expected to be the world's largest fully automated container terminal, with an ultimate annual capacity of 65 million TEUs upon full completion in the 2040s. Designed as a next-generation mega hub, Tuas Port was built with automation, AI and digitalisation at its core. Fully automated quay and yard cranes, driverless vehicles, and 5G-enabled systems enhanced efficiency, productivity and safety.

Shanghai secured second place, reflecting continuous expansion at Yangshan Phase IV and investments in automation and smart port

technologies. The port's integration of 5G networks, AI-driven terminal operating systems, and advanced cargo handling equipment signals a deliberate strategy to enhance capacity while maintaining operational efficiency. Busan ranked third, with plans to expand terminal capacity, upgrade automation systems, and enhance connectivity with regional feeder networks. Ningbo-Zhoushan followed in fourth place, benefiting from China's strategic investments in Belt and Road infrastructure and port capacity expansion to accommodate growing trade flows. Guangzhou ranked among the top five, with expansion initiatives focusing on increasing throughput capacity and enhancing intermodal connectivity.

RESPONSIVENESS & EASE IN BUSINESS DEALINGS

This indicator measures the efficiency and smoothness of customer interactions with port authorities, terminal operators, and service providers. It reflects the quality of customer service, the speed of decision-making, and the overall user experience when coordinating vessel calls, cargo handling, and logistics operations.

As shown in Figure 7, Singapore once again led with a first-place ranking, recognised for its proactive communication, streamlined processes, and customer-focused operational culture. Shanghai ranked second, demonstrating strong customer engagement and efficient coordination despite managing the world's highest container throughput. Hong Kong claimed third place, benefiting from its long-standing reputation for business-friendly operations and transparent, efficient administrative processes. Busan secured fourth position, reflecting its efforts to enhance customer service quality and operational responsiveness amid regional competition. Shenzhen completed the top five, leveraging its proximity to Hong Kong and adopting similar customer-centric approaches to port management.

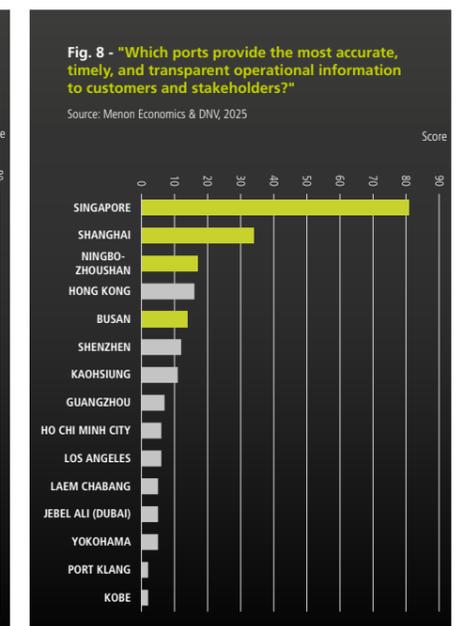
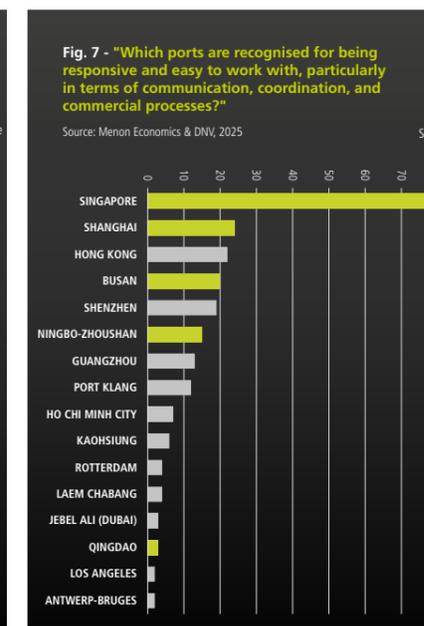
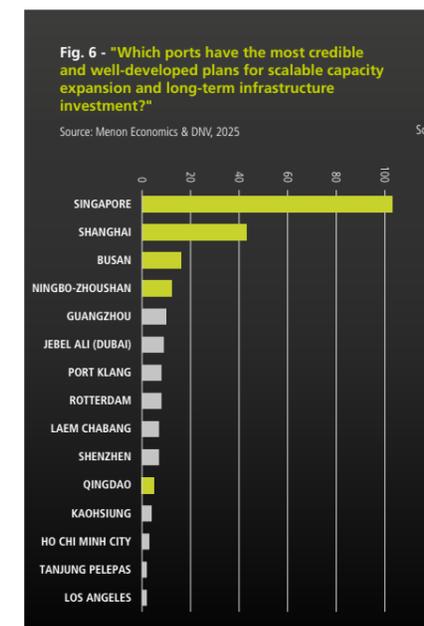
Shanghai ranked second, demonstrating strong customer engagement and efficient coordination despite managing the world's highest container throughput. Hong Kong claimed third place, benefiting from its long-standing reputation for business-friendly operations and transparent, efficient administrative processes. Busan secured fourth position, reflecting its efforts to enhance customer service quality and operational responsiveness amid regional competition. Shenzhen completed the top five, leveraging its proximity to Hong Kong and adopting similar customer-centric approaches to port management.

ACCURACY & TIMELINESS OF INFORMATION

Accurate and timely information is critical for shipping lines and logistics providers who depend on real-time data to optimise vessel schedules, plan cargo movements, and manage supply chain operations. This indicator measures the reliability and timeliness with which ports communicate with stakeholders regarding berthing schedules, cargo status, operational disruptions, and procedural updates. Figure 8 presents the scores provided by the experts.

Singapore topped this category, supported by its advanced Port Community System (PORTNET), which provides integrated, real-time data sharing across all port stakeholders. The platform enables seamless communication, reduces information asymmetries, and enhances operational coordination.

Shanghai ranked second, with investments in digital platforms and data integration systems that facilitate real-time information exchange. Ningbo-Zhoushan secured third place, demonstrating improvements in communication infrastructure and digital transparency. Hong Kong and Busan tied for fourth and fifth place, respectively, both recognised for maintaining reliable communication channels and transparent information dissemination practices.



VALUE-ADDED SERVICES OFFERED

Value-added services extend beyond basic cargo handling to include logistics support, warehousing, customs facilitation, cold chain management, cargo consolidation, and specialised handling services. Ports that offer comprehensive value-added services create additional revenue streams, enhance customer loyalty, and differentiate themselves in competitive markets. Singapore led this indicator again, offering a wide range of services including bunkering (conventional and alternative fuels), ship repair, logistics and warehousing, cold chain facilities, and customs brokerage.

Shanghai ranked second (see Figure 9), offering extensive value-added services that are integrated with China's broader logistics and manufacturing ecosystems. Jebel Ali (Dubai) and Hong Kong tied for third place, both recognised as full-service maritime hubs offering diverse logistics, trade facilitation, and specialised cargo handling services. Rotterdam completed the top five, leveraging its role as Europe's logistics gateway to offer comprehensive services including petrochemical handling, cold storage, and inland distribution.

RELIABILITY OF PORT INFRASTRUCTURE

Infrastructure reliability measures the consistency, dependability, and resilience of port facilities, including berths, cranes, storage areas, and supporting systems. Reliable infrastructure minimises disruptions, reduces vessel waiting times, and ensures predictable operational performance, which are critical factors for shipping lines operating on tight schedules.

As shown in Figure 10, Singapore was ranked first, reflecting the authorities' foresight and long-term investment in infrastructure, regular maintenance, and active asset management. The port's reliable infrastructure contributes to its strong performance and provides shipping lines with reassurance on operational consistency.

Shanghai ranked second, demonstrating that despite high throughput volumes, the port maintains reliable infrastructure through continuous

upgrades and systematic maintenance. Shenzhen secured third place, thanks to relatively modern terminal infrastructure and advanced cargo-handling systems. Ningbo-Zhoushan and Rotterdam tied for fourth place, both recognised for maintaining high standards of infrastructure quality and operational resilience.

The expert assessments reveal that customer value is multidimensional, encompassing not only connectivity and network reach but also the quality of interactions, the reliability of information, the comprehensiveness of services, and the consistency of infrastructure performance. Ports that excel across these dimensions create competitive advantages that extend beyond cost and efficiency. They build trust, foster long-term partnerships, and position themselves as indispensable nodes in global supply chains.

"Modern port competitiveness requires moving beyond transactional terminal service agreements toward transparency-based relationships where service levels are standardised across all carriers based on operational efficiency rather than cargo volume. This standardisation creates meaningful value for both shippers and consumers by ensuring level competitive playing fields that prevent market concentration and monopolistic service disadvantages."

OBJECTIVE INDICATORS' ASSESSMENT

The objective assessment of the Connectivity & Customer Value pillar draws on three quantitative indicators that measure network integration, service reach, and global connectivity: the number of top 15 global shipping line customers calling

the port by fleet size in TEU, the Liner Shipping Connectivity Index (LSCI), and the number of mainline services.

NUMBER OF CUSTOMERS AMONG TOP 15

This indicator measures how many of the world's top 15 shipping lines, ranked by fleet capacity, regularly call at a port. Serving a diverse portfolio of top-tier shipping lines reflects a port's strategic importance, operational reliability, and ability to meet the demanding requirements of the industry's largest and most influential operators. Ports that attract all top 15 carriers demonstrate comprehensive network integration and competitive positioning. This is particularly significant because the top 15 container liners collectively control around 90% of global container shipping capacity, meaning that securing their presence ensures access to the vast majority of global trade flows and reinforces the port's role in international logistics.

Singapore, Shanghai, Ningbo-Zhoushan, Qingdao, Shenzhen, Jebel Ali (Dubai), Hong Kong, Port Klang, Guangzhou, and Xiamen all share first place, serving all 15 of the world's largest shipping lines. This convergence affirms the strategic importance of Asian ports in global maritime networks, driven by the region's dominant position in manufacturing, exports, and transshipment activities. These ports function as critical hubs connecting Asia with Europe, North America, and other global markets, making them indispensable to the operational strategies of major shipping alliances.

In contrast, Busan and Kaohsiung rank 15th, serving a slightly smaller subset of top carriers, though they remain critical regional hubs. European ports, such as Rotterdam, Antwerp-Bruges, Hamburg, Los Angeles, and New York & New Jersey, rank 28th, reflecting the geographic distribution of shipping services and the fact that not all top global carriers operate extensively in European or North American markets. However, these ports maintain strong relationships with carriers prioritising their respective regions,

ensuring robust connectivity despite lower rankings on this global metric.

This indicator emphasises the centrality of Asian ports in contemporary global shipping networks. The concentration of top-tier customers in Asia reflects the region's role as the world's manufacturing heartland and the primary point of origin for containerised exports. European and North American ports, while essential gateways for their respective markets, operate in a more regionally segmented maritime environment.

LINER SHIPPING CONNECTIVITY INDEX

The Liner Shipping Connectivity Index, developed by UNCTAD, is a comprehensive measure of a port's connectivity to global shipping networks. The index considers six components: the number of shipping lines serving the port, the number of services offered, the total vessel capacity deployed, the size of the largest vessel, the number of countries connected, and the number of other ports connected. The LSCI scores in Figure 11 offer a comprehensive perspective on a port's integration into the global maritime trade network.

Shanghai leads the LSCI ranking, with 237 regular liner services connecting it to over 400 ports worldwide. Its position as the world's busiest container port, combined with its integration into major trade routes (Asia-Europe, Asia-North America, and intra-Asian services), ensures unparalleled network connectivity. Shanghai's deep-water infrastructure further reinforces its connectivity, accommodating the largest container vessels in operation.

Ningbo-Zhoushan ranks second, benefiting from its proximity to Shanghai and its role as a complementary gateway to the Yangtze River Delta. The port's rapid expansion and integration into Belt and Road trade corridors have enhanced its connectivity, making it an increasingly attractive alternative for shipping lines seeking capacity and efficiency. Singapore follows in third place, leveraging its strategic location at the crossroads of major East-West and North-South shipping

lanes. Singapore's role as a major transshipment hub ensures that it connects a vast array of feeder and mainline services, linking smaller regional ports with global shipping networks.

Busan ranks fourth, serving as Northeast Asia's primary transshipment hub and a critical link between China, Japan, Korea, and trans-Pacific routes. Qingdao ranks fifth, benefiting from its role as Northern China's leading port and its investments in automation and smart port technologies that enhance operational efficiency and attract shipping lines.

The LSCI ranking highlights the dominance of Asian ports in global connectivity, reflecting the region's centrality to international trade. European ports, while highly developed, rank lower on this global index due to their regional focus and the geographic concentration of their primary markets. Rotterdam ranks eighth, maintaining strong connectivity within Europe and serving as a critical gateway for trans-Atlantic and Asia-Europe routes. Antwerp-Bruges follows in ninth, benefiting from the recent port merger and enhanced network integration.

NUMBER OF MAINLINE SERVICES

Mainline services refer to direct, long-haul shipping routes connecting major ports across continents, typically operated by large container vessels on regular schedules. The number of mainline services a port offers directly reflects its importance in global trade and its attractiveness to shipping lines seeking efficient, high-capacity routes. Ports with more mainline services provide cargo owners with greater scheduling flexibility, more direct routing options, and reduced transshipment requirements.

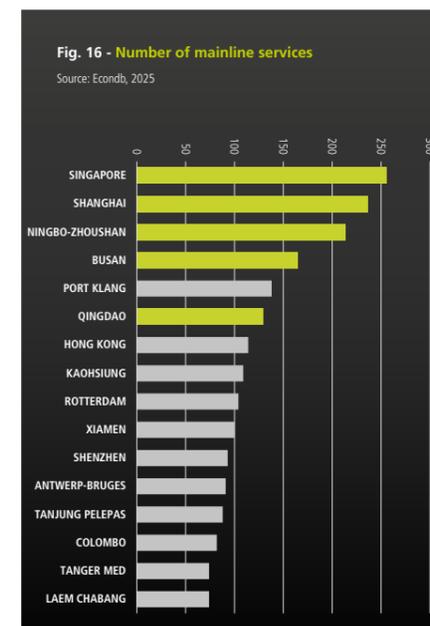
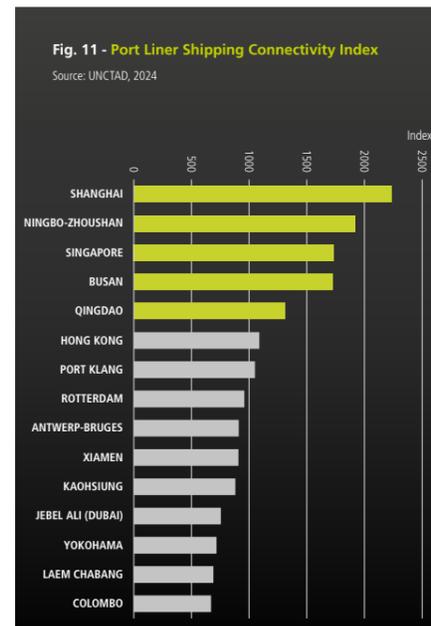
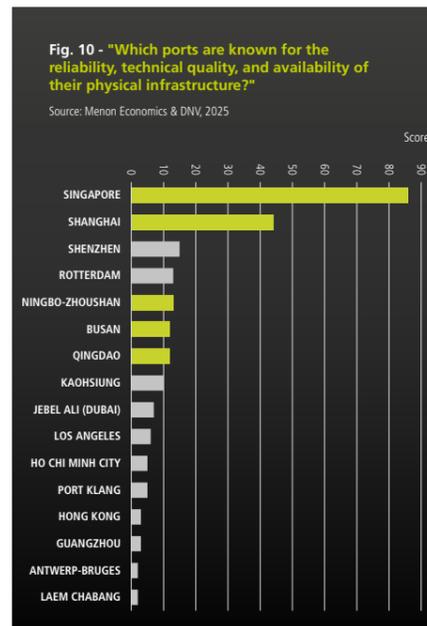
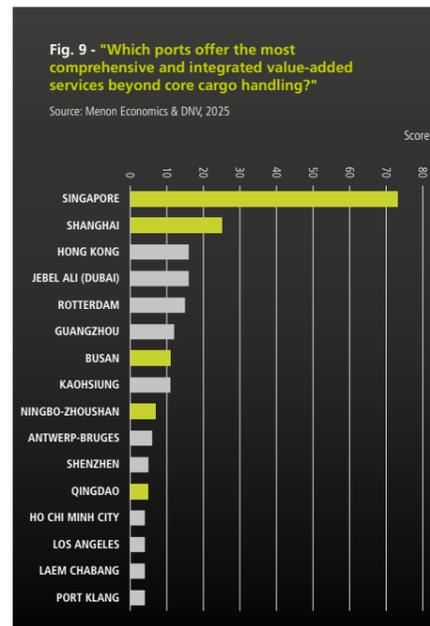
Singapore leads with the most mainline services (rank 1), offering direct connections to all major global trade regions, including Europe, North America, the Middle East, Africa, and Oceania. This extensive mainline network reinforces Singapore's position as a leading global maritime hub and transshipment centre. Shanghai ranks second (see Figure 12), with mainline services

spanning Asia-Europe, Asia-North America, and intra-Asian routes, supported by its deep-water facilities and integration with China's export economy.

Ningbo-Zhoushan follows in third place, demonstrating rapid growth in mainline service offerings as shipping lines increasingly utilise the port as a primary call on major trade routes. Busan ranks fourth, maintaining its role as a key transshipment hub with strong mainline connectivity to North America, Europe, and intra-Asian destinations. Port Klang completes the top five, benefiting from its strategic location in Southeast Asia and its role as a gateway to the Malacca Strait, one of the world's busiest maritime chokepoints.

The mainline services ranking highlights the strategic importance of hub ports, which combine geographic positioning, infrastructure capacity, and operational efficiency to attract direct long-haul services. Ports that rank highly in this indicator reduce cargo transit times, lower transshipment costs, and provide more reliable scheduling for cargo owners, which are critical factors in competitive global supply chains.

The Connectivity & Customer Value pillar assessment demonstrates that excellence in this domain requires a multifaceted approach encompassing network integration, service reach, customer engagement, and operational reliability. Ports that lead in connectivity and customer value understand that their role extends beyond physical cargo handling; they serve as critical facilitators of global trade, relationship managers for complex logistics networks, and value creators for the shipping lines and cargo owners who depend on their services. The convergence of objective network metrics and subjective customer satisfaction assessments reveals that a competitive advantage in this pillar demands continuous investment in infrastructure, technology, service quality, and stakeholder relationships.



PRODUCTIVITY

SUMMARY



"Port investment in advanced automation equipment directly enhances operational efficiency by reducing vessel port stay duration, which simultaneously improves environmental performance by decreasing emissions per vessel call—demonstrating the mutual reinforcement of productivity and sustainability objectives."

The Productivity pillar refers to a container port's capacity to handle large volumes of operations using efficient processes, technological tools, and adaptable methods for managing fluctuations in demand. It is structured around five essential dimensions: berth utilisation, berth productivity, peak volume handling, just-in-time performance, and leadership in digitalisation and automation. Collectively, these measures highlight how ports optimise infrastructure, streamline workflows, and adapt to market volatility, setting benchmarks for global maritime competitiveness.

Productivity is more complex in transshipment ports than in gateway ports. Transshipment facilities face distinct operational challenges, including the need to efficiently coordinate schedules for both large mainline vessels and smaller feeder ships. Achieving seamless container transfers between these vessel types within stringent time constraints requires meticulous planning. The high volume and variety of vessel calls, coupled with the need for optimal connectivity and reduced dwell times, require advanced digital platforms, predictive analytics, and real-time resource management. Notably, port congestion and the need to secure berths were repeatedly highlighted in expert interviews as persistent challenges for shipping companies, underscoring the operational pressures these ports face to maintain efficiency, minimise delays, and support global supply chains. Additionally, unlike gateway ports, which predominantly manage local trade flows,

transshipment hubs serve as essential links in global supply chains, where operational inefficiencies can have significant repercussions. It is important to note that Productivity measures may be affected by exogenous factors like vessel call size and global disruptions like the Red Sea crisis, beyond the control of terminal operators.

Singapore came out on top in productivity, even though it did not lead any individual objective category. It achieved the highest aggregated score for objective measures and also excelled in both subjective assessments. Key contributors included AI-powered berth scheduling and autonomous yard cranes, significantly reducing turnaround times. Its integration of predictive analytics and scalable digital platforms ensures smooth cargo flow even during peak periods, reinforcing its status as a leading transshipment hub.

Ningbo-Zhoushan claimed second place, driven by its ability to handle peak volumes and advanced automation. The port introduced AI-based container management systems and expanded its smart terminal infrastructure, improving surge capacity and operational reliability.

Shanghai ranked third, excelling in both subjective indicators, following Singapore. The deployment of 5G-enabled terminals and AI-driven container tracking systems has enhanced its ability to manage large-scale operations with precision. Qingdao, in fourth position, stood out, ranking in the top 8 across all indicators, particularly strong in peak volume



PRODUCTIVITY

| | Berth utilisation | Berth productivity | Peak volume | Q: Just in time effectiveness | Q: Leading in digitalisation and automation processes |
|-------------------|-------------------|--------------------|-------------|-------------------------------|---|
| SINGAPORE | 10 | 15 | 3 | 1 | 1 |
| NINGBO-ZHOUSHAN | 1 | 36 | 1 | 4 | 5 |
| SHANGHAI | 12 | 7 | 2 | 2 | 2 |
| QINGDAO | 5 | 6 | 4 | 7 | 8 |
| BUSAN | 13 | 22 | 7 | 5 | 5 |
| ROTTERDAM | 30 | 42 | 5 | 9 | 3 |
| JEBEL ALI (DUBAI) | 20 | 29 | 6 | 12 | 10 |
| COLON-CRISTOBAL | 2 | 47 | 30 | - | - |
| MUNDRA | 4 | 17 | 19 | - | - |
| KAOHSIUNG | 28 | 31 | 8 | 8 | 14 |
| AMBARLI | 3 | 46 | 35 | - | - |
| KOBE | 50 | 1 | 46 | 13 | 14 |
| LAEM CHABANG | 11 | 25 | 32 | 9 | 16 |
| TANJUNG PELEPAS | 16 | 8 | 24 | 14 | 12 |
| COLOMBO | 8 | 25 | 22 | - | - |

and berth productivity. Busan completed the top five, recognised for its automation leadership and strong digital infrastructure. The rollout of blockchain-based documentation and AI-assisted crane operations enhanced transparency and speed, reinforcing Busan's role as a key hub in Northeast Asia.

It is worth noting that the leaders in berth utilisation and berth productivity differ significantly from the overall top five ports. Ningbo-Zhoushan leads in berth utilisation with an exceptionally high occupancy rate, reflecting intense operational activity and infrastructure pressure. In contrast, ports such as Kobe and Shenzhen dominate berth productivity rankings, achieving rapid container moves per metre of berth length, but did not make it to the top 5. It was also evident that high berth utilisation does not always equate to superior productivity; some ports prioritise efficiency during active berthing rather than maximising berth occupancy. In contrast, global leaders like Singapore and Shanghai rely on advanced automation and holistic operational models to handle a sudden surge in demand and maintain balanced performance across all dimensions.

The Productivity pillar assessment, therefore, shows that success depends on more than physical capacity. Market leaders invest strategically in technology, process optimisation, and scalable operational models. Ports that excel in this pillar combine efficiency, resilience, and innovation, ensuring long-term growth and strong partnerships with global shipping lines.



