



# CLOSING THE GAPS

**Key Actions in  
Digitalization,  
Decarbonization  
and Resilience  
in the Maritime  
Sector**

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# FOREWORD

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**Define and identify,**  
on a global level,  
**the principal gaps in port and port-related infrastructure and to envisage a concrete action plan**  
to close those gaps.

This report is the culmination of an exercise that began with the closing remarks of our International Association of Ports and Harbors (IAPH) 2021 virtual World Ports Conference held during the second and third waves of the global pandemic. By then, the initial collapse of global demand for consumer goods, commodities and raw materials had been replaced by resurgent demand for consumables. This was boosted by rapid digitalization of retail activity and the replacement of entertainment and travel by domestic consumption way above anyone's expectations.

The impact of these demand swings on the entire global supply chain, and correspondingly on the maritime supply chain, is still being felt today. At the end of the 2021 conference our outgoing and incoming IAPH presidents concurred with the irrefutable fact that most ports were not prepared for such extreme swings, principally due to long term under-investment in port and port-related infrastructure. It was also recognized that the time needed to

plan, successfully lobby for, fund, invest, tender for and implement new or improved infrastructure in and around ports is far longer than it takes to design a new ultra-large container vessel, test out a new low or zero carbon bunker fuel, or program a new disruptive technological solution that on paper improves cargo flow efficiency.

IAPH therefore took the decision to define and identify, on a global level, the principal gaps in port and port-related infrastructure and to envisage a concrete action plan to close those gaps. These gaps were identified in terms of efficiency, connectivity and accessibility, digitalization, decarbonization, shipping costs and regulatory environment.

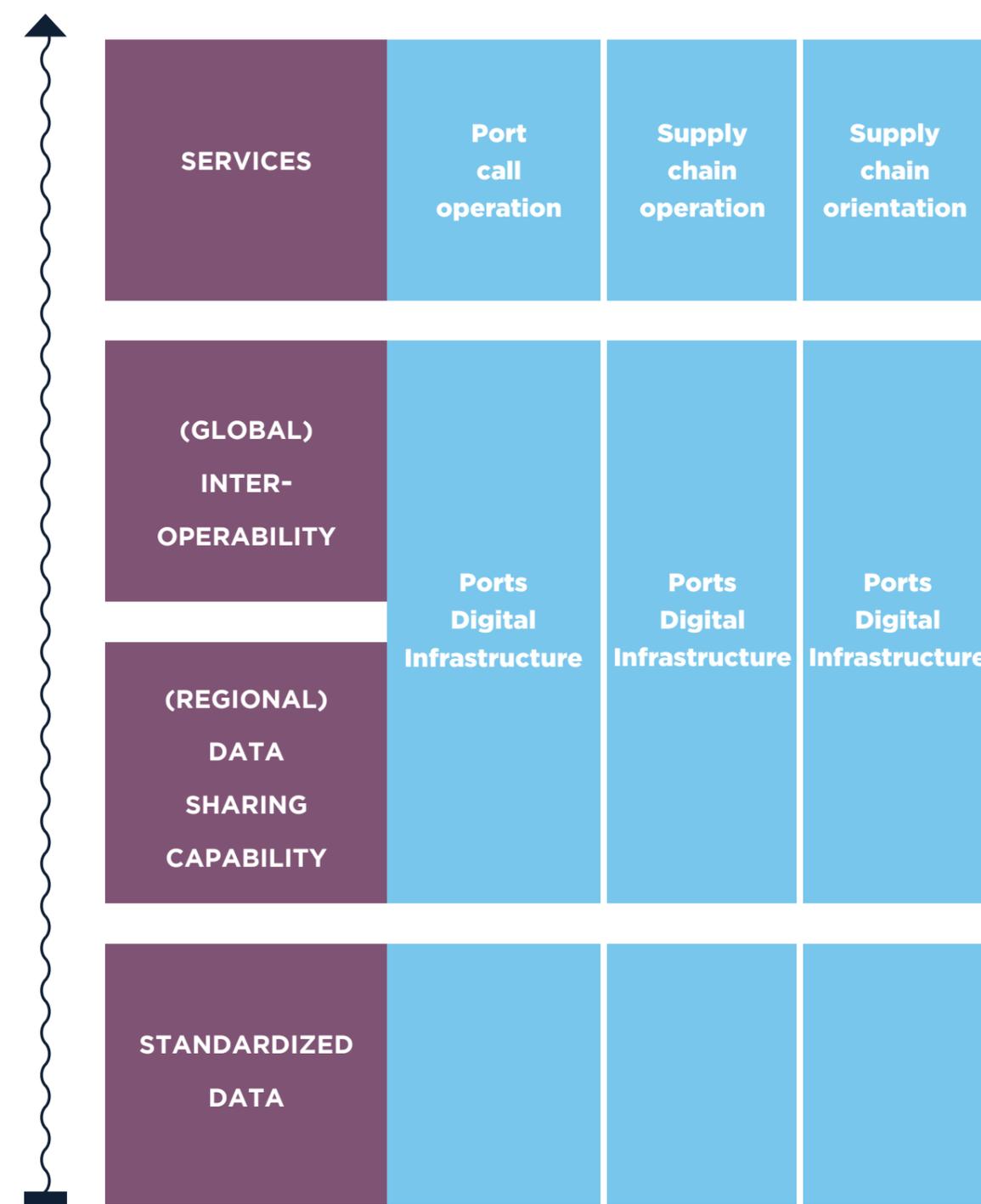
Over a three-month period in early 2022, eight regional workshops to **#CloseTheGaps** were conducted in partnership with the World Bank under the Chatham House rule with eighty-five maritime and logistics executives from thirty-five countries representing shippers, forwarders, container carriers, shipowners, NVOCCs,

shipping agencies, digital innovators, terminal operators, port authorities, consultants, real estate experts, leading maritime academics and regional development banks. The results of these revealing and highly relevant two-and-a-half hour discussions were distilled into eight summary reports which were distributed and discussed with the attendees of the eight regional meetings which took place at the IAPH 2022 World Port Conference last May in Vancouver, Canada.

The result of this exercise is now reflected in this report, which serves as a basis for an action plan which IAPH has embarked upon in collaboration with the World Bank and through its main climate and energy, data collaboration and risk and resilience technical committees. These actions to **#CloseTheGaps** will also involve extensive work in partnership with the IMO, UN agencies, other industry associations as well as with our membership, namely port authorities and operators and the organizations that serve them.

# INTRODUCTION

APPLICATION



FOUNDATION

Figure 1: Connecting digital infrastructure of ports (Source: Hamburg Port Authority)

**The IAPH – World Bank #CloseTheGaps exercise, which included the input of 85 maritime and logistics professionals from 35 countries as well as the speakers and attendees of the IAPH 2022 World Ports Conference, is reflected in this report.** In 2022 eight regional online workshops following the Chatham House rule and moderated by IAPH and World Bank staff gathered input on global port infrastructure gaps and how to deal with them. These were discussed further during eight regional meetings and the main program of the IAPH 2022 World Ports Conference in Vancouver. This report is a summary of that exercise.

**As one of the consequences of the COVID19 pandemic, ports have been placed in the global spotlight as key gateways for trade and supply chain fluidity.** As the global pandemic unfolded from the second quarter of 2020 onwards, the initial collapse in demand for products and goods was followed by the unexpected sharp recovery avalanche of demand by consumers for goods and consumable products. This disrupted the global supply chain to a point where Just-In-Time (JIT) has been superseded by inventory build ups that have clogged the world's seaborne and landside transportation arteries,

inland storage and distribution centers and resulted in port congestion in the world's largest gateways.

**The congestion in key global port hubs and the reduced efficiency in hinterland connectivity for inbound and outbound cargo resulting in consumer and industrial supply shortages has exposed the lack of long-term investment in port infrastructure.** Maritime transport carries 80 percent of all merchandise trade, with a fleet of approximately 99,800 vessels<sup>1</sup> calling at a global network of approximately 8,000 ports<sup>2</sup> carrying 10.6 billion tons of cargo.<sup>3</sup> The collapse in many maritime logistical chains has had tangible repercussions for countries served by the ports, and their respective populations. Recent disruptions due to the COVID19 pandemic and the Russia-Ukraine conflict have exposed gaps in port capacity and efficiency, which now appears at the top of regional, national and international regulators' agendas. This offers an opportunity to address these port infrastructure gaps.

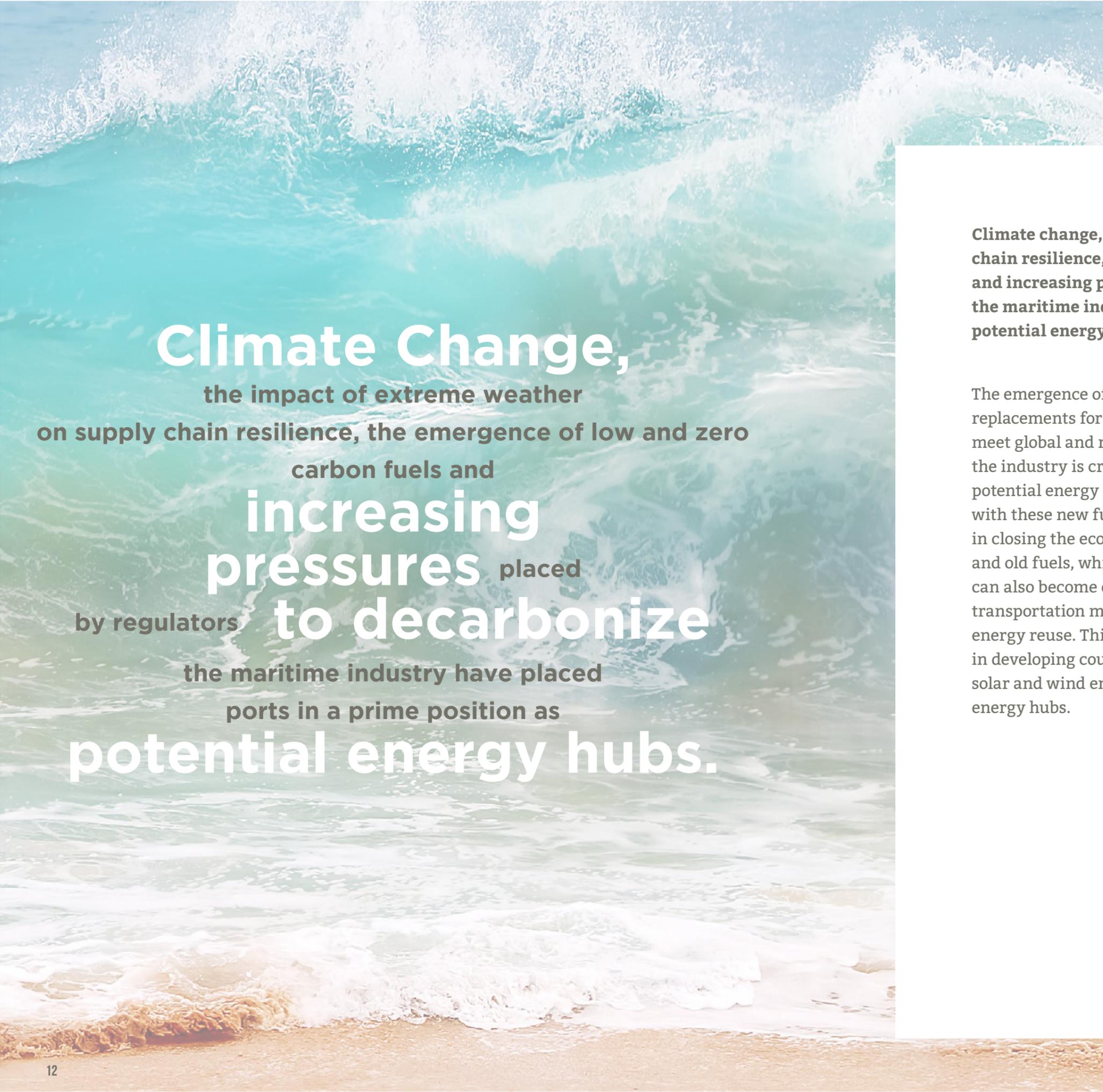
**Maritime ports face the unique challenge of being at the intersection of the seaborne maritime supply chain and the landside logistics chain involving complex interactions**

**between public and private sector stakeholders;** ports have the potential as enablers of digitalization to improve the competitiveness of both chains. The key issue of cargo and passenger traceability accentuated by the pandemic has resulted in the awareness of a greater need to accelerate digitalization through the global supply chain. While digitalization has reduced human interactions to minimize health risks, it has also exposed difficulties in achieving genuine data collaboration due to gaps in governance, global data standards adoption, low willingness to share data due to vested interests and a lack of data transparency between public and private entities. Port authorities have the potential to act as ombudsmen between the various stakeholders to encourage data collaboration through the initial adoption of a maritime single window, and the potential unification of port stakeholders' interests in collaboratively sharing nautical, administrative and operational data to reduce inefficiencies, increase supply chain fluidity and ultimately reduce vessel berth idle time.

<sup>1</sup> Vessels greater than 100 gross tonnes - *UNCTAD 2021 Review of Maritime Transport*.

<sup>2</sup> *Lloyds Maritime Atlas*.

<sup>3</sup> *UNCTAD 2021 Handbook of Statistics*.



**Climate Change,**  
the impact of extreme weather  
on supply chain resilience, the emergence of low and zero  
carbon fuels and  
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**Climate change, the impact of extreme weather on supply chain resilience, the emergence of low and zero carbon fuels and increasing pressures placed by regulators to decarbonize the maritime industry have placed ports in a prime position as potential energy hubs.**

The emergence of low and zero carbon fuels as potential replacements for traditional hydrocarbon-based equivalents to meet global and regional regulatory ambitions to decarbonize the industry is creating the opportunity for ports to become potential energy hubs. Ports can do more than solely serve vessels with these new fuels. The challenge to fulfil their potential lies in closing the economic gap in production costs between the new and old fuels, which can only be bridged if the selected ports can also become energy hubs for manufacturing, land-based transportation modes, local population energy supply and/or energy reuse. This also opens up new possibilities for certain ports in developing countries in regions with the potential for green solar and wind energy generation to become both bunker and energy hubs.



The overall demand for  
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**The overall demand for new zero carbon fuels creates new trading opportunities for ports.**

The estimation that the world will need an eighteen-fold increase in renewable capacities of all zero emission fuels to meet the recent COP26 goals and that 50% percent of all that capacity could be carried by ships<sup>4</sup> creates an additional opportunity for ports. In addition, the relative low density of zero carbon fuels means that ships will have to bunker more frequently irrespective of on-board fuel storage capacity of the most advanced vessels, creating unique opportunities for ports that are

well-positioned to receive them on principal trading routes for container, bulk and multipurpose cargo. However, there is a risk that developing countries might be left behind (also losing vessel calls and cargo capacity) if the new fuel hubs are limited to developed countries in Europe, North America and Asia. The World Bank is commencing a program to support suitable countries and ports to assess their viability as production sites for green fuels, and to emerge as new bunkering hubs.

<sup>4</sup> Report : *"Fuelling the Fourth Propulsion Revolution"*, ICS, June 2022.

**The gaps in global port infrastructure are being strained to a point where the supply chain crunch may not be seen as a single event, but an entanglement involving all the stakeholders in the supply chain.**

The supply chain crunch is an entanglement impacting port resilience with ports as a single node in a complex inter-related logistics network.

These include (but are not limited to) port authorities, terminal operators, carriers, Beneficial Cargo Owners (BCOs), the COVID19-impacted workforce, drayage, rail carriers, chassis owners and truck drivers.

The problems cannot be singularly called out, and therefore the issue becomes one of entanglement where it is very difficult to distinguish interconnected problems for effective intervention. The infographic (figure 2) illustrates vertical and lateral impacts of disruptions in maritime shipping in the region.

The entanglement essentially is one which means that importers and exporters are locked into supply chain flows (even when using replacement port supply chains in neighboring or alternative countries or regions), with each part of the chain interdependent and susceptible to the weakest link, and many parts of the chain lacking the sufficient information and data to react or proactively plan for future cargo flows.

The solution to disentanglement lies in active collaboration between logistics players at each exchange point for cargo with improved transparency in data availability and exchange, including ports.

