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# Anchoring to digital operations

Why modernizing maritime ports matters



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## About this report

To identify barriers to port modernization, we interviewed 17 executives during June and July of 2024 from Canada, Greece, India, Japan, Morocco, The Netherlands, Saudi Arabia, Singapore, Spain, UK and US. These leaders represented port authorities, terminal operators, border agencies and shipping lines. This report, based on those interviews, our client experience and third-party sources, aims to help ports enhance economic growth, safety, security and sustainability.





## Navigating new horizons:

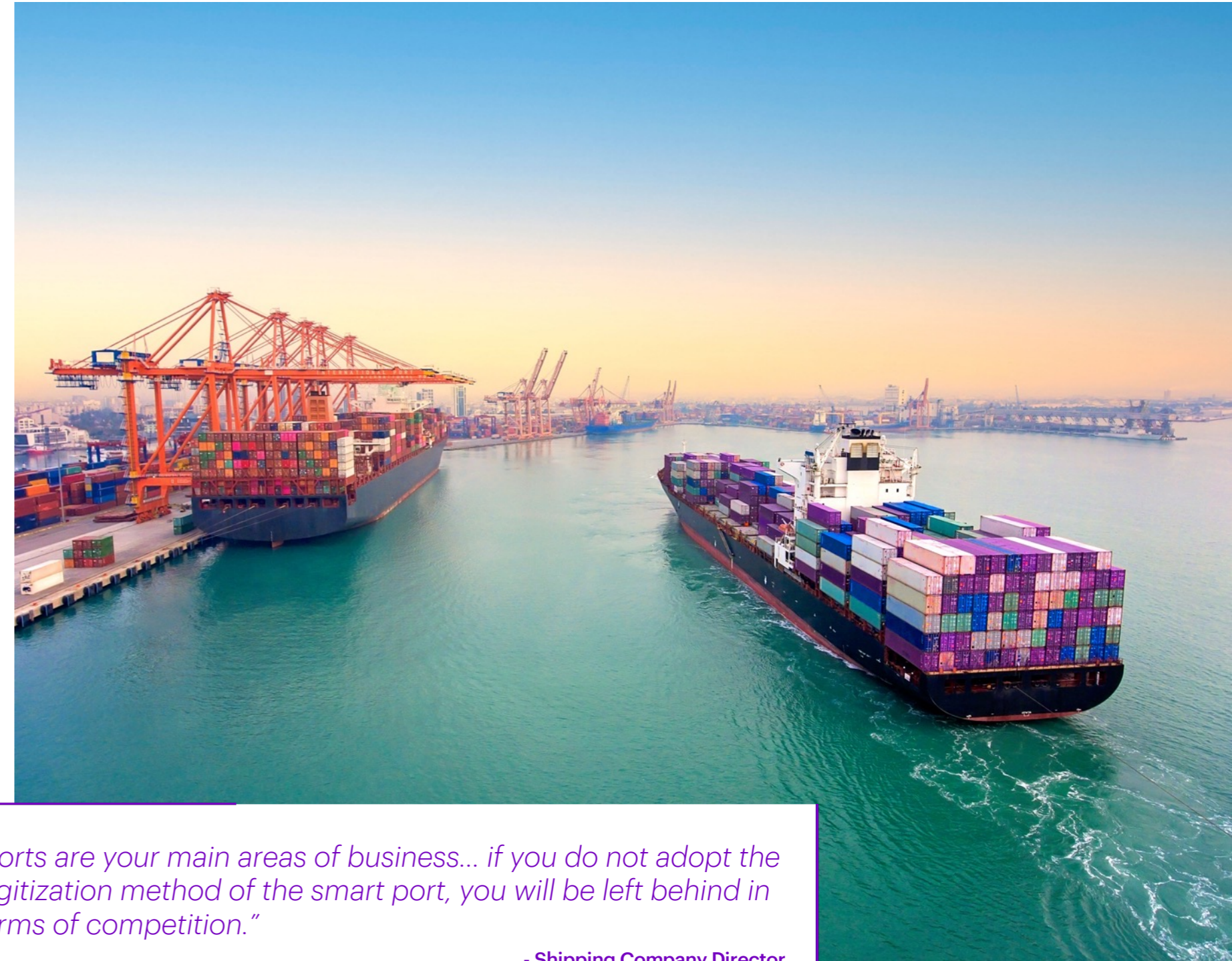
# Enhancing port capabilities for a dynamic world

Centuries ago, maritime ports were the bustling centers of global trade. Sailors, dockworkers and merchants labored side-by-side in a world where manual effort powered the exchange of goods. Ships unloaded cargo on crowded docks, communication was face-to-face and every transaction required a personal touch. Fast forward to today and these central lifelines of commerce are on the verge of a profound transformation, one that can reshape the ports of tomorrow to be smart, interconnected ecosystems, orchestrating trade in real-time, aided by advanced technologies.