EXPERT ASSESSMENT

As a part of the subjective assessment, industry experts from the world's top 20 shipping companies evaluated ports across two indicators within the Productivity pillar: just-in-time effectiveness and leadership in digitalisation and automation. These assessments represent the operational realities and strategic perspectives of maritime professionals who engage with these ports daily.

JUST-IN-TIME EFFECTIVENESS

Just-in-time effectiveness denotes the strategic coordination of vessel arrivals and cargo movements at ports to minimise waiting times and enhance supply chain efficiency. Achieving this requires precise scheduling, real-time communication, and flexible operations to accommodate changes as they arise. Port congestion and prolonged wait times continue to be persistent challenges for many facilities. Maintaining consistent schedules and allocating berths promptly can significantly reduce congestion and waiting times, thereby improving operational efficiency. Furthermore, experts advocate for the adoption of advanced digital planning tools at ports, which facilitate real-time berth management through either liner company platforms or neutral third-party systems. These technologies target congestion and transactional complexity by enabling seamless digital coordination, optimising berth allocation, and minimising vessel idle periods.

As shown in Figure 13, Singapore was ranked first by experts due to PSA's investments in advanced digital platforms, such as the Opt-E product suite, and PORTNET, which enable seamless coordination.

Shanghai secured second place by leveraging smart port technologies and integrated systems. The port's use of AI-driven terminal operating systems and 5G-enabled communication networks enables accurate scheduling and rapid response to disruptions. Shenzhen, although not in the top 15, is ranked third by industry experts

for its digitalisation capabilities. The port's investments in advanced automation, real-time data sharing, and integrated digital platforms enable efficient coordination and reliable operations, positioning Shenzhen as a leader in technology-driven port productivity.

LEADERSHIP IN DIGITALISATION AND AUTOMATION

Leadership in digitalisation and automation evaluates the extent to which ports employ advanced technologies and automated systems to enhance operational efficiency and support informed decision-making. Successful digitalisation requires unified systems that connect customs authorities, terminal operators, regulators, and supply chain stakeholders, thereby enhancing transparency and reducing inefficiencies. Industry experts emphasise that reliance on isolated digital solutions contributes to fragmentation. Furthermore, they recognise that focusing on quay-side optimisation can further facilitate cargo movement and increase overall efficiency. Therefore, ports demonstrating excellence in this area prioritise investment in AI-driven berth planning, automated cargo handling, and cohesive digital platforms.

Experts ranked Singapore as leading in this area (Figure 14), setting global standards with its Next Generation Port 2030 initiative, which features fully automated container handling and predictive analytics for resource allocation. Singapore's automated cranes and AI-driven scheduling systems enable efficient, high-volume processing and rapid adaptation to changing demands.

Shanghai ranks second, with continuous upgrades to terminal operating systems and the deployment of smart equipment, including 5G-enabled control systems and automated guided vehicles. These innovations improve productivity and reliability, enabling seamless cargo movement and rapid operational responses.

Rotterdam is third, recognised for its highly automated terminals and commitment to digital

transformation. The port's use of remote-controlled equipment and advanced data platforms supports efficient cargo handling and real-time monitoring, boosting throughput and operational resilience.

These examples show that true leadership in digitalisation and automation means integrating technology with operational processes to drive efficiency, reliability, and long-term competitiveness.

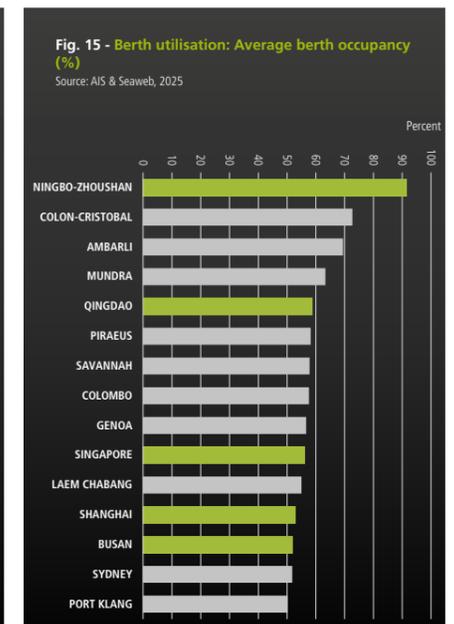
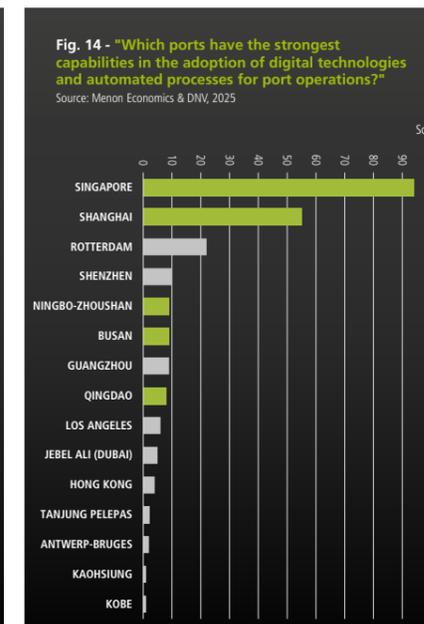
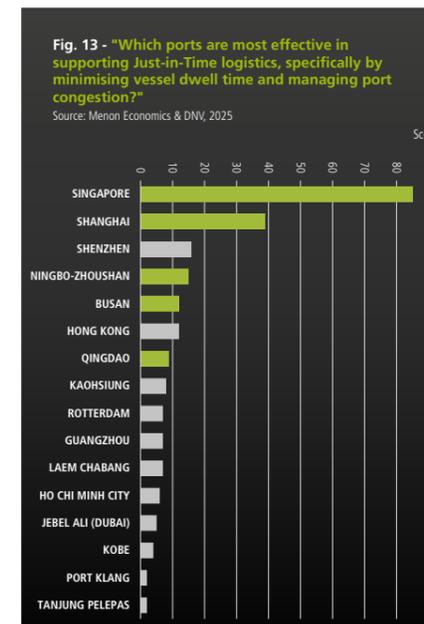
In short, these expert assessments reveal that productivity is multidimensional, encompassing not only efficiency but also the ability to innovate and optimise operations. Ports that excel across these dimensions create competitive advantages and position themselves as indispensable nodes in global supply chains.

OBJECTIVE INDICATORS' ASSESSMENT

The objective assessment of the Productivity pillar relies on three quantitative indicators: berth utilisation, berth productivity, and peak volume. These metrics collectively assess the efficiency with which a port utilises its infrastructure, sustains high cargo-handling rates, and accommodates surges in vessel traffic, thus providing a comprehensive overview of overall productivity. Together, these indicators equip stakeholders with valuable insights into a port's operational performance, growth potential, and competitive standing within the global maritime supply chain.

BERTH UTILISATION

In Figure 15, ports are ranked by average berth utilisation (%). Berth utilisation reflects how effectively ports deploy their available berths, directly influencing vessel turnaround times, congestion risks, and overall efficiency. Higher berth utilisation means that a port is making more effective use of its infrastructure by keeping its berths occupied more often. When berth utilisation is high, it indicates that the port is consistently busy, with vessels frequently docking and minimal berth



idle time. This efficient usage demonstrates that the port is maximising the capacity of its existing facilities. Analysing berth utilisation helps port operators and stakeholders pinpoint where operational improvements or further investments may be needed to maintain or boost performance, ensuring the port remains competitive and reliable in handling growing trade volumes.

On this indicator, Ningbo-Zhoushan stands out at the top, achieving an impressive berth occupancy rate of 92%. This high utilisation highlights its status as one of the world's foremost container gateways, reflecting robust trade flows and consistent activity from ultra-large container vessels. The port's advanced automation and deep-water facilities enable it to handle significant volumes efficiently, illustrating its capacity to meet global shipping demands.

Colon-Cristobal ranks second, with a berth occupancy rate of 87%, largely due to its strategic location within the Panama Canal corridor. This high occupancy is further supported by the port's substantial market share, which places it in ninth place overall, despite its comparatively short berth length, ranking only 38th. Its robust transshipment volumes and critical function in international maritime routes underscore its vital role in facilitating global supply chain connectivity. Ambarli ranks third with an 85% berth occupancy rate, underscoring its significance as Turkey's premier container facility. Like Colon-Cristobal, the port effectively accommodates more vessel calls within the available berth length.

Mundra records a berth occupancy rate of 72%, striking a balance between strong growth in Indian container traffic and ongoing investments in berth capacity and automation. This utilisation supports reliable turnaround times while accommodating future demand. Qingdao stands at 58.61%, benefiting from smart port initiatives and robust export activity. Its balanced utilisation reflects efficient scheduling and advanced digitalisation, enabling resilience under heavy trade flows.

Among the leading container ports, Singapore ranks 10th with a berth occupancy rate of 56.28%, while Shanghai ranks 12th at 52.94% and Busan ranks 13th at 52.94%. Except for Ningbo-Zhoushan, the relatively moderate berth utilisation observed at these major hubs stems from the extraordinary scale of container volumes they manage and the intricate nature of their transshipment operations. Handling such high throughput and complex transshipment flows necessitates meticulous scheduling and often results in more dynamic berth allocation, which can reduce average utilisation rates compared to ports with simpler operational profiles.

Furthermore, the predominance of larger vessels at these ports means ships require more time for berthing and manoeuvring, further influencing their overall berth utilisation figures. An additional consideration is the provision of bunkering services at ports such as Singapore and Shanghai. While most bunkering for container vessels is conducted simultaneously with cargo handling (a process known as SIMOPS), the overlap of these operations can extend the time vessels spend at berth, thereby impacting berth utilisation metrics.

Collectively, these factors illustrate that achieving high productivity and operational excellence is not merely about maximising berth occupancy. It also requires expertly managing complex logistics, accommodating larger vessels, and efficiently orchestrating transshipment activities through advanced technology and skilled coordination.

BERTH PRODUCTIVITY

In Figure 16, ports are ranked by average berth productivity, measured as the number of container moves per metre of berth length per hour, a direct indicator of operational efficiency and cargo-handling performance. Berth productivity reflects how effectively ports move containers relative to their available berth infrastructure, directly influencing vessel turnaround times, port throughput,

and overall competitiveness. Higher berth productivity means a port can handle more cargo in less time, signalling advanced operational practices, modern equipment, and a skilled workforce. This can result in shorter vessel stays, reduced congestion, and greater capacity to accommodate growing trade volumes. Conversely, ports with lower berth productivity may experience slower cargo flows, longer vessel turnaround times, and an increased risk of bottlenecks. For this particular measure, normalisation of results by vessel size and call size is not performed due to a lack of data; however, it may have an impact on average berth productivity.

The top five ports for berth productivity, in order, are Kobe, Qinzhou (Beibu Gulf), Shenzhen, Tianjin, and Guangzhou. Kobe stands out by leading in berth productivity despite ranking last (50th) in berth utilisation. Shenzhen and Tianjin show a similar pattern, achieving high productivity while maintaining very low utilisation, ranking 49th and 42nd, respectively. Guangzhou and Qinzhou also combine strong productivity with moderate or low berth occupancy.

In contrast, Singapore, Shanghai, Rotterdam, and Busan consistently rank among the world's top container ports overall, despite not leading in berth productivity. Singapore is 15th for this metric, Shanghai 7th, Busan 22nd, and Rotterdam 42nd.

Singapore's relatively lower berth productivity ranking is directly attributable to its role as the leading transshipment hub, with transshipment volumes accounting for more than three-quarters of total throughput. This creates exceptional operational complexity through the simultaneous management of "many-to-one" and "one-to-many" cargo consolidation and distribution patterns. In a "many-to-one" scenario, containers originating from multiple regional feeder ports are consolidated onto large mainline vessels for long-haul international routes; conversely, in "one-to-many" operations, containers from a single large mainline vessel are distributed to numerous

regional and local feeder vessels serving different destinations.

As noted by Lam (2016) in "Strategy of a Transshipment Hub: The Case of Port of Singapore," published in *Dynamic Shipping and Port Development in the Globalised Economy*, Singapore operates under a hub-and-spoke network model where mainline vessels carrying large cargo volumes must be coordinated with numerous feeder vessels that distribute containers across the region. This coordination challenge is further compounded by Singapore's open-port policy of accommodating all major shipping lines without restriction, resulting in highly variable vessel arrival patterns and frequent scheduling adjustments. Unlike gateway ports where containers move in a relatively linear flow from vessel to hinterland, transshipment ports must orchestrate the transfer of containers between ultra-large container ships and multiple smaller feeder vessels, each with different schedules, turnaround requirements, and operational windows.

The port handles over hundreds of vessel calls weekly from lines serving multiple ports and geographies, creating complex berth allocation dynamics that prioritize connectivity and service reliability over pure productivity metrics. This strategic trade-off of accepting lower berth productivity to maintain unparalleled global connectivity is fundamental to Singapore's competitive advantage as a transshipment hub and explains why productivity metrics alone do not capture the full operational excellence of major international hubs.

Unlike major international hubs such as Shanghai or Singapore, Kobe and Qinzhou experience fewer traffic surges and peak-volume events. Their stable, predictable throughput enables more efficient planning and avoids the complexities of managing sudden influxes of large container ships.

ABILITY TO HANDLE PEAK VOLUME

In Figure 17, ports are ranked by their ability to handle a sudden surge in vessel calls, especially larger ships, within a single week. This indicator reflects a port's capacity to respond quickly to spikes in vessel arrivals, testing operational resilience and flexibility. Ports with high peak volumes show robust infrastructure and the ability to scale up operations and mobilise resources efficiently when demand increases.

Ningbo-Zhoushan ranks first in peak volume, showing strong readiness to manage sudden increases in vessel traffic. The port's rapid-response workforce pool and pre-arranged equipment deployment plans enable a 20 per cent surge in handling capacity within 48 hours. Advanced automation and digital systems enable real-time berth allocation and dynamic scheduling, allowing the port to quickly adapt to changing arrival patterns. Expansive terminal layouts and deep-water berths enable the simultaneous processing of multiple ultra-large container ships, minimising delays even during peak periods.

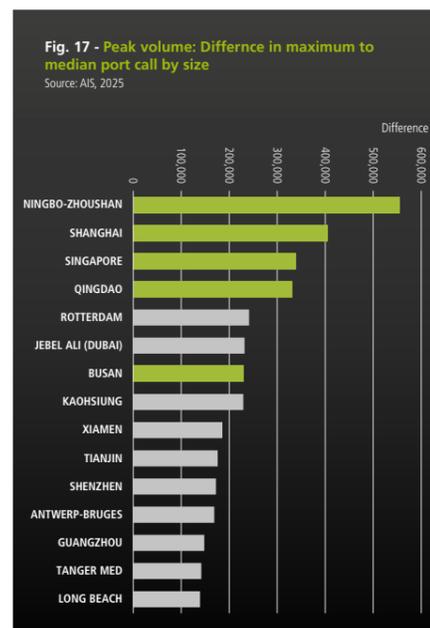
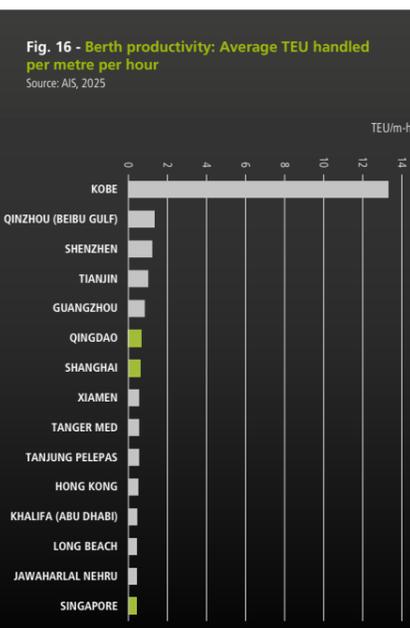
Shanghai is second in terms of peak volume, reflecting its robust infrastructure and ability to respond quickly to spikes in vessel arrivals. The

Yangshan Deep-Water Port handles several ultra-large container vessels simultaneously without significant congestion. Integrated logistics platforms and real-time data sharing facilitate the coordination of activities across terminal operations, trucking, and rail connections, thereby reducing bottlenecks. Shanghai's blockchain-based cargo-tracking system also enhances transparency and trust across the supply chain.

Singapore ranks third in peak volume. Integrated logistics platforms and real-time data sharing ensure smooth coordination across terminal and trucking operations. Furthermore, the Next Generation Port 2030 initiative utilises AI-driven berth planning and predictive analytics to optimise vessel scheduling in real-time. Deep-water berths and scalable terminal layouts enable Singapore to handle multiple ultra-large container ships simultaneously.

Qingdao, ranked fourth for peak volume, efficiently manages sudden surges in vessel traffic through the use of automation, advanced infrastructure, and integrated logistics. Rotterdam, in fifth place, stands out for its highly automated terminal operations, deep-water berths, and real-time coordination across transport modes, enabling the port to maintain smooth cargo flow and reliable performance during periods of peak demand.

Clearly, the Productivity pillar assessment shows that excellence is multidimensional, requiring a balance of operational efficiency, surge-handling capacity, digital innovation, and infrastructure scalability. While some ports lead in berth productivity and utilisation, others excel in managing peak volumes and accommodating ultra-large container ships, capabilities that are critical for resilience and global connectivity. Lower scores in berth productivity or utilisation do not indicate poor performance; rather, these ports demonstrate strength in handling complex transshipment flows and sudden demand spikes, which is reflected in their high overall rankings. Together, they highlight that competitive advantage depends on continuous investment in technology, process optimisation, and workforce agility. Ports that integrate these elements achieve efficiency and adaptability, positioning themselves as indispensable hubs in global supply chains.



"Common digital platforms that enable faster cargo turnaround through operational optimization directly reduce emissions, demonstrating how port operational efficiency and sustainability performance are inherently aligned rather than competing objectives."

SUSTAINABILITY

SUMMARY



"Ports with mature infrastructure providing on-shore power supply and scalable access to alternative fuels at competitive pricing, ideally powered by renewable energy sources such as wind, solar, or nuclear energy, will increasingly become preferred choices for environmentally-conscious liner operators pursuing end-to-end emissions reduction."

The Sustainability pillar reflects a port's capacity to minimise its environmental impact while supporting global trade. Although experts may regard this pillar as less critical than others, sustainability has garnered considerable attention due to rigorous international regulations for shipping, such as those from the IMO and FuelEU Maritime, which mandate reductions in greenhouse gas emissions. Ports are key enablers of maritime decarbonisation implementing environmentally friendly technologies, using alternative fuels such as bio/e-MGO, bio/e-LNG, bio/e-methanol, and blue/e-ammonia and adopting operational methods to reduce carbon emissions. Hydrogen, however, is not considered a viable solution for global deep-sea shipping but may find application in niche coastal operations. For example, onshore power supply at ports will allow vessels to shut down engines while berthed, significantly reducing emissions and improving air quality for surrounding communities. Similarly, the availability of alternative fuels enables vessels to move away from fossil fuels, accelerating the shift to cleaner operations. Ports that invest in these areas not only reduce emissions but also position themselves as leaders in the transition to zero-emission shipping, securing long-term resilience and market relevance.

Measuring sustainability involves a comprehensive set of indicators that capture both infrastructure readiness and operational performance. Eight key dimensions were

used to define this pillar: emissions per TEU, emissions per port call, availability of alternative fuels, onshore power supply, green vessel calls, green corridor initiatives, leadership in environmental processes, and multi-fuel bunkering. These metrics provide a clear picture of how effectively a port is moving toward a low-carbon ecosystem. Together, they set benchmarks for ports striving to meet global sustainability goals and comply with evolving environmental standards.

Singapore maintained its leadership in the Sustainability pillar, ranking first overall due to its strength in the supply of alternative fuels and green corridor initiatives. This position is reinforced by industry experts, who rated Singapore highest for sustainable environmental processes and multi-fuel bunkering capabilities. The Maritime and Port Authority of Singapore (MPA) has launched pilot trials for biofuels and methanol, set ambitious targets such as harbour craft electrification by 2030, and introduced LNG bunkering services as early as 2017. These efforts, combined with six announced green shipping corridors and significant alternative fuel capacity, aim to retain Singapore's reputation as the leading bunkering hub.

Shanghai claimed second place, driven by its robust onshore power infrastructure and extensive green corridor initiatives, which significantly reduce emissions at the port. Experts also recognised Shanghai for its leadership in multi-fuel bunkering, supported



SUSTAINABILITY

| | Emissions per TEU | Emissions per port call | Availability of alternative fuels | Onshore power supply | Number of green vessel calls | Number of green corridor initiatives | Q: Leading in sustainable environmental processes | Q: Leading multi-fuel bunkering port |
|-----------------|-------------------|-------------------------|-----------------------------------|----------------------|------------------------------|--------------------------------------|---|--------------------------------------|
| SINGAPORE | 17 | 33 | 2 | 12 | 4 | 1 | 1 | 1 |
| SHANGHAI | 6 | 15 | 3 | 12 | 1 | 6 | 3 | 2 |
| ROTTERDAM | 50 | 13 | 1 | 10 | 2 | 3 | 4 | 3 |
| LOS ANGELES | 32 | 50 | 10 | 1 | 37 | 2 | 2 | 10 |
| HAMBURG | 44 | 22 | 10 | 2 | 7 | 6 | - | - |
| SHENZHEN | 1 | 6 | 5 | 5 | 11 | 14 | 7 | 5 |
| BUSAN | 21 | 19 | 7 | 12 | 6 | 6 | 8 | 6 |
| NINGBO-ZHOUSHAN | 35 | 39 | 10 | 12 | 3 | 14 | 5 | 4 |
| LONG BEACH | 20 | 49 | 10 | 4 | 10 | 3 | - | - |
| ANTWERP-BRUGES | 29 | 38 | 10 | 11 | 5 | 6 | 6 | 11 |
| YOKOHAMA | 30 | 3 | 9 | 12 | 26 | 3 | 15 | 14 |
| GUANGZHOU | 5 | 18 | 10 | 9 | 16 | 6 | 10 | 12 |
| QINGDAO | 7 | 28 | 10 | 12 | 8 | 14 | 9 | 8 |
| SYDNEY | 3 | 5 | 10 | 12 | 48 | 14 | - | - |
| TOKYO | 13 | 1 | 10 | 12 | 23 | 14 | - | - |

by a large-scale LNG network and methanol bunkering pilots. Shanghai's commitment to electrification and clean energy adoption positions it as a key player in Asia's green shipping network, complemented by its high number of alternative-fuel-capable vessel calls.

Rotterdam ranked third, recognised for its pioneering role in multi-fuel bunkering capabilities. Industry evaluations highlight Rotterdam's leadership in the availability of alternative fuels, including LNG, methanol and bio-LNG, and its ongoing investments in hydrogen infrastructure. Rotterdam excels in its strong energy transition strategies and collaboration with shipping lines, reinforcing its reputation as Europe's sustainability leader.

Los Angeles secured fourth place largely due to its extensive shore power infrastructure, the highest globally at 40 MW. Experts ranked Los Angeles second for sustainable environmental processes. However, its high emissions per port call reflect the challenges of legacy infrastructure and dense traffic volumes. Regulatory frameworks and partnerships continue to drive its progress toward zero-emission shipping.

Hamburg completed the top five, distinguished by its strong alternative fuel infrastructure and commitment to green corridor development. Hamburg ranks among the leaders in Europe for shore power capacity and is actively investing in bunkering solutions for LNG and emerging fuels. While emissions intensity remains higher than some

peers, Hamburg's strategic investments signal its long-term sustainability ambitions.