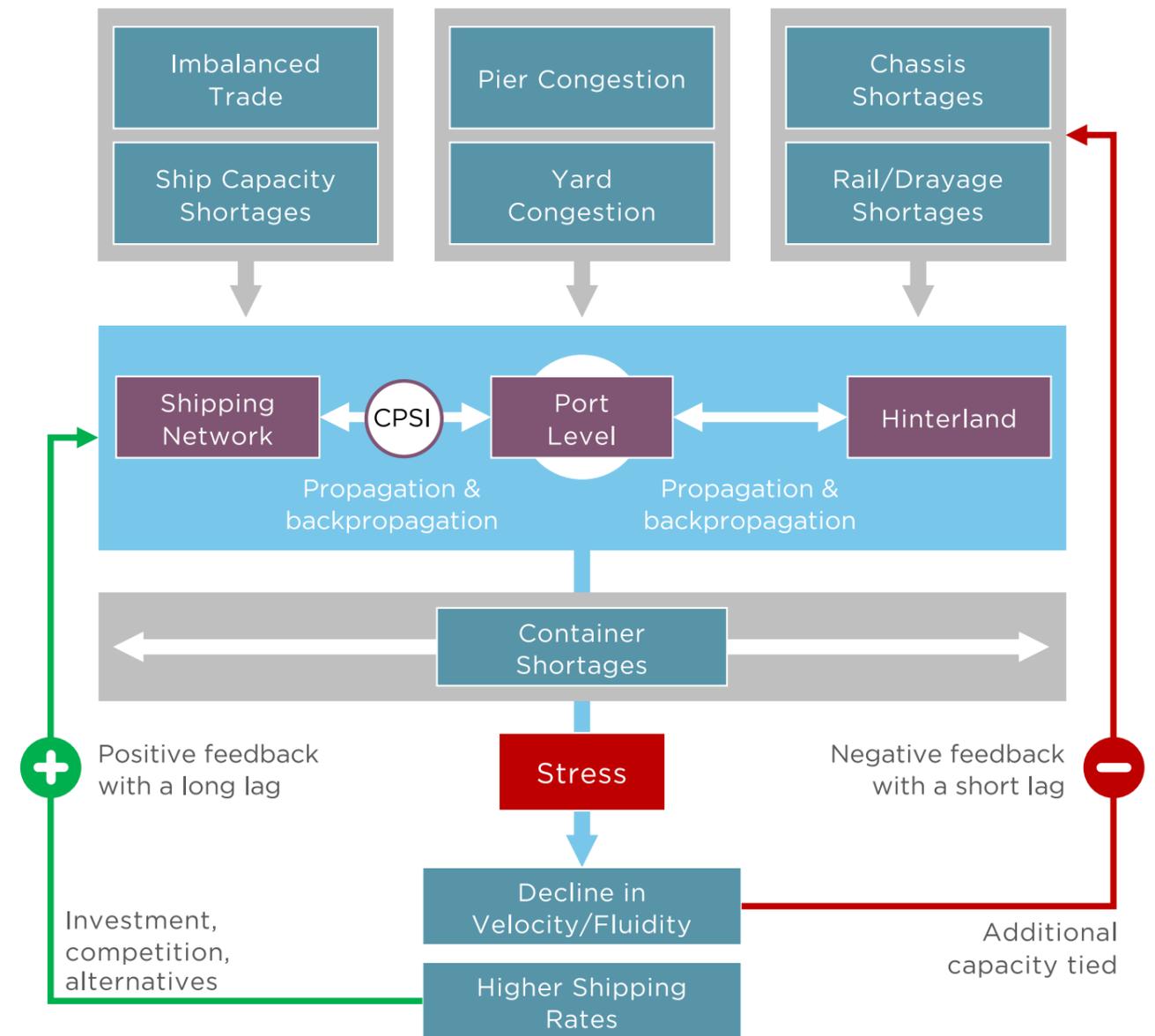


Figure 2. The Great Entanglement: Vertical and Lateral Impacts of Disruptions in Maritime Shipping<sup>5</sup>

<sup>5</sup> Professor Jean-Paul Rodrigue, IAPH North America Regional Workshop – 8 February 2022.



**The gaps in port infrastructure are being strained to a point where the supply chain crunch may not be seen as a single event but an entanglement involving all the stakeholders in the supply chain**

**The continued reliance on trucks versus other intermodal transportation options is impacting supply chain fluidity and efforts to decarbonize.** The majority of the world's regions still rely on trucks as the main hinterland transport mode connecting ports. The impact of COVID19, low retention of an ageing workforce and alternative local delivery work has reduced long distance truck driver availability. Ageing diesel-fueled fleets with inefficient engines queuing for loads have created congestion and air quality issues, especially at ports located within city limits with limited capacity for highway extensions. Unstable fuel prices are impacting a sector dominated by single owner operators and is leading to widespread industrial unrest. Efforts have been made by pioneering ports to incentivize replacing inefficient engines<sup>6</sup> and use alternative low or zero carbon fuels<sup>7</sup>, although widespread adoption is limited.

**While progress has been achieved in some regions to move cargo from road to rail and barge, further improvements in efficiency are required to persuade cargo owners to switch modes.** While progress has been made in some regions to improve rail connectivity either by investments in improving accessibility through new routings or expanding service frequencies, many regions of the world do not have sufficient tracks, rolling stock or driver availability to absorb additional demand. Progress to improve barge hinterland connectivity remains hampered in many regions due to the predominance of single owner-operators in the sector lacking scale and coordination, the low priority ports assign to load and discharge barges and in some cases the accessibility of rivers and lakes due to seasonal draft changes caused by climate change.<sup>8</sup> However, increased global consolidation within the private end-to-end logistics sector in many regions offers the potential for improved synchronization between ship-to-shore and landside and waterway cargo intermodal operability.

<sup>6</sup> Northwest Ports Clean Air Strategy: IAPH World Ports Sustainability Program Project.

<sup>7</sup> Port of Barcelona Air Quality improvement plan: IAPH World Ports Sustainability Program Project.

<sup>8</sup> IAPH-WPSP Covid19 Port Economic Barometer report, various editions.

**The increased frequency in maximum capacity utilization of port and inland warehousing and distribution infrastructure requires ports to revise their land investment portfolios and partner with investors in new inland container depot and cross dock facilities.** The incidence of warehouses and distribution centers at near full or full capacity during the recovery in demand following the global pandemic have resulted in congestion at berth and on the quayside. Shippers failing to recover cargo due to lack of trucking or rail options or a preference to keep stock in ports as a back-up despite demurrage charges remains a major challenge for ports. The creative search for unused land in the vicinity of ports to act as “popup” storage areas, partnering with logistics companies to enlarge or invest in new cross dock and inland container depots at strategic intermodal intersections has already been proven way of improving supply chain resilience.

**Efforts to improve port efficiency through automation vary considerably between regions of the world and are impacted by their location, labor skillsets and labor regulatory environments.** The **#CloseTheGaps** exercise has identified a number of examples of greenfield sites<sup>9</sup> successfully deploying automation processes for cargo handling at the ship-shore interface and between the quayside and the port gates. However, achieving significant productivity improvements at brownfield sites has proved more challenging, with an absence of labor skillsets and the resistance to change by the workforce.<sup>10</sup> For those ports located in cities with limited options to expand capacity, combining investments in labor and a pragmatic combination of automated and skilled labor processes may offer a path forward to meet future demand.

**The narrowing of gaps of efficiencies in public authority cargo, passenger and other public agency clearances should be dealt with together, not in isolation.** In many developing countries, a port or terminal’s efficiency is dependent on the transparency and efficiency of clearance procedures. Without a well-established governance structure with inter-ministerial intervention which brings private and public sector together to implement a digitalized process, efforts to rationalise customs clearance and other processes are unlikely to succeed.

**Human capital is seen as a critical factor in closing the gaps in global port infrastructure .** Transforming ports from landlords to potential orchestrators of supply chain fluidity, decarbonized energy hubs for industrial production and maritime clusters to serve their local port communities requires changes in the way ports are governed and the management profiles to lead them. The **#CloseTheGaps** exercise has identified this change taking place in many of the world’s largest shipping lines, terminal operators and logistics providers. However, examples of significant changes in the way port authorities and port operators are organized have been limited so far. Ports will only succeed in the process to **#CloseTheGaps** by attracting young and diverse talent into the industry.<sup>11</sup>

**To achieve a mindset change by ports and other supply chain stakeholders towards offering supply chain as a service, the industry also requires measurable, comparable and updated port performance data.** This data can be utilized to analyze trends and where possible forecast future shocks. In addition to existing tools and market intelligence, S&P and World Bank have commenced publishing their Container Port Performance Index and IAPH has published the first editions of its World Ports Tracker. This will also require a focus on performance across the board with bulk, liquid bulk, cruise and passenger vessels, not just the liner container business. Many small and medium ports offer capacity as well as solutions to **#CloseTheGaps**.

<sup>9</sup> Regional **#CloseTheGaps** Workshops, Mediterranean-Iberia-Black Sea 15 February 2022, East Asia 29 March 2022.

<sup>10</sup> Regional **#CloseTheGaps** Report: Mediterranean-Iberia-Black Sea.

<sup>11</sup> Regional **#CloseTheGaps** Workshop, Middle East, South and Central Asia, 24 March 2022.

# inadequate infrastructure to absorb and respond to shocks in demand and supply



## KEY ACTIONS IN RESILIENCE

### 2.1 THE GAPS IN RESILIENCE

**One of the main consequences of the COVID19 pandemic has been the exposure of global supply chains – including ports – in terms of inadequate infrastructure to absorb and respond to shocks in demand and supply.**

Previous reliance on Just-in-Time supply chain synchronization was impacted by the initial collapse in demand due to global lockdowns during the first waves of the global pandemic in 2020 as the disease gradually spread from the Far East to the Americas across the planet. Supply chain resilience has been further strained with the explosion in demand as the world emerged out of the initial waves of the pandemic in 2021. This was spurred on by consumer expenditure on goods and services instead of travel and entertainment as restrictions remained. The Russia-Ukraine conflict, sanctions and the energy crisis has further strained supply chain resilience and the ability for ports to absorb shocks, with a number of developing countries experiencing food and energy shortages.

**Ports are exposed to breakdowns in hinterland storage capacity and intermodal connectivity of end-to-end supply chains.** Ports have been at the front line of congestion as high inland storage and warehousing capacity utilization, shortage of rail rolling stock, trailers, barges and truck drivers in many parts of the world have caused serious cargo congestion within port gates. Shippers either failing to pick up cargo due to lack of storage capacity or port operations themselves failing to clear shipments or make empty containers available efficiently due to lack of truck, rail or barge availability has in many cases led to the build-up of large numbers of vessels at anchor or beyond awaiting a berthing window at ports. Recently labor unrest in Asia, South Asia, Europe and North America in the port, rail and trucking industries due to a combination of high fuel costs and inflationary pressures have also aggravated congestion problems at ports.

**The supply chain crunch is an entanglement impacting port resilience with ports as a single node in a complex inter-related logistics network.**

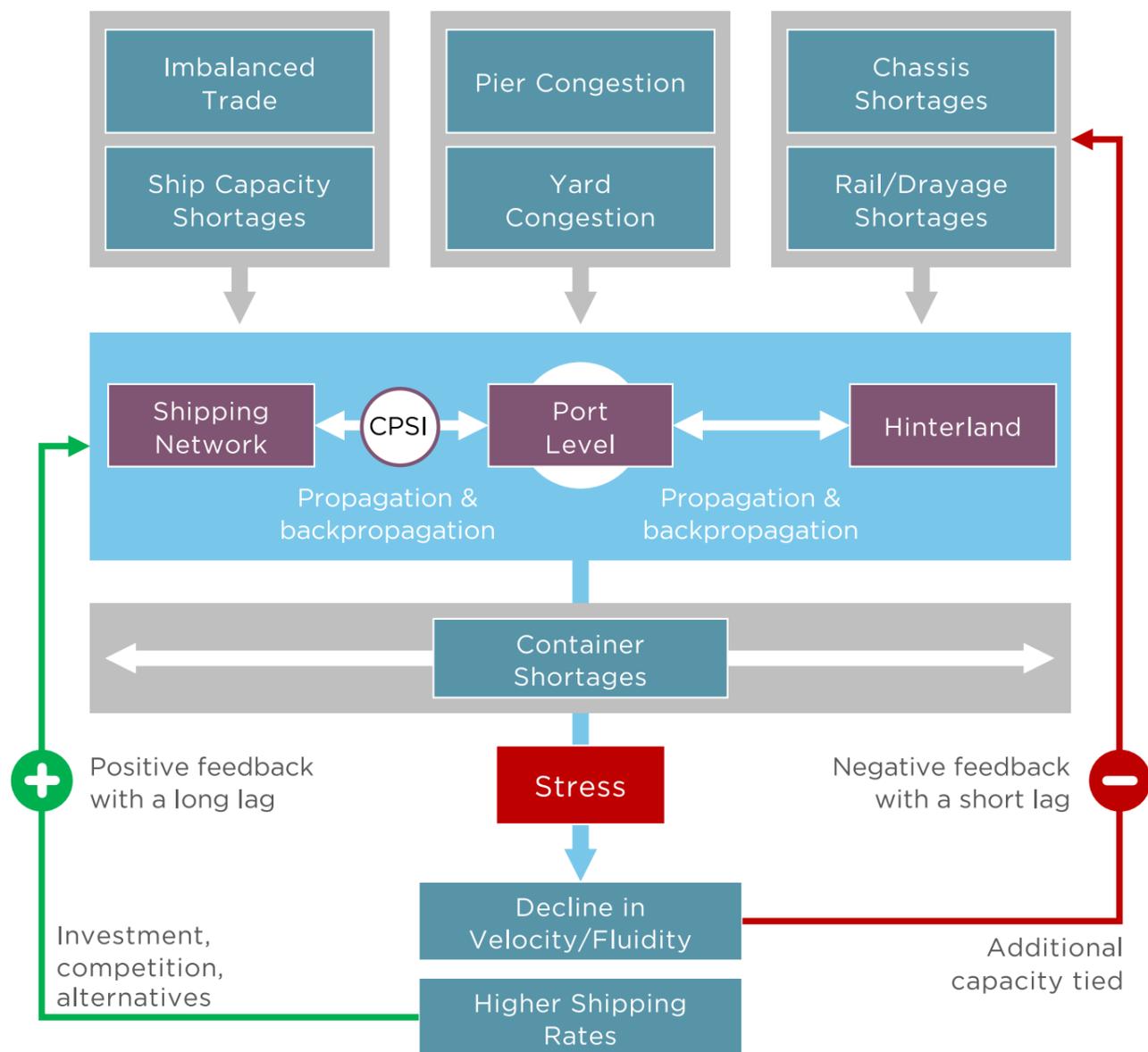


Figure 2: The Great Entanglement: Vertical and Lateral Impacts of Disruptions in Maritime Shipping (source: Professor Jean-Paul Rodrigue, IAPH North America Regional Workshop – 8 February 2022)

The gaps in global port infrastructure are being strained to a point where the supply chain crunch may not be seen as a single event, but an entanglement involving all the stakeholders in the supply chain. These include (but are not limited to) ports themselves, carriers, BCOs, the COVID19-impacted workforce, drayage, rail carriers, chassis owners and truck drivers. The problems cannot be singularly called out, and therefore the issue becomes one of entanglement where it is very difficult to distinguish interconnected problems for effective intervention.

Figure 2 illustrates vertical and lateral impacts of disruptions in maritime shipping in the region. The entanglement essentially is one which means that importers and exporters are locked into supply chain flows (even when using replacement port supply chains in neighboring or alternative countries or regions), with each part of the chain interdependent and susceptible to the weakest link, and many parts of the chain lacking the sufficient information and data to react or proactively plan for future cargo flows.<sup>12</sup>

**Port congestion impacting the global container sector supply chain is highly concentrated with problems in a number of key global gateways having a knock-on effect on other regions .**

As vessels queue up at berth and ports are omitted due to congestion, container capacity is absorbed, reducing supply of containers and space on board, resulting in higher freight rates and long delivery delays. It is important to state that not all ports are suffering from congestion – many small and medium ports are operating with available berth capacity and in some highly efficient regions (such as the Middle East) terminal capacity is being underutilized. However, the lack in consistency in space utilization and ship-shore productivity between regions combined with national COVID lockdowns are creating bottlenecks that are impacting the entire global supply chain, as figure 3 illustrates for the liner shipping sector.