Imagine a port where autonomous cranes, powered by AI, unload mega-container ships with real-time data shared seamlessly between terminal operators, shipping lines and customs agencies.

Blockchain ensures transparent tracking and customs agents receive real-time cargo updates. Ports like Rotterdam and Singapore are already leading this future, where smart sensors and AI-driven logistics enable efficient, sustainable and resilient operations.<sup>1</sup>

As the global economy grows in both size and complexity, the entire port ecosystem — including port authorities, terminal operators, shipping lines, customs agencies and logistic providers — faces mounting pressure to modernize. The advent of mega-container ships, evolving customs regulations and the demand for transparent, real-time shipment tracking are driving a shift to smarter and more agile infrastructure.

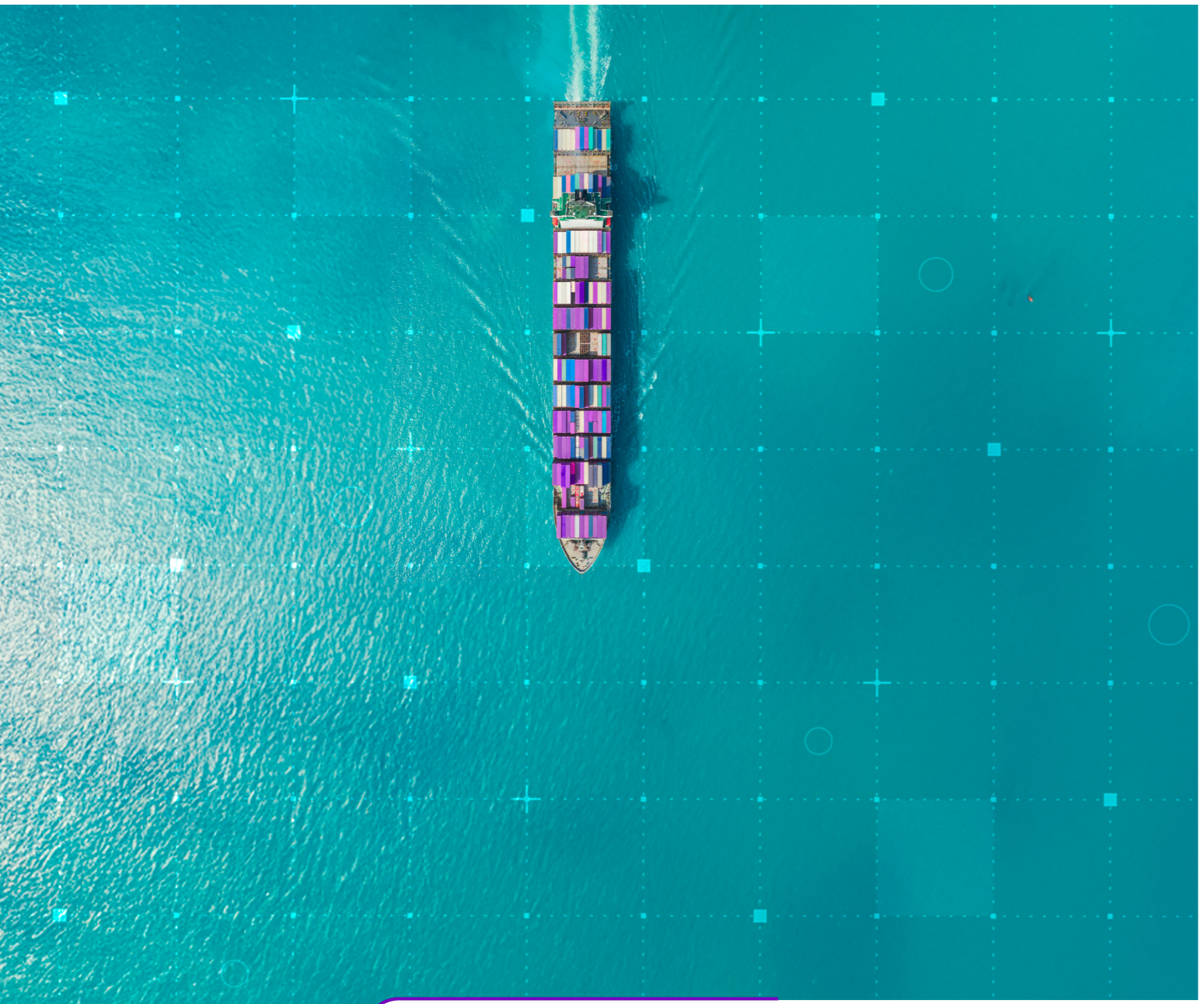


*“Ports are your main areas of business... if you do not adopt the digitization method of the smart port, you will be left behind in terms of competition.”*