It is worth noting that indicator-specific leaders differ significantly from the overall top five. For example, Shenzhen achieved the lowest emissions per TEU globally, and Tokyo led in green vessel calls, yet neither ranked among the top five overall. This contrast accentuates that leadership in sustainability requires a holistic approach that balances emissions reduction with infrastructure readiness and collaborative initiatives. Ports that lead in this pillar not only reduce their carbon footprint but also strengthen their role as trusted partners in global trade, ensuring long-term competitiveness in an era of environmental accountability.

EXPERT ASSESSMENT

As part of the subjective assessment, industry experts from the world's top 20 shipping companies evaluated ports across two indicators within the Sustainability pillar: leading in sustainable environmental processes and leading as a multi-fuel bunkering port. These evaluations capture how ports are advancing decarbonisation, implementing eco-friendly operational practices, and enabling alternative fuel options to support the global transition toward greener maritime logistics.

LEADING IN SUSTAINABLE ENVIRONMENTAL PROCESSES

This indicator assesses how ports implement environmentally sustainable technologies and practices, including shore power, energy-efficient terminals and emissions-reduction measures. Ports that excel in this area demonstrate a commitment to decarbonisation and long-term ecological responsibility through innovative infrastructure and operational strategies.

As shown in Figure 18, Singapore was ranked first by industry experts. This perception is supported by its higher number of green vessel calls, reflecting readiness to accommodate cleaner fleets. The Maritime and Port Authority of Singapore (MPA) has launched multiple pilot trials for alternative fuels, including biofuels and methanol, and set ambitious targets, such as electrifying harbour craft by 2030. These initiatives are aimed at positioning Singapore as a leader in Sustainable environmental practices.

Los Angeles secured second place, largely due to its extensive shore power infrastructure, which allows vessels to plug into the electrical grid during port calls. This capability is also reflected in the shore power indicator, where Los Angeles ranks first. The port's Clean Air Action Plan further reinforces its commitment to zero-emission cargo handling equipment and aggressive emissions-reduction programs.

Shanghai and Rotterdam follow closely.

Rotterdam's strong performance is backed by its leadership in alternative fuel availability, including LNG and bio-LNG, which aligns with expert perceptions of its sustainability leadership. The port also invests in the integration of renewable energy, supporting Europe's green shipping ambitions. Additionally, Rotterdam has an upcoming plan to establish a 'zero emission' shipping zone within a two nautical mile radius of the port, promoting the use of zero-emission fuels and battery-powered operations to further reduce local emissions.

Completing the top five is Ningbo-Zhoushan, which has made significant strides in calling vessels capable of using alternative fuels and green corridor initiatives. The port's efforts to expand alternative fuel infrastructure and improve emissions performance reflect China's broader push toward sustainable maritime operations.

LEADING MULTI-FUEL BUNKERING PORT

This indicator measures a port's ability to offer diverse fuel options, such as LNG, biofuels, methanol, and emerging low-carbon alternatives, supporting the maritime industry's transition to cleaner propulsion systems. Ports that excel in this area enable shipping lines to adopt flexible fuel strategies and comply with tightening global emissions regulations.

As shown in Figure 19, Singapore, being the leading bunkering hub, ranks first by a significant margin. Its leadership is backed by LNG bunkering services introduced in 2017, making it one of the earliest adopters globally. The Maritime and Port Authority of Singapore (MPA) has conducted biofuel and methanol bunkering trials and is actively preparing infrastructure for ammonia and hydrogen bunkering under the Green Energy Programme. Singapore also launched the Maritime Decarbonisation Blueprint 2050, which sets clear targets for the adoption of alternative fuels.

Rotterdam ranks third and is widely recognised as Europe's alternative fuel hub. It offers bio-LNG

bunkering, has completed methanol bunkering trials, and is investing in hydrogen supply chain infrastructure through projects like HyTransPort. Rotterdam also hosts the Port of Rotterdam Energy Transition Hub, which coordinates renewable energy and fuel innovation.

Completing the top five are Ningbo-Zhoushan and Shenzhen. Ningbo-Zhoushan has expanded its LNG bunkering capacity and is working on synthetic fuel pilot programs as part of China's national decarbonisation strategy. Shenzhen is advancing methanol bunkering trials and exploring green ammonia supply chains, supported by partnerships with major shipping companies.

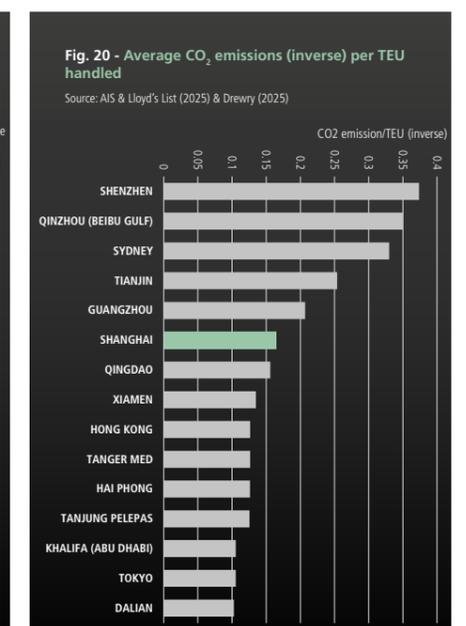
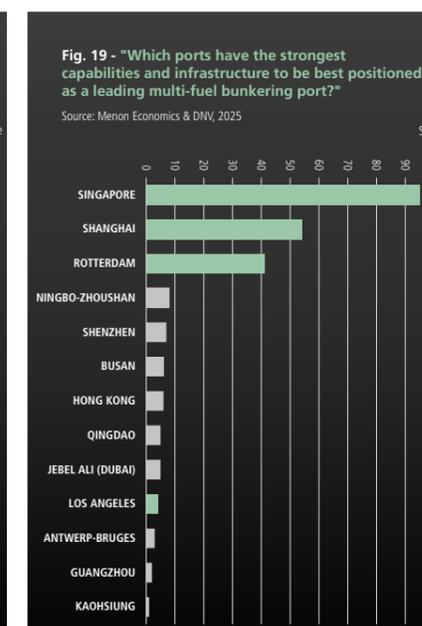
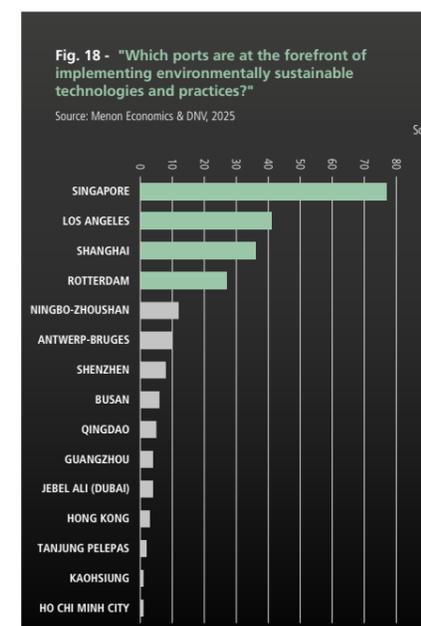
OBJECTIVE INDICATORS' ASSESSMENT

The objective assessment of the Sustainability pillar draws on six quantitative indicators that measure environmental performance and green readiness: emissions per TEU, emissions per port call, availability of alternative fuels, onshore power supply, number of green vessel calls, and number of green corridor initiatives. These metrics capture how ports are reducing carbon intensity, enabling cleaner vessel operations, and investing in future-ready infrastructure.

EMISSIONS PER TEU HANDLED

In Figure 20, ports are ranked by their ships average emissions per TEU, a direct measure of environmental efficiency and carbon intensity in container handling. Ships Emissions per TEU reflect how effectively ports minimise greenhouse gas output relative to their throughput, directly impacting their sustainability profile and alignment with global decarbonisation goals. Lower ships emissions per TEU indicate advanced operational practices, adoption of cleaner fuels, and investments in green technologies.

The top five ports for ships emissions per TEU are Shenzhen, Qinzhou (Beibu Gulf), Sydney, Tianjin, and Guangzhou. Notably, this ranking closely mirrors the order of berth productivity,



except for Sydney (Port Botany). Shenzhen is in the top 5 in both emissions per TEU and berth productivity, demonstrating that operational excellence and environmental performance can go hand in hand. Qinzhou (Beibu Gulf), Tianjin, and Guangzhou also feature prominently in both rankings, suggesting that ports that can move containers efficiently relative to their berth infrastructure are often those that achieve lower ships emissions per unit handled.

Sydney stands out as an exception, while it ranks third in ships emissions per TEU, its berth productivity does not match that of the very top performers. This divergence may reflect local operational practices, vessel mix, or investments in emissions-reducing technologies.

Leading international ports, such as Singapore, do not rank among the highest in ships emissions per TEU. This is partly due to the current absence of an onshore power supply at these locations, and also the high number of small feeder ships that the port serves. Notably, Rotterdam, which ranks first in terms of alternative fuel availability, is positioned at 50th for emissions efficiency per TEU. Furthermore, Rotterdam is currently ranked 10th for onshore power supply, a modest standing given the scale and complexity of its operations. The significant scale and diverse vessel mix at these major ports, characterised by frequent calls from both ultra-large container ships and feeder vessels, pose distinct challenges in balancing operational efficiency with environmental performance. More than the mere availability of OPS infrastructure, the key determinant is the readiness of vessels calling at these ports to connect to such systems, which depends on whether shipowners have invested in compatible equipment and whether it is economically viable given the high cost of electricity.

Overall, the close alignment between ships emissions per TEU and berth productivity among the leading ports highlights the potential for integrated strategies that advance both efficiency and sustainability. Ports that invest in modern

equipment, skilled workforces, and green infrastructure are well-positioned to deliver superior performance on both fronts, setting benchmarks for the industry as it transitions toward a low-carbon future.

"While alternative bunkering infrastructure may not be universally feasible across all ports, operational decarbonization measures remain available across virtually all port facilities. Ports pursuing credible Scope 3 emissions reductions through operational improvements will increasingly attract environmentally-committed liner operators."

EMISSIONS PER PORT CALL

Figure 21 presents ports ranked by average ship emissions per port call. This metric complements ships emissions per TEU, providing additional insight into the environmental performance and carbon intensity of each vessel visit. Ships Emissions per port call capture how efficiently ports manage ship operations, berthing, cargo handling, and auxiliary services, relative to their environmental impact. Lower emissions per port call suggest effective port management, adoption of cleaner fuels, and investments in green infrastructure, all of which are increasingly critical as the maritime industry faces stricter decarbonisation targets.

The top five ports for ships emissions per port call are Tokyo, Kobe, Yokohama, Nagoya, and Sydney. These ports share several operational characteristics that help explain their strong performance in this metric. Notably, none of these ports currently provides shore power for vessels, and none handle ULCV calls, which are typically

associated with higher emissions due to the size and energy requirements of ultra-large container ships. The absence of ULCVs means these ports primarily serve smaller ships, which generally produce fewer emissions during each port visit. Additionally, except for Tokyo, these ports see fewer vessel calls than the world's largest hubs, resulting in less congestion and more predictable, efficient operations. Their overall cargo volumes are also lower, which means vessels tend to spend less time at berth, further minimising emissions associated with idling and cargo handling.

When compared to other sustainability indicators, such as ships emissions per TEU, a nuanced picture emerges. While these ports excel at minimising emissions per vessel visit, their lower cargo volumes and absence of ULCVs mean their emissions per port call may not be as competitive as those of high-throughput ports like Shanghai or Singapore.

AVAILABILITY OF ALTERNATIVE FUELS

The capacity of bunker vessels to offer alternative fuels is a direct measure of a port's ability to support the maritime energy transition at scale, reflecting both infrastructure investment and a strategic commitment to decarbonisation. Ports with higher alternative fuel bunker capacity are better equipped to meet the growing demand for low-carbon shipping, enabling vessels to refuel in significant volumes with FAME, HVO, biofuels, and methanol, with ammonia on the horizon. This indicator highlights not only the presence of alternative fuels but also the scale at which ports can supply them.

As shown in Figure 22, Rotterdam ranks first in alternative fuel bunker capacity (measured as the total tank volume capacity of all alternate fuel bunker vessels operating in the port, from DNV's Alternative Fuel Insight), with 70,949 cubic meters (cbm) available, emphasizing its leadership and its readiness to serve next-generation, low-emission vessels. Singapore follows with 46,200 cbm, leveraging its position as the busiest

transshipment hub and its ongoing investments in clean fuel infrastructure. Shanghai is third, with 36,000 cbm, reflecting China's strategic push to modernise its port sector and support sustainable growth along key Asia-Europe and trans-Pacific routes.

Vancouver (22,800 cbm) and Shenzhen (8,500 cbm) complete the top five, each making significant strides in expanding their alternative fuel offerings and positioning themselves as regional leaders in North America and East Asia. Genoa, Busan, Barcelona, and Yokohama also provide alternative fuel bunker capacity, though at a smaller scale, rounding out the group of nine ports globally that currently offer this capability.

The ranking reveals a clear divide: major European and Asian hubs dominate alternative fuel infrastructure, driven by regulatory pressures, market demand, and proactive investment. In contrast, most ports worldwide, including several that perform well on other sustainability indicators, do not yet supply alternative fuels at scale, highlighting the uneven pace of the maritime energy transition. As decarbonisation accelerates, ports with robust alternative fuel bunker capacity will be increasingly sought after by shipping lines aiming to meet environmental targets and future-proof their operations.

ONSHORE POWER SUPPLY

The installed shore power capacity (measured in megawatts, MW) is a key indicator of a port's ability to provide vessels with clean electricity while at berth, reducing emissions from auxiliary engines and supporting the decarbonisation of port operations. Ports with higher shore power capacity can play a leading role in meeting regulatory requirements for air quality and greenhouse gas reduction. This infrastructure investment is increasingly critical as environmental standards tighten, and shipping lines seek greener port calls.

As in Figure 23, Los Angeles ranks first in installed shore power capacity, with 40 MW available for vessel connection. This substantial

investment reflects the port's leadership in North American sustainability initiatives and its commitment to reducing emissions from one of the world's busiest container gateways. Hamburg follows with 30 MW, positioning itself as a European leader in shore power provision and supporting a wide range of vessel types. New York & New Jersey are third, with 20 MW, further demonstrating North America's proactive approach to clean port operations.

Long Beach (16 MW), Oakland (8 MW), Barcelona (8 MW), Shenzhen (6.4 MW), Vancouver (6 MW), Guangzhou (2.4 MW), Rotterdam (2.24 MW), and Antwerp-Bruges (0.64 MW) complete the group of ports currently offering shore power at scale. These ports have made significant investments to enable vessel electrification, reduce local air pollution, and support the transition to zero-emission shipping.

The ranking reveals a clear divide: major North American and European ports lead in shore power capacity, driven by regulatory pressures, public health concerns, and ambitious climate targets. Asian ports, while making progress, generally offer lower installed capacity, with Shenzhen and Guangzhou among the few exceptions. As decarbonisation accelerates, ports with robust shore power infrastructure will be increasingly attractive to shipping lines operating next-generation, low-emission vessels and seeking to comply with evolving environmental standards.

NUMBER OF GREEN VESSEL CALLS

The number of vessel calls by ships that can use alternative fuels as their primary energy source serves as an indicator of a port's involvement in the maritime energy transition and its capacity to support low-emission shipping. Shanghai has the highest number of alternative-fuel-capable vessel calls globally and is third for alternative fuel availability, indicating a close relationship between vessel traffic and refuelling infrastructure. Rotterdam ranks first in alternative fuel availability and second in vessel calls, reflecting its

active support for alternative-fuel shipping.

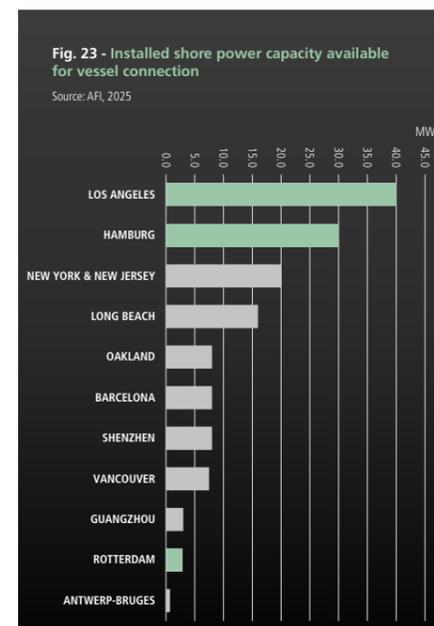
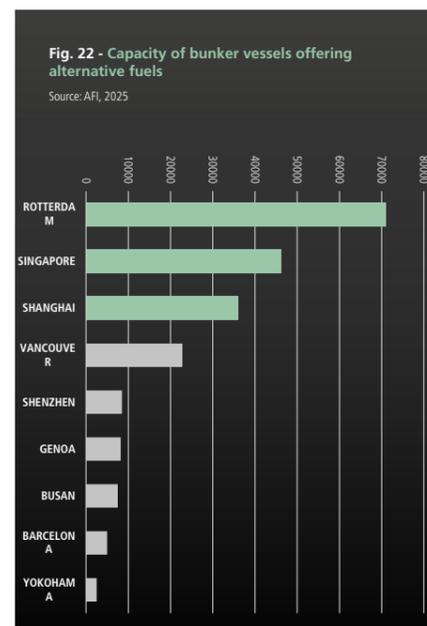
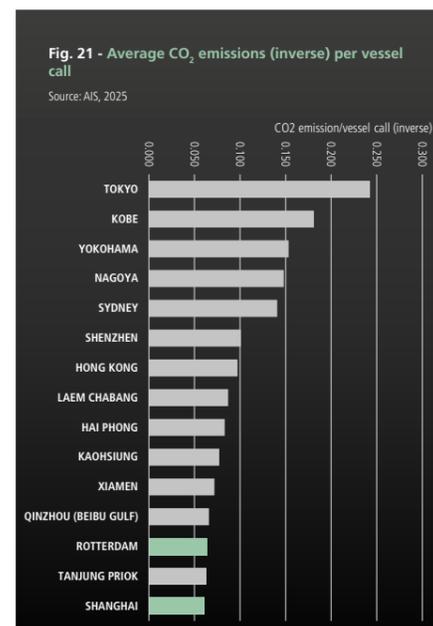
Ningbo-Zhoushan, despite ranking third in green vessel calls, urgently needs to accelerate the development of its alternative fuel infrastructure. The current lack of robust refuelling facilities risks leaving the port behind in supporting next-generation low-emission vessels, especially as global shipping rapidly shifts towards cleaner energy sources. Swift investment in alternative fuel capacity will be essential for Ningbo-Zhoushan to maintain its competitive edge and fully contribute to the maritime energy transition.

Singapore, ranking fourth in vessel calls, is also second in alternative fuel availability (based on the total tank volume capacity of all alternate fuel bunker vessels operating in the port, from DNV's Alternative Fuel Insight), reflecting its dual role as a major transshipment hub and a leader in clean fuel infrastructure. Antwerp-Bruges, fifth in vessel calls, is experiencing a similar challenge to Ningbo-Zhoushan, with a noticeable gap between the number of alternative-fuel-capable vessel calls and the availability of refuelling infrastructure.

Other ports, such as Busan and Hamburg, appear in both rankings, though their positions differ, highlighting varying levels of alignment between vessel calls and infrastructure. Ports like Long Beach, Klaipeda, Lazaro Cardenas, Cai Mep, and Kingston attract alternative-fuel-capable vessels but do not feature among the leaders in alternative fuel availability, suggesting opportunities for further investment.

Overall, ports that rank highly in both alternative-fuel-capable vessel calls and alternative fuel availability, such as Shanghai, Rotterdam, and Singapore, are best positioned to lead the industry's shift toward cleaner shipping. Where there is a gap between vessel calls and infrastructure, ports may need to accelerate development to remain competitive as the adoption of alternative fuels grows.

Figure 24 illustrates the number of vessel calls by ships capable of using alternative fuels at each port, providing a clear visual comparison of



the leading ports and their relative positions in supporting the maritime energy transition.

NUMBER OF GREEN SHIPPING CORRIDORS ANNOUNCED

The number of announced green shipping corridor initiatives is a clear indicator of a port's commitment to fostering international collaboration for decarbonising maritime transport. These corridors are designed to accelerate the deployment of low- and zero-emission vessels by ensuring that supporting infrastructure, regulatory frameworks, and operational practices are in place along key trade routes. It should be emphasised that this measure includes only those corridors where the participating ports are explicitly identified.

Singapore leads globally with six announced green shipping corridor initiatives, reflecting its proactive approach to sustainability and its role as a major transshipment hub. These corridors include partnerships with the Netherlands (Port of Rotterdam), the United States (Ports of Los Angeles and Long Beach), China (Tianjin and Shandong), Japan, Australia, and India. This leadership is reinforced by Singapore's high ranking in both alternative fuel availability and the number of vessel calls by ships capable of using alternative fuels, demonstrating a comprehensive strategy that combines infrastructure investment with international partnership.

Los Angeles follows with five initiatives, highlighting the port's ambition to be at the forefront of green shipping in North America. Its corridors include partnerships with Singapore, China (Ports of Shanghai and Guangzhou), and Japan (Ports of Tokyo, Yokohama, and Nagoya). Los Angeles also stands out for its significant installed shore power capacity and its participation in multiple green corridors, positioning it as a key gateway for low-emission shipping on trans-Pacific routes.

Sharing the third position are Rotterdam, Yokohama, Long Beach, and Seattle/Tacoma, each having announced two green corridor initiatives. Rotterdam has established green

shipping corridors with Singapore and Gothenburg (Sweden), exemplifying its strategic role in connecting European and Asian decarbonization efforts. Yokohama's involvement includes corridors with the United States (Ports of Los Angeles and Oakland), notable given its growing number of alternative-fuel-capable vessel calls and its investments in shore power. Long Beach's dual focus on green corridors with Singapore and China (the Port of Shanghai) and on shore power further strengthens its sustainability profile. Seattle/Tacoma, through the Northwest Seaport Alliance, has partnered with South Korea (Ports of Busan and Ulsan), reinforcing its role in Pacific Northwest sustainability efforts.

Shanghai, Busan, Antwerp-Bruges and Hamburg have each announced one green shipping corridor initiative. For Shanghai, this complements its leadership in alternative-fuel-capable vessel calls and strong ranking in alternative fuel availability, reinforcing its position as a central player in Asia's maritime energy transition. Shanghai's corridor includes partnerships with the United States (Ports of Los Angeles and Long Beach), Germany (Port of Hamburg), Australia (Port of Melbourne), Spain (Port of Barcelona), and Belgium (Port of Antwerp-Bruges). Busan's participation in a green corridor with the United States (Ports of Seattle and Tacoma) highlights its strategic importance in Northeast Asia. Hamburg's participation in a green corridor with China (Port of Shanghai) aligns with its investments in shore power and its role as a European leader in sustainable port operations.

Figure 25 illustrates the number of announced green shipping corridor initiatives at each port, providing a visual overview of the ports most actively shaping the future of green maritime trade.

It is worth noting that a growing number of green shipping corridor initiatives are currently under discussion among major ports and stakeholders worldwide. As collaborative efforts intensify and sustainability becomes a core objective for

the maritime industry, the number of announced corridors is expected to vary significantly in the coming years. This dynamic landscape means that future rankings and assessments will likely reflect substantial changes as new partnerships and projects are formalised.

Overall, the assessment of the Sustainability pillar reveals that true environmental leadership in ports is multifaceted, encompassing emissions reduction, adoption of clean energy, and participation in collaborative green initiatives. Leading ports excel in operational efficiency, alternative fuel provision, and the adoption of onshore power and multi-fuel bunkering. High levels of green vessel calls and involvement in green shipping corridors affirm alignment with global climate objectives. Ultimately, a port's competitive advantage is rooted in embedding sustainability throughout its operations, investing in clean energy infrastructure, and fostering industry-wide collaboration, positioning it as a resilient and forward-looking hub for low-carbon maritime trade.