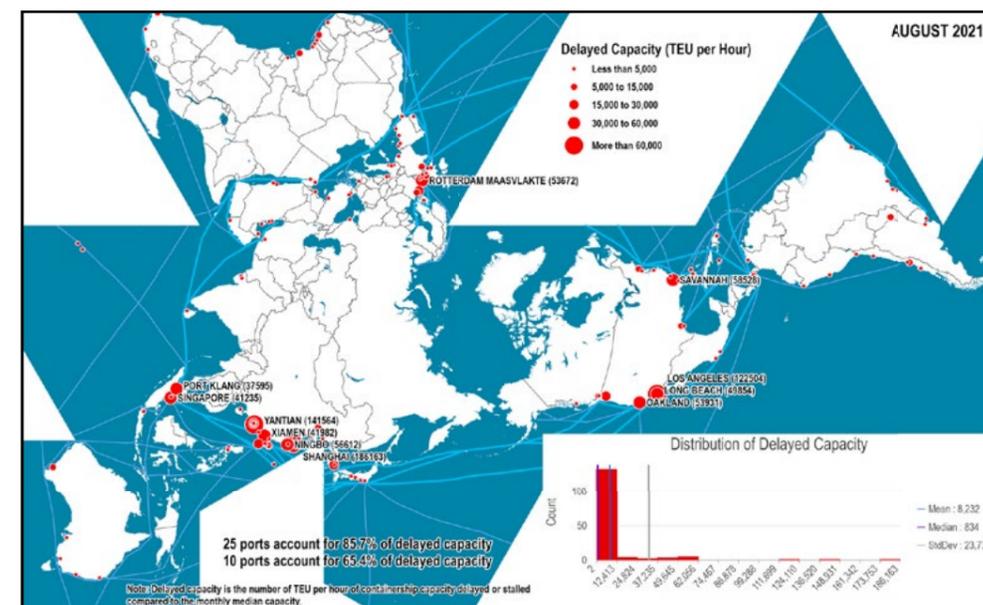


Figure 3: Containership Delayed Capacity in TEU per Hour at Port, August 2021 ((source Professor Jean-Paul Rodrigue, IAPH North America Regional Workshop – 8 February 2022)

<sup>12</sup> "The Great Entanglement: Competitiveness Challenges for North American Ports" Dr. Jean-Paul Rodrigue. Hofstra University, presentation to IAPH North America Regional Workshop – 8 February 2022.

# The Gaps in Resilience

**The data published in the recent S&P Global- World Bank 2021 Container Port Performance Index points towards a potential correlation between the ranking of a port and its status in terms of digitalization.**

The recent data on global port productivity for the liner shipping sector published 2021 Container Port Performance Index report by S&P Global and the World Bank points towards a potential correlation between the ranking of a port and its status in terms of digitalization.<sup>13</sup> From this deduction, a port with less digitalized processes is more likely to suffer poorer port productivity performance. However, the level of digitalization at a port needs to be much more scientifically analyzed and determined as there is a gap in this knowledge level in the industry. As the recent results of the 2020 IAPH-World Bank survey on levels of FAL implementation at ports proved, there is a definite gap between developed and developing countries. However, further analysis is needed on defining how wide the gaps are before proposing any solutions moving ahead.

**The continued reliance on trucks versus other intermodal options is impacting supply chain fluidity and the efforts to decarbonize.**

The majority of the world's regions still rely on trucks as the main hinterland transport mode connecting ports as the example for Europe (Figure 4) illustrates. The impact of COVID19, low retention of an ageing workforce and alternative local delivery work has reduced long distance truck driver availability. Ageing diesel-fuelled fleets with inefficient engines queuing for loads have created congestion and air quality issues, especially at ports located within city limits with limited capacity for highway extensions. Unstable fuel prices are impacting a sector dominated by single owner operators and is leading to widespread industrial unrest. Efforts have been made by pioneering ports to incentivize replacing inefficient engines and use alternative low or zero carbon fuels, although widespread adoption is limited.

**The preference for trucks over rail and barge varies between regions and infrastructure availability.**

The availability of alternative transport modes to trucks, namely rail and waterways, varies per region and depends on both the topography of the land as well as levels of investment in supporting infrastructure for rail and barge/short sea shipping options. Nonetheless, a recent regional study in Europe points towards a choice preference by beneficial cargo owners for truck over rail and barge mainly due to its greater flexibility and overall customer service despite the latter two modes ranking better in terms of a lower propensity for loss/damage and lower cost at scale. Cargo owners' highest modal choice preference, namely reliability, registered with only marginal differences of ranking between the modes.<sup>14</sup> Shippers and supply chain solution providers' increasing propensity to switch from truck to rail, barge or even air freight for high value cargo has changed since the pandemic outbreak.

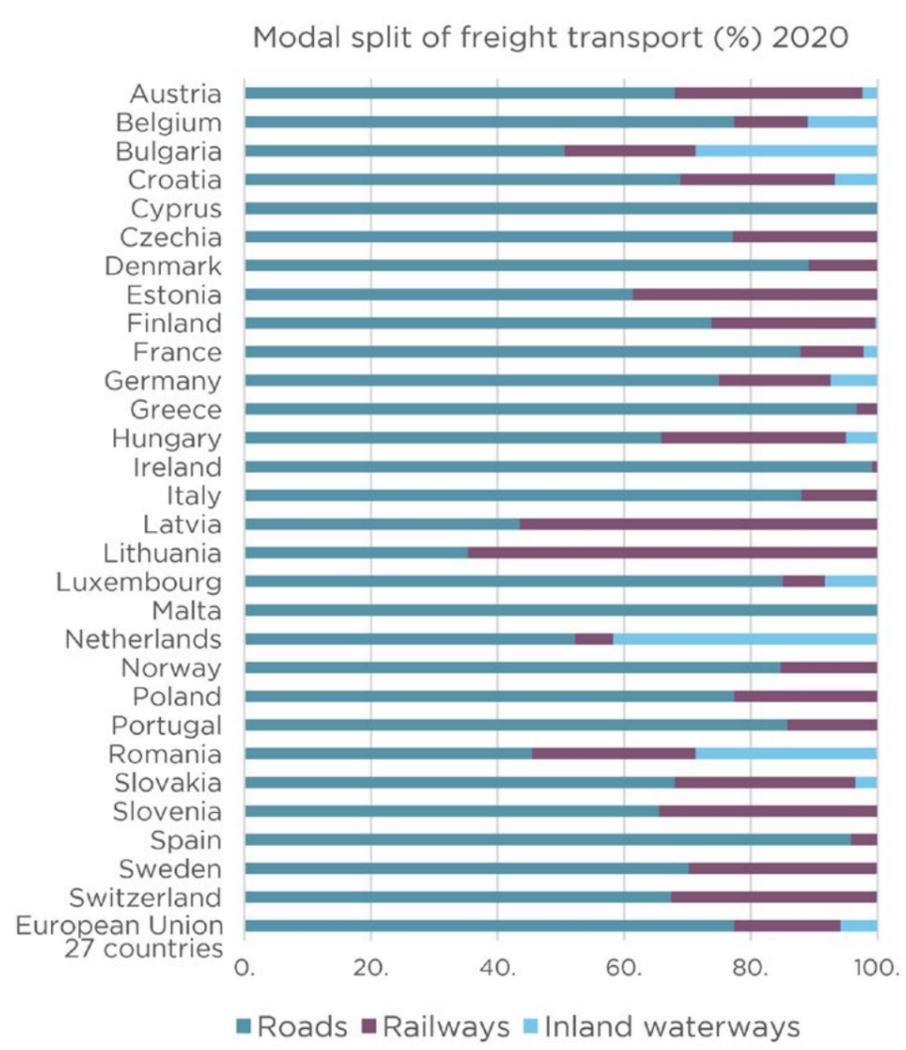


Figure 4: Modal split of freight transport (%) 2020  
 Source : Eurostat – North Europe Regional #CloseTheGaps Workshop presentation by Professor Thierry Vanelander, University of Antwerp – 8 February 2022.

**While progress has been achieved in some regions to move cargo from road to rail and barge, further improvements in efficiency are required to persuade cargo owners to switch modes.**

While progress has been made in some regions to improve rail connectivity either by investments in improving accessibility through new routings or expanding service frequencies, many regions of the world do not have sufficient tracks, rolling stock or driver availability to absorb additional demand. In others (especially developing regions such as Sub-Saharan Africa), the costs, low reliability and security risks make intermodal transportation prohibitive, even against airfreight.<sup>15</sup> Progress to improve barge hinterland connectivity remains hampered in many regions due to the predominance of single owner-operators in the sector lacking scale and coordination, the low priority ports assign to load and discharge barges and in some cases the accessibility of rivers and lakes due to seasonal draft changes caused by climate change.

<sup>13</sup> 2021 Container Port Performance Index (CPPI) report – Transport Global Practice of the World Bank – S&P Global and World Bank, June 2022. Source : World Bank website.

<sup>14</sup> Professor Thierry Vanelander, University of Antwerp, North Europe presentation to IAPH North Europe Regional #CloseTheGaps Workshop, 10 February 2022.

<sup>15</sup> IAPH Sub-Saharan Africa #CloseTheGaps Workshop, 15 March 2022.



# building resilience needs a significant change in industry mindsets

## Building in resilience into supply chains and the infrastructure investment required needs a significant change in industry mindsets.

The overall consensus from the regional workshops was that the global supply chain had, up until the pandemic, been designed with optimization in mind of ports and terminals from a cost and utilization perspective to a point that no redundancy was built in to withstand the impact of a once-in-lifetime event such as the pandemic. Moving ahead, a change of mindset would be required by cargo and vessel owners alike and their service providers (including ports) throughout the supply chain to build resilience into the system with a cost and investment implication for all parties. This issue was recognized as a major gap as it requires a complete change in mindset, given the profit motive and lean process management of the private sector and the stringent, delayed application of long-term public investment funding (both nationally and regionally) to the ports sector. Any such costs would have to be borne ultimately by the consumer.

## The gap in internal coordination between procurement and logistics departments of beneficial cargo owners has impacted supply chain fluidity.

Ports participating in the **#CloseTheGaps** exercise as well as their users such as ocean carriers, shipowners and forwarders concurred that beneficial cargo owners' as well as traders' internal organizations often split the function of logistics and supply chain management from procurement, which commonly reports to the finance function.<sup>16</sup> This creates a conflict of interest between procurement cost optimization (irrespective of location and delivery challenges) on one hand, and the demand for reliable, flexible supply chain management on the other. The latter may not influence a purchasing decision as much as lower cost will often influence the supplier selection the most.

<sup>16</sup> IAPH North Europe  
#CloseTheGaps Workshop,  
15 February 2022.

efforts to  
**automate** vary  
considerably between regions  
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environments

**Efforts to improve port efficiency through automation vary considerably between regions of the world and are impacted by their location, labor skillsets and labor regulatory environments.**

The *#CloseTheGaps* exercise identified a number of greenfield sites which have been successful in deploying automation processes for cargo handling at the ship-shore interface and between the quayside and the port gates. However, achieving significant productivity improvements at brownfield sites has proved more challenging, with an absence of labor skillsets and the resistance to change by the workforce cited as the principal issues faced.<sup>17</sup> One workshop identified a port which figures in the top five most efficient global ports in the S&P Global – World Bank 2021 Container Port Performance index where productivity is directly attributable to the labor skills of the experienced and well-remunerated ship-to-shore crane and materials handling equipment operators retained by the operator in question.<sup>18</sup>

<sup>17</sup> IAPH Mediterranean, Iberian and Black Sea *#CloseTheGaps* Workshop, 15 February 2022.

<sup>18</sup> IAPH East Asia Regional *#CloseTheGaps* Workshop, 29 March 2022.

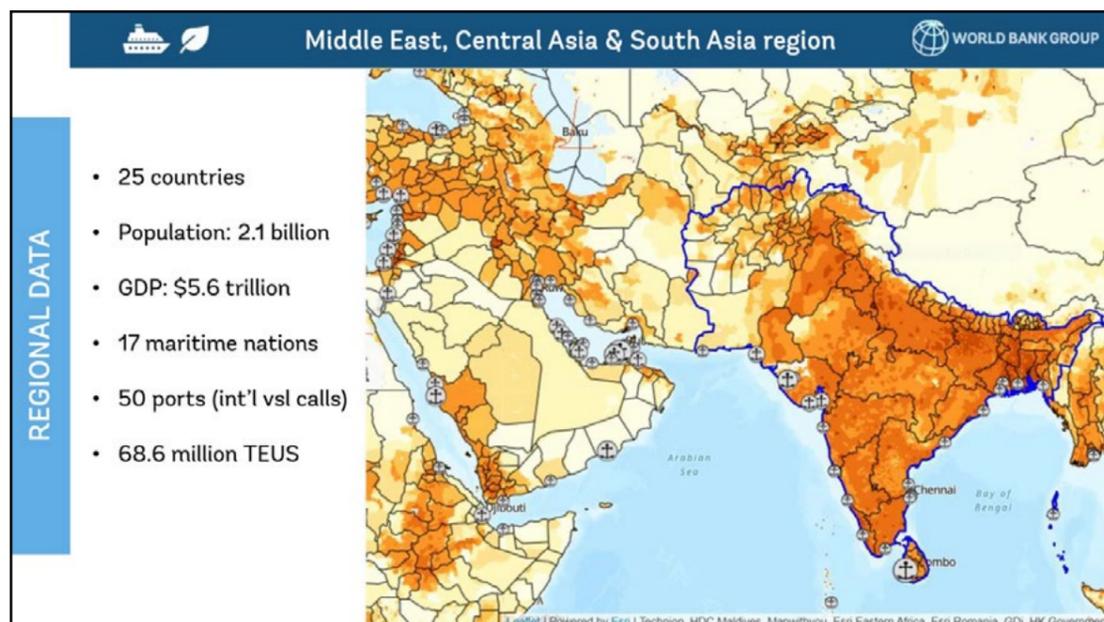


Figure 5: Key figures for Middle East Central and South Asia Region (source : Biju Nina Oommen, World Bank at the IAPH Middle East Central and South Asia Regional #CloseTheGaps workshop, 24 March 2022)

**The narrowing of gaps of efficiencies in public authority cargo, passenger and health clearances should be dealt with together, not in isolation.**

In many developing countries, a port or terminal's efficiency is dependent on the transparency and efficiency of clearance procedures. Without the intervention of a well-established governance structure to implement a digitalized process, efforts to rationalize customs clearance and other processes are unlikely to succeed. In one Regional #CloseTheGaps Workshop a port efficiency program led since 2017 by the country's vice president aimed at creating paperless operations in and around the port resulted in reducing the number of government agencies having to inspect cargo from eight and ten different times to three, with all of them are obliged to inspect the cargo at the same time.<sup>19</sup>

**Human capital is seen as a critical factor in closing the gaps in global ports.**

Transforming ports from landlords to potential orchestrators of supply chain fluidity, decarbonized energy hubs for industrial production and maritime clusters to serve their local port communities requires changes in the way ports are governed and the management profiles to lead them. The #CloseTheGaps exercise has identified this change taking place in many of the world's largest shipping lines, terminal operators and logistics providers. However, examples of significant changes in the way port authorities and port operators are organized have been limited so far. Ports will only succeed in the process to #CloseTheGaps by attracting young and diverse talent into the industry.<sup>20</sup>

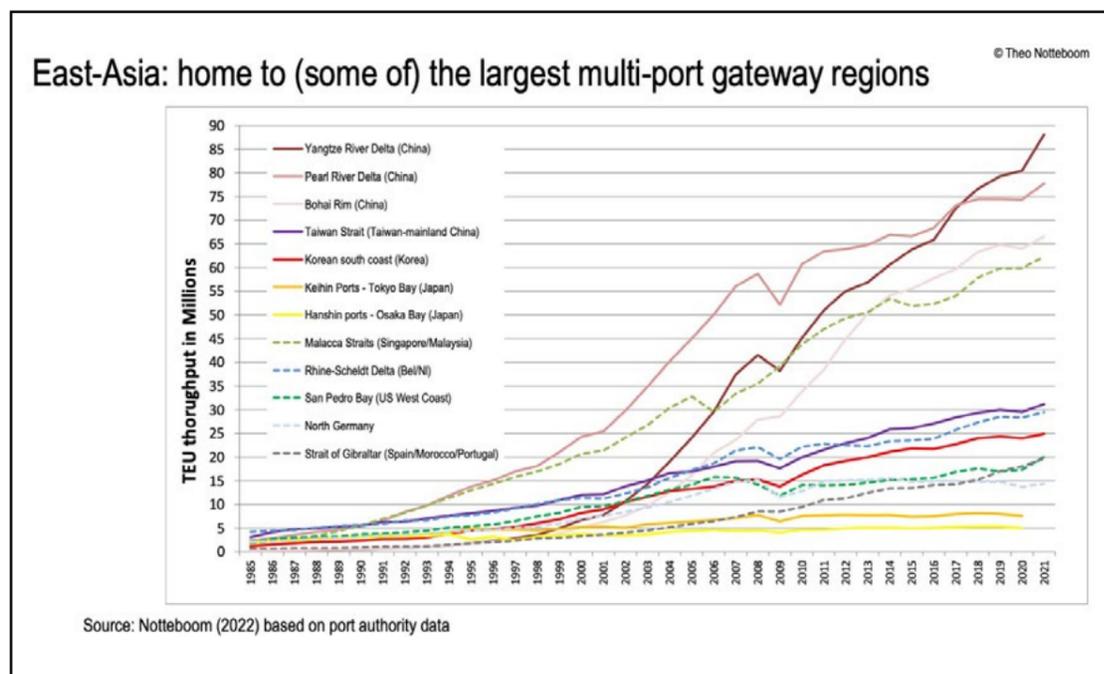


Figure 6: Comparative TEU throughput, Asia Region compared to west coast USA and Europe/Mediterranean ((source : Professor Theo Notteboom, University of Ghent and Shanghai Maritime University at the IAPH East Asia Regional #CloseThe Gaps workshop, March 29 2022)

**Future port expansions will need to attract financing from private sector capital markets as public sector funding will no longer suffice.**

The forecasts for global demand growth, particularly in all regions of Asia, will require the support of private sector investment in addition to public funds committed by local, regional, national or international authorities. Despite flagging current global growth it is estimated that 1 billion new people will join the middle class during the decade, most of whom will come from Asia. The scale of regions such as the upcoming Middle East Central and South Asia region (see Figure 5) and the growth in capacity needs across East and South East Asia relative to other world regions (see Figure 6) will put further pressure on the entire global supply chain network.