- Shipping Company Director







*“To improve the case for making actions... it needs to be addressed that ports are fundamental linchpins to a lot of global economies.”*

**-- Maritime & Ports Accelerator Director**

Despite the clear benefits of modernization, many ports are still struggling to get there. This leads to significant variation across the industry in the ability to improve efficiency, reduce bottlenecks and make data-driven decisions. Accenture experience shows organizations that embrace [reinvention as a strategy](#)—focusing on a digital core and new ways of working that establish a culture and capability for continuous innovation—can improve outcomes in the face of almost any type of disruption. With this type of approach, ports can modernize and be better equipped to secure supply

chains and economic growth for generations to come. Ports that dismiss reinvention and are behind on modernization risk being bypassed by shipping lines.

How, then, can today’s ports become the ports of tomorrow, cementing their status as cornerstones of trade? Recognizing and addressing the challenges of modernization through digitization is essential to meeting the demands of the future.



## Barriers to change:

# Challenges in modernizing ports

Modernization for ports will come through digital transformation. This requires upgrading outdated infrastructure, securing funds and adhering to evolving international regulations — all while maintaining daily operations and remaining competitive. To better understand and unpack modernization challenges and identify solutions, Accenture conducted interviews with 17 global leaders including port authorities, terminal operators, border agencies and shipping lines.

Several common challenges and insights emerged from our discussions. While these challenges are common across many industries, ignoring the roadblocks to modernization in ports can have massive global economic repercussions:

## High costs and operational disruption:

Modernizing ports often involves making updates to [capital infrastructure](#). Infrastructure upgrades demand significant financial investments and often lead to operational disruptions, which can be particularly daunting in such a high-volume industry on which so many supply chains depend.

## Siloed legacy systems:

Maritime shipping is a historic industry, and many ports still rely on outdated systems that function in silos, creating communication gaps between different parts of the ecosystem. This lack of interoperability causes operational inefficiencies, bottlenecks and decision-making delays.

## Workforce resistance:

In some countries, ports are highly unionized. Industry workers' resistance to automation and technological change slows down digitization efforts, making it difficult to implement modernization strategies.

## Data-sharing concerns:

Many maritime port stakeholders and ecosystem members are cautious about sharing customer data due to cyber risks or competitive disadvantages. Additionally, regulatory limitations on data sharing restrict information exchange across organizations and borders. These factors hinder the adoption of integrated platforms and real-time data exchange across the global port ecosystem.

## IT skills gaps:

Historically, ports have been rooted in physical labor and operations. As the industry shifts toward more technology-driven operations, such as automated systems, data analytics and integrated platforms, the demand for IT skills has outpaced the availability of skilled workers.





"Ports are often caught between outdated systems and the frontier of technological innovation, making it difficult to plan a clear path forward."

- Maritime & Ports Accelerator Director

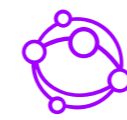
"The borders agencies are operating according to a rulebook that is very seldom updated. And the environment in which real time shipping and ports operate is changing rapidly all the time."

- Customs & Borders Advocacy Group Leader



## Three strategies to accelerate modernization through digitization

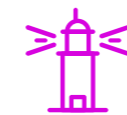
Our interviews uncovered strategies that have helped leading ports overcome these barriers and move toward the smart ports of tomorrow. When implemented effectively, they can result in faster turnaround times, reduced bottlenecks and significant cost savings:



Facilitate ecosystem collaboration to develop stronger solutions that will serve all parties' needs