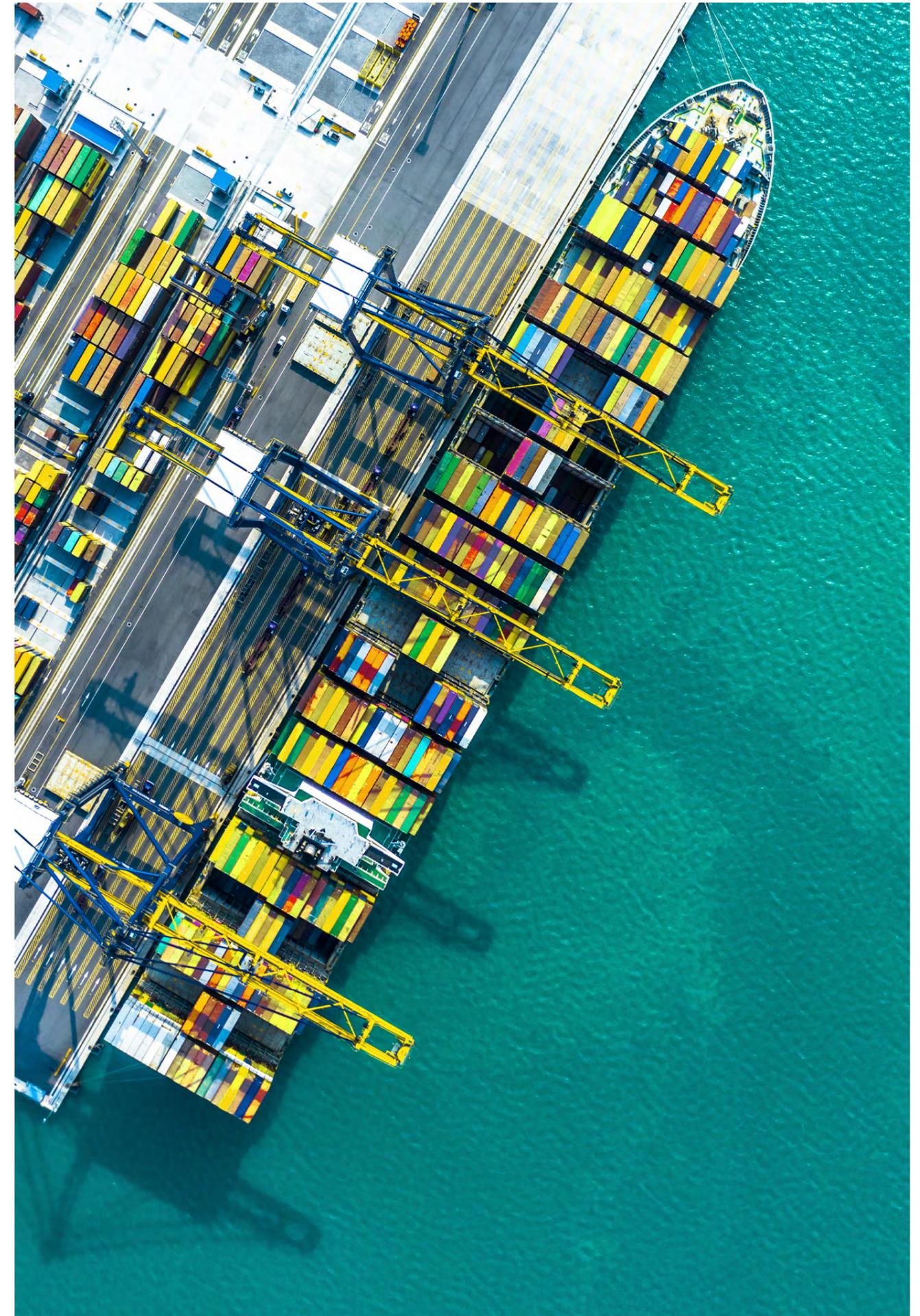


Fig. 24 - Number of vessel calls by ships capable of using alternative fuel

Source: AIS, 2025

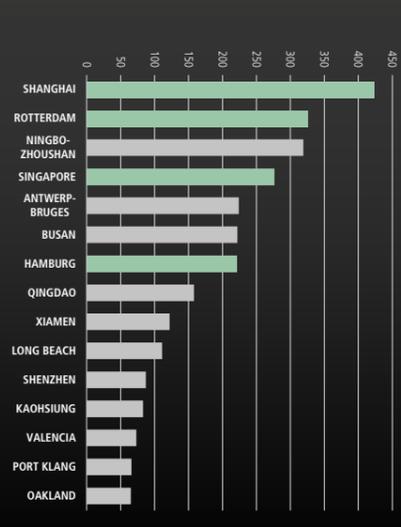
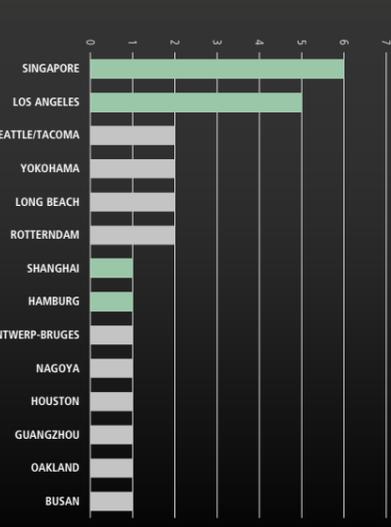


Fig. 25 - Number of announced green corridor initiatives

Source: GMF, 2025



OVERALL IMPACT

SUMMARY



"A port's true competitive advantage lies in its agility to absorb and respond to dynamic trade flow fluctuations driven by geopolitical shifts, tariff changes, and supply chain reconfiguration. Operational resilience in managing these fluctuations distinguishes leading ports from their regional counterparts."

The Overall Impact pillar assesses a container port's extensive role in global trade by evaluating not only throughput but also scale, connectivity, and growth momentum. Although high TEU volumes reflect capacity, meaningful impact is determined by factors such as network connectivity, technological advancement, and adaptability. Emerging hubs often exhibit rapid percentage growth from smaller starting points, indicating future potential, while transshipment ports present unique opportunities for innovation in scheduling, automation, and digital solutions. Accommodating ULCVs introduces additional complexities, requiring deep-water berths, high-capacity cranes, and robust infrastructure. Ports that effectively integrate scale, connectivity, and sustainable practices secure a competitive advantage through ongoing investment in infrastructure, digitalisation, and environmental stewardship, thereby establishing themselves as essential links within global supply chains.

Singapore leads in overall impact, handling 41.1 million TEUs, driven by its strategic location on the East-West trade corridor, connecting to over 130 countries. MPA's proactive policies, including concessions on port dues and incentives for green initiatives, attract major shipping lines and enhance competitiveness. The ongoing development of Tuas Port is expected to become the world's largest fully automated terminal, with a capacity of 65 million TEUs in the 2040s, further strengthening Singapore's leadership and future-readiness.

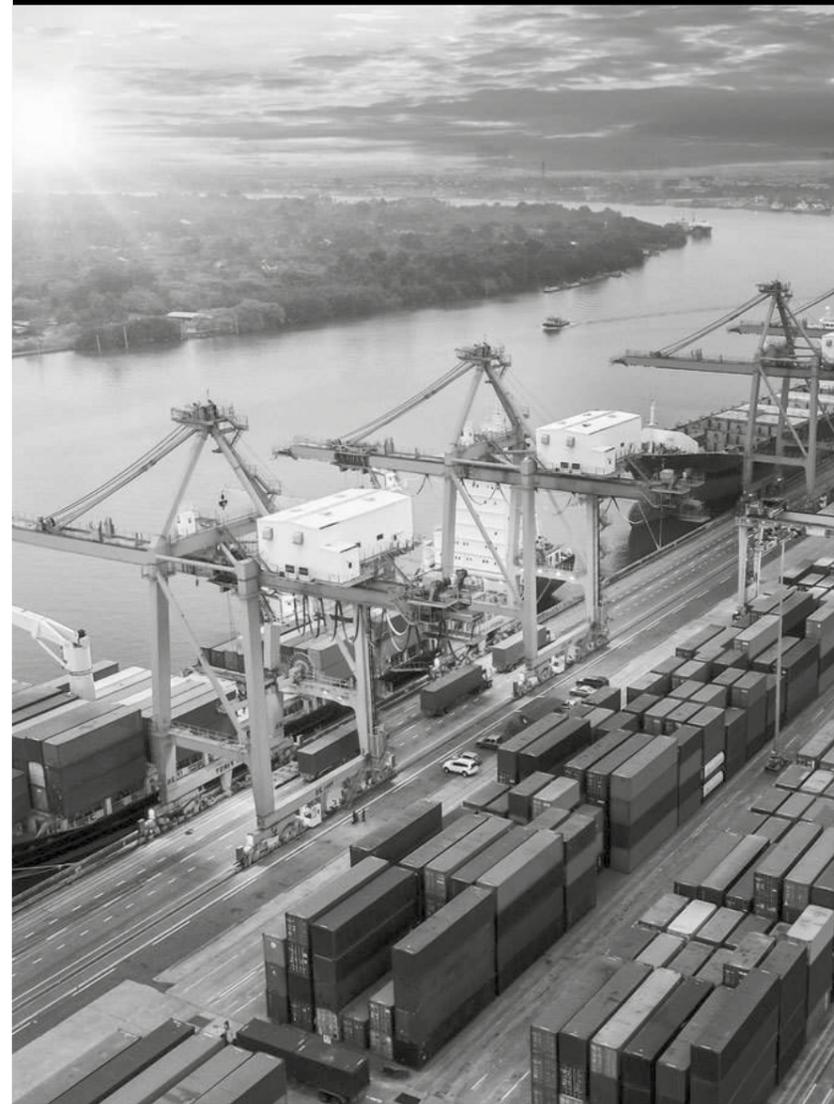
Shanghai ranks second overall, driven by its unmatched container throughput and exceptional connectivity. In 2024, Shanghai handled 51.5 million TEUs, making it the busiest container port. Its deep-water Yangshan terminal and advanced

automation systems enable efficient handling of ultra-large container vessels, while its integration with China's manufacturing and export ecosystem ensures steady cargo flows. While its transshipment share is modest compared to Singapore, Shanghai's strength lies in its scale, operational efficiency, and continuous investment in smart port technologies.

Ningbo-Zhoushan secures third place overall, propelled by rapid growth and strategic expansion. Handling 39.3 million TEUs in 2024, it recorded the highest growth among the top ports at 26%, reflecting China's strategy to diversify port capacity and strengthen regional trade corridors. Ningbo-Zhoushan's deep-water terminals and advanced logistics systems position it as a critical hub for gateway cargo and emerging transshipment activities.

Busan ranks fourth overall, standing out as Northeast Asia's logistics powerhouse. With 24.4 million TEUs handled, and 14,869 vessel calls in 2024, Busan combines operational efficiency with advanced digitalisation. Its strategic location on major shipping lanes and proximity to South Korea's export-driven economy make it a vital hub for containerised trade. Busan's terminals are equipped to handle ULCVs, and its focus on smart port technologies enhances competitiveness.

Shenzhen takes fifth place overall, reflecting its role as a key hub in Southern China's manufacturing and export ecosystem. Handling 33.4 million TEUs in 2024 and recording 16% growth, Shenzhen demonstrates strong operational capacity and adaptability. Its terminals are equipped for ULCV handling, and ongoing investments in automation and digital platforms enhance efficiency. Shenzhen's strength lies in gateway cargo and integration with regional supply chains.



OVERALL IMPACT

| | Market share (throughput) | Market share (vessel calls) | Growth rate (throughput) (%) | Growth rate (throughput) (absolute) | Volume of TEU handled | Volume of transshipment TEU handled | Number of vessels call | Number of yearly ULCV call | Q: Global centres for ports and logistics |
|-------------------|---------------------------|-----------------------------|------------------------------|-------------------------------------|-----------------------|-------------------------------------|------------------------|----------------------------|---|
| SINGAPORE | 1 | 6 | 19 | 6 | 2 | 1 | 2 | 1 | 2 |
| SHANGHAI | 8 | 4 | 21 | 4 | 1 | 6 | 1 | 2 | 1 |
| NINGBO-ZHOUSHAN | 14 | 8 | 6 | 1 | 3 | 11 | 3 | 3 | 3 |
| BUSAN | 2 | 7 | 27 | 13 | 7 | 3 | 4 | 14 | 8 |
| SHENZHEN | 7 | 15 | 11 | 3 | 4 | 24 | 9 | 29 | 4 |
| ROTTERDAM | 10 | 1 | 47 | 49 | 11 | 14 | 5 | 4 | 5 |
| QINGDAO | 24 | 26 | 5 | 2 | 5 | 22 | 11 | 5 | 7 |
| TANGER MED | 3 | 14 | 4 | 7 | 17 | 2 | 25 | 11 | 17 |
| JEBEL ALI (DUBAI) | 6 | 3 | 17 | 11 | 9 | 8 | 16 | 28 | 9 |
| GUANGZHOU | 12 | 22 | 23 | 9 | 6 | - | 13 | 16 | 6 |
| HAMBURG | 5 | 2 | 48 | 48 | 24 | 21 | 14 | 7 | - |
| ANTWERP-BRUGES | 11 | 27 | 18 | 15 | 13 | 9 | 18 | 6 | 11 |
| SANTOS | 4 | 5 | 16 | 23 | 31 | 26 | 39 | 31 | - |
| COLOMBO | 17 | 11 | 26 | 24 | 26 | 13 | 26 | 19 | - |
| MUNDRA | 16 | 16 | 9 | 14 | 23 | 23 | 31 | 31 | - |

EXPERT ASSESSMENT

When industry experts were asked to identify the leading global centres for ports and logistics, Shanghai Port emerged as the clear leader for 2024. Handling over 51 million TEUs annually and ranking highest on the Port Liner Shipping Connectivity Index, Shanghai sets the benchmark for global port excellence. Its deep-water Yangshan terminal, advanced automation systems, and continuous investment in smart technologies deliver unparalleled efficiency. While alternative fuel infrastructure is still developing, Shanghai's integration with China's manufacturing base and its commitment to digital transformation reinforce its dominant position.

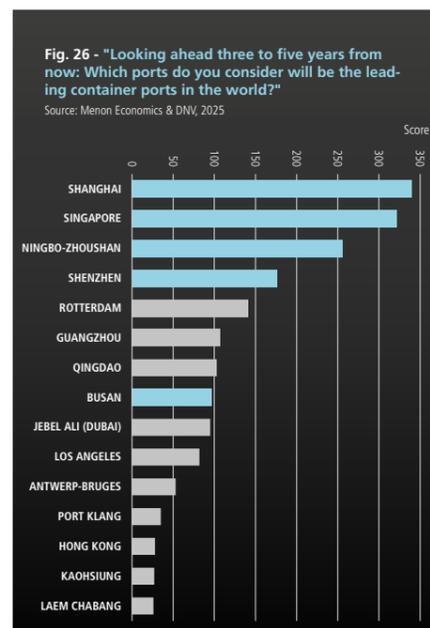
Singapore ranks second, recognised for its exceptional operational efficiency and connectivity to more than 130 countries. It leads in sustainability initiatives, and the development of Tuas Port is set to become the world's largest fully automated terminal with a capacity of 65 million TEUs, positioning Singapore as a future-ready hub.

Ningbo-Zhoushan follows in third place, driven by rapid growth and strong integration with China's Belt and Road Initiative. Its ability to handle massive cargo volumes and expand deep-water berths makes it a critical link in global supply chains.

Rotterdam secures fourth as Europe's green gateway, pioneering alternative fuel infrastructure, advanced automation, and digital twin technology. Its commitment to sustainability and innovation positions it as a leader in European logistics.

Busan completes the top five, combining digital innovation with strategic positioning in Northeast Asia. Its investment in smart port technologies and strong transshipment capabilities make it a vital hub for regional and global trade.

Figure 26 below illustrates the relative positions of these leading ports, based on expert assessments of which hubs are expected to dominate global container shipping over the next three to five years.



OBJECTIVE INDICATORS' ASSESSMENT

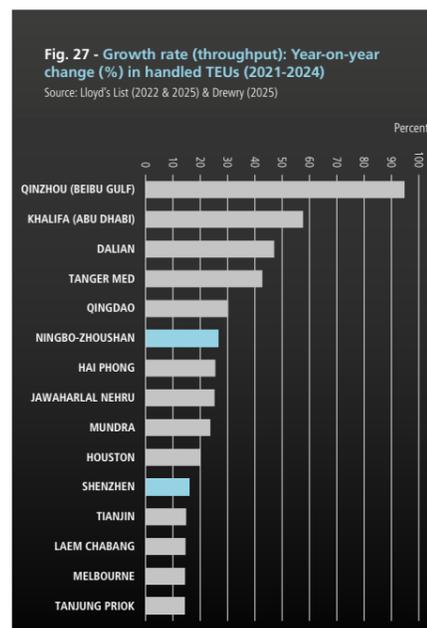
Eight objective indicators were chosen to benchmark the overall impact of container ports. These indicators measure the total volume of twenty-foot equivalent units (TEUs) handled by the ports, including transshipment TEUs, as well as the total number of vessel calls, with specific consideration for ULCV calls. Additionally, they assess market share based on throughput and vessel calls, along with the three-year growth rate expressed both as a percentage and in absolute TEU values.

These eight objective indicators not only enable direct comparisons between ports but also provide insight into the underlying trends shaping the industry. By examining both percentage growth and absolute TEU increases, the assessment captures both short-term momentum and long-term scale. Incorporating metrics such as transshipment TEUs and ULCV handling provides further insight into each port's specialisation and global reach. This comprehensive benchmarking ensures that assessments reflect a balanced view of operational performance, market influence, and future expansion potential within the global maritime landscape.

MARKET SHARE (THROUGHPUT)

Market share by throughput reflects a port's relative contribution within its regional trade network, highlighting its competitive strength in proportion to the size and intensity of competition in that region. Ports that achieve higher positions in highly competitive regions demonstrate superior connectivity, infrastructure, and strategic importance.

Market share was derived by first calculating each port's share in its own region. This ensures that performance is assessed within the context of regional competitiveness. We then normalised these values based on the overall volume of the region compared to the other 14 global regions. This approach strikes a balance between local dominance and global influence, enabling us



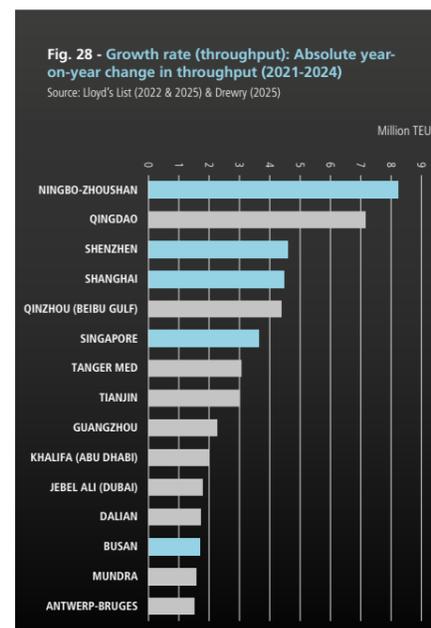
to identify ports that excel both regionally and internationally.

Singapore leads South-East Asia at 1st position, reinforcing its role as the region's premier transshipment hub and global maritime centre. Busan is the dominant port in Korea and Japan, holding 2nd position, supported by its strong export-oriented economy and advanced logistics systems. In the Mediterranean and North Africa, Tanger Med has emerged as a key player at 3rd position, driven by its strategic location and rapid capacity expansion. Santos in Brazil and Hamburg in Germany each hold 4th position, underscoring their importance as leading gateways for South America and Northern Europe, respectively.

In the Middle East, Jebel Ali commands 6th position, maintaining its role as the region's primary logistics hub. Among Chinese ports, Shenzhen and Shanghai rank high, with 7th and 8th positions, reflecting their dominance in southern and northern China. Oceania's leading ports, Melbourne and Sydney (Port Botany), contribute 9th and 10th positions, while Rotterdam and Antwerp-Bruges remain critical to Western Europe with 11th and 12th positions. Other notable ports include Guangzhou (13th), Ningbo-Zhoushan (14th), and Los Angeles (15th), highlighting the global distribution of competitive throughput across major trade corridors.

MARKET SHARE (VESSEL CALLS)

Market share based on vessel calls is particularly important for understanding the operational reach and accessibility of container ports. This indicator not only reflects the frequency of ship arrivals but also offers a perspective on the diversity of services and trade routes a port accommodates. Ports with a high proportion of vessel calls tend to exhibit robust infrastructure, efficient turnaround capabilities, and flexibility in handling a wide range of cargo types. By normalising market share values across regions, the benchmarking process ensures that each port's performance is evaluated within a broader international context, allowing

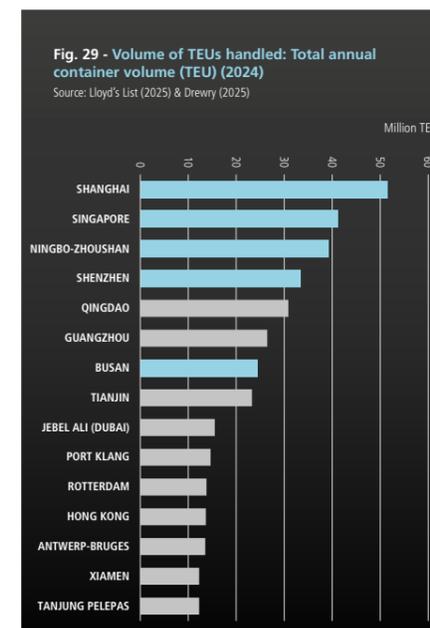


for meaningful comparisons between differing scales of operation and strategic positioning. This approach ultimately highlights those ports that are best equipped to respond to evolving trade patterns and shifting global supply chains.

Rotterdam leads Western Europe in 1st position, maintaining its role as the primary gateway for trade in Northern Europe. Hamburg follows closely at 2nd position, reinforcing its importance as a hub for continental cargo flows. In the Middle East, Jebel Ali in Dubai holds 3rd position, supported by its extensive logistics infrastructure and strategic location. Shanghai remains dominant in Northern China, ranking 4th, while Santos in Brazil matches this at 5th position, underscoring its significance as South America's leading container port.

Singapore continues to be the top performer in South-East Asia, ranking 6th, while Busan, South Korea, ranks 7th, reflecting its strong integration into Northeast Asian trade routes. Ningbo-Zhoushan follows at 8th position, driven by rapid growth in Chinese exports. Other notable ports include Colon-Cristobal in Panama (9th) and Hong Kong (10th), both of which serve as critical transshipment points. Colombo, Sri Lanka, holds 11th position, while Sydney in Oceania and New York & New Jersey in North America register 12th and 13th positions, respectively. Tanger Med in Morocco continues its rise at 14th position, and Shenzhen rounds out the list at 15th position, highlighting the competitive dynamics among Southern China ports.

Comparing throughput and vessel call metrics reveals that ports like Singapore and Shanghai excel in cargo volumes, often calling larger vessels. At the same time, Rotterdam and Hamburg lead in vessel call share, highlighting their broad connectivity. Ports such as Busan and Jebel Ali perform well in both areas, demonstrating resilience and adaptability. Emerging ports like Tanger Med and Santos are growing in both metrics, signalling rising strategic importance. Overall, high throughput indicates scale and efficiency, while a



strong vessel call share reflects diverse trade links. Ports that are strong in both are best positioned for future success.