<sup>19</sup> IAPH Sub Saharan Africa #CloseTheGaps Workshop, 15 March 2022.

<sup>20</sup> IAPH 2022 World Ports Conference session "How is Leadership in Diversity Making Your Port More Competitive?" May 18, 2022.



potential  
**solutions:**  
RESILIENCE

## 2.2 POTENTIAL SOLUTIONS TO CLOSE THE GAPS IN RESILIENCE

**One solution to disentanglement lies in active collaboration between logistics players at each exchange point for cargo with improved transparency in data availability and exchange, including ports.**<sup>21</sup>

Reinventing supply chains including logistics corridors, reshoring, improving procurement practices and investing in port-centric distribution channels to build in ability absorb shocks in capacity are also recommended.<sup>22</sup> One example cited the development of a non-for-profit organization corridor over two decades between over-the-border countries applying road and rail pilots with shippers and the port, which increased traffic to 600,000 tons annually as an alternative regional gateway.<sup>23</sup>

**The increased frequency in maximum capacity utilization of port and inland warehousing and distribution infrastructure requires ports to revise their land investment portfolios and partner with investors in new inland container depot and cross dock facilities.**

The incidence of warehouses and distribution centers at near full or full capacity during the recovery in demand following the global pandemic have resulted in congestion at berth and on the quayside. The failure to pick up cargo due to lack of trucking or rail options or a preference by the shipper without storage options inland to keep stock in ports as a back-up despite demurrage charges remains a major challenge for ports. The creative search for unused land in the vicinity of ports to act as “popup” storage areas, or partnering with logistics companies to enlarge or invest in new cross dock and inland container depots at strategic intermodal intersections have already been proven ways of improving supply chain resilience.<sup>24</sup>

**Increased global consolidation within the private end-to-end logistics sector in many regions offers the potential for improved synchronization between ship-to-shore and landside and waterway cargo intermodal operability.**

During the regional **#CloseTheGaps** workshops, examples were cited in Europe, South and East Asia, North America and the Middle East where coordinated efforts were being made between shippers, supply chain solution providers, intermodal operators, terminals, ports and public authorities to unify the end-to-end supply chain for shipments across all modes. Examples cited included increased transparency by means of regular review meetings, data collaboration, and innovative intermodal workarounds (e.g. double stacked container trains, short sea shipping/seagoing barges). The increasing market consolidation

<sup>21</sup> IAPH Central and South America and Middle East Central and South Asia **#CloseTheGaps** Workshops 22, 24 March 2022.

<sup>22</sup> “The Great Entanglement: Competitiveness Challenges for North American Ports” Dr. Jean Paul Rodrigue, Hofstra University, presentation to IAPH North America **#CloseTheGaps** Workshop – 8 February 2022.

<sup>23</sup> IAPH Sub-Saharan Regional **#CloseTheGaps** Workshop, 15 March 2022.

<sup>24</sup> IAPH North America **#CloseTheGaps** Workshop, 8 February 2022.

between terminal operators, carriers, logistics providers and intermodal operators that is taking place as a consequence of previously unseen profit levels in the sector does improve the prospects of the offer of “supply chain as a service”. Nonetheless the mindset change may also require changes in the governance of supply chains to facilitate this concept as leaving the responsibility to the market may lead to further commoditization of supply chains at the lowest cost or a reduction in choice of solutions.<sup>25</sup>

**Ports will have to attract private sector finance in addition to public funds to meet demand.**

A well-defined land use plan by ports is vital to resolving short-term congestion (such as pop-up storage within the vicinity of the port) as is the creation of a five-to-ten year strategic expansion plan in consultation with the port’s key strategic stakeholders, starting with shippers. That strategic plan should reflect a property portfolio management plan which optimizes financial performance as well as enhancing portfolio value and maximising revenue.<sup>26</sup> This will require accessing private sector capital markets, and where possible offering long land leases to attract that capital.<sup>27</sup>

**The need for an industry mindset change towards offering supply chain as a service also requires measurable, comparable and consistent port performance data.**

This data can be utilized to analyze trends and where possible forecast future shocks. UNCTAD also publishes its annual Review of Maritime Transport<sup>28</sup> with its liner connectivity shipping index and UNCTAD’s training branch UN TrainforTrade publishes an annual port performance scorecard<sup>29</sup> of its client countries. However the gap in terms of standardized, consistent and up-to-date data from the previous quarter is urgently needed by the industry. From the liner shipping industry perspective, the S&P Global-World Bank Container Port Productivity<sup>30</sup> Index now endeavors to identify, classify and track port performance by applying both administrative and statistical approaches. IAPH has also announced and published the successor to its regular IAPH-WPSP Port Economic Impact Barometer report with its quarterly, member survey-based World Ports Tracker<sup>31</sup>, which covers container, bulk, liquid bulk, cruise and passenger markets. The tracker also incorporates the S&P Global-World Bank Container Port Productivity Index data analysis, as well as other sources.



<sup>25</sup> IAPH North Europe #CloseTheGaps Workshop, 15 February 2022.

<sup>26</sup> IAPH 2022 World Ports Conference keynote – What drives investment in port portfolios? 18 May 2022.

<sup>27</sup> IAPH Central and South America Workshop, 22 March 2022.

<sup>28</sup> UNCTAD Annual Review of Maritime Transport, UNCTAD, 2021. Source: UNCTAD website.

<sup>29</sup> UNCTAD TrainforTrade Annual Newsletter, UNCTAD TFT 2021. Source: UNCTAD TrainForTrade website.

<sup>30</sup> S&P-World Bank Container Port Productivity Index, S&P Global & World Bank, June 2022. Source: World Bank website.

<sup>31</sup> IAPH World Ports Global Tracker, edition 2, June 2022. Source: IAPH World Ports Sustainability Program website.

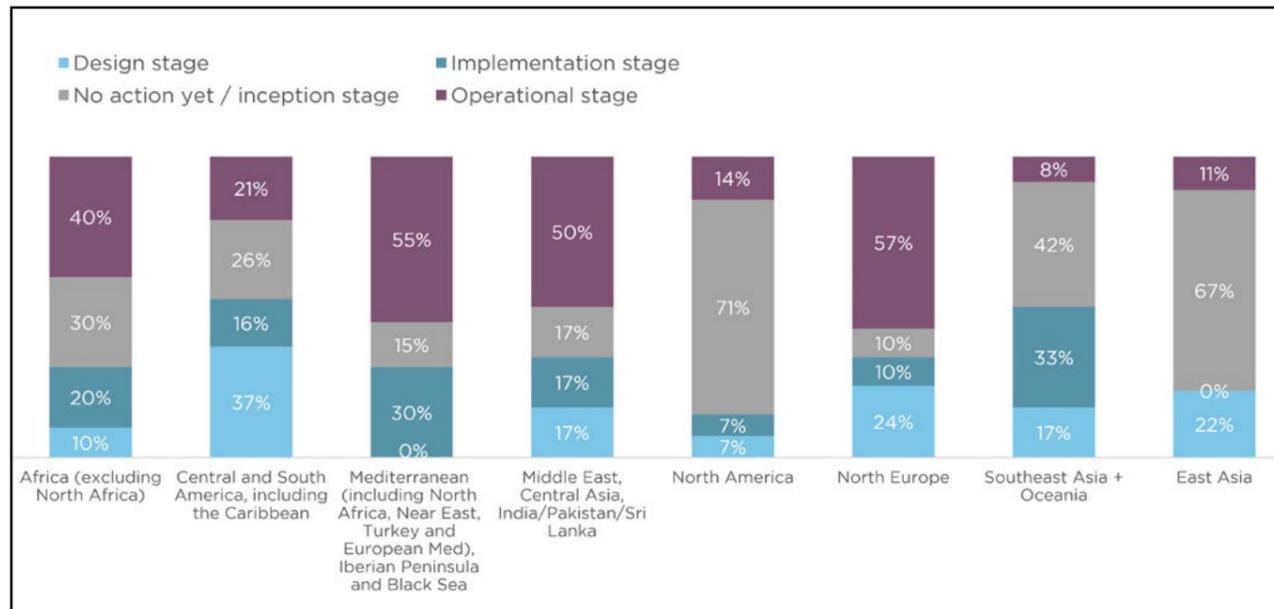


Figure 7: Status of digitalization of ports  
(source : IAPH survey on port implementation status levels of the IMO FAL requirements, December 2020)

# KEY ACTIONS IN DIGITALIZATION

## 3.1

# The Gaps in Digitalization

The digitalization gaps in the port sector point towards a significant variance between regions of the world, reflecting a digital divide between countries in terms of the maturity in adoption of maritime single window system and port community systems.

In December 2020 IAPH conducted a survey of the implementation of the basic IMO FAL convention requirements and the presence of port community systems in the ports between regions. In the results, the variance is noticeable. The sample of 111 responding global ports to the IAPH-WPSP survey on digitalization and the Port Community Systems (PCS) database of Maritime Street illustrates this variance.

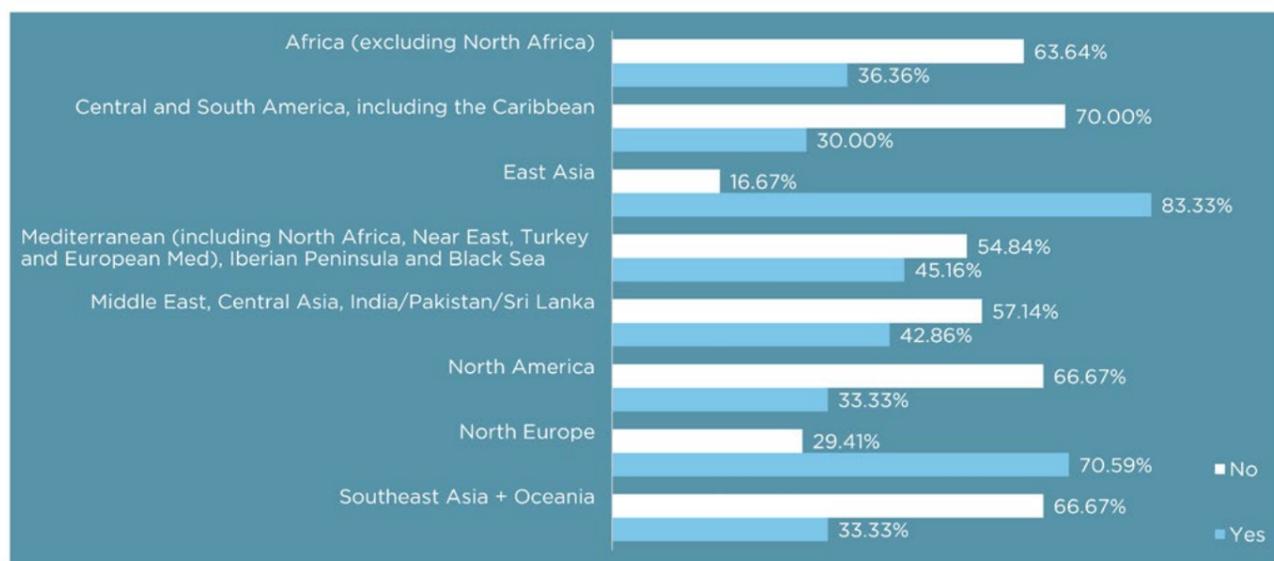
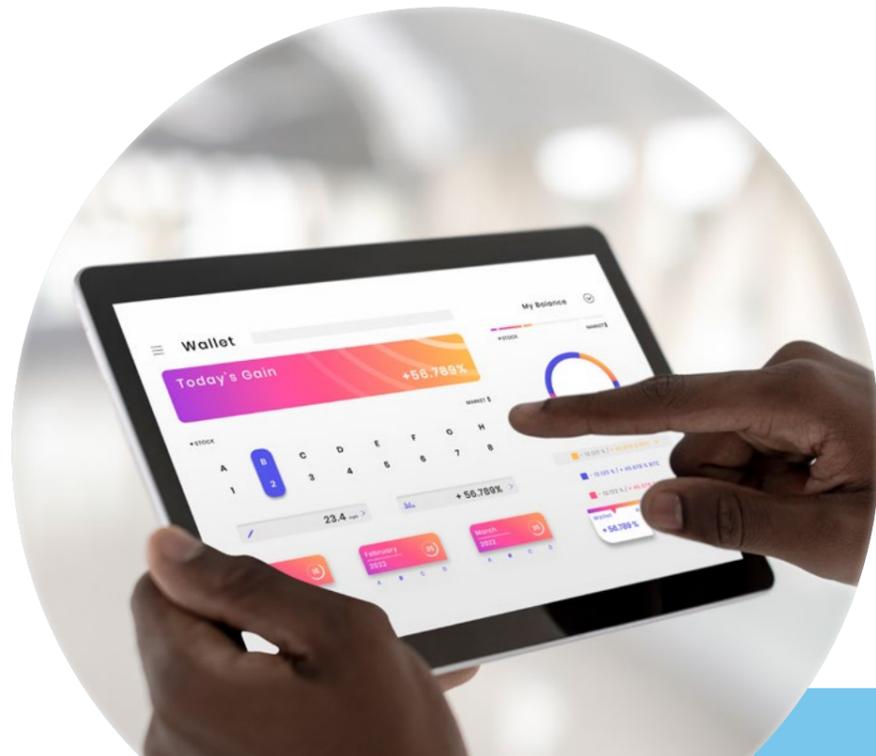


Figure 8: Presence of port community systems by region (source Maritime Street, 2020)

The incidence of a significant number of respondents yet to commence or reach the first stage in the implementation of digitalization of ship-shore FAL requirements and port community processes was confirmed in several of the regional workshops.

The reasons cited include an absence of applicability of FAL requirements for some of the countries, especially in developing regions. Lack of a digital regulatory legal framework is also cited as a principal cause for the absence of a port community system, with paper-based systems remaining as the established norm. Contributions also given at regional workshops pointed towards a desire to maintain the status quo, given the fear of disruptions to the labor market any digital migration might entail.