Engage the workforce to secure support for ongoing innovation



Build a long-term, scalable vision backed by short-term wins







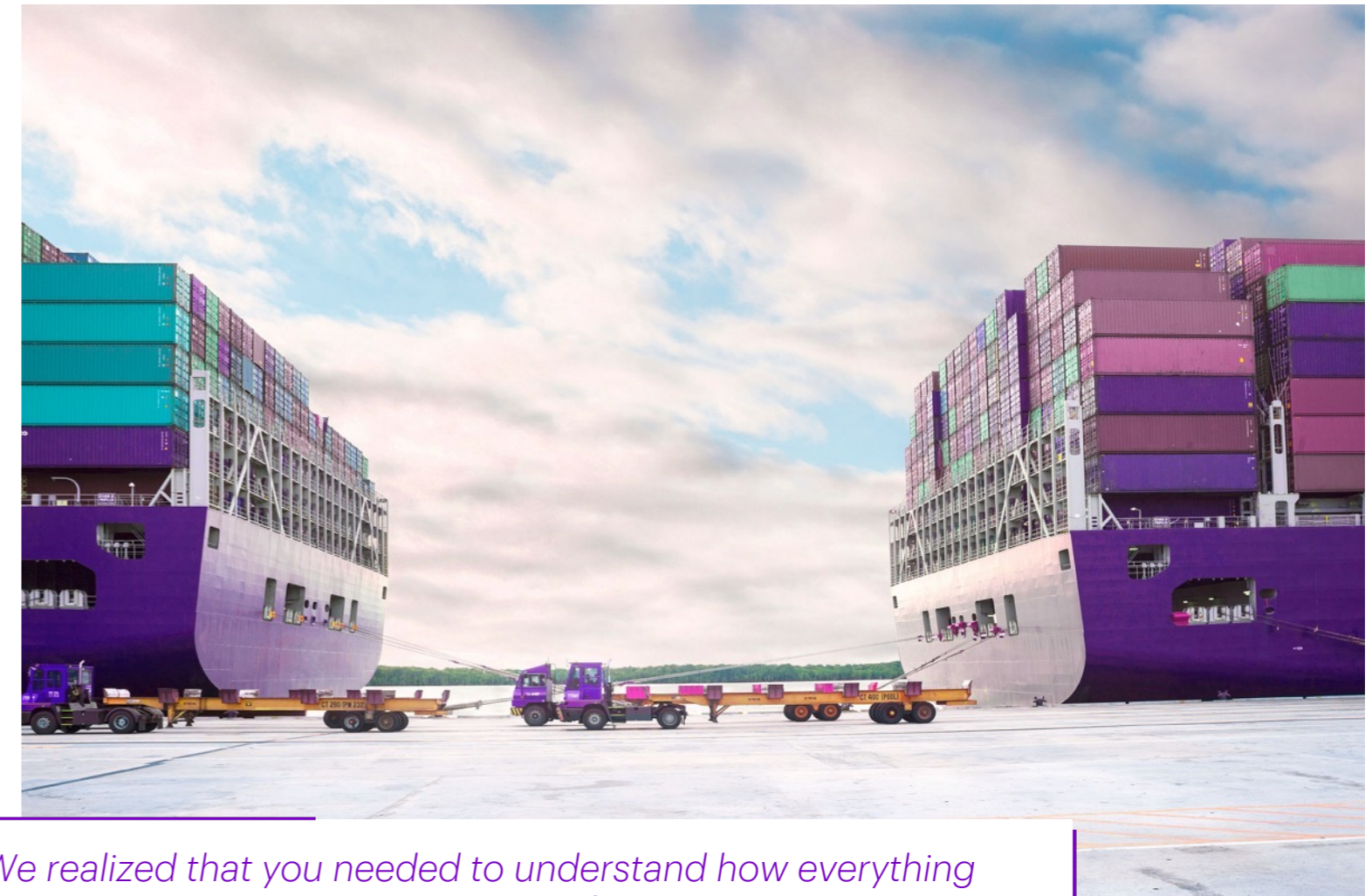
## Facilitate ecosystem collaboration to develop stronger solutions that will serve all parties' needs

Challenges addressed: High costs and operational disruption, siloed legacy systems and data-sharing concerns

Partnerships across the maritime ecosystem are key for modernization. For instance, terminal operators can collaborate with shipping lines and rail operators to optimize vessel scheduling, reducing bottlenecks within the port. Similarly, ports can collaborate with customs authorities and trucking companies to streamline cargo inspections and speed up the flow of goods. Port authorities are uniquely positioned to drive collaboration between different stakeholders, given their central role in coordinating operations. As one

industry leader we interviewed noted, “The Port Authority often has the 40,000-foot view of the local reality and can facilitate stakeholder communications to draw up the best system.”