GROWTH RATE IN PERCENTAGE (THROUGHPUT)

The growth rate, expressed as a percentage, is a key indicator of dynamic changes in port performance, revealing emerging hubs and established leaders as they adapt to shifting trade patterns. Ports with high growth rates often reflect major infrastructure upgrades, capacity expansion projects, and deeper integration into global supply chains.

Figure 27 illustrates the ports with the highest growth rates and their increasing influence on global trade. Qinzhou (Beibu Gulf) ranks first with an exceptional 94.8% growth of 4.39 million TEUs over the past three years, from 4.63 million TEU in 2021 to 9.02 million TEU in 2024. This surge is fuelled by the expansion of automated container terminals and improved rail-sea intermodal connectivity under China's Belt and Road Initiative and the New International Land-Sea Trade Corridor, positioning Qinzhou as a critical gateway for ASEAN trade.

Khalifa Port (Abu Dhabi) takes second place with 57.6% growth, from 2.22 million TEU in 2021 to 3.70 million TEU in 2024, driven by the completion of new container terminals such as the CMA CGM terminal and strategic partnerships with global shipping lines, including COSCO, MSC, and CMA CGM. These developments have reinforced Khalifa's role as a major logistics hub in the Middle East. Dalian ranks third with 47.1% growth, an increase of 1.98 million TEU from 7.17 million TEU in 2021, supported by modernisation projects, the addition of new shipping routes to South America, and expanded capacity for both bulk and containerised cargo through enhanced sea-rail intermodal services.

Tanger Med secures fourth place with 42.8% growth, an increase of 1.72 million TEU from 2021, driven by the completion of Tanger Med

2, increased transshipment activity, and its strategic location at the Strait of Gibraltar, making it Africa's top-ranked port and a vital link between Europe and Africa. Qingdao rounds out the top five with 30.2% growth, reflecting significant investments in deep-water berths, advanced automation systems, and its strategic role in Northern China's export network.

Among the global leaders, growth remains steady but significant. Shanghai, the world's busiest container port, recorded 9.5% growth, reflecting incremental capacity upgrades and continued investment in automation and smart port technologies. Singapore achieved 9.8% growth, supported by the ongoing development of Tuas Port, which is expected to become the world's largest fully automated terminal. Ningbo-Zhoushan stands out with 26.5% growth, signalling aggressive expansion and its strategic role in China's export network, including Belt and Road trade corridors.

GROWTH RATE (ABSOLUTE THROUGHPUT)

Growth in absolute TEU terms provides a clear picture of which ports are adding the largest container volumes, while percentage growth highlights the pace of expansion relative to their existing scale. Together, these metrics offer a balanced perspective on capacity expansion and strategic momentum within global shipping networks.

Ningbo-Zhoushan leads in absolute growth, adding 8.24 million TEUs over the past three years with a 26.5% growth rate. This performance reflects aggressive capacity expansion, deep-water terminal development, and advanced automation, reinforcing its position as one of the world's busiest container hubs. Ranking second, Qingdao recorded 7.16 million TEUs, a 30.2% increase, signalling strong volume gains supported by investments in smart port technologies and enhanced connectivity to Northern China's industrial base.

In third place, Shenzhen posted a 4.61 million



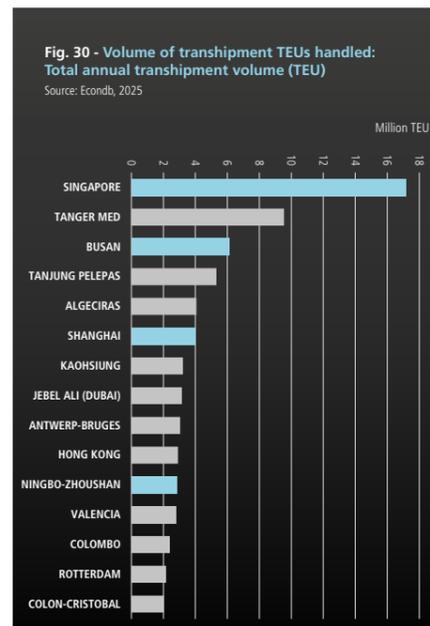
TEU increase, up 16%, showing significant absolute gains but moderate percentage growth typical of mature ports serving Southern China's manufacturing clusters. Shanghai, the world's largest container port, ranked fourth by adding 4.48 million TEUs, a 9.5% increase, underscoring its maturity. While its percentage growth is modest, the absolute increase demonstrates its ability to scale further despite operating at near-maximum capacity.

Among emerging hubs, Qinzhou (Beibu Gulf) stands out with 4.39 million TEUs and an extraordinary 94.8% growth rate, highlighting rapid transformation from a smaller base. This surge is driven by the expansion of automated container terminals and improved rail-sea intermodal connectivity under China's Belt and Road Initiative and the New International Land-Sea Trade Corridor. Singapore, a global leader in transshipment, added 3.65 million TEUs, a 9.8% increase, supported by the ongoing development of Tuas Port, which is expected to become the world's largest fully automated terminal. Meanwhile, Tanger Med recorded 3.07 million TEUs, a 42.8% increase, fuelled by the completion of Tanger Med 2, increased transshipment activity, and its strategic location at the Strait of Gibraltar.

Current trends indicate two principal forces influencing the competitiveness of global ports. Major established ports, including Ningbo-Zhoushan, Qingdao, Shanghai, and Singapore, are reinforcing their leading positions by enhancing technological efficiency and gradually increasing capacity. Conversely, emerging ports such as Qinzhou and Tanger Med are utilising ambitious infrastructure projects and strategic geographic advantages to attract additional cargo flows and redefine regional trade dynamics.

Figure 28 illustrates these trends side by side, emphasising how scale and momentum together define the competitive landscape of global container shipping.

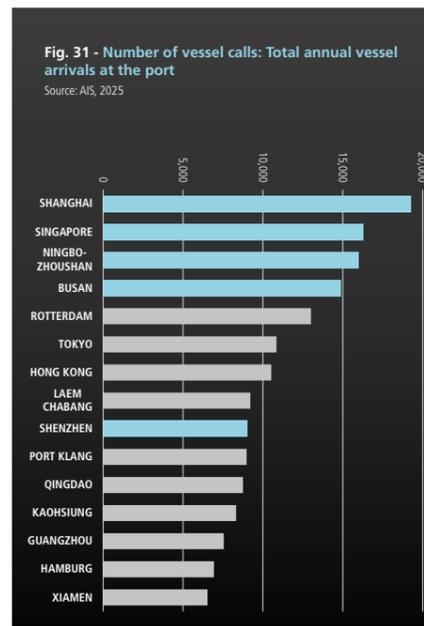
VOLUME OF TEU HANDLED



Handling a large volume of containers requires deep-water berths, high-capacity cranes, and sophisticated scheduling systems to accommodate ULCVs and maintain quick turnaround times. As ports scale up to handle greater throughput, higher volumes often require even more advanced infrastructure, better equipment, expanded terminal space, and enhanced technology to ensure operations remain efficient and competitive. Modern ports operate as highly integrated ecosystems, combining advanced terminal operating systems, automation, and digital platforms to manage millions of containers efficiently. Figure 29 illustrates the comparative TEU volumes handled by the top container ports.

Asian ports have dominated global container throughput for the past two decades, now accounting for more than 60% [according to Drewry, it's 55% in 2024] of worldwide TEU volumes. In 2024, Shanghai retained its position as the world's busiest container port, handling 51.5 million TEUs, supported by its extensive deep-water facilities and advanced automation systems. Singapore followed closely with 41.1 million TEUs, leveraging its strategic location and reputation as a premier transshipment hub. Ningbo-Zhoushan ranked third with 39.3 million TEUs, recording the highest growth among the top ports at 26%, driven by strong domestic and international trade flows. Shenzhen and Qingdao ranked among the top five, handling 33.4 million TEUs and 30.9 million TEUs, respectively, driven by robust export activity and investments in smart port technologies.

Other major players include Guangzhou and Busan, with Busan standing out as Northeast Asia's key hub for ULCVs and advanced logistics, processing 24.4 million TEUs. Outside Asia, Jebel Ali in Dubai led the Middle East with 15.5 million TEUs. At the same time, European ports such as Rotterdam and Antwerp-Bruges faced mixed fortunes; Rotterdam posted a 10% decline, whereas Antwerp-Bruges grew by 13%. Hong Kong experienced the sharpest contraction



among major ports, dropping 23% to 13.7 million TEUs, reflecting shifting trade patterns and competitive pressures.

VOLUME OF TRANSHIPMENT TEU

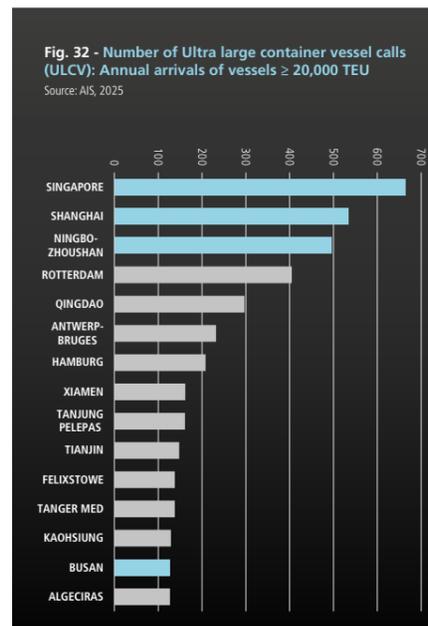
"Port capacity constraints and expansion plans represent critical decision factors for carrier network development. Liner operators require ports demonstrating clear three-to-five-year expansion strategies and capacity commitments; ports without articulated growth plans present unacceptable operational risk for carriers pursuing their own service expansion."

HANDLED

Transshipment ports play a pivotal role in global container logistics, acting as critical hubs where cargo is transferred between vessels to optimise routing and connectivity. These ports are strategically located along major shipping lanes and rely on advanced infrastructure and scheduling systems to handle large volumes efficiently. Transshipment operations demand high levels of coordination and automation, as containers often move through multiple terminals within tight timeframes.

Figure 30 illustrates the distribution of transshipment volumes across leading ports, highlighting Singapore's dominance and Tanger Med's rapid rise as a global transshipment powerhouse.

Singapore remains the undisputed leader in transshipment activity, with over three-quarters of the total volume handled in 2024 being transshipped, supported by its world-class port infrastructure and strategic position at the crossroads of major East-West trade routes. Tanger Med has emerged as a fast-growing hub, recording 9.5



million TEUs and achieving a 43% growth rate, driven by expanding capacity and its proximity to European and African markets. Busan ranks third with 6.1 million TEUs, leveraging its advanced terminal systems and strong integration with Northeast Asian trade flows. Tanjung Pelepas in Malaysia handles 5.3 million TEUs, reinforcing its role as a key transshipment centre in Southeast Asia.

European ports such as Algeciras and Antwerp-Bruges maintain significant positions, handling 4.06 million TEUs and 3.05 million TEUs, respectively, although growth remains modest compared to Asian hubs. Shanghai, despite being the world's busiest container port, recorded 4.03 million TEUs in transshipment, ranking sixth, reflecting its primary focus on gateway cargo. Other notable players include Jebel Ali in Dubai (3.15 million TEUs) and Hong Kong (2.91 million TEUs), though Hong Kong continues to face a sharp decline amid regional competition. Emerging hubs like Colombo and Marsaxlokk are steadily building their transshipment capabilities, with Colombo handling 2.4 million TEUs in 2024.

NUMBER OF VESSEL CALLS

Vessel calls are a key indicator of port activity and connectivity, reflecting the frequency and scale of maritime traffic a port handles. Ports with higher vessel calls typically serve as major gateways for trade and transshipment, requiring advanced scheduling systems and deep-water berths to accommodate diverse vessel sizes, including ULCVs.

A consistently high number of vessel calls signals a port's operational significance, demonstrating the port's capacity to efficiently manage a steady flow of ships and cargo under tight schedules. This level of activity underpins the port's role as a crucial node in global supply chains and enhances its attractiveness to shipping lines seeking reliable, quick turnaround times. To support this volume, leading ports invest in cutting-edge terminal operating systems, automation, and digital solutions that streamline vessel traffic management and minimise congestion.

Figure 31 illustrates the distribution of vessel calls across major ports. Shanghai leads globally with 19,258 vessel calls in 2024, supported by its position as the world's busiest container port and its ability to handle ultra-large container vessels efficiently. Singapore follows closely with 16,263 calls, leveraging its strategic location and reputation as a premier transshipment hub. Ningbo-Zhoushan ranks third with 15,977 calls, driven by strong domestic and international trade flows, while Busan secures fourth place with 14,869 calls, reinforcing its role as Northeast Asia's logistics powerhouse.

European ports maintain significant positions, with Rotterdam recording 13,011 calls, making it the leading gateway in Europe despite a slight decline in overall throughput. Tokyo and Hong Kong remain important regional hubs, handling 10,844 and 10,524 calls, respectively, though Hong Kong continues to face competitive pressures from mainland Chinese ports. Other notable ports include Laem Chabang (9,217 calls) and Shenzhen (9,036 calls), both benefiting from

growing Southeast Asian trade. Qingdao and Port Klang also feature prominently, with 8,757 and 8,977 calls, respectively, while Kaohsiung and Guangzhou round out the top tier with 8,320 and 7,553 calls.

NUMBER OF MEGA-VESSEL CALLS

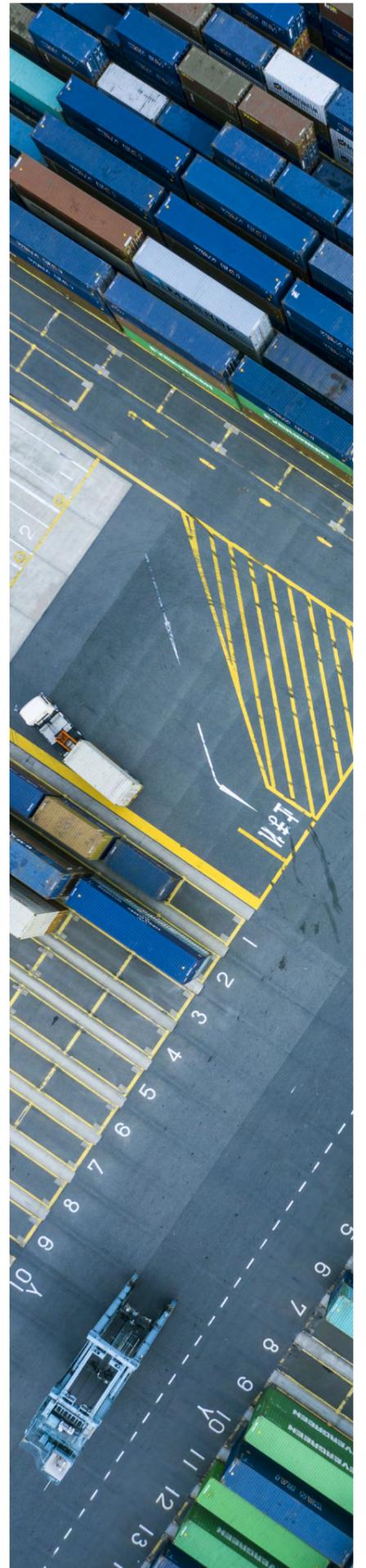
ULCV (mega-vessels) calls are a critical indicator of a port's ability to handle the largest container ships in the world, requiring deep-water berths, high-capacity cranes, and advanced scheduling systems. These vessels, often exceeding 20,000 TEU capacity, concentrate cargo flows and demand exceptional operational efficiency.

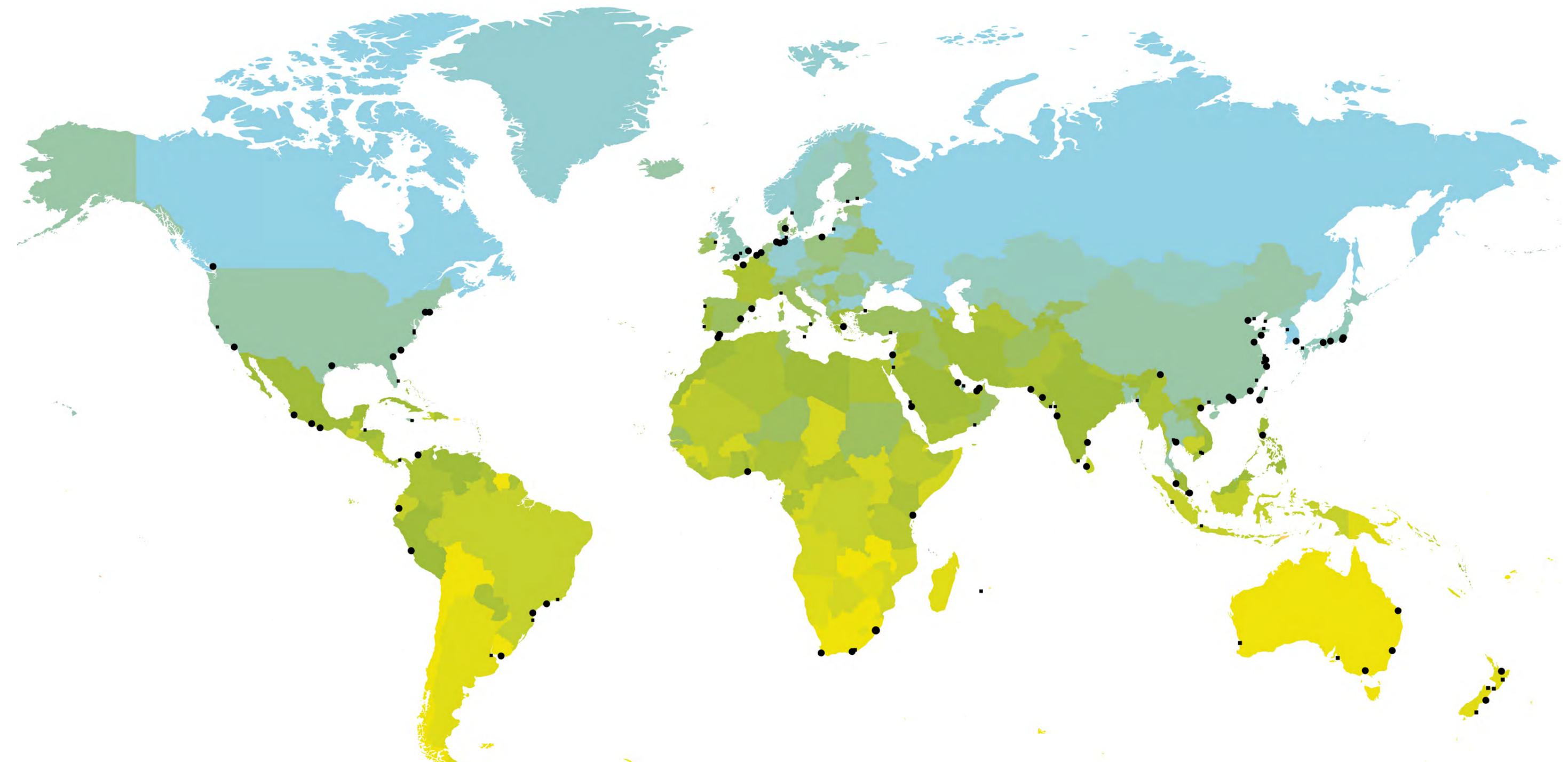
Ports that successfully attract and accommodate ULCVs benefit from increased throughput per call and enhance their status as key nodes in global shipping networks. Handling these giants of the sea requires significant investment in infrastructure, including longer berths, reinforced quay walls, and state-of-the-art terminal operating systems that can manage large numbers of containers swiftly and safely. The arrival of ULCVs also necessitates highly skilled labour, robust safety protocols, and seamless coordination among port authorities, shipping lines, and logistics providers. Moreover, ports with high ULCV calls often become preferred transshipment and gateway hubs, attracting further investment and reinforcing their strategic importance in international trade.

Singapore leads globally in this category (as in Figure 32), recording 664 ULCV calls in 2024, reinforcing its position as the premier transshipment hub with world-class infrastructure and connectivity. Shanghai follows with 535 calls, leveraging its extensive deep-water facilities and status as the world's busiest container port. Ningbo-Zhoushan ranks third with 497 calls, supported by rapid growth and strong integration into China's export network. Among European ports, Rotterdam stands out with 405 ULCV calls, maintaining its role as the leading gateway for Northern Europe despite overall throughput challenges.

Qingdao and Antwerp-Bruges also feature prominently, handling 297 and 232 calls, respectively, while Hamburg recorded 208 calls, reflecting its continued importance in European trade. In Asia, Xiamen and Tanjung Pelepas managed 162 and 161 calls, showcasing their growing relevance in regional shipping networks. Other notable ports include Tianjin (148 calls) and Tanger Med (138 calls), with Tanger Med emerging as a fast-developing hub in the Mediterranean. Kaohsiung rounds out the top tier with 129 calls, despite facing competitive pressures from mainland Chinese ports.

The assessment of eight indicators shows that some ports are expanding through strong TEU growth, while others excel in market share or resilience. High transshipment volumes and the ability to handle large vessels indicate advanced infrastructure, and growth at major hubs reinforces the value of incremental innovation. Differences in scores indicate areas such as gateway cargo, transshipment, or network connectivity. These findings suggest competitiveness relies on continual investment in technology, scalable infrastructure, and integrated operations





REGIONAL BENCHMARKING



NORTH AMERICA

New York and New Jersey stand out as pivotal gateways to the largest metropolitan economy in the United States, offering unparalleled economic access and infrastructure. The port complex boasts direct connectivity to more than 23 million consumers and supports a regional GDP exceeding \$1.8 trillion. This strategic location drives persistent demand for imports and positions the port as a preferred East Coast entry point for discretionary cargo, providing shippers with the flexibility to choose between coastal ports. Internationally, the port's proximity to dense economic activity and availability of onshore power supply further enhance its reputation. Nonetheless, assessments reveal lower rankings in productivity and overall impact, largely attributed to operational challenges, such as labour relations issues common among major North American ports and infrastructure constraints that impede throughput

expansion.

Long Beach secures the second spot, largely due to its enduring dominance in trans-Pacific trade and its outstanding economic ties to Southern California's vast market. With the highest regional throughput and impressive growth rates, Long Beach exemplifies California's strong import appetite and dynamic consumption trends. The port's commitment to sustainability is evidenced by its pioneering investments in onshore power supply, earning it the distinction of a 'green port' benchmark. However, its connectivity lags, as it offers fewer direct liner services compared to Los Angeles. The two Southern California ports, Long Beach and Los Angeles, work in tandem, efficiently sharing cargo flows and complementing each other's strengths.

Los Angeles rounds out the top three, holding the title of North America's busiest container port by total throughput volume. The port excels in productivity and sustainability, featuring highly

efficient terminal operations and significant environmental initiatives, supported by record-breaking EPA grants aimed at decarbonising operations. Industry experts highlight Los Angeles's global lead in onshore power supply, with the port boasting the largest installed shore power capacity at 40 MW. However, it falls short of New York and New Jersey in terms of connectivity and proximity to economic activities, underscoring the nuanced strengths and challenges facing each of North America's leading ports.