**A key gap identified by the IAPH FAL survey and confirmed at the #CloseTheGaps Regional Workshops involves lack of multi-stakeholder collaboration.**

The lack of multi-stakeholder collaboration was a common conversation thread running through the workshops. Comments included the conflict of interests in data sharing between public and private sectors, and the commercial sensitivities around data that inhibit key players to share information. Some private sector participants felt that a lot of data input was being fed into public systems in a one-directional manner with very little useful information filtering back.

**Other port users pointed out that obtaining basic data on cargo quay location and berthing times were either unavailable or absent with the need to seek informal channels of communication to acquire this data.<sup>32</sup>**

This lack of visibility and predictability is the core issue facing shippers. Many port users at the Regional Workshops questioned why carriers were unable to release information when their cargo leaves the previous port call to be able to forecast their own inventory situations.

# The Gaps in Digitalization

What challenges are you facing / have you faced in getting electronic data exchange up and running? Please rank these from 1 (very low challenge) to 5 (very high challenge)

	1 (VERY LOW CHALLENGE)	2 (LOW CHALLENGE)	3 (REASONABLE CHALLENGE)	4 (HIGH CHALLENGE)	5 (EXTREMELY HIGH CHALLENGE)	TOTAL
Technology / IT	10.31% 10	21.65% 21	34.02% 33	20.62% 20	13.40% 13	97
Human resources	10.31% 10	22.68% 22	35.05% 34	22.68% 22	9.28% 9	97
Legal framework	3.09% 3	14.43% 14	30.93% 30	38.14% 37	13.40% 13	97
Multi-stakeholder collaboration	7.22% 7	8.25% 8	20.62% 20	40.21% 39	23.71% 23	97
Budget	8.25% 8	20.62% 20	36.08% 35	26.80% 26	8.25% 8	97

Figure 9 –Challenges faced by ports on digitalization  
Source: IAPH survey on port implementation status levels of the IMO FAL requirements December 2020

**A terminal concession’s main aim to maximize efficiency and have the best-suited vessel alongside for the operation to maximize the use of available cargo handling assets at that moment is not necessarily compatible with the wider interest of optimizing vessel calls.**

A terminal operator committing in advance to accepting a vessel berth at a specific time may not necessarily be optimizing their productive yard space and materials handling equipment.<sup>33</sup> According to regional workshop participants, this scenario applies across cargo segments. Vessel loading/unloading efficiency will in part be determined by the container stack and discharge and load plan of the carrier following the previous port call. The flexibility required from a port by a tramp operator in arriving at its bulk destination during a specific time window to fulfil its charterer’s and its own interests according to contract may take priority. The obligation of a liquid bulk tanker to undertake one or more surveys of its cargo before being accepted for discharge by the purchaser at the port call in question may take priority over planning a berth slot.

<sup>32</sup> IAPH South East Asia and Oceania Central and South America, East Asia #CloseTheGaps workshops, 16 February, 22 and 24 March, 2022.

<sup>33</sup> IAPH Mediterranean, Iberian and Black Sea #CloseTheGaps Workshop, 15 February 2022.

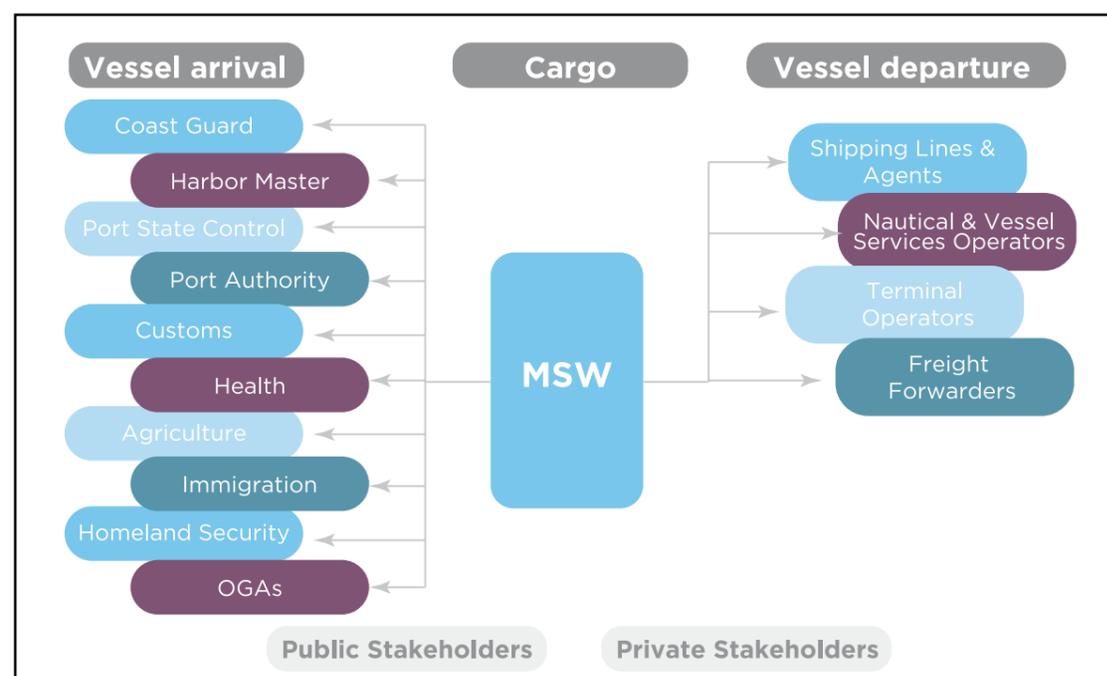


Figure 10: A Maritime Single Window System (source – joint IAPH-World Bank paper)

The overall absence in applying the same data standards, often within the same country between different ports, is seen as a major obstacle to achieving improved efficiency in a port call.

The standards and data elements that need to be harmonized to facilitate the exchange of information between ship and port and the interoperability of its electronic system should in theory follow the IMO Compendium on Facilitation and Electronic Business.<sup>34</sup> The IMO compendium data set and model is designed to support transmission, receipt, and response via EDI of information required for arrival, stay and departure of ships, persons, and cargo to or from a port, enabling companies to create software that can communicate no matter the standard on which they are based. Not all existing systems follow the compendium's guidelines. Numerous port users testified that a ship's crew has to deal with different systems with a variety of data definitions of standards at each port of call, even sometimes in the same country. This is due to a misalignment between countries in terms of governance between municipal, regional, federal, national and international authorities on data standards. The IMO mandatory requirement for member states to adopt a maritime single window system by January 2024 presents an opportunity for alignment. However, a global commitment to common nautical, administrative and operational data standards will only work with a sound regulatory framework for the structuring and sharing of data.

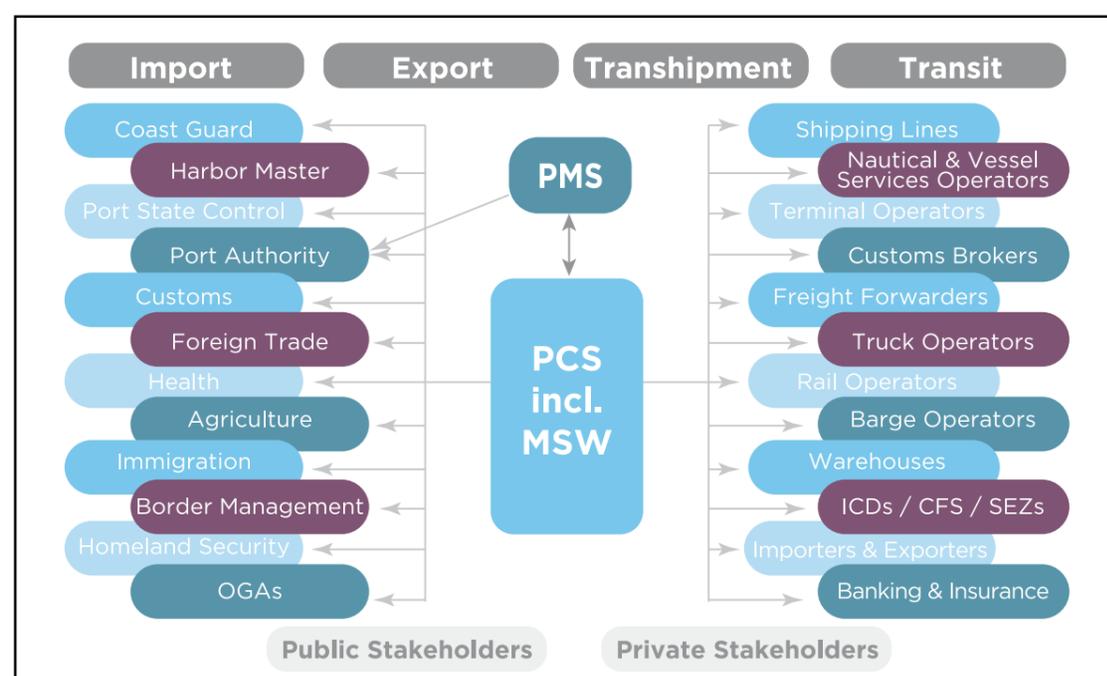


Figure 11: A Port Community System optimal architecture (source-joint IAPH-World Bank paper)

The gap in governance and understanding on the definition and inclusion of stakeholders in a maritime single window system and a port community system and their roles are an impediment to digitalization.

Clarity around the definition and distinction between a maritime single window (MSW) and a port community system<sup>35</sup> (PCS), their differing roles in the synchronization of nautical/operational and administrative data and the order in which they should be governed, designed and implemented has proved to be a clear digital gap in developed and developing countries alike. While some MSWs and PCSs are highly developed and integrated in some ports, others are not being fully utilized to their potential. In developing countries, ambitions are at times limited to developing a MSW instead of a wider objective to develop both in an integrated way.

<sup>34</sup> *IMO compendium on Facilitation and Electronic Business*, IMO website.  
<sup>35</sup> *Accelerating digitalization: Critical Actions to Strengthen the Resilience of the Maritime Supply Chain*, World Bank and IAPH 2020.

# data sophistication, governance and collaboration

## **The use and level of sophistication of a port management system will determine the port's ability to optimize a port call.**

The requirement for ports as a third step in the digitalization process to have a well-functioning port management system<sup>36</sup> to control all port traffic through a single digital interface (for port calls, dues, incidents, waste, dangerous goods, inspections, permits, a.s.o.) will determine the feasibility and way forward to seamlessly connect a ship's navigational Electronic Chart Display and Information System (ECDIS) via an Application Program Interface (API) to a port's management system to better synchronize a port call. In most ports the introduction of a system is plagued with challenges given the variety and sophistication of localized nautical systems developed for each port.

## **Data governance between the port authority and the public authorities and its fluidity determines the ability of the port to clear cargo efficiently.**

In one specific workshop it was stated that port authorities & customs are involved in 80% of vessel call processes. If those processes have not been migrated from paper to digital transactions the scope for inefficiencies and governance malpractices increases. Legislation and regulation

usually moves slower than technology. Also incumbents may resist digitalization as they see it as a job threat or a highlighter of mistakes made.<sup>37</sup>

## **The lack of cooperation between neighboring and or competing ports makes data collaboration challenging.**

In order to achieve port call efficiencies and good exception management, several workshops recognized the need for ports to receive digital updates the moment a vessel has departed from its previous destination in order to accurately provide predictability and certainty in terms of the next port arrival. Each port tends to use a different system, software, solution from different providers. Without cooperation with one another on electronic data exchanges through application program interfaces (APIs), a neutral organization given the mandate to manage data exchanges and well-defined time stamp management, the opportunities to improve port call efficiencies is effectively limited.

<sup>36</sup> *Accelerating digitalization: Critical Actions to Strengthen the Resilience of the Maritime Supply Chain*, World Bank and IAPH 2020.

<sup>37</sup> *IAPH South East Asia and Oceania #CloseTheGaps Workshop 16 February 2022.*



# significant gaps in Digitalization

**A significant gap is appearing between the liner container sector and the bulk, liquid bulk, multipurpose, ro-ro and general cargo sectors in terms of advances in digitalization.**

The advances and improvements made through collaborative projects between ports, terminals, forwarders and carriers in the liner container sector to accelerate digitalization in both administrative and operational data (e.g. common data standards between parties on smart container handling and track and trace, advances on eBill of lading and digitalizing other shipping documentation) is creating a gap with other sectors which have barely begun the process of digitalization.<sup>38</sup> Ports working with dry bulk owner operators cite tight business margins and homogenized commodities as a reason behind not investing large sums of money in digitalization.<sup>39</sup> This will nonetheless impact the overall efficiency of a port which has more than one cargo handling activity.

**The reluctance of private sector parties in sharing critical data with public authorities is in part due to concerns around cybersecurity.**

As recent cyberattacks on prominent port infrastructures have illustrated, ports need to ensure that they have a sound cybersecurity strategy implemented in their port and in particular throughout their organization before they can expect other stakeholders to demonstrate a willingness to share and exchange data on common use data platforms. The digitalization of port communities means ports will need to pay increased attention to cybersecurity risks. This led to a group of IAPH experts identifying the urgent need to develop a set of cybersecurity guidelines for ports and port facilities to deal with this problem.<sup>40</sup>

**There is a definite need to invest in human capital to drive digitalization in the maritime and port sector (upskilling, training on cybersecurity, raise awareness, maritime tech start-ups).**

The gap in skilled talent to manage the acceleration of digitalization in the maritime transport chain will have to be filled if improvements in efficiency, traceability and predictability are to be achieved.

<sup>38</sup> IAPH 2022 World Ports Conference keynote session "Connecting digital infrastructure of ports" May 17 2022.

<sup>39</sup> IAPH Middle East Central and South Asia #CloseTheGaps Workshop, 24 March.

<sup>40</sup> IAPH launches Cybersecurity Guidelines for Ports and Port Facilities as part of industry call to action to digitalize the maritime transport chain, IAPH press release, 2 September 2021.



potential  
solutions:  
DIGITALIZATION

<sup>41</sup> The IMO Global Industry Alliance is public-private partnership initiative of the IMO under the framework of the GEF-UNDP-IMO GloMEEP Project that aims to bring together maritime industry leaders to support an energy efficient and low carbon maritime transport system.

## 3.2 POTENTIAL SOLUTIONS TO CLOSE THE GAPS IN DIGITALIZATION

The overwhelming majority of participants of the #CloseTheGaps exercise advocate the standardization of data exchange between stakeholders, with overarching regulatory authorities to provide a legal framework for the structuring and sharing of data.

The existence of diverse systems, software, hardware and network infrastructure at ports in the different regions of the world managing the exchange of nautical, operational and administrative ship-shore data make the task of uniform data exchange a real challenge. Efforts to adopt robust standards are underway, led by various organizations, including DCSA, BIMCO, TIC 4.0, IPCSA, ITPCO and leading ports including the Maritime Port Authority of Singapore and the Port of Rotterdam.

1

Adoption of the IMO compendium on operational data and the implementation of an obligatory Maritime Single Window adhering to the FAL documentation requirements in IMO member states by January 2024 will be supported by capacity building and best practice sharing by IMO's Global Industry Alliance<sup>41</sup>, IAPH and other entities. A guideline for ports on how to implement the requirements with regionalized role model examples is under development.

2

The universal adoption of International Hydrographic Organization nautical data standards is already widely accepted by the industry. Similar to point one, a practical guideline for ports with concrete examples in practice is under development.

3

Efforts are being made through the establishment of a neutral, innovative approach towards operational and administrative data integration standards through the International Standards Organization, which are in the process of defining ISO 28005-2, which will contain technical specifications that facilitate an efficient exchange of electronic information between ships and shore for coastal transit or port calls. It will define the general message format, the general message exchange patterns, and the transfer protocols. Other parts of the series define data models for various types of message transfers.



**The clearly-identified gap in multi-stakeholder collaboration between parties is an issue of governance.**

One proven way of closing the stakeholders' gap is to establish an inter-ministerial committee chaired by the nation's legislative leader (President, Prime Minister or otherwise) to set out a plan to design and implement both a maritime single window and national port community system which is inclusive and then supported by appropriate legislation regarding its use.<sup>42</sup> Then the following two steps can be adopted:

1

Set up a Steering Committee composed of all stakeholders from the private and public sector to lead the implementation of a digital maritime trade and logistics roadmap, and to play an instrumental part in the long term for the sustainability of the digital platform and systems.