One clear benefit of collaboration is improved disruption mitigation. Events such as the COVID-19 pandemic, the Red Sea crisis, the Suez Canal blockage, the Ukraine War, the Francis Scott Key Bridge collapse and natural disasters can severely disrupt global supply chains and ocean shipping.



*“We realized that you needed to understand how everything worked, because each component of the ecosystem is inextricably linked, and when one fails, it all fails.”*

**- Bethann Rooney, Director, Port Authority of New York and New Jersey**





*“If you can get supply and demand working together — if you get that port looking to invest in hydrogen supply chain working together with a shipping company that's looking to utilize it — that's where the derisking happens. You already have the market there working with you.”*

**- Maritime & Ports Accelerator Director**

During the Suez Canal blockage in 2021, an estimated \$9.6 billion in global trade was disrupted every day.<sup>2</sup> Better coordination between ports, ocean carriers and terminals can enhance resilience and more quickly restore supply chain normalcy in such crises.

The Council on Port Performance (CPP) in New York and New Jersey exemplifies how collaboration across stakeholders—terminal operators, ocean carriers, labor unions and customs—can mitigate crises. During the COVID-19 pandemic, the CPP’s collective

approach prevented the severe congestion seen in other ports. Ongoing meetings allowed stakeholders to identify potential bottlenecks like empty container build-ups and take proactive measures, including creating additional storage lots to prevent disruption.





## Secure stakeholder buy-in:

Given the significant costs associated with digitization and the resistance to change often seen among stakeholders, securing early buy-in is essential. This requires building clear business cases tailored to each party's goals — whether that be increased efficiency, safety or sustainability. In this way, ports can align stakeholders and build trust around shared objectives.



## Foster interoperable systems

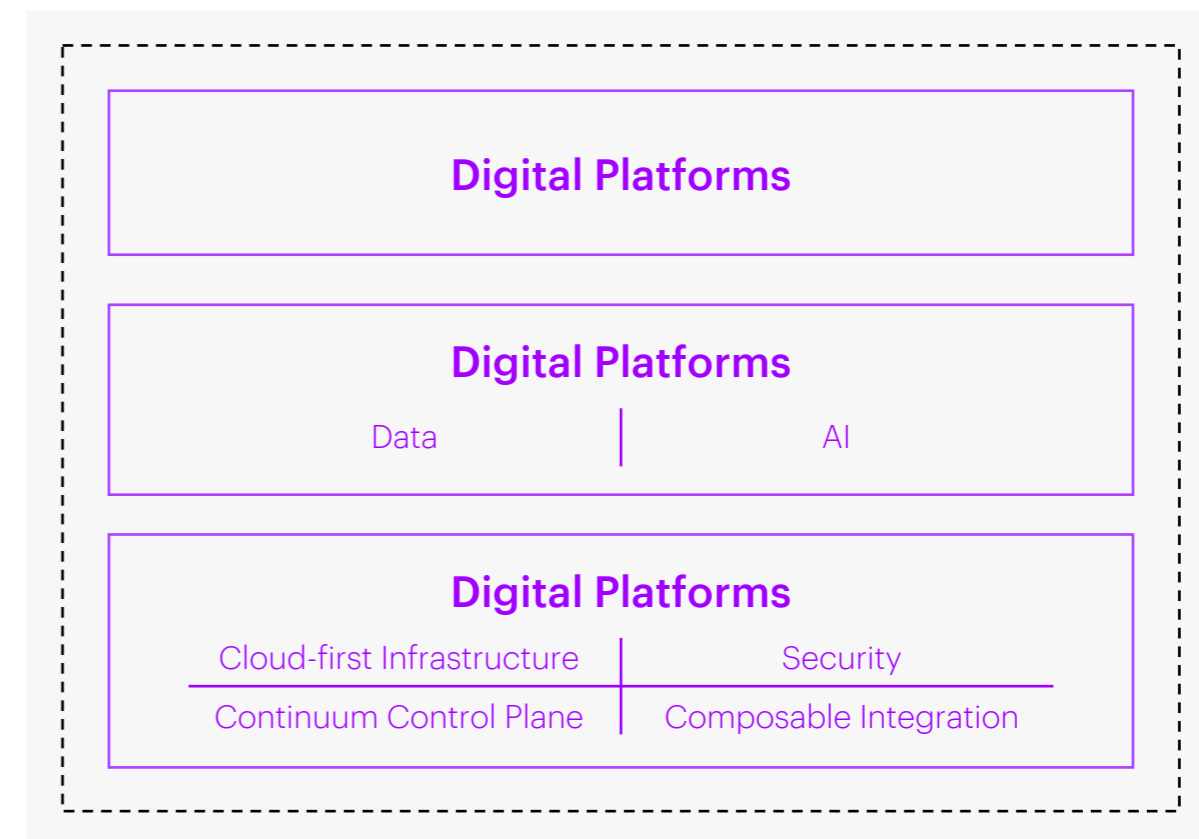
For optimal interoperability and enhanced collaboration capabilities, a strong [digital core](#) (Figure 1) is key. It is the critical technology foundation that enables organizations to realize their modernization ambitions with security by design at every level.