Vancouver ranks highly for alternative fuel availability but was not among the top five cities overall for sustainability. However, the port did rank in the top five for two specific pillars.

| RANK | ENABLERS | CONNECTIVITY & CUSTOMER VALUE | PRODUCTIVITY | SUSTAINABILITY | OVERALL IMPACT | OVERALL RANK |
|------|-----------------------|-------------------------------|--------------------------|-----------------------|--------------------------|-----------------------|
| 1 | NEW YORK & NEW JERSEY | NEW YORK & NEW JERSEY | LOS ANGELES | LOS ANGELES | LONG BEACH | NEW YORK & NEW JERSEY |
| 2 | LONG BEACH | CHARLESTON | NEW YORK & NEW JERSEY | LONG BEACH | NEW YORK & NEW JERSEY | LONG BEACH |
| 3 | LOS ANGELES | LOS ANGELES | LONG BEACH | NORFOLK | LOS ANGELES | LOS ANGELES |
| 4 | VANCOUVER | NORFOLK | HAMPTON ROADS (VIRGINIA) | OAKLAND | HAMPTON ROADS (VIRGINIA) | VANCOUVER |
| 5 | OAKLAND | VANCOUVER | NORFOLK | NEW YORK & NEW JERSEY | VANCOUVER | CHARLESTON |



CENTRAL AND GULF OF AMERICA (GULF OF MEXICO)

Savannah in United States, which holds the 34th position overall, stands out as the region's leading port through its commitment to operational excellence, making it the fastest-growing major container port on the U.S. East Coast. Significant investments in infrastructure underpin this prominence, most notably berth realignment projects that enable the simultaneous handling of multiple ultra-large container vessels. With the highest liner shipping connectivity ranking in the region and a broad array of mainline services, Savannah has firmly established itself as the premier gateway for discretionary cargo, offering shippers the flexibility of entry via either the East or West Coast. Its strong performance across key enablers is further bolstered by its strategic proximity to the economic heartland of the Southeastern United States and a reputation for transparent

governance, laying a robust institutional foundation for sustained growth. Despite Savannah's strengths, Puerto Cortés leads the region in sustainability, achieving the lowest overall emissions per TEU and per port call, a clear demonstration that environmental leadership can arise from unexpected sources.

Colon-Cristobal in Panama, ranked second in the region and 36th globally, exerts its influence through transshipment on an impressive scale, handling the highest vessel call volumes in the Western Hemisphere at the pivotal junction of Asia-Americas-Europe trade. Panama's strategic canal location enables the port to seamlessly facilitate transshipment flows between the Atlantic and Pacific, while its top regional ranking for mainline services highlights its integration into all major shipping alliances. Although the port excels operationally, governance challenges, particularly around transparency, have limited its performance in the enablers pillar, placing it fifth in this regard.

Nevertheless, Colon-Cristobal's productivity highlights the efficiency of its terminal operations.

Completing the top three, Houston leverages its unparalleled economic proximity, serving as the maritime gateway to Texas's \$2 trillion economy, which is anchored by the energy, petrochemical, and manufacturing sectors. Houston's top-tier ranking in enablers reflects its strategic location rather than a focus on container-specific infrastructure, as the port's primary strengths lie in specialised cargo handling. Although Houston is ranked eighth in connectivity, indicating a comparatively lower integration into global liner networks than Savannah or Colon-Cristobal, it continues to demonstrate solid absolute growth, propelled by the region's dynamic economic expansion.

| RANK | ENABLERS | CONNECTIVITY & CUSTOMER VALUE | PRODUCTIVITY | SUSTAINABILITY | OVERALL IMPACT | OVERALL RANK |
|------|-----------------|-------------------------------|-----------------|-----------------|-----------------|-----------------|
| 1 | HOUSTON | SAVANNAH | SAVANNAH | PUERTO CORTES | COLON-CRISTOBAL | SAVANNAH |
| 2 | SAVANNAH | CARTAGENA | COLON-CRISTOBAL | LAZARO CARDENAS | BALBOA | COLON-CRISTOBAL |
| 3 | KINGSTON | COLON-CRISTOBAL | MANZANILLO | CARTAGENA | HOUSTON | HOUSTON |
| 4 | PORT EVERGLADES | MANZANILLO | CARTAGENA | KINGSTON | LAZARO CARDENAS | CARTAGENA |
| 5 | COLON-CRISTOBAL | LAZARO CARDENAS | HOUSTON | HOUSTON | CARTAGENA | MANZANILLO |

SOUTH AMERICA

Santos (Brazil) is South America's busiest container port and the region's sole representative among the world's top 50 ports. Leading positions in enablers, connectivity, and overall impact emphasise its preeminence. Strategically located near São Paulo, the continent's largest industrial centre and consumer market, boasting a metropolitan economy valued at \$500 billion, Santos serves as Brazil's principal economic gateway. The port is directly linked to all major global shipping lines, offering extensive mainline services that connect Brazil with Europe, North America, and Asia. This unrivalled connectivity, combined with its commanding position in the highest regional market share and TEU volumes, cements Santos's strategic role.

Callao (Peru) has emerged as the leading gateway on South America's Pacific coast, distinguishing itself through strategic positioning for Peru and the landlocked Bolivian trade. The port is at the forefront of environmental stewardship, attracting calls from alternative fuel-capable vessels that set the regional environmental performance benchmarks. Callao's liner services and increasing market presence are reflected in its second-place rankings for connectivity and overall impact, particularly facilitating cargo flows between South America and Asia via the Pacific. Nonetheless, operational inefficiencies persist, as evidenced by lower productivity scores, highlighting the need for terminal modernisation and process improvements.

Completing the region's top three, Paranaguá exemplifies Brazil's diversified approach to port development, one that extends beyond the dominance of Santos. The port leads in productivity, driven by highly efficient cargo handling, especially for bulk agricultural commodities and containerised exports, which are central to Brazil's thriving agricultural sector. Paranaguá's strong liner service offerings and solid market presence secure it in third place in both connectivity and overall impact. The port's operational excellence in productivity reinforces its role as a crucial hub in Brazil's export economy.



| RANK | ENABLERS | CONNECTIVITY & CUSTOMER VALUE | PRODUCTIVITY | SUSTAINABILITY | OVERALL IMPACT | OVERALL RANK |
|------|----------------|-------------------------------|----------------|----------------|----------------|--------------|
| 1 | SANTOS | SANTOS | PARANAGUA | CALLAO | SANTOS | SANTOS |
| 2 | MONTEVIDEO | CALLAO | SANTOS | ITAJAI | CALLAO | CALLAO |
| 3 | CALLAO | PARANAGUA | GUAYAQUIL | SANTOS | GUAYAQUIL | PARANAGUA |
| 4 | BUENOS AIRES | MONTEVIDEO | MONTEVIDEO | PARANAGUA | PARANAGUA | MONTEVIDEO |
| 5 | RIO DE JENEIRO | BUENOS AIRES | RIO DE JENEIRO | GUAYAQUIL | BUENOS AIRES | GUAYAQUIL |



NORTH EUROPE

Hamburg has claimed the top spot among Northern European ports, reaffirming its position as the region's leader through a well-rounded display of excellence across connectivity, productivity, sustainability, and overall impact. As Germany's foremost maritime gateway, Hamburg boasts unrivalled liner shipping connectivity, acting as a key hub for mainline services that bridge Northern European markets with critical global trade routes. The port's reputation for productivity is underpinned by highly efficient cargo handling, a testament to its state-of-the-art terminal infrastructure and the expertise of its workforce. Furthermore, Hamburg's commitment to sustainability is evident in its progressive adoption of shore power facilities and active participation in green shipping corridors, underscoring its role as a leader in environmental sustainability. Nevertheless, the port's third-place ranking

in enablers reflects a relative disadvantage in geographic proximity to major metropolitan centres, compared to some of its European peers.

Bremen/Bremerhaven (Germany) maintains its stronghold as the second-ranked port in the region, benefiting from Germany's diversified port strategy. This twin-port complex efficiently integrates container throughput with specialist operations in automotive and project cargo, reinforcing its significance as both a gateway and transshipment centre. Enduring relationships with major shipping lines and impressive cargo volumes drive its robust connectivity and overall impact. However, the port's sustainability ranking lags competitors, signalling the necessity for increased investment in alternative fuel bunkering and shore power solutions.

Aarhus in Denmark, meanwhile, distinguishes itself within the Nordic region through exceptional economic proximity, by capitalising on direct access to Denmark's key economic hubs and

benefiting from renowned Scandinavian governance standards. Unlike Hamburg and Bremen/Bremerhaven, Aarhus primarily serves regional feeder traffic and niche Baltic trade flows, rather than competing for the largest mainline services. The port's strong sustainability performance, closely aligned with Denmark's ambitious climate objectives, secures it a second-place ranking in this pillar.

Finally, Gdansk in Poland, which holds fourth place overall, stands out for its remarkable growth trajectory. The port's ascent reflects Poland's robust economic expansion and ongoing investments in infrastructure, positioning Gdansk as a rising force among Europe's leading maritime gateways.

| RANK | ENABLERS | CONNECTIVITY & CUSTOMER VALUE | PRODUCTIVITY | SUSTAINABILITY | OVERALL IMPACT | OVERALL RANK |
|------|---------------|-------------------------------|--------------------|----------------|--------------------|--------------------|
| 1 | AARHUS | HAMBURG | HAMBURG | HAMBURG | HAMBURG | HAMBURG |
| 2 | WILHELMSHAVEN | BREMEN/BREMERHAVEN | BREMEN/BREMERHAVEN | AARHUS | BREMEN/BREMERHAVEN | BREMEN/BREMERHAVEN |
| 3 | HAMBURG | KLAIPEDA | GDANSK | KIEL | GDANSK | AARHUS |
| 4 | GOTHENBURG | WILHELMSHAVEN | HELSINKI | GDANSK | WILHELMSHAVEN | GDANSK |
| 5 | KOTKA | GDANSK | KLAIPEDA | KLAIPEDA | GOTHENBURG | WILHELMSHAVEN |

WEST EUROPE

Rotterdam remains the undisputed leader among European container ports, a position underpinned by its comprehensive strengths across infrastructure, connectivity, and sustainability. This dominance reflects not only the Netherlands' longstanding maritime heritage but also its commitment to institutional excellence. The Port of Rotterdam Authority has positioned Rotterdam as Europe's largest and most innovative port through strategic investments and forward-thinking sustainability initiatives, while continuously investing in smart infrastructure, including digital twins, autonomous navigation systems, and real-time asset monitoring technologies. The port boasts world-class infrastructure and unrivalled access to the continent's inland waterways, most notably the Rhine-Meuse-Scheldt delta, which allows cargo to penetrate deep into Europe's heartland. Transparent and effective governance further cements Rotterdam's position. On the connectivity front, the port's extensive mainline services provide seamless links between Europe, Asia, North America, and other key global markets. Meanwhile, sustainability is a core pillar of Rotterdam's operations, with pioneering investments in shore power and the development of alternative fuel bunkering infrastructure, encompassing LNG, methanol, and ammonia, demonstrating a firm commitment to supporting the maritime sector's energy transition and the port Authority's commitment to environmental stewardship. Through public-private partnerships, the Port Authority has facilitated multi-modal connectivity and logistics efficiency that strengthen Rotterdam's role as a critical gateway for European trade.

Following a strategic merger, Antwerp-Bruges has consolidated Belgium's port capabilities, creating Europe's second-largest port complex. This merger has resulted in increased scale and bargaining power, with Antwerp-Bruges now leading in regional market share and posting strong growth figures. The port consistently ranks second in terms of infrastructure, connectivity, and sustainability, showcasing a well-balanced performance across all key competitive dimensions. Its robust liner services position Antwerp-Bruges as a premier gateway for cargo bound for

Central Europe, thanks to vital connections via the Albert Canal and the Rhine. Significant investments in environmental infrastructure reinforce the port's sustainability credentials, although the rollout of alternative fuel bunkering is still in progress.

Although Sines does not feature among the top five overall, it takes the top spot for productivity. This distinction is largely due to Sines being a smaller port with less complex operations. Its specialised terminals handle traffic efficiently, but the overall scale is modest compared to Europe's major ports.

Completing the top three is Southampton, now the United Kingdom's principal container hub. Southampton reflects a more limited range of liner services, with the port primarily focused on feeder traffic, UK gateway cargo, and automotive exports that support Britain's manufacturing sector. The port's balanced performance across productivity, sustainability, and overall impact is bolstered by ongoing investments aimed at enhancing competitiveness and addressing potential bottlenecks as British supply chains adapt to post-Brexit realities.



| RANK | ENABLERS | CONNECTIVITY & CUSTOMER VALUE | PRODUCTIVITY | SUSTAINABILITY | OVERALL IMPACT | OVERALL RANK |
|------|----------------|-------------------------------|----------------|----------------|-------------------|-------------------|
| 1 | ROTTERDAM | ROTTERDAM | SINES | ROTTERDAM | ANTWERP-BRUGES | ROTTERDAM |
| 2 | ANTWERP-BRUGES | ANTWERP-BRUGES | ROTTERDAM | ANTWERP-BRUGES | ROTTERDAM | ANTWERP-BRUGES |
| 3 | LONDON | HAROPA (LE HAVRE) | ANTWERP-BRUGES | LEIXOES | HAROPA (LE HAVRE) | SOUTHAMPTON |
| 4 | SOUTHAMPTON | FELIXSTOWE | SOUTHAMPTON | DUBLIN | FELIXSTOWE | FELIXSTOWE |
| 5 | DUBLIN | LONDON | FELIXSTOWE | SOUTHAMPTON | SOUTHAMPTON | HAROPA (LE HAVRE) |



MEDITERRANEAN & NORTH AFRICA

Tanger Med has rapidly transformed the Mediterranean port landscape, becoming a leading transshipment hub in under two decades. Ranked 19th globally and second by transshipment volume, it holds the region's third-largest market share by total throughput. Morocco's strategic location enables Tanger Med to serve as a vital link between Asia and Europe, dominating in connectivity and overall impact by attracting major shipping alliances and logistics clusters.

Valencia, Spain's foremost gateway port, benefits from proximity to a major metropolitan area and strong EU governance, excelling in digitalisation, hinterland connectivity, and safety standards. With a higher Liner Shipping Connectivity Index than Tanger Med, Valencia offers extensive global connections but faces productivity constraints due to its older infrastructure, ranking

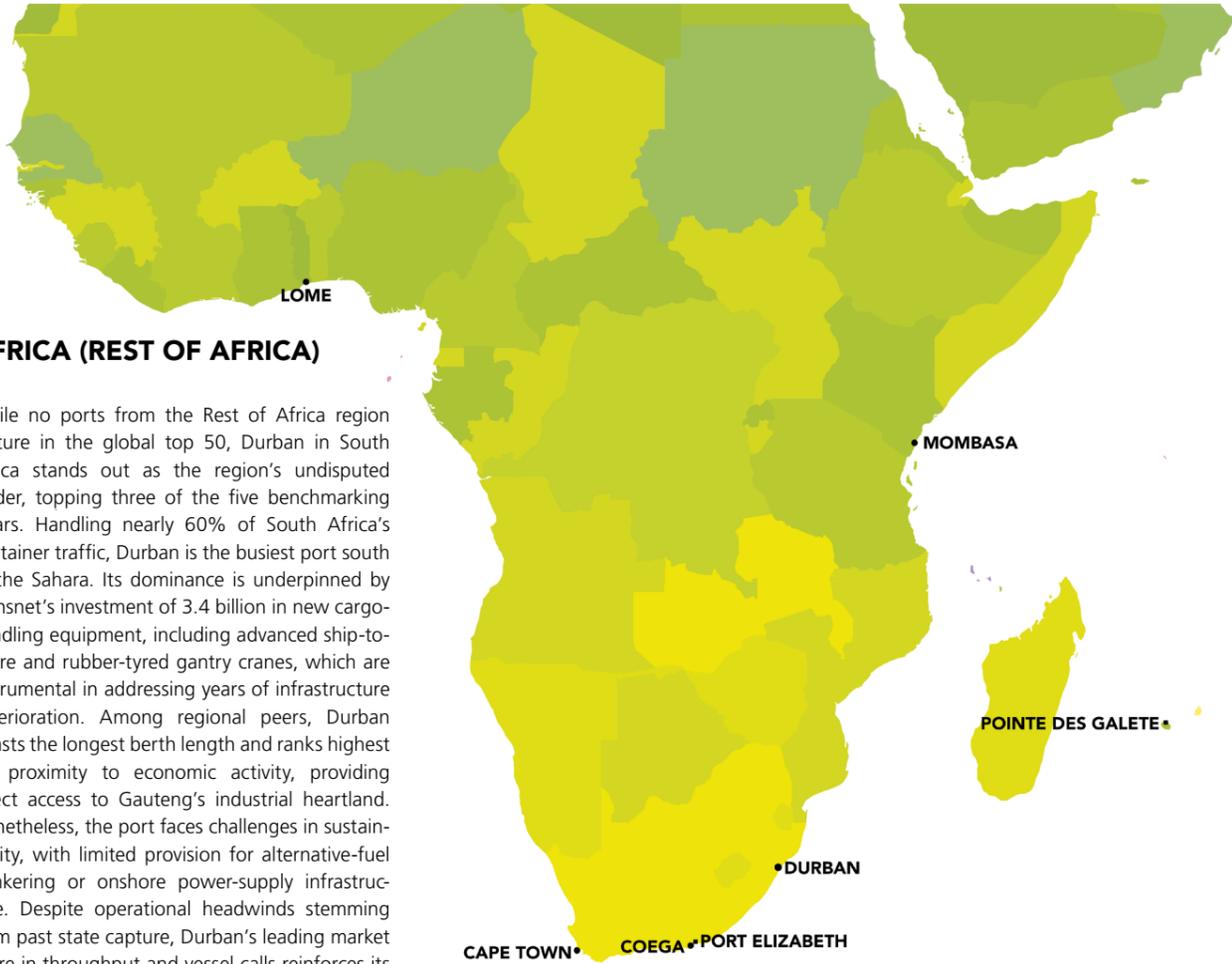
sixth in this metric. Despite these challenges, it remains a key gateway and transshipment hub for the Iberian Peninsula, handling over five million TEU annually.

Algeciras, located at the Strait of Gibraltar, utilises its strategic position to intercept major East-West shipping flows, ranking fifth globally in terms of transshipment volume. It scores highly in connectivity, productivity, and Overall impact, serving as a crucial hub for leading shipping lines and feeder networks linking smaller Mediterranean and West African ports.

Barcelona distinguishes itself in sustainability, being the only regional port with an onshore power supply for vessels and recording a high number of green vessel calls. Conversely, Marseille's market share has declined, now ranking 13th as competition from Spanish and Moroccan ports intensifies. This highlights the Mediterranean sector's dynamic and competitive nature, where adaptability, investment, and

forward-thinking governance are crucial for success in global trade.

| RANK | ENABLERS | CONNECTIVITY & CUSTOMER VALUE | PRODUCTIVITY | SUSTAINABILITY | OVERALL IMPACT | OVERALL RANK |
|------|-------------|-------------------------------|--------------|----------------|----------------|--------------|
| 1 | VALENCIA | TANGER MED | TANGER MED | BARCELONA | TANGER MED | TANGER MED |
| 2 | GENOA | VALENCIA | AMBARLI | GENOA | ALGECIRAS | VALENCIA |
| 3 | BARCELONA | ALGECIRAS | ALGECIRAS | VALENCIA | VALENCIA | ALGECIRAS |
| 4 | GIOIA TAURO | PIRAEUS | MERSIN | TANGER MED | GIOIA TAURO | BARCELONA |
| 5 | ALGECIRAS | AMBARLI | PIRAEUS | MARSAXLOKK | BARCELONA | PIRAEUS |



AFRICA (REST OF AFRICA)

While no ports from the Rest of Africa region feature in the global top 50, Durban in South Africa stands out as the region's undisputed leader, topping three of the five benchmarking pillars. Handling nearly 60% of South Africa's container traffic, Durban is the busiest port south of the Sahara. Its dominance is underpinned by Transnet's investment of 3.4 billion in new cargo-handling equipment, including advanced ship-to-shore and rubber-tyred gantry cranes, which are instrumental in addressing years of infrastructure deterioration. Among regional peers, Durban boasts the longest berth length and ranks highest for proximity to economic activity, providing direct access to Gauteng's industrial heartland. Nonetheless, the port faces challenges in sustainability, with limited provision for alternative-fuel bunkering or onshore power-supply infrastructure. Despite operational headwinds stemming from past state capture, Durban's leading market share in throughput and vessel calls reinforces its strategic significance.

Lome (Togo) claims second place and is rapidly establishing itself as West Africa's transshipment powerhouse, defying traditional perceptions of African port competitiveness. The Togolese port leads the region in both connectivity and sustainability, processing 2.06 million TEUs in 2024. As West Africa's only natural deep-water port, Lome's 16.6-metre channel depth enables accommodation of ultra-large container vessels without tidal constraints, attracting ships diverted from congested Mediterranean hubs. The Mediterranean Shipping Company's full operational control, through Terminal Investment

Limited, has transformed Lome into a hub-and-spoke centre, achieving an average of 32.5 crane moves per hour and supporting transshipment traffic growth of 7.11% year-on-year. However, governance limitations, particularly regarding transparency, constrain Lome's ranking in the enabler pillar, highlighting a disconnect between operational efficiency and institutional oversight.

Cape Town ranks third, benefitting from an unanticipated surge in vessel traffic due to Red Sea diversions, which have prompted ships to reroute via the Cape of Good Hope. This influx has strained local infrastructure, resulting in average

waiting times exceeding six days and causing major carriers such as Maersk to omit scheduled calls. Nevertheless, Cape Town's strategic relevance along the Cape Route has grown, and its robust transparency ranking matches Durban's governance standards. The port primarily serves the Western Cape economy, limiting its transshipment activities compared to Durban and Lome. Persistent infrastructure challenges, however, offer potential for private sector involvement, especially in light of South Africa's recent drive to encourage investment in port operations.

| RANK | ENABLERS | CONNECTIVITY & CUSTOMER VALUE | PRODUCTIVITY | SUSTAINABILITY | OVERALL IMPACT | OVERALL RANK |
|------|----------------|-------------------------------|--------------|-------------------|----------------|--------------|
| 1 | DURBAN | LOME | DURBAN | LOME | DURBAN | DURBAN |
| 2 | CAPE TOWN | DURBAN | MOMBASA | PORT ELIZABETH | LOME | LOME |
| 3 | COEGA | MOMBASA | LOME | MOMBASA | MOMBASA | CAPE TOWN |
| 4 | PORT ELIZABETH | CAPE TOWN | CAPE TOWN | POINTE DES GALETS | CAPE TOWN | MOMBASA |
| 5 | LOME | POINTE DES GALETS | COEGA | COEGA | COEGA | COEGA |



MIDDLE EAST

Ranked eighth globally, Jebel Ali continues to assert its position as the Middle East's leading container gateway, topping regional scores in enablers, connectivity, and overall impact. Its dominance reflects decades of investment in large-scale infrastructure and a dense mainline network that links the Gulf with Asia, Europe, and Africa. Integration with Etihad Rail, which will connect both Dubai and Abu Dhabi ports, is set to expand inland distribution and strengthen regional import-export flows. However, sustainability remains a critical area for improvement. Jebel Ali shows the region's widest gap in alternative-fuel readiness and shore-power availability, both of which fall below global benchmarks and represent core priorities for future development.