2

The third tier of the institutional architecture is the Business Process Committee which should comprise of business process expert representatives of all public agencies and private stakeholder organizations involved in the project. The role is business process analysis, optimization, automation, and reengineering of the digital road map. The committee will have a key role in the long term for the ongoing evolution and sustainability of digital business processes.

**The impact of COVID19 on global supply chains has spurred on national and regional initiatives to accelerate digitalization in the maritime supply chain.**

Governments which have come under pressure due to the collapse in national local supply chains have responded by introducing national plans to accelerate digitalization. This includes developed countries such as in the United States and Australia as well as other countries in several developing countries (see the example in Annex 1 on Democratic Republic of Congo).

The solution to disentanglement lies in active collaboration between logistics players at each exchange point for cargo with improved transparency in data availability and exchange, including ports. Government intervention has the potential to be effective only if all stakeholders are involved in the process and an adequate, 360-degree analysis of the current issues impacting supply chains can be made. Both IAPH and World Bank will respond to specific requests to support these analyses.

<sup>42</sup> Section 6.2. *The Institutional Framework of a Digitalized Maritime Trade Platform, Accelerating digitalization: Critical Actions to Strengthen the Resilience of the Maritime Supply Chain*, World Bank and IAPH, December 2020.

potential  
**solutions:**  
DIGITALIZATION

potential solutions: DIGITALIZATION

The way forward for global ports to digitalize identified in the #CloseTheGaps exercise involves setting out a realistic, long-term digitalization roadmap.

The World Bank and IAPH publication “Accelerating digitalization – Critical actions to strengthen the resilience of the Maritime Supply Chain” (2020) sets out a clear roadmap for ports to follow in order to take the shift towards becoming a Smart Port.<sup>43</sup> While the timeline may vary between ports depending on availability of resources and the willingness of all parties to collaborate, the essential order and priority of that roadmap remains the same.

A structured, three-tiered strategic approach toward digitalization at a port is advocated. The roadmap dovetails with a structured approach towards digitalization.<sup>44</sup> As part of this structured approach towards digitalization, a three-phased approach is recommended:

- 1 The optimization of processes around trade to close the gaps between stakeholders through inclusivity and a 360-degree analysis of each touchpoint of the maritime supply chain where information and cargo is exchanged between parties.
- 2 The use of digitalization levers beyond efficiency which address specific supply chain and port-related issues. Examples include the potential use of blockchain technology combined with Internet of Things (IoT) and Artificial Intelligence and Digital Twins to track bunkering operations. These would include existing hydrocarbons as well as the wide range of future low and zero carbon fuels that will be coming on stream (traceability per vessel, quality and operational safety standards). Similarly, cargo traceability could be improved using smart container tracking technology. The use of 5G and automated tracking also has the potential to facilitate smarter cargo capacity management as does the use of drone technology to conduct vessel inspections, surveys and pollution prevention operations as well as urgent low-volume, high-value supplies to and from ships.
- 3 The combination of 1 and 2 could then lead to a digital transformation which provides the opportunity for ports to extend their activities and offer new solutions (such as data sharing as a service and community cybersecurity) and improve their competitiveness through semi-automation and automation.

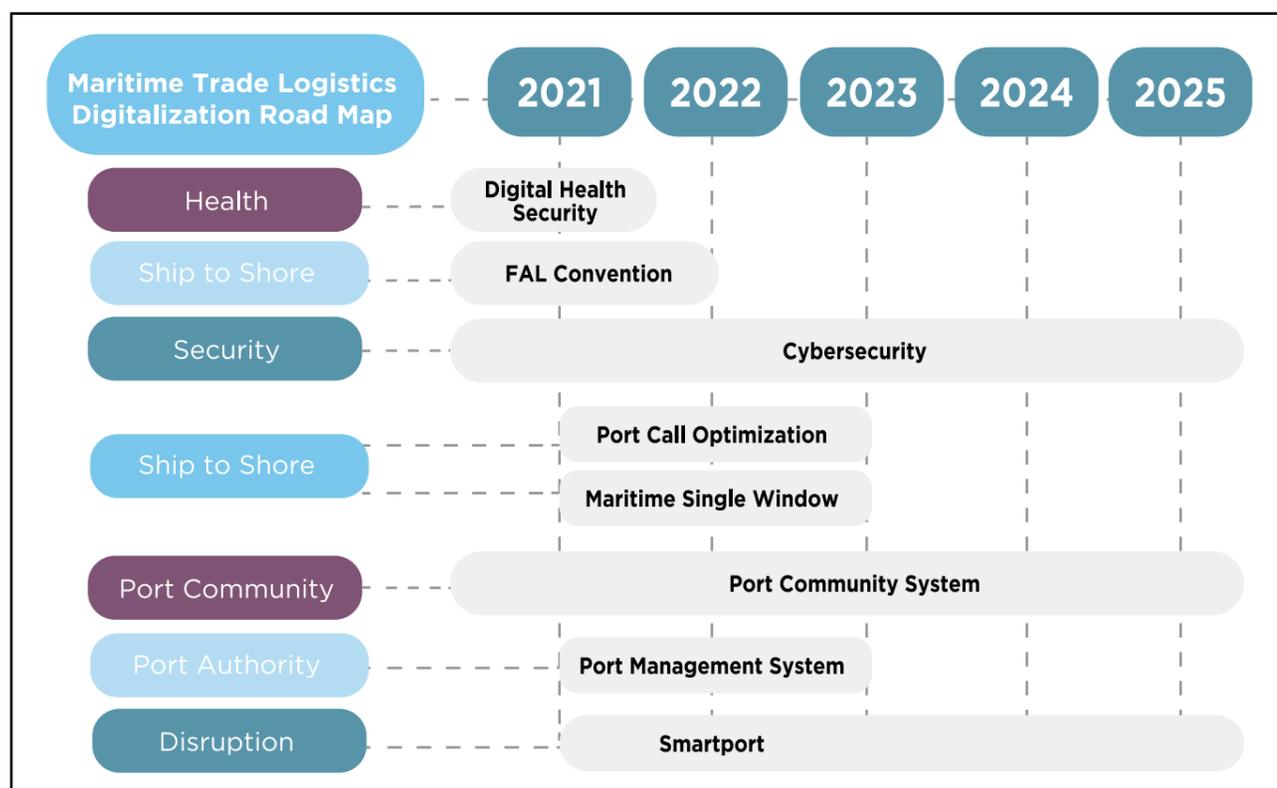


Figure 12: Digitalization roadmap for maritime trade logistics (source: joint IAPH - World Bank paper)

<sup>43</sup> Accelerating digitalization: Critical Actions to Strengthen the Resilience of the Maritime Supply Chain, World Bank and IAPH 2020.

<sup>44</sup> Presentation by Dominik Englert, Economist World Bank Group at the IAPH 2022 World Ports Conference, Vancouver.



### To put in place a sound cybersecurity strategy for the port.

To ensure the safe and secure migration to a smart, digitalized port, the recommendation to adopt and implement the IAPH Cybersecurity Guidelines for Ports and Port Facilities which have received recognition at IMO FAL.<sup>45</sup>

### To establish a recruitment and retention strategy for technological expertise and talent.

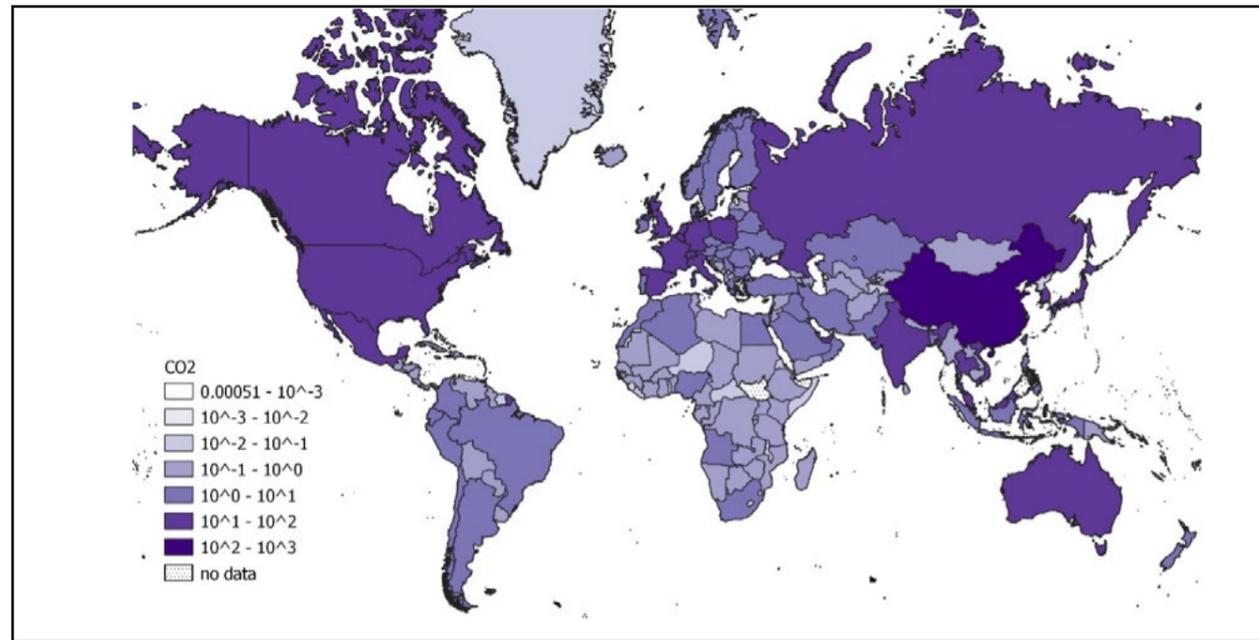
Feedback from port users and service providers clearly demonstrated that private sector players have a clear recruitment strategy to attract young talent into the port industry, especially from other major e-commerce multinationals, social media and high end software and search engine solution providers.<sup>46</sup> This also has the positive impact of bringing in proven innovative ideas from outside the maritime sector and to support the reinvention of maritime digitalized supply chain processes. Advanced ports are also establishing innovation hubs and incubators, supporting proof of concepts and pilots that resolve their pain points and are in some cases assisting start-ups to grow in association with venture capital partners. This indirect approach also attracts new talent to the industry.

<sup>45</sup> *IAPH Cybersecurity Guidelines for Ports and Port Facilities. Endorsed by IMO in 2021/2022 via MSC-104 and FAL-76 and to be mentioned in MSC-FAL.1/Circ.3 Objectivized method of working and objectivized referential character in context of i) insurance and ii) aftermath of an incident.*

<sup>46</sup> *IAPH Middle East Central and South Asia #CloseTheGaps Workshop, 24 March.*



potential  
**solutions:**  
DIGITALIZATION



Source: Aronietis, van Hassel, Vanelslander (2020) based on UNCTAD and Clarksons data

# KEY ACTIONS IN DECARBONIZATION

Figure 13: Estimated shipping-related CO<sup>2</sup> emissions, millions of tons, log scale, 2019

## 4.1

# The Gaps in Decarbonization

While climate change and the challenge of decarbonization is a global phenomenon, there is a regional split in terms of pollution caused by shipping-related carbon emissions, which needs to be considered collectively rather than separately.

As figures 13 and 14 indicate, there is a significant disparity in CO<sup>2</sup> emissions between regions. This disparity is one of the main underlying problems for developing and small island developing states when it comes to financing decarbonization in shipping with the developed world as major emitters. Solutions will nonetheless need to be global for any significant progress to be made to decarbonize the industry as the vast majority of emissions occur during the sea leg.



Source: Aronietis, van Hassel, Vanelslander (2020) based on UNCTAD and Clarksons data



Figure 14 - Estimated regional CO<sup>2</sup> emissions, millions of tons, 2019



# scarcity of low and zero carbon sources of power



## One of the principal gaps facing ports in their efforts to decarbonize is the availability of low or zero carbon sources of power .

In order to significantly reduce emissions in and around ports, the electrification of materials handling equipment, the introduction of onshore power for vessels at berth and other measures being taken by ports need to be matched by the availability of solar, wind, geothermal, tidal and other renewable energy sources. This is especially true for developing nations in the Southern Hemisphere. Ports will need to source this low carbon energy, otherwise efforts to reduce emissions within the port gates will effectively be cancelled out or even worsened.

## The absence of regulation and the necessary funding to close the gap between the cost of production of zero carbon fuels and hydrocarbons increases risk for ports committing to invest in bunkering infrastructure.

The lower density of zero carbon fuels necessitating more frequent vessel refueling creates the opportunity for a greater number of ports to participate in the markets for vessel bunkering. Nonetheless, ports are exposed to investment risks in long-term infrastructure investments while there is no real indicator of which fuel(s) will be adopted by shipowners to gain the necessary critical mass. There is every indication

that the market will be requiring a mix of low and zero carbon fuels in the future with no one fuel emerging as the standard.<sup>47</sup>

## In order to construct and develop future zero carbon bunkering infrastructure, ports will have to take into consideration spatial planning to ensure safety and security in the provision of future bunkering fuels.

The safe and secure provision of low carbon fuels will require ports to adequately take into account spatial planning. This is not only to ensure that bunkering can take place for visiting vessels in the most efficient manner, but to also ensure safety and security factors are taken into account when it comes to the storage, supply and bunkering operations each new fuel entails, especially when the port is located within the vicinity of urban conurbations.<sup>48</sup> The increasing competition for land use between residential and urban development presents ports with an additional potential gap in availability of space to develop bunkering hubs.

<sup>47</sup> IAPH 2022 World Ports Conference breakout session: Getting ready for zero marine carbon fuels, May 17 2022.

<sup>48</sup> External safety study - bunkering of alternative marine fuel for seagoing vessels, DNV for the Port of Amsterdam, April 2021.

# shipping will have to **compete** for **zero carbon fuels**

**Shipping will be competing with other industries to obtain and gain access to zero carbon fuels.**

It has been estimated that in order to provide zero carbon fuels to the world shipping fleet, the entire supply of current alternative energy sources would need to be used. It is also estimated that approximately half of the new alternative zero carbon fuels will need to be transported by ship to meet global demand between producers and consumers for these fuels.<sup>49</sup> The supply of “green” versions of these new fuels (using renewable energy without use of hydrocarbons or derivatives of hydrocarbons in the production process) will most likely be prioritized for the industries emitting the highest concentrations of CO<sub>2</sub> globally, such as the construction industry. This will probably mean that shipping will have to adopt a mix of “blue” (partially sustainable using low carbon energy) and “grey” (derived from processes involving hydrocarbons) versions of these alternative fuels during an interim period while the production infrastructure is put in place for green alternative fuels.

**The speed of implementation of zero carbon fuels is dependent on the speed of technological development of ships’ engines, onboard fuel storage technologies and committed investments by shipyards and shipowners.**

Much of the funds into research and development being made in combustion engines that can work efficiently on zero carbon fuels and offer a realistic return on investment are currently dependent on the more advanced shipowner-operators and yards seeking first mover advantage in developing pioneering cargo and passenger vessels. The lack of progress at the IMO’s Marine Environment Protection Committee (MPEC) in reaching consensus between member states on a method and legislation to create a fund put in place through market-based measures (i.e. taxes to fund research and development into bringing the economic costs of production of these new fuels down) means that for now, speed of development is mainly dependent upon efforts conducted in the private sector.

**The high economic costs of production, the challenges in the funding of the infrastructure and the availability of resource for supplying zero carbon fuels implies that ports aiming to become bunkering ports will have to consider becoming zero carbon energy hubs themselves.**

Not all ports will become low and zero carbon fuel bunkering hubs. Some will need to provide maintenance facilities for vessels running on dual fuel or zero carbon fuel propulsion when they make a port call. Other ports will need to have the necessary safety and operational procedures in place with trained personnel to receive the vessels running on these fuels. Those that are aiming to become bunkering hubs for the new fuels also need to consider attracting energy suppliers to make ports their production hubs for other transport modes and for supplying energy to industry and community households.

<sup>49</sup> *Fueling the Fourth Propulsion Revolution* - International Chamber of Shipping, May 2022. Source : ICS website.