Successful partnerships in the port ecosystem depend heavily on seamless data sharing and trusted multi-stakeholder platforms. Maritime Port Authority (MPA) of Singapore's Chief Information Officer emphasizes, "Interoperability and collaboration go hand in hand — with collaborative engagements playing an essential role in developing interoperable systems, and interoperable systems playing an essential role in seamless exchanges of data for frictionless transactions and customer experience."

For instance, the MPA of Singapore's Just-in-Time (JIT) platform allows multiple stakeholders like ship agents, towage service providers and bunker suppliers to exchange and access real-time data on services required when ships arrive. This helps them coordinate services like pilotage, towage, bunker services and supplies more efficiently, reducing time spent at anchorages.<sup>3</sup>

In another case, the Port of Rotterdam established the PortXchange startup, a platform that allows shipping lines, terminal operators and logistics providers to coordinate port calls more efficiently and reduce emissions.<sup>4</sup>

## Digital core framework



**Figure 1:** Accenture defines a digital core as the critical technological capability that can create and empower an organization's unique reinvention ambitions.





Maersk collaborates with the Port of Rotterdam through PortXchange, sharing data about its vessel movements to enable better coordination with terminal operators and logistics providers. This collaboration has generated a 20% reduction in wait time<sup>5</sup> and resulted in faster turnaround times, fewer delays and significant cost savings for all parties involved.<sup>6</sup> One port innovation leader we interviewed described the project of creating a "single source of truth" across the ecosystem as the "holy grail" of their collaboration efforts.

The Indonesia Port Corporation (IPC) digitized its operations with the Accenture Connected Ports Platform. By integrating real-time IoT data from port equipment with operational systems, IPC gained better visibility into its

operations and was able to improve the way assets were used.<sup>7</sup> This "system of systems" approach ensures that technologies and data sources work together seamlessly, allowing ports to adjust plans, predict maintenance needs and optimize resources in real time. Here, interoperability laid an essential foundation for driving real-time responsiveness and more productive collaboration across the ecosystem.

# The Accenture Connected Ports Platform

This platform combines data from existing port terminal operating systems, a broad range of inputs from IoT sensors and analytics capabilities into an integrated command center, accessible anywhere.

With this cloud-based dashboard for marine container ports, port terminal operators, port authorities and port owners' benefits can include

- Streamlining port operations
- Reducing congestion
- Improving productivity
- Increasing worker safety
- Monitoring and tracking performance of equipment, identifying equipment anomalies and providing a faster response time in case of breakdown
- Identifying idle equipment, improving equipment utilization, reducing unnecessary equipment runtime and monitoring the energy usage of individual equipment





*"One of the key ingredients for a more efficient maritime transport chain is the agreed mindshare on the need to share data among stakeholders"*

**- MPA Chief Information Officer (CIO)**

*"As a shipping line, I'm co-loading with another shipping line, which is initially a partner but also a competitor, I will give him, you know, the minimum information."*

**- Safoin Ziane, Logistics and Shipping Consultant**





## Share data, increase trust

Ports manage vast, complex and often dangerous cargo every day, but when it comes to data, many still struggle to share the critical information needed for efficient operations. Despite the 2019 International Maritime Organization (IMO) mandate — requiring member countries to electronically exchange key data under the [Facilitation of International Maritime Traffic Convention \(FAL\)](#) — many ports are yet to comply due to regulatory barriers and lack of private-public stakeholder collaboration.<sup>8</sup> Additionally, as direct competitors, shipping lines are often hesitant to share data, fearing it could compromise their competitive advantage, further complicating efforts to build a cohesive data-sharing ecosystem.

Not all data, however, must be shared. It's possible to focus only on the information that enables safer and more efficient operations. And blockchain, with its decentralized and secure nature, enhances transparency and traceability in data exchanges, ensuring that only authorized parties access the right information at the right time.