Abu Dhabi's Khalifa Port has emerged as the UAE's fastest-growing counterpart, ranking

second globally for percentage TEU growth and tenth for absolute throughput gains. Long-term concessions, including CSP Abu Dhabi Terminal (COSCO) and the CMA Terminals joint venture, make it the only Gulf port with dedicated terminals operated by three of the world's top five carriers: COSCO, CMA CGM, and MSC. These achievements reflect AD Ports Group's ambition to become a major global player, supported by strategic and sustainability-focused planning. New agreements with Nimex Terminals to develop LNG and LPG hubs, combined with Etihad Rail-linked customs corridors connecting the port with KEZAD and the wider GCC, position Khalifa Port as a future low-carbon, multimodal hub. Earlier investments in alternative-fuel infrastructure, including shore power at CMA Terminal, align the port with the UAE's net-zero strategy and place it on a faster sustainability trajectory than Jebel Ali. Digital integration, led by Maqta Technologies,

is driving the adoption of advanced solutions, including autonomous technologies and robotics, reinforcing Khalifa Port's role as a technology leader.

On the Gulf coast, King Abdulaziz Port (Dammam) remains Saudi Arabia's principal container hub, supporting national logistics ambitions under Vision 2030. Its strong connectivity performance is driven by targeted liner-network expansion and customer-engagement strategies, while new concessions and terminal upgrades are set to lift capacity and modernise operations. On the Red Sea, Jeddah Islamic Port is undergoing a parallel wave of improvements, including DP World's renewed South Container Terminal and a planned Terminal 4 developed with RSGT and CMA CGM, reinforcing its role as the country's primary east-west gateway. In contrast, King Abdullah Port has been heavily impacted by Red Sea security disruptions and the rerouting of services around the Cape of Good Hope, with throughput falling sharply in 2024, an 82.7% decline driven by the collapse in discretionary transshipment volumes.

| RANK | ENABLERS | CONNECTIVITY & CUSTOMER VALUE | PRODUCTIVITY | SUSTAINABILITY | OVERALL IMPACT | OVERALL RANK |
|------|---------------------|-------------------------------|---------------------|---------------------|---------------------|---------------------|
| 1 | JEBEL ALI (DUBAI) | JEBEL ALI (DUBAI) | JEBEL ALI (DUBAI) | KHALIFA (ABU DHABI) | JEBEL ALI (DUBAI) | JEBEL ALI (DUBAI) |
| 2 | KHALIFA (ABU DHABI) | DAMMAM | DAMMAM | ASHDOD | KHALIFA (ABU DHABI) | KHALIFA (ABU DHABI) |
| 3 | KING ABDULLAH PORT | JEDDAH | KHALIFA (ABU DHABI) | KING ABDULLAH PORT | DAMMAM | DAMMAM |
| 4 | JEDDAH | KHALIFA (ABU DHABI) | AQABA | DAMMAM | SALALAH | JEDDAH |
| 5 | ASHDOD | HAMAD | SALALAH | JEBEL ALI (DUBAI) | JEDDAH | ASHDOD |



NORTHERN CHINA

Northern China's container ports have established themselves as some of the most influential and innovative hubs in global maritime trade. Shanghai, consistently ranked as the world's busiest container port, demonstrates a remarkable blend of scale, efficiency, and sustainability. Its unmatched throughput of over 51 million TEUs annually is underpinned by world-class infrastructure and institutional expertise, making it a benchmark for operational excellence. The Shanghai Municipal Commission of Transport has been central to Shanghai Port's transformation into a world-leading international shipping centre, coordinating comprehensive port development strategies and multimodal transport integration, overseeing the construction of facilities such as the Xiaoyangshan North Operation Area that enabled Shanghai to become the first port globally to exceed 50 million TEUs annually. Through implementation of smart port technologies and green

fuel infrastructure development, the Commission has fostered an advanced maritime ecosystem. Shanghai's strengths are further evidenced by Shanghai's leadership in connectivity and its robust investment in alternative fuels, as well as the development of green shipping corridors that reinforce its position as a comprehensive hub connecting production centres with global consumption markets.

Meanwhile, Ningbo-Zhoushan is rapidly closing the gap with Shanghai, having secured a reputation as the world's most productive container port. Advanced automation technologies and streamlined cargo handling have propelled it to the forefront of the industry, enabling exceptionally swift vessel turnaround times. The governance structure, Ningbo Municipal Port Bureau, overseeing Ningbo-Zhoushan Port has driven the integration and development of China's largest cargo-handling port complex through strategic consolidation and infrastructure investment, with the unified port group now operating China's

most extensive network of super-large deepwater berths with natural harbour advantages. Its strategic integration into the Belt and Road Initiative and its growing role as an alternative gateway during periods of congestion reinforce its rising global significance. However, there remains potential for further progress in sustainability and investment in green infrastructure.

Completing the region's top three, Qingdao stands out as a pioneer in port automation. As home to the world's first fully automated container terminal, Qingdao leverages artificial intelligence and autonomous vehicles to set new standards in efficiency and technological sophistication. While it is geographically more distant from the Yangtze River Delta's economic powerhouse, Qingdao continues to expand its market share and deepen its integration with global liner services, solidifying its position as a leader in smart port operations.

These achievements are complemented by rapid growth in ports such as Jiaxing, underlining Northern China's role as a dynamic engine for innovation and expansion in the global shipping industry. Altogether, four ports from this region have secured places in the world's top 50, underscoring the strategic and competitive strength that underpins the area's continuing ascent in international maritime logistics.

| RANK | ENABLERS | CONNECTIVITY & CUSTOMER VALUE | PRODUCTIVITY | SUSTAINABILITY | OVERALL IMPACT | OVERALL RANK |
|------|-----------------|-------------------------------|-----------------|-----------------|-----------------|-----------------|
| 1 | SHANGHAI | SHANGHAI | NINGBO-ZHOUSHAN | SHANGHAI | SHANGHAI | SHANGHAI |
| 2 | NINGBO-ZHOUSHAN | NINGBO-ZHOUSHAN | SHANGHAI | LIANYUNGANG | NINGBO-ZHOUSHAN | NINGBO-ZHOUSHAN |
| 3 | TANGSHAN | QINGDAO | QINGDAO | YANTAI | QINGDAO | QINGDAO |
| 4 | QINGDAO | DALIAN | JIAXING | NINGBO-ZHOUSHAN | TIANJIN | TIANJIN |
| 5 | JIAXING | TIANJIN | NANTONG | TAICANG | DALIAN | LIANYUNGANG |



KOREA & JAPAN

Busan, positioned fourth in the global rankings, has established itself as a leading force in international shipping, exerting considerable regional influence through its robust transshipment services and exceptional operational efficiency. The port demonstrates excellence across four of five critical performance metrics, adeptly managing substantial volumes of transshipment cargo that connect China, Japan, and Korea via prominent trans-Pacific and Asia-Europe routes. Busan Port Authority has transformed Busan into Northeast Asia's leading transshipment hub through ambitious infrastructure development and operational innovation, managing comprehensive berth expansion programmes, including the ongoing Jinhae New Port project with 66 planned berths capable of accommodating 30,000 TEU-class vessels, which will increase the port's container capacity to 39.66 million TEUs by 2045. The Authority has pioneered digital solutions such as the blockchain-based Chain Portal platform, enabling real-time terminal monitoring

and vehicle booking systems that significantly reduce truck waiting times and improve operational efficiency. Busan's superior liner shipping connectivity, cutting-edge management practices, and extensive adoption of terminal automation facilitate swift vessel turnaround, a key advantage for supply chains where time is of the essence. Strategic investments in alternative-fuel supply infrastructure and emissions-reduction initiatives further affirm the port's commitment to meeting evolving regulatory standards. Despite being ranked seventh in enablers due to its geographic distance from major metropolitan centres, Busan's operational strengths, including high berth productivity and the capacity to accommodate peak volumes, effectively offset locational challenges and reinforce its competitive standing within the region.

Tokyo claims second place in the regional rankings, distinguished by its unparalleled proximity to economic activity. Serving the Greater Tokyo Area, which boasts a \$2 trillion economy, Tokyo stands as Japan's foremost container gateway. Its leading position in enablers is attributable to direct access to the nation's largest consumer market and manufacturing hub, underpinned by

transparent governance frameworks emblematic of Japanese institutional excellence. While Tokyo ranks third in connectivity, reflecting its primary role as a gateway port rather than a transshipment hub, it excels in productivity. The port's operational strengths underpin just-in-time logistics, which are crucial for Japan's manufacturing and export sectors, thereby cementing Tokyo's indispensable role in supporting domestic consumption and outbound trade.

Yokohama rounds out the top three, striking a careful balance between gateway operations and a complementary partnership with Tokyo to serve the wider Kanto region. The port's second-place ranking in connectivity attests to its historical significance and enduring relationships with leading shipping lines, which enable it to maintain a diverse and resilient service portfolio. Yokohama's operational model integrates both gateway and transshipment functions, demonstrating adaptability to shifting competitive pressures while sustaining high levels of productivity and customer value. This flexibility ensures Yokohama's continued prominence within the regional port ecosystem, supporting both local industry and international trade flow.

| RANK | ENABLERS | CONNECTIVITY & CUSTOMER VALUE | PRODUCTIVITY | SUSTAINABILITY | OVERALL IMPACT | OVERALL RANK |
|------|----------|-------------------------------|--------------|----------------|----------------|--------------|
| 1 | TOKYO | BUSAN | BUSAN | BUSAN | BUSAN | BUSAN |
| 2 | KOBE | YOKOHAMA | TOKYO | YOKOHAMA | TOKYO | TOKYO |
| 3 | YOKOHAMA | TOKYO | KOBE | HAKATA | YOKOHAMA | YOKOHAMA |
| 4 | OSAKA | NAGOYA | NAGOYA | TOKYO | INCHEON | KOBE |
| 5 | NAGOYA | INCHEON | YOKOHAMA | NAGOYA | NAGOYA | NAGOYA |



CENTRAL-EAST ASIA

All the region's top five ports have secured positions within the global top 50. Notably, using only objective assessment places Kaohsiung ahead of Shenzhen, despite Shenzhen's higher ranking in the overall global standings. This highlights a distinct divergence between expert opinion and actual port performance.

Regionally, Kaohsiung stands out for its balanced strengths in both enablers and productivity, reflecting Taiwan's robust governance and operational efficiency. The port benefits from its strategic proximity to Taiwan's manufacturing centres, superior infrastructure, and transparent governance frameworks, setting it apart from its mainland Chinese counterparts. Kaohsiung's leadership in productivity is underpinned by advanced cargo-handling capabilities, terminal automation, and effective workforce management, hallmarks of Taiwan's industrial competitiveness.

Nevertheless, the port's connectivity lags behind Hong Kong's extensive liner service network, and lower sustainability scores indicate a need for accelerated investment in green infrastructure to address environmental challenges.

Shenzhen has become Southern China's pre-eminent container port, claiming first place in both sustainability and overall impact through significant strategic investment and operational scale. The port's sustainability credentials are exemplified by pioneering initiatives, such as the implementation of shore power and emissions reduction, which align with China's broader environmental policy objectives. Its dominance in overall impact is driven by the region's largest market share, with over 33 million TEUs handled across major terminal complexes, including Yantian, Shekou, Chiwan, and Dachan Bay. However, Shenzhen's lower scores in connectivity and productivity indicate ongoing challenges in network integration when compared with Hong

Kong and Kaohsiung.

Hong Kong retains third place, distinguished by its leadership in connectivity and its enduring reputation as a neutral, business-friendly maritime hub. The port's extensive liner services and strong global shipping partnerships are a testament to decades of institutional excellence and transparent governance. However, Hong Kong's lower scores in enablers are attributable to limited land availability, which restricts infrastructure development and results in higher operational costs. Additionally, lower rankings in productivity and sustainability suggest that ageing terminal facilities and the slow adoption of green technologies are hindering its competitiveness relative to mainland Chinese ports. It is also noteworthy that Qinzhou (Beibu Gulf), although ranked sixth in the region, is exhibiting the fastest growth trajectory.

| RANK | ENABLERS | CONNECTIVITY & CUSTOMER VALUE | PRODUCTIVITY | SUSTAINABILITY | OVERALL IMPACT | OVERALL RANK |
|------|-----------|-------------------------------|----------------------|----------------|----------------|--------------|
| 1 | KAOHSIUNG | HONG KONG | KAOHSIUNG | SHENZHEN | SHENZHEN | KAOHSIUNG |
| 2 | SHENZHEN | KAOHSIUNG | QINZHOU (BEIBU GULF) | GUANGZHOU | GUANGZHOU | SHENZHEN |
| 3 | GUANGZHOU | XIAMEN | GUANGZHOU | XIAMEN | KAOHSIUNG | HONG KONG |
| 4 | HONG KONG | SHENZHEN | SHENZHEN | DONGGUAN | XIAMEN | XIAMEN |
| 5 | KEELUNG | GUANGZHOU | XIAMEN | QUANZHOU | HONG KONG | GUANGZHOU |

SOUTH-EAST ASIA

The South-East Asian port sector is characterised by a dynamic interplay of established leaders and rapidly ascending challengers, each shaping the region's evolving maritime landscape. Singapore stands as a good example, having consistently cultivated a robust institutional framework and invested strategically in cutting-edge infrastructure. The Maritime and Port Authority of Singapore has been instrumental in establishing Singapore as a global hub port and international maritime centre, driving the development of infrastructure including the Tuas Port project. Singapore's port not only handles highest transshipment volumes and comprehensive carrier coverage but also leads in adopting sustainable practices such as alternative fuel bunkering and green shipping initiatives, supported by MPA's proactive regulatory framework and strategic international collaborations. This commitment to innovation has enabled Singapore to set the benchmark for maritime efficiency and environmental stewardship, reinforcing its status as both a regional and global hub.

Port Klang, occupying a strong second place, underpins Malaysia's economic development by facilitating both transshipment and gateway cargo flows. The port's strategic integration into regional feeder networks and its substantial throughput highlight its pivotal role within the Malacca Strait corridor. Nevertheless, Port Klang faces challenges in governance and infrastructure that temper its competitive edge, particularly in the areas of operational efficiency and sustainability. Continued investment in these domains will be crucial for maintaining its position amid intensifying competition from emerging regional players.

Completing the top three, Laem Chabang serves as Thailand's principal maritime gateway, closely linked to the nation's thriving industrial heartland. Its proximity to major manufacturing zones has strengthened its role as a primary export conduit for automotive, electronics, and consumer goods. However, the port's limited connectivity and lower sustainability scores emphasize the need for further enhancements, particularly in environmental management and the adoption of green technologies.

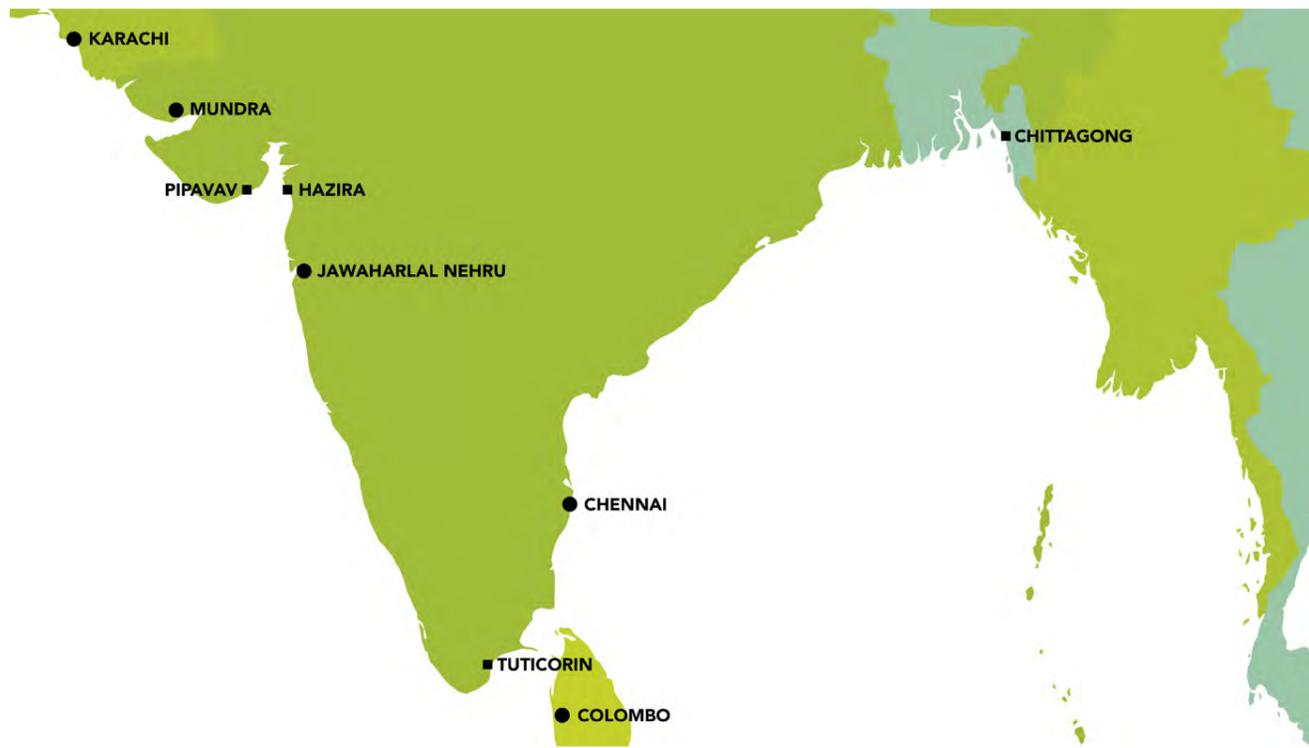


Ports including Cai Mep and Ho Chi Minh City illustrate the significant growth potential of the region, demonstrating substantial improvements in both environmental performance and berth productivity. Nevertheless, Manila outperformed these ports, achieving higher scores in the enablers and connectivity categories, particularly excelling in proximity to economic activities, number of customers, and mainline service offerings.

Tanjung Pelepas, situated near the southern tip of Peninsular Malaysia by the strategic Malacca Strait, has dropped out of the region's top five

ports. While it has improved throughput and operational efficiency, the port faces stiff competition from Singapore and Port Klang, primarily due to weaker connectivity metrics, a smaller customer base, and a lower Liner Shipping Connectivity Index (LSCI). Continued investment in infrastructure, technology, and sustainability will be crucial for Tanjung Pelepas to regain its competitive standing in the South-East Asian port sector. However, it is essential to note that the port achieved a position within the top 50, ranking 33rd due to favourable expert evaluations.

| RANK | ENABLERS | CONNECTIVITY & CUSTOMER VALUE | PRODUCTIVITY | SUSTAINABILITY | OVERALL IMPACT | OVERALL RANK |
|------|---------------|-------------------------------|-----------------|------------------|-----------------|--------------|
| 1 | SINGAPORE | SINGAPORE | SINGAPORE | SINGAPORE | SINGAPORE | SINGAPORE |
| 2 | LAEM CHABANG | PORT KLANG | BANGKOK | HO CHI MINH CITY | CAI MEP | PORT KLANG |
| 3 | MANILA | HAI PHONG | TANJUNG PELEPAS | BANGKOK | HAI PHONG | LAEM CHABANG |
| 4 | PORT KLANG | MANILA | LAEM CHABANG | CAI MEP | LAEM CHABANG | HAI PHONG |
| 5 | TANJUNG PRIOK | LAEM CHABANG | PORT KLANG | PORT KLANG | TANJUNG PELEPAS | MANILA |



INDIAN SUBCONTINENT

Mundra has emerged as the leading port in the Indian subcontinent, closely rivalled by Jawaharlal Nehru Port, both of which compete for supremacy within India's pivotal maritime sector. Mundra stands as a testament to private-sector excellence, with Adani Ports' operational prowess propelling it to the forefront of national port rankings in both productivity and overall impact. Distinguished as India's first automated terminal, Mundra's pre-eminence in productivity is underpinned by advanced cargo-handling technologies and an advantageous position along the western manufacturing corridor. The port caters to all major global shipping lines and commands the region's largest market share, efficiently managing a wide spectrum of cargo from textiles to automotive components. Its robust connectivity, ranked second, demonstrates an extensive suite of mainline services, successfully challenging

the traditional dominance of Mumbai. Notably, Mundra placed ninth globally in terms of growth rate (percentage), illustrating its considerable potential.

Jawaharlal Nehru Port (JNPT) secures second place, buoyed by its historic legacy and unparalleled access to Mumbai's vast metropolitan economy. However, operational limitations have allowed Mundra to gain a competitive edge in market share. JNPT's leadership in enablers is largely attributed to its strategic proximity to Maharashtra's industrial heartland, but its fifth-place ranking for productivity highlights persistent infrastructural bottlenecks that hinder throughput expansion. With a third-place ranking in connectivity, JNPT maintains strong relationships with international shipping lines. Current efforts to expand terminal capacity and introduce digitalisation are aimed at regaining its competitive position. However, governance issues and congestion continue to impede performance

when compared to Mundra's agile private-sector operations.

Colombo distinguishes itself as South Asia's premier transshipment hub, ranking first in both connectivity and sustainability. Sri Lanka's neutral stance enables Colombo to serve as a crucial conduit, connecting Indian subcontinent feeder routes with global mainline services bound for Europe, East Asia, and the Americas. Its top ranking for liner shipping connectivity and the breadth of its mainline offerings underscore its strategic value to international shipping alliances. Moreover, Colombo leads the region in sustainability, achieving emission reductions that outpace its peers. Nonetheless, its relative remoteness from key economic centres and ongoing governance challenges tempers its enablers' performance, leaving the port vulnerable despite its operational strengths.

| RANK | ENABLERS | CONNECTIVITY & CUSTOMER VALUE | PRODUCTIVITY | SUSTAINABILITY | OVERALL IMPACT | OVERALL RANK |
|------|------------------|-------------------------------|------------------|------------------|------------------|------------------|
| 1 | JAWAHARLAL NEHRU | COLOMBO | MUNDRA | COLOMBO | MUNDRA | MUNDRA |
| 2 | MUNDRA | MUNDRA | COLOMBO | TUTICORIN | JAWAHARLAL NEHRU | JAWAHARLAL NEHRU |
| 3 | CHENNAI | JAWAHARLAL NEHRU | KARACHI | PIPAVAV | COLOMBO | COLOMBO |
| 4 | TUTICORIN | KARACHI | CHITTAGONG | MUNDRA | CHITTAGONG | CHENNAI |
| 5 | HAZIRA | CHITTAGONG | JAWAHARLAL NEHRU | JAWAHARLAL NEHRU | KARACHI | KARACHI |



OCEANIA

A dynamic interplay of economic strength, connectivity, and sustainability marks the port landscape in Oceania. Sydney's Port Botany maintains its position at the forefront, owing to its strategic economic access and robust institutional framework. The port excels in enablers, owing to its proximity to Australia's largest metropolitan economy and the exemplary transparency embedded in national governance standards. Its infrastructure is both modern and resilient, underpinning significant trade flows that are vital to the region's prosperity. Port Botany efficiently links Australia to critical Asian and trans-Pacific markets. Despite these strengths, Melbourne emerges as the leader in overall impact, driven by its commanding throughput and dominant market share, powered by the excellence of DP World.

Melbourne's port stands out for its remarkable productivity and its pivotal role in serving Victoria's thriving import market. The facility's operational efficiency is demonstrated by streamlined terminal processes that maximise cargo handling and throughput. This productivity, coupled with Melbourne's status as Australia's second-largest metropolitan area, underpins its leadership in regional market share and growth. Nevertheless, Melbourne's relative distance from Sydney's larger economic hub is reflected in its sixth-place ranking for enablers. Environmental progress remains a challenge, highlighting the need for accelerated investment in green infrastructure.