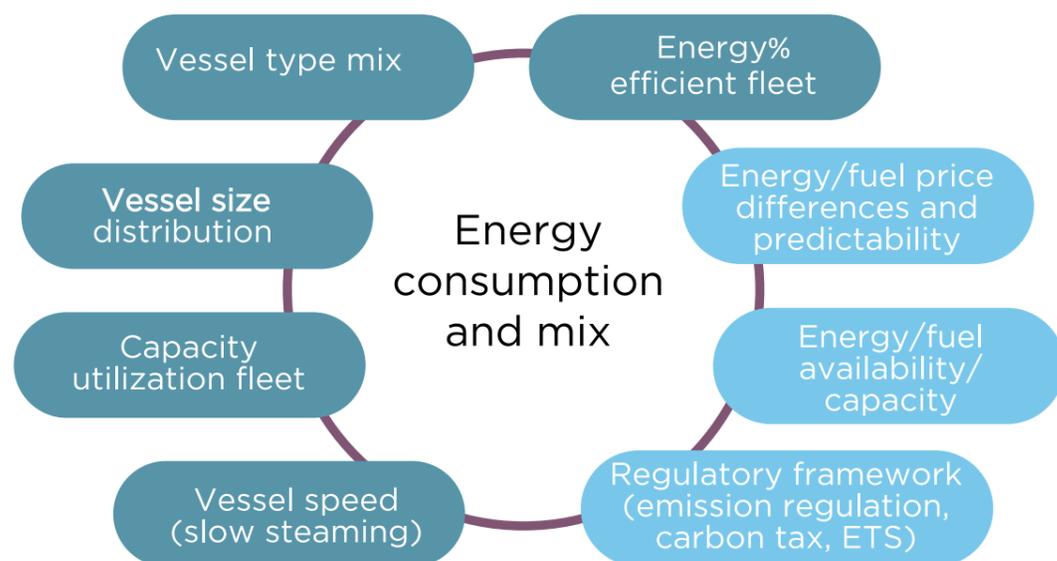


**The type of energy consumption is also dependent on the future global vessel fleet composition, vessel speed and capacity utilization.**

As indicated in Figure 15, the global vessel fleet composition will determine which bunker fuels are consumed. The ability to retrofit newly-built vessels to suit the new zero carbon fuels will be an important factor to also take into account as both ammonia and methanol fuels will require modifications to existing technical ship specifications. Trading patterns and capacity utilization will also influence which fuel is deployed and which type of fuel is more suited. Ultra Large Container ships are typically associated with biofuels and LNG, with future potential conversions to working with methanol as a fuel. Smaller passenger ferries will most likely be more attracted to using hydrogen or ammonia given relatively low fuel consumption, whereas liquid bulk and gas tankers will more likely use low carbon fuels such as LPG and LNG as well as ammonia and ethanol to complement the same cargoes that are being carried on board.

## The Gaps in Decarbonization

### Key determinants of future ship fuel consumption and mix



Source: Notteboom (2022), Shell scenarios workshop, March 2022

**The high levels of investments required in future low and zero carbon fuel bunkering infrastructure runs the risk of creating a further divide between ports in developing and developed countries .**

Guaranteeing the necessary economies of scale of investments in future alternative fuel infrastructure risks creating a gap between those larger ports capable of attracting large scale investment of this kind<sup>50</sup> and those - particularly in developing countries - where creating critical mass for demand and supply will be more challenging. Without support from governmental, NGO and financial institutions, many strategically-located ports which are well-suited to low density fuel bunkering along cargo trading and cruise passenger routes may lose out to existing global bunkering hubs and /or ones located along the existing energy supply chain.

<sup>50</sup> *Shell to commence production of Europe's largest green hydrogen plant; Port of Rotterdam press release 6 July 2022.*

Figure 15: Factors impacting future energy consumption and mix



potential  
solutions:  
DECARBONIZATION

<sup>51</sup> *The Getting to Zero coalition is a partnership between the Global Maritime Forum, Friends of Ocean Action and World Economic Forum – and the Energy Transitions Commission.*

<sup>52</sup> *The First Wave, a Blueprint for Zero Emissions Shipping: Blueprint for commercial-scale zero-emission shipping pilots - special report by the Energy Transitions Commission for the Getting to Zero Coalition, 2020. Source: Global Maritime Forum.*

## 4.2 POTENTIAL SOLUTIONS TO CLOSE THE GAPS IN DECARBONIZATION

**The first “no-regret” measure is for ports to actively reach out to all their stakeholders in the energy value supply chain to assess what is feasible and what can be achieved in order to serve vessels running on the new fuels visiting their berths.**

One of the key feedbacks on the **#CloseTheGaps** exercise by ports and senior port panelists at the IAPH 2022 World Ports Conference was the need for ports to work beyond their role as landlords and/or operators. Ports should investigate the possibilities of creating renewable energy generation along their coastlines by consulting with energy providers in offshore wind, solar, biothermal, wave and even nuclear energy, and by actively engaging with the world’s leading providers of low and zero carbon fuels, research institutes and foundations established to accelerate R&D into the use and adoption of new alternative fuels. By doing so this creates additional opportunities for ports to be able to provide bunkering options for its shipowner customer base. In East Asia this would include consultations with the world’s major shipyards given the significant impact this sector has on coastal maritime development. In Europe this also includes outreach to regional institutions such as the European Union and in the United States to the Federal Department of Transportation, both of whom have introduced recent legislation to support the decarbonization of shipping.

**Ports should look beyond their own location and determine the role they can potentially play in developing low and zero carbon trading routes for cargo, cruise tourism and/or passengers.**

The much vaunted “green corridor” approach for all port and maritime supply chain stakeholders has garnered significant attention since the 2020 Getting to Zero<sup>51</sup> Coalition publication of the business case for a commercial-scale zero-emission pilot in “The First Waves: A Blueprint for Zero-Emission Shipping”.<sup>52</sup> Several green corridors have been announced including between the ports of Los Angeles and Shanghai, and the ports of Antwerp and Montreal. The most recent agreement between the Port of Seattle, City and Borough of Juneau, Vancouver Fraser Port Authority, and several cruise Lines was made at the IAPH 2022 World Ports Conference to explore the feasibility for a first-of-its-kind ‘Green Corridor’ for cruise. The definition of the key actors in the implementation of such corridors can be found in Figure 16. The role of a port authority can be seen here as coordinator between stakeholders on the land side. The key issue is to establish a fuel pathway which is realistic and can meet stakeholders’ expectations and objectives.

potential  
**solutions:**  
DECARBONIZATION

**Revenue-raising Market-Based-Measures (MBMs) established through the IMO have the potential to balance the competitiveness gap between the zero carbon and hydrocarbon fuels and can potentially offer a just and equitable transition.**

The multiple MBM proposals placed on the table at the IMO's MEPC offer a potential way forward to fund the fuels of the future while ensuring developing nations are included in the transition.<sup>53</sup>

Ports are unlikely to make investments in bunkering infrastructure and related facilities if there is no obvious demand for them as the risk of being left with large, stranded assets is high. Equally ship owners are unlikely to invest in zero carbon fuels or onshore power provisions if no infrastructure is available at ports. Financial support to decarbonization investments in ports, of developing countries in particular, through revenues generated from an MBM could help resolve this deadlock.<sup>54</sup> It could also encourage the simultaneous deployment of ship-based technologies and onshore infrastructure.

**The positive impact of onshore power supply (OPS) on decarbonization will be determined by the uniformity of its deployment and the use of renewable energy to power it.**

The adoption of onshore power offers a proven method of having a short-term positive impact on reducing vessel emissions at berth. A number of advanced ports have already successfully implemented onshore power systems with partners using renewable energy, so acquiring knowhow from these first installations is a priority. Providing ports with practical guidance on operational, economic, organizational and technological aspects of OPS through initiatives such as guidance tools by IAPH and World Ports Climate Action Program and capacity building in developing countries through IMO-Norway GreenVoyage2050 will support this adoption.

**Offering incentives to shipowners to continuously improve the environmental performance of their fleets using an index-based calculation system is a proven method of reducing at berth emissions.**

By offering incentives such as reductions in port dues to shipowners demonstrating material improvements in environmental performance by means of a neutral, well defined index-based calculation system, ports are able to have a direct, positive impact on improving air quality and potentially reducing carbon and particulate emissions. The IAPH Environmental Index (ESI), manages just under 7,000 vessels with 62 incentive providers in 24 countries and is an index that has been put in place for just over a decade.<sup>55</sup>

<sup>53</sup> Document MEPC 77/7/19 (World Bank's) key finding is that many countries – both developed and developing – could seize business and development opportunities in shipping's energy transition, and enter the global market for zero-carbon bunker fuels.

<sup>54</sup> IAPH commenting paper submitted to IMO on the findings of document MEPC 77/7/19 (World Bank).

<sup>55</sup> IAPH Environmental Ship Index Source : International Association of Ports & Harbors.

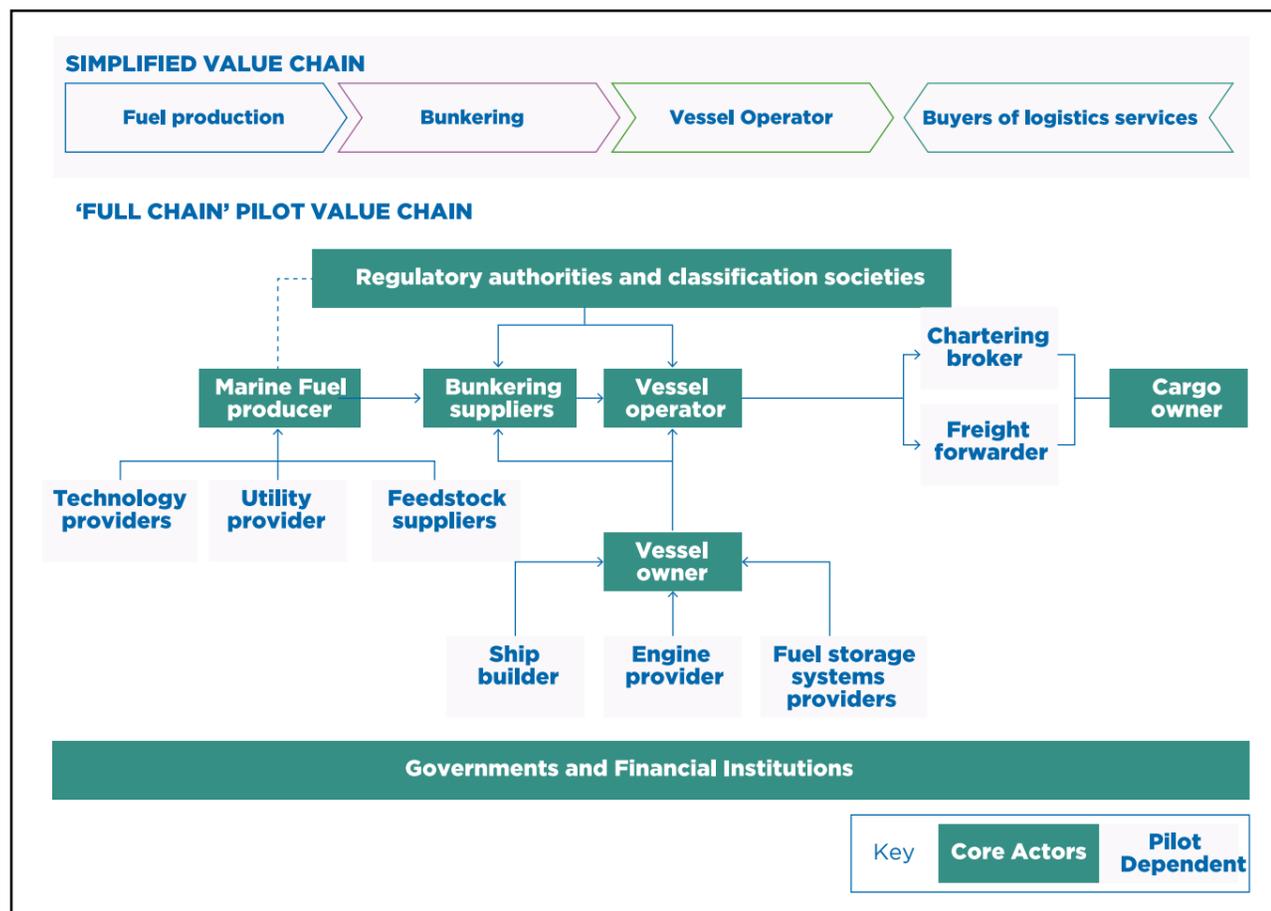


Figure 16: Key partners to be involved in an end-to-end pilot (Source: The First Wave- A blueprint for commercial-scale zero-emission shipping pilots, Getting to Zero Coalition, 2020)



# activities and potential sources of assistance

## NEXT STEPS

As mentioned in the Introduction, this report is the culmination of an exercise that began with the closing remarks of our International Association of Ports and Harbors (IAPH) 2021 virtual World Ports Conference held during the second and third waves of the global pandemic. The IAPH – World Bank **#CloseTheGaps** exercise, which included the input of 85 maritime and logistics professionals from 35 countries as well as the speakers and attendees of the IAPH 2022 World Ports Conference, is reflected in this report. In 2022 eight regional online workshops following the Chatham House rule and moderated by IAPH and World Bank staff gathered input on global port infrastructure gaps and how to deal with them. These were discussed further during eight regional meetings and the main program of

the IAPH 2022 World Ports Conference in Vancouver.

The objective of the exercise was to identify the key issues in the views of the participants of the workshops and the attendees at the Vancouver Conference. The second phase was then to present the findings and potential options to move forward in the three key priority areas, resilience, digitalization, and decarbonization in this report. This section indicates the activities and potential sources of assistance available to ports in the client countries of the World Bank in the three areas, both currently, and as part of the ongoing reform of the World Bank Port Reform Toolkit, which is being undertaken by the WB and IAPH.

The World Bank Group (WBG) provides a unique repository

of knowledge, technical assistance, and financial support for developing countries around the world. The WBG is not a bank in the commercial sense, but rather acts as a partner to assist countries in their journeys to reduce poverty and facilitate development. In the maritime sector, and the transport sector more generally, the WBG offers support to developing countries through policy advice, research, and analysis drawing on the best global knowledge along with targeted technical assistance to build capacity and developed human capital in client countries. This analysis often underpins the case for subsequent public and/or private investment for priority projects and programs.

# resilience



## RESILIENCE

One of the key drivers of change is the increasing awareness in the maritime industry of its responsibility to protect the global and maritime environments. The shipping industry, in part, is playing a proactive role in driving change to become more sustainable and promoting environmental awareness. This reflects the introduction of international agreements, global regulations for emissions, domestic policy and consumer preference. The IMO is responding to the global effort against climate change and has adopted mandatory measures to reduce greenhouse gas emissions. The target the IMO has set for the maritime industry is to reduce the carbon intensity of international shipping by at least 40% by 2030 and 70% by 2050, compared to the 2008 baseline. Moreover, the IMO aims to reduce the total greenhouse gas emissions from international shipping by at least 50% by 2050. The decarbonization targets will demand changes to the way maritime businesses are conducted, including how the current fleet of vessels is operated and designed, and how ports operate, placing far greater emphasis on the greening of their operations. Options in respect of the former are discussed in more detail in the next section, here the focus is on the former, improving the resilience and environmental performance of the ports themselves.



**improve  
resilience  
and  
sustainability  
of ports**

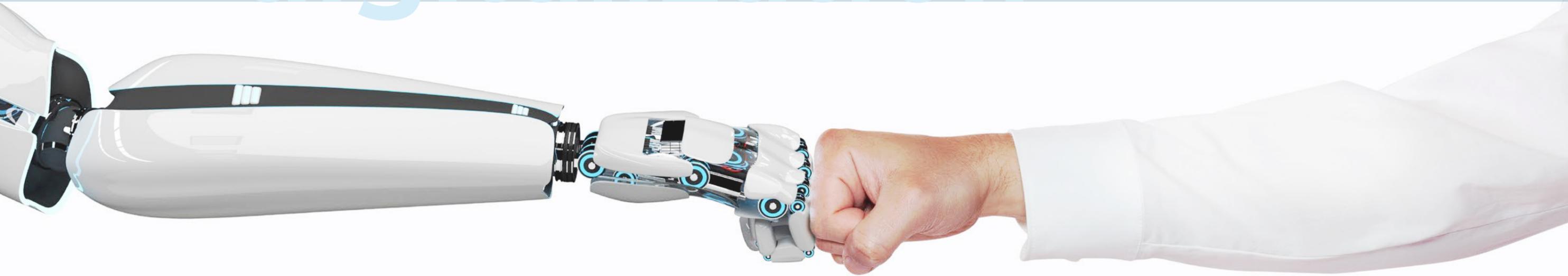
The landside activities in shipping, such as cargo operations at the terminal, as well as water pollution and untreated water and waste disposal from port operations are important sources of emissions. These aspects are not considered as part of the discussions about the decarbonization of the maritime fleet, excepting in a reactive way to facilitate the provision of green fuels etc. There is an increasing awareness on the part of many port authorities to the impact of noise pollution, waste disposal and airborne emissions on the people and cities around the port, and in certain contexts major steps have been taken. Regrettably, this is not the case in many of the client countries of the World Bank. A good summary of different instruments to 'green' a port is provided in Bergqvist and Monios (2019)<sup>56</sup> the most pertinent of which are summarized below.