*"When it comes to sharing data with port authorities or customs, we have noticed hesitation, especially from government authorities who have their own reservations about connecting with the shipping line... But private ports are more open to data sharing and optimizing efficiency."*

- Shipping Business Development Manager





*"We encourage the shipping companies and the regulator to work side by side, because cybersecurity is an area in which the more data sharing, the better and stronger posture we can have together...Yearly, we do cybersecurity exercises with shipping lines and port terminal operators to simulate such an incident and work together on how we would handle systematically."*

**- Kenneth Lim, Assistant Chief Executive (Industry & Transformation),  
Maritime and Port Authority of Singapore (MPA)**

Although it seems counterintuitive, data-sharing can even improve cybersecurity. Ecosystem collaboration can help identify risks through shared intelligence, best practices and resources across stakeholders, leading to a more comprehensive and proactive defense against threats. Building the trust needed for effective data-sharing begins with clear data governance policies that define access, usage and security measures.

Cultural openness is also key and regular workshops, cross-stakeholder forums and leadership buy-in encourage greater transparency and collaboration. Through the CPP at the Port of New York and New Jersey, regular stakeholder meetings create

a culture of openness and trust, allowing partners to address concerns in real time. By facilitating such collaboration, port authorities can position the ecosystem for better performance, encouraging knowledge-sharing and aligning goals to common industry priorities.





## Engage the workforce to secure support for ongoing innovation

Challenges addressed: Workforce resistance and IT skills gaps

The recent Accenture report, [Change reinvented: A new blueprint for continuous, meaningful, successful change](#), found that a science-backed formula can be used to predict the likelihood of success when implementing change. When done well, change can be a source of innovation and growth, energizing leaders and teams to truly embrace modernization efforts. This research shows that workers experiencing a greater degree of support from their organizations are better prepared to envision and realize the value of new technologies like automation platforms and AI. These findings underscore the importance for ports undergoing transformation to engage the workforce early, turn resistance into enthusiasm and drive long-lasting change.