Brisbane rounds out the region's top three, serving as Queensland's principal maritime gateway and an increasingly significant player in Oceania's trade network. Its strong performance in connectivity and overall impact is a

testament to effective liner service offerings and a growing market presence, both of which are vital to Queensland's resource-driven economy and burgeoning population. However, the port faces notable challenges in infrastructure and geographic positioning, ranking it lower in enablers. Productivity and sustainability indicators suggest ongoing operational and environmental hurdles, yet recent terminal upgrades and modernisation efforts signal a commitment to enhanced efficiency and reduced environmental impact, supporting Queensland's continued economic expansion.

| RANK | ENABLERS | CONNECTIVITY & CUSTOMER VALUE | PRODUCTIVITY | SUSTAINABILITY | OVERALL IMPACT | OVERALL RANK |
|------|----------|-------------------------------|--------------|----------------|----------------|--------------|
| 1 | SYDNEY | SYDNEY | MELBOURNE | SYDNEY | MELBOURNE | SYDNEY |
| 2 | TAURANGA | MELBOURNE | SYDNEY | TAURANGA | SYDNEY | MELBOURNE |
| 3 | NAPIER | BRISBANE | TAURANGA | NELSON | BRISBANE | BRISBANE |
| 4 | NELSON | TAURANGA | ADELAIDE | WELLINGTON | TAURANGA | TAURANGA |
| 5 | OTAGO | FREMANTLE | FREMANTLE | LYTTELTON | FREMANTLE | LYTTELTON |

APPENDIX A: OVERALL CONTAINER PORT RANKINGS

| | SINGAPORE | SHANGHAI | NINGBO-ZHOUSHAN | BUSAN | ROTTERDAM | QINGDAO | SHENZHEN | JEBEL ALI (DUBAI) | KAHSIUNG | ANTWERP-BRUGES | HONG KONG | GUANGZHOU | PORT KLANG | HAMBURG | LOS ANGELES | XIAMEN | TOKYO | NEW YORK & NEW JERSEY | TANGER MED | MUNDRA |
|---|-----------|----------|-----------------|-------|-----------|---------|----------|-------------------|----------|----------------|-----------|-----------|------------|---------|-------------|--------|-------|-----------------------|------------|--------|
| Overall rank | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| ENABLERS | | | | | | | | | | | | | | | | | | | | |
| Proximity to Economic Activity | 17 | 11 | 14 | 48 | 13 | 21 | 18 | 43 | 10 | 12 | 24 | 18 | 37 | 39 | 3 | 30 | 7 | 1 | 42 | 44 |
| Berth length | 1 | 3 | 6 | 7 | 4 | 17 | 2 | 10 | 20 | 5 | 8 | 9 | 18 | 19 | 15 | 12 | 46 | 16 | 31 | 41 |
| Transparency & corruption | 1 | 31 | 31 | 23 | 2 | 31 | 31 | 14 | 16 | 13 | 31 | 31 | 28 | 5 | 17 | 31 | 8 | 17 | 44 | 42 |
| Q: Infrastructure for multi-modal connectivity | 1 | 2 | 5 | 8 | 3 | 8 | 6 | 11 | 13 | 11 | 7 | 8 | 15 | - | 4 | - | - | - | 15 | - |
| Q: Labor union management relationship | 1 | 2 | 7 | 6 | 10 | 8 | 3 | 10 | 4 | 16 | 4 | 10 | 14 | - | 8 | - | - | - | 17 | - |
| CONNECTIVITY & CUSTOMER VALUE | | | | | | | | | | | | | | | | | | | | |
| Number of top 15 customers | 1 | 1 | 1 | 14 | 28 | 1 | 1 | 1 | 14 | 28 | 1 | 1 | 1 | 28 | 28 | 1 | 14 | 28 | 28 | 1 |
| Liner Shipping Connectivity Index | 3 | 1 | 2 | 4 | 8 | 5 | - | 12 | 11 | 9 | 6 | - | 7 | 16 | 41 | 10 | 20 | 29 | 25 | 17 |
| Number of mainline services | 1 | 2 | 3 | 4 | 9 | 6 | 11 | 18 | 8 | 12 | 7 | - | 5 | 19 | 37 | 10 | 29 | 28 | 15 | 22 |
| Q: Future plans for scalable expansion | 1 | 2 | 4 | 3 | 7 | 11 | 9 | 6 | 12 | 16 | 16 | 5 | 7 | - | 13 | - | - | - | 15 | - |
| Q: Responsiveness & ease in business dealings | 1 | 2 | 6 | 4 | 10 | 12 | 5 | 12 | 9 | 14 | 3 | 7 | 8 | - | 14 | - | - | - | 16 | - |
| Q: Accuracy & timeliness of information | 1 | 2 | 3 | 5 | 19 | 15 | 6 | 10 | 7 | 15 | 4 | 8 | 13 | - | 9 | - | - | - | 15 | - |
| Q: Value-added services offered | 1 | 2 | 9 | 7 | 5 | 11 | 11 | 3 | 7 | 10 | 3 | 6 | 13 | - | 13 | - | - | - | 17 | - |
| Q: Reliability of port infrastructure | 1 | 2 | 4 | 6 | 4 | 6 | 3 | 9 | 8 | 14 | 12 | 12 | 11 | - | 10 | - | - | - | 16 | - |
| PRODUCTIVITY | | | | | | | | | | | | | | | | | | | | |
| Berth utilisation | 10 | 12 | 1 | 13 | 30 | 5 | 49 | 20 | 28 | 39 | 43 | 37 | 15 | 27 | 35 | 44 | 18 | 38 | 19 | 4 |
| Berth productivity | 15 | 7 | 36 | 22 | 42 | 6 | 3 | 29 | 31 | 28 | 11 | 5 | 19 | 42 | 19 | 8 | 22 | 19 | 8 | 17 |
| Peak volume | 3 | 2 | 1 | 7 | 5 | 4 | 11 | 6 | 8 | 12 | 17 | 13 | 21 | 20 | 16 | 9 | 28 | 18 | 14 | 19 |
| Q: Just in time effectiveness | 1 | 2 | 4 | 5 | 9 | 7 | 3 | 12 | 8 | 17 | 5 | 9 | 14 | - | 16 | - | - | - | 17 | - |
| Q: Leading in digitalisation and automation processes | 1 | 2 | 5 | 5 | 3 | 8 | 4 | 10 | 14 | 12 | 11 | 5 | 16 | - | 9 | - | - | - | 16 | - |
| SUSTAINABILITY | | | | | | | | | | | | | | | | | | | | |
| Emissions per TEU | 17 | 6 | 35 | 21 | 50 | 7 | 1 | 28 | 26 | 29 | 9 | 5 | 24 | 44 | 32 | 8 | 13 | 39 | 10 | 23 |
| Emissions per port call | 33 | 15 | 39 | 19 | 13 | 28 | 6 | 37 | 10 | 38 | 7 | 18 | 23 | 22 | 50 | 11 | 1 | 46 | 24 | 35 |
| Availability of alternative fuels | 2 | 3 | 10 | 7 | 1 | 10 | 5 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Onshore power supply | 12 | 12 | 12 | 12 | 10 | 12 | 5 | 12 | 12 | 11 | 12 | 9 | 12 | 2 | 1 | 12 | 12 | 3 | 12 | 12 |
| Number of green vessel calls | 4 | 1 | 3 | 6 | 2 | 8 | 11 | 37 | 12 | 5 | 18 | 16 | 14 | 7 | 37 | 9 | 23 | 21 | 24 | 28 |
| Number of green corridor initiatives | 1 | 6 | 14 | 6 | 3 | 14 | 14 | 14 | 14 | 6 | 14 | 6 | 14 | 6 | 2 | 14 | 14 | 14 | 14 | 14 |
| Q: Leading in sustainable environmental processes | 1 | 3 | 5 | 8 | 4 | 9 | 7 | 10 | 14 | 6 | 12 | 10 | 15 | - | 2 | - | - | - | 15 | - |
| Q: Leading multi-fuel bunkering port | 1 | 2 | 4 | 6 | 3 | 8 | 5 | 8 | 13 | 11 | 6 | 12 | 14 | - | 10 | - | - | - | 14 | - |
| OVERALL IMPACT | | | | | | | | | | | | | | | | | | | | |
| Market share (throughput) | 1 | 8 | 14 | 2 | 10 | 24 | 7 | 6 | 34 | 11 | 26 | 12 | 31 | 5 | 15 | 29 | 38 | 23 | 3 | 16 |
| Market share (vessel calls) | 6 | 4 | 8 | 7 | 1 | 26 | 15 | 3 | 18 | 27 | 10 | 22 | 31 | 2 | 38 | 24 | 20 | 13 | 14 | 16 |
| Growth rate (throughput) (%) | 19 | 21 | 6 | 27 | 47 | 5 | 11 | 17 | 44 | 18 | 50 | 23 | 29 | 48 | 41 | 33 | 25 | 40 | 4 | 9 |
| Growth rate (throughput) (absolute) | 6 | 4 | 1 | 13 | 49 | 2 | 3 | 11 | 47 | 15 | 50 | 9 | 21 | 48 | 44 | 31 | 27 | 43 | 7 | 14 |
| Volume of TEU handled | 2 | 1 | 3 | 7 | 11 | 5 | 4 | 9 | 20 | 13 | 12 | 6 | 10 | 24 | 16 | 14 | 36 | 22 | 17 | 23 |
| Volume of transshipment TEU handled | 1 | 6 | 11 | 3 | 14 | 22 | 24 | 8 | 7 | 9 | 10 | - | 16 | 21 | 42 | 25 | 44 | 39 | 2 | 23 |
| Number of vessels call | 2 | 1 | 3 | 4 | 5 | 11 | 9 | 16 | 12 | 18 | 7 | 13 | 10 | 14 | 44 | 15 | 6 | 38 | 25 | 31 |
| Number of mega vessel call | 1 | 2 | 3 | 14 | 4 | 5 | 29 | 28 | 13 | 6 | 17 | 16 | 22 | 7 | 31 | 8 | 31 | - | 11 | 31 |
| Q: Global centres for ports and logistics | 2 | 1 | 3 | 8 | 5 | 7 | 4 | 9 | 14 | 11 | 13 | 6 | 12 | - | 10 | - | - | - | 17 | - |

APPENDIX B: METHODOLOGY AND DATA SOURCES

DEFINITIONS

WHAT IS THE DEFINITION OF A LEADING CONTAINER PORT?

A leading container port is a strategically positioned maritime hub that plays a vital role in global trade and supply chain by handling high volumes of containerised cargo and offering strong liner connectivity. It also has strong operational capabilities and possesses advanced infrastructure and technological abilities. These ports are distinguished by their deepwater berths, modern terminal infrastructure, and advanced cargo handling equipment, enabling efficient operations. They are pioneers in adopting digital and automation technologies, including smart port systems, real-time data sharing, and automated handling processes. Sustainability is a core focus, with investments in shore power infrastructure, alternative fuel bunkering, and other green initiatives. Furthermore, leading container ports foster a collaborative ecosystem among shipping lines, terminal operators, logistics providers, and regulatory authorities, ensuring seamless and resilient operations. Their success is driven by factors such as strategic location, proximity to production and trade centres, transparent governance, investment in infrastructure and technology and access to skilled talent and innovation networks.

WHAT IS A PORT AND ITS GEOGRAPHIC BOUNDARIES?

In this report, the boundaries of a port are defined by functional connectivity rather than formal administrative divisions. The port

region includes all areas that encompass not only the core waterfront infrastructure but also surrounding terminals, logistics centres, industrial zones, and supporting service providers that are economically and operationally linked to port activities. By focusing on real-world accessibility and integration, this approach captures the full extent of a port's economic footprint and influence.

DESCRIPTION OF DATA SOURCES AND METHODOLOGY EXPERTS' ASSESSMENT

We engaged a global panel of Maritime Industry Experts who provided in-depth evaluations of ports within their respective regions. Each expert also participated in ranking nominated ports across a broad set of indicators.

SUBJECTIVE ASSESSMENT

We surveyed a global panel of experts representing different parts of the container transport chain. The respondents thoroughly assessed the top-nominated ports across a wide range of indicators. In total, we received responses from 41 experts based in eight cities across seven countries. The respondents represent a variety of positions across liner headquarters, regional headquarters, and offices. A majority (73 per cent) reported experience with more than 20 ports, while the remaining respondents reported experience with between 6 and 20 ports.

In total, 43 per cent of the respondents are based in the Southern China and Taiwan region, while a further 40 per cent are based

in South-East Asia, all of whom are located in Singapore. The remaining participants are based in Korea and Japan, South America, the Mediterranean and North Africa, and Europe.

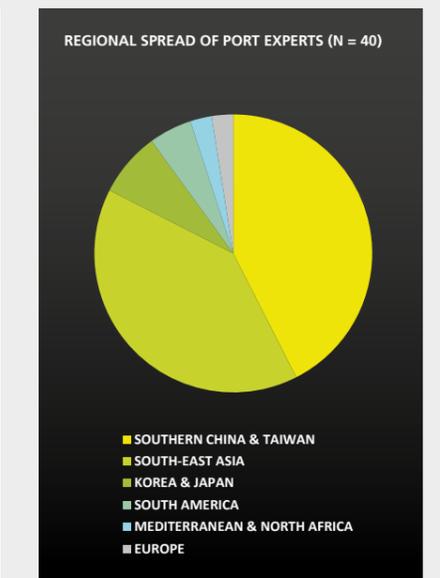
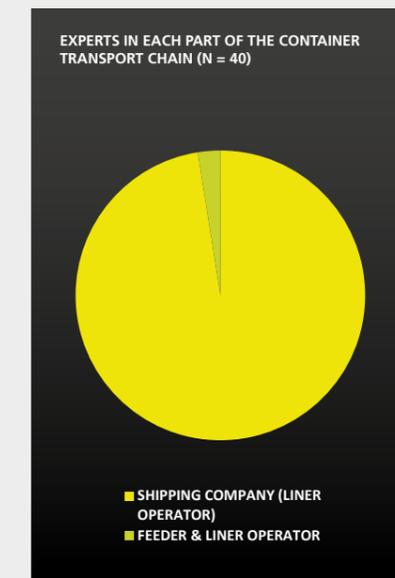
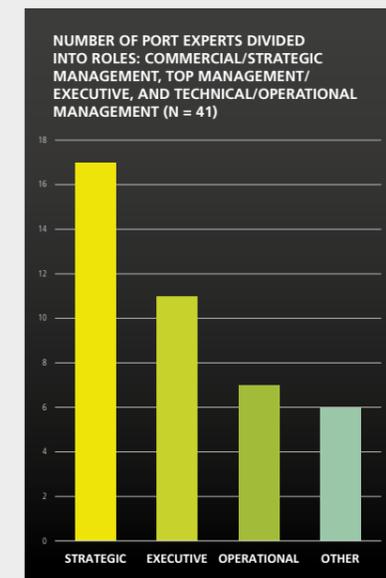
Clearly, the distribution of respondents is not globally balanced. However, it reflects the nature of global container shipping, in which cities such as Singapore, Hong Kong, Shanghai, and Tokyo host the global HQs of major shipping companies, as noted in the Leading Maritime Cities publication. Additionally, Asian ports account for a significant share of total container throughput, indicating higher activity in the region. Nevertheless, this may introduce a degree of home bias toward the largest ports, as respondents based in major hubs may be more inclined to rate their own location slightly higher.

Statistical tests show that Singapore-based respondents (which include non-Singaporean nationalities) tend to rate Singapore higher than respondents from other regions, and this difference is statistically significant. However, excluding Singapore-based responses from the analysis did not change the overall rankings. Therefore, this potential bias not affect the overall conclusions of the study.

ENABLERS

WORLD BANK DATABASE

National GDP figures for various indicators were obtained from the World Bank database. For the proximity to economic activity indicator, both national and regional GDP data were considered to evaluate economic



size and connectivity. Regional GDP data originated from official national statistics agencies, including Eurostat for EU member states, the Bureau of Economic Analysis for the United States, and the Office for National Statistics for the UK, among others. Due to the range of sources, the term "official national statistics agencies" is used collectively. Data compilation and analysis were conducted by Menon Economics.

BERTH LENGTH

Berth length was calculated in Google Maps by visually inspecting ports and focusing on the placement of cranes and ships to estimate the total available wharf length. This approach enabled approximate measurements when official data was not readily available. The analysis was conducted by DNV.

TRANSPARENCY INTERNATIONAL

The Corruption Perceptions Index, which measures the perceived level of public sector corruption, is based on data from Transparency International.

CONNECTIVITY & CUSTOMER VALUE

AUTOMATIC IDENTIFICATION SYSTEM (AIS) MASTER MODEL, DNV

We referenced the Alphaliner Top 100 ranking and selected the top 15 shipping lines by fleet size. Using port call data for 2024, computed using DNV's AIS Master Model, we identified the number of operator groups that made calls to the port.

UNCTAD

We used the UNCTAD Liner Shipping Connectivity Index to measure port performance. The index is based on six components that measure both port connectivity and capacity.

ECONDB

We used Econdb to calculate the number of mainline services. The dataset provides detailed information on scheduled liner services, enabling us to identify and quantify mainline connectivity for each port.

PRODUCTIVITY

AUTOMATIC IDENTIFICATION SYSTEM (AIS) MASTER MODEL, DNV

Using UN/LOCODEs, all values were extracted from the DNV AIS Master Model to calculate berth hours, port hours, and weekly vessel calls for each port. TEU and LOA for vessels were obtained from IHS Fairplay for every port call, enabling accurate analysis of peak volumes and operational efficiency.

SUSTAINABILITY

AUTOMATIC IDENTIFICATION SYSTEM (AIS) MASTER MODEL, DNV

We used the DNV AIS Master Model emissions module to calculate emissions at each port in 2024. UN/LOCODEs were used to accurately identify the 160 ranked ports, ensuring precise allocation of emissions data to each location.

ALTERNATIVE FUEL INSIGHTS, DNV

DNV Alternative Fuel Insights was used to gather information on ports with LNG bunkering and shore power facilities. Ports were ranked by aggregate LNG bunker vessel tank capacity and total installed shore power capacity.

GLOBAL MARITIME FORUM

We used the Global Maritime Forum's 2024 report to determine the number of announced green shipping corridors. The report provides comprehensive insights into corridor initiatives, enabling us to identify and quantify announced green shipping routes globally.

OVERALL IMPACT

LLOYD'S LIST & DREWRY

We used Lloyd's List Top 100 Ports 2025, which ranks ports by TEU throughput and includes data from 2024. For ports beyond the top 100, we supplemented coverage using Drewry data.

ECONDB

We used Econdb to calculate transshipment throughput. The dataset provides detailed port-level data, enabling us to identify and quantify transshipment activity for each port.

AUTOMATIC IDENTIFICATION SYSTEM (AIS) MASTER MODEL, DNV

We utilised the DNV AIS Master Model to determine the number of vessel calls to each port in 2024, including those of ULCVs. The analysis was based on UN/LOCODEs for the 160 ranked ports to ensure accurate identification of ports. ULCVs were defined as those with a capacity greater than 20,000 TEU, and these were filtered separately to highlight calls by the largest container ships.

RANKING METHODOLOGY

The ranking methodology is based on the same framework used in the 2024 edition of the Leading Maritime Cities of the World, with a few small adjustments tailored to container ports.

The ranking process follows a bottom-up approach. It starts by identifying the 50 leading ports from a global pool of 160 ports. This selection is based on 23 objective indicators grouped into five pillars: "Enablers", "Connectivity & Customer Value", "Productivity", "Sustainability" and "Overall impact". From this group of 50 ports, 20 are selected for further assessment by experts from different parts of the container transport

chain. In the final stage, the analysis encompasses a total of 35 indicators, comprising 23 objective and 12 expert-based assessments. The combined results form an internal ranking of the 50 leading container ports worldwide, ensuring that the outcome reflects both data-driven performance and insights from experienced industry professionals.

To ensure comparability across indicators, each value is standardised using a simple normalisation method. This process standardises all indicators on a common scale by eliminating differences in units and magnitude. Indicators are then adjusted to minimise the influence of extreme values, ensuring that outliers do not unduly affect the results. Ports with missing data receive a small deduction to maintain consistency and fairness in the overall comparison.

The comprehensive ranking is determined at the global level, ensuring a consistent and thorough evaluation across all ports. Regional rankings, however, are derived exclusively from objective indicators, as the limited number of expert responses within each region does not permit a robust subjective assessment. Indicator values are normalised within each respective comparison group, which can result in minor discrepancies in scaling and consequently slight variations in scores between regional and global rankings. Specifically, while regional rankings apply normalisation within the region, the global ranking standardises indicators across the entire dataset. As a result, both the relative and average scores for each port may vary, and the ranking order of ports can shift between regional and global assessments.

All pillars are given equal weight in both the initial and final rankings, ensuring consistency and fairness in the evaluation of the ports. All indicators within each pillar are also equally weighted, with the sole exception of the emissions and customer satisfaction indicators. Together, these indicators hold the weight of one, as they measure closely related aspects of the port.

KEY STRENGTHS OF THE REPORT

A Wide Range of Indicators

The report moves beyond the traditional focus on throughput and productivity that has dominated many port performance studies. It introduces a comprehensive set of indicators that capture both current achievements and future potential. These include enabling factors such as infrastructure and governance, customer value through service quality, global connectivity, and sustainability measures. By integrating both lagging indicators, which reflect historical performance, and leading indicators, which signal future readiness, the methodology provides a balanced and forward-looking perspective on port competitiveness.

Expert Assessment

Quantitative data alone cannot fully explain

the dynamics of port performance. To address this, the report combines rigorous statistical benchmarking with qualitative insights from seasoned industry professionals. Survey insights were directly used in the rankings as part of subjective assessments, ensuring the rankings are grounded in the perspectives of industry participants across various roles. In addition, structured interviews were conducted to provide deeper reasoning and context behind the rankings. These interviews help uncover operational realities and offer valuable explanations for why ports perform as they do. This integrated approach ensures that the rankings reflect not only empirical data and survey responses, but also informed judgment and expert rationale, resulting in a richer understanding of the factors shaping the port performance.

Who Can Use It

The report serves as a practical decision-support tool for a broad range of stakeholders. Port authorities can benchmark their operations against global leaders to identify areas for improvement and guide strategic planning. Terminal operators gain clarity on where to focus investments for maximum impact, while shipping companies and logistics providers benefit from insights that inform network design, port selection, and partnership strategies. By combining robust quantitative measures with expert perspectives, the report delivers actionable intelligence that drives best practices and informed decision-making across the container port sector.

LIMITATIONS AND FUTURE IMPROVEMENTS

While this edition sets a new benchmark in container port evaluation, it does have certain limitations. Notably, the absence of call-size data, the number of containers handled during a vessel's port call, restricts a complete assessment of operational efficiency. Vessel waiting time, repeatedly emphasised by industry experts as a vital performance measure, was also excluded due to current computational constraints. Both metrics are strong candidates for future inclusion, promising to enhance the robustness of subsequent assessments. Emissions at ports were estimated using DNV's AIS master model, which provides a reasonable approximation, but integrating real ship emissions data would significantly improve accuracy and reliability.

Objective data collection for the top 160 container ports worldwide was achieved; however, the survey analysis was limited to the Top 20 ports due to computational limitations. As a result, only the Top 20 major container ports are included in the final rankings. Regional rankings rely solely on objective indicators, as there was insufficient expert response across all 14 regions to support a subjective analysis. While this approach ensures consistency, it may not fully capture qualitative nuances across regions.

Looking forward, DNV and Menon Economics are committed to addressing these challenges to enhance the accuracy and depth of future port performance evaluations. Expanding computational capacity, integrating additional performance metrics such as call size and vessel waiting time, and incorporating real emissions data will enable more robust and insightful benchmarking in the next editions of this publication.