- Applying green port dues to incentivize cleaner ships, using shore power supply from renewable sources, and supporting the introduction and provision of green fuels.
- Greening port operations by the introduction of electric vehicles and superstructure, in combination with energy transition and green concession policies.
- Greening inland logistics by synchro modality, inland terminals and port-hinterland concepts, traffic spread and pipeline networks.
- Supporting the circular economy by industrial ecology, seaports as recycling hubs and use of renewable energy.
- Monitoring, benchmarking and measuring pollution to keep track of the environmental footprint of a port/terminal, and provide a clear record of the financial benefits, and as well and the social and economic benefits that result from energy savings and emission reductions.

The forthcoming Port Reform Toolkit proposes to include a module on how a port needs to respond to the decarbonization agenda more broadly, but also the road map and priorities to identify, measure, and implement actions to improve the resilience and environmental performance of the port itself. This is intended to provide guidance to policymakers and practitioners with case studies, and an approach to improve resilience and sustainability in the ports in the client countries of the WBG. Subsequent vulnerability analysis could lead to support to client countries in the form of targeted technical assistance to build capacity and developed human capital in client countries, and underpins the case for subsequent public and/or private investment for priority projects and programs.

<sup>56</sup> See R. Bergqvist & J. Monios (Eds) *Green Ports: Inland and Seaside Sustainable Transportation Strategies*, Elsevier, London.

# digitalization



## DIGITALIZATION

This report makes clear that the maritime ports are just one node in a complex logistical chain involving a number of interactions and digitization is vital to improving the competitiveness of that chain. The digital revolution has emerged in the last decade as one of the main drivers of change in the port and maritime sector, and requires a high level of integration between devices, agents and activities. This together with the increased connectivity between ports it has created a new ecosystem in the industry – one where being on the outside is a significant disadvantage for ports and countries. It is vital that maritime ports improve their position in respect of technological innovation and integration, both to ensure or improve their competitiveness, but also reduce the cost of international trade for their respective hosts and hinterland. Maritime transport carries ninety percent of global merchandise trade, and impediments to ports' logistical chains will have tangible repercussions. In the short term, this is likely to take the form of shortages of essential goods and higher prices; in the medium to longer

term, slower economic growth, less employment, and higher trade costs. In the digitization of the maritime sector, the World Bank Group can mobilize financing for clients at different stages of their digital development path. The WBG can mobilize grant financing, subject to a successful application, from a range of potential sources—including, among other things, the Digital Development Partnership (DDP), the Public-Private Infrastructure Advisory Facility (PPIAF), and the Global Infrastructure Facility (GIF)—to facilitate upstream investigations to support clients in making informed choices about the how, the when, and the what of their evolution along the digital road. Non-reimbursable grants have been provided to a number of countries to undertake an assessment of their digital status, and to outline a roadmap to client countries. Subsequently, the WBG can facilitate, following a formal request and the necessary due diligence, financing in the form of concessional or semi-concessional finance, and possibly grants, to support agreed investments—either unilaterally or in partnership with private finance. In terms of Technical Assistance, the forthcoming update of the Port Reform toolkit will provide a generic path of improvement for digitalization and cybersecurity, illustrated by case studies.

# de-carbon-ization

## DECARBONIZATION

It is difficult to overstate the economic importance of international maritime transport. Shipping allows trade at a scale that has been fundamental for globalization and many key developments in the world economy. Today, international maritime transport accounts for around 80% in volume and 70% in value of all world trade. Unlike other sectors, developing countries play a major role in the sector. Almost all small island developing states (SIDS) and many least developed countries (LDCs) are highly dependent on maritime transport for the supply of basic goods such as food, clothing, and shelter.

The sector contributes a share of 2-3% (about 800-900 million tCO<sub>2</sub>e annually) to global greenhouse gas (GHG) emissions. If the sector were a country, it would be the sixth largest GHG emitter worldwide (between Japan and Germany). Under a business-as-usual scenario, GHG emissions from international maritime transport are expected to increase by 20-120% (Baltic and International Maritime Council, 2017) or 50-250% (International Maritime Organization, 2014) potentially raising the share of the sector in global GHG emissions to as much as 17% by 2050 (European Parliament, 2015). At the same time, shipping accounts for about 15% of global sulphur and nitrogen oxide emissions. These air pollutants from vessels cause about 60,000 premature deaths annually.



In April 2018, the International Maritime Organization (IMO) adopted its Initial IMO Strategy on Reduction of GHG Emissions from Ships (“initial strategy”). The IMO is the United Nations’ specialized agency with responsibility for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships. It develops the regulatory framework for international maritime transport. The initial strategy requires the IMO to take appropriate measures to reduce GHG emissions from shipping by “at least” 50% by 2050 (compared to 2008) with a strong emphasis on increasing the cut towards 100% by 2050 if this can be shown to be possible. This level of ambition is approximately commensurate to the Paris Agreement temperature goal of 2°C, but is insufficient to meet the increased ambition of keeping global temperature rise well below 2°C or even 1.5°C.

As of today, various policy measures to implement the initial strategy are being discussed at the IMO. The Initial Strategy and its related policy measures are to be finalized in 2023. Yet, negotiations at the Marine Environment Protection Committee (MEPC) are advancing only slowly. In light of the long lifespan of ships (20-25 years), many maritime experts posit that the world’s first zero-emission vessels need to enter the global fleet by 2030 to keep IMO’s 2050 target of “at least 50% GHG reduction” in reach. Given the expected continued sector growth these zero-emission vessels will be urgently needed to counterbalance GHG emissions from conventional vessels which will still run on heavy fuel oil by then and to pave the way for fully decarbonizing the sector as soon as possible.

To reduce the sector’s current dependence on heavy fuel oil, the most promising solutions options are increased energy efficiency in the short-term and new zero-emission fuels such as green hydrogen/ammonia for long-distance and electrification for short-distance/coastal shipping in the mid- to long-term. While many proven energy efficiency technologies already exist but have often not been picked up due to market failures, zero-emission fuels are still under development and not economically viable yet. There is also considerable potential for certain countries to develop these fuels, and for some the chance to emerge as a bunkering hub for the sector.



# Global, Regional and Country level support

The contribution of the World Bank in this space, often in concert with IAPH, is threefold:

- **Global level:**

**Analytical reports:** Building on its research from Phase 1, the World Bank intends to continue and enhances these analytics in the fields of zero-carbon bunker fuels, increased energy efficiency, and market-based measures/carbon revenues in international shipping.

**Capacity development:** In that context, the World Bank is supporting the Dublin City University to develop and deliver training on market-based measures/carbon revenues in international shipping specifically designed for small island developing states (SIDS), and least developed countries (LDCs).

- **Regional level:**

**Advisory:** As part of a broader program on the Pacific maritime transport sector, the World Bank is supporting the development of the Pacific Blue Shipping Partnership, an alliance of eight Pacific SIDS committed to fully decarbonize their domestic shipping by 2050, in terms of its emissions baseline assessment, zero-carbon transition plan, finance roadmap, and governance structure.

That broader program also includes an analytical component on fostering green ports (climate and environmental challenges and opportunities) in the Pacific.

- **Country level**

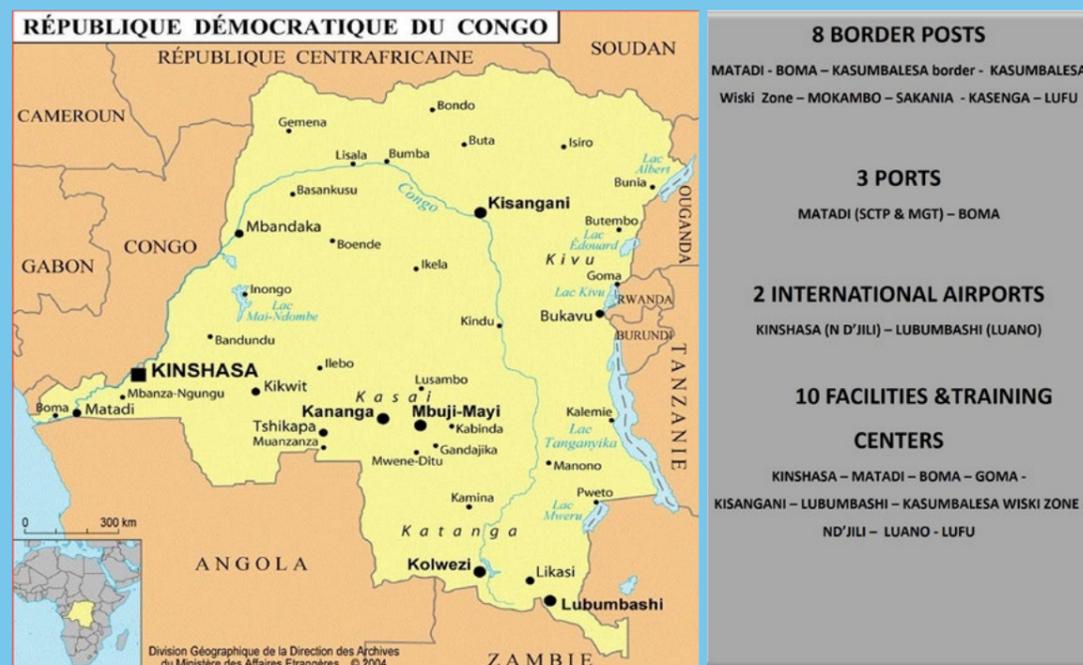
**Project identification:** The World Bank has started to identify and outline pilot projects for zero-carbon bunker fuel (based on green hydrogen) production, bunkering, supply, and export in developing countries. Pre-feasibility for selected port locations in South Africa and Morocco are underway. Dialogues with additional pilot countries such as Panama, Brazil, Sri Lanka, or Turkey are being held.

**Advisory and project identification:** As part of a consortium and supported by Germany's International Climate Initiative, the World Bank is commencing to work with five African countries, namely Comoros, Kenya, Mauritius, Namibia, and Tanzania, to develop national action plans for transitioning towards zero-carbon shipping and taking full advantage of the business and development opportunities arising from a shift of international shipping to zero-carbon bunker fuels.

# ANNEX 1 CASE STUDIES

## Accelerating digitalization by establishing a sound regulatory framework – the case of Democratic Republic of Congo (DRC)

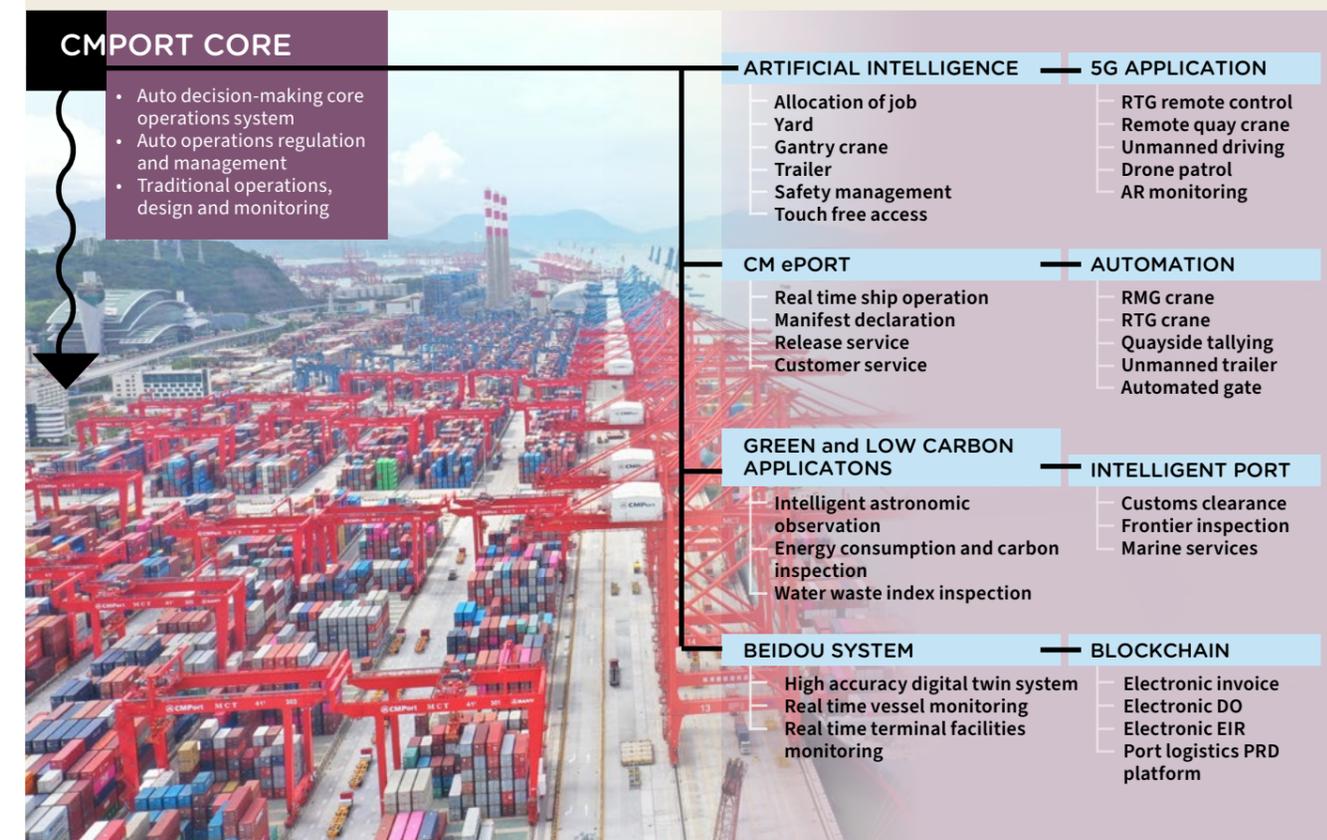
In 2014, the government of the Democratic Republic of Congo (DRC) decided to adopt a national single window system incorporating a multimodal port community system including air, sea, rail, road and waterways intermodal transactions as well as cargo activities with Angola and the Great Lakes region. An inter-ministerial committee to implement a digitalization roadmap was put in place, chaired by the Prime Minister to work on the legal framework.



In addition, a steering and a business process committee were established with all the relevant government agencies and stakeholders to design, implement and operate the system. In each DRC region, a key focus was given on the human element of implementation, training more than 25,000 people on the workings of the NSW and PCS. In early 2022, the government of the DRC awarded a long-term concession to develop a major terminal in Banana, along the country’s 37km coastline on the Atlantic Ocean. The terminal will include a 600-meter quay with an 18- meter draft with a capacity for approximately 450,000 twenty-foot equivalent units (TEUs), opening up the country’s connectivity to international trade.

## Digitalization roadmap: the transition to a smart port – the Mawan SmartPort case study

The China Merchants Group (CMG) and China Merchants Port (CMPort) home base in Shekou, Western Shenzhen has evolved from a fishing village to a modernized city over period of just over 40 years. With its Shekou Container Terminal, Chiwan Container Terminal and other port and logistics activities, the location has become a major global trade hub. The “Mawan SmartPort” strategic port project is now deploying full automation of materials handling equipment, artificial intelligence, blockchain, cloud computing, a digital twin for simulation and an energy and waste efficiency system which will establish the template for roll out of all other CMPort terminals in China and the rest of the world. In addition, the “Coordinated port project” aims at unifying electronic data interchange between the main coastal ports and 18 inland ports in the Pearl River Delta Region, synchronizing customs clearance process and documentation flows to enhance intra port and hinterland mobility.





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