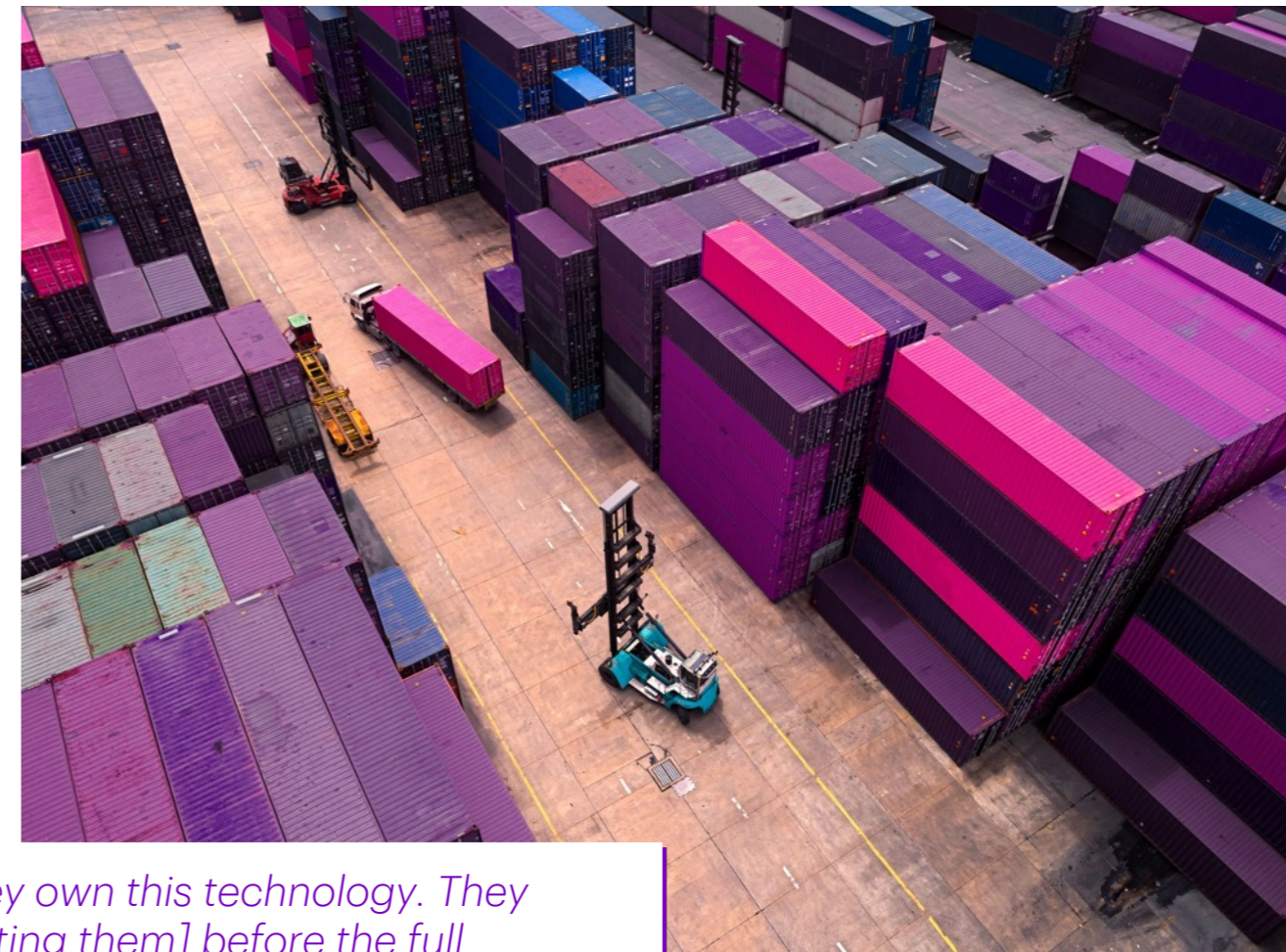




## Facilitate an informed workforce journey

Ports cannot simply impose new technologies on workforces to modernize operations — they must engage the people who will use these tools every day. By involving the workforce in decision-making and providing them with continuous learning opportunities, ports can create a sense of ownership that minimizes anxiety and fosters buy-in. The goal is not just to get employees to accept new systems, but to empower them to shape how those systems are used to simplify or enhance their work.

Highlighting improvements in safety, job quality and professional development can bolster workforce support and smooth the path to implementation. By demonstrating how new technologies can reduce risks and enhance the safety of complex machinery handling, for example, ports can build trust with employees and unions.



*"[The workers] need to feel they own this technology. They must see the benefits [of assisting them] before the full adoption can take place."*

- Kenneth Lim, Assistant Chief Executive (Industry & Transformation),  
Maritime and Port Authority of Singapore (MPA)





## Address skills shortages

As the maritime ecosystem transforms, new jobs are being created in areas such as data analytics, automation and sustainability. Across all industries, AI proliferation is changing skills requirements for many jobs. A [report issued by the AI-Enabled ICT Workforce Consortium](#), of which Accenture is a member, found that 92% of the Information Communication Technology (ICT) jobs analyzed are expected to undergo either high or moderate transformation due to advancements in AI.

Training the workforce to adapt to new systems and ways of working is a major challenge for port ecosystems due to rapid technological advances and historical cultural resistance to change. Developing a

skilled workforce ensures safer, more efficient port operations.<sup>9</sup> Ports must shift from simply hiring "labor" to hiring and upskilling "IT professionals" who can manage and integrate modern technologies into operations. Collaborative upskilling and reskilling programs can help overcome resistance to change and create a more attractive work environment that draws in and retains skilled talent. For example, retraining longshore personnel as computer tech operators can improve job quality, safety and operational efficiency, while also ensuring that ports remain competitive in an increasingly digital world.





Singapore offers a prime example of how effective workforce engagement can support transformation. The MPA of Singapore and the Singapore Maritime Foundation convened the Tripartite Advisory Panel (TAP) to assemble industry partners, unions and academia. These entities work together to attract young talent, upskill and reskill the current workforce and redesign job roles to keep career pathways fresh and exciting.<sup>10</sup>

Workforce Singapore's Career Conversion Programme (CCP) for Sea Transport

Professionals and Associates offers salary support for mid-career professionals to undergo skills conversion and take on new roles in port operations and services, shipping and maritime services. By focusing on key areas like digitization, decarbonization and cybersecurity, the CCP has upskilled over 340 individuals since 2019, ensuring the workforce is equipped to handle the future of port operations.<sup>11</sup>

*"The main mistake made is that they introduce a system but forget to train the people to work with it, which means a lot of mistakes, a lot of failures."*

**- Port Commercial Manager**

*"They kept the longshore personnel employed. They trained them to be computer tech operators on all the lifting equipment involved. The work is better. There's certainly less safety risk."*

**- Port Authority Leader**





*"[Unions] also see their younger membership coming into the longshore trade are more comfortable with technology. They want to go into work that has some modernity to it. I've talked to young people that went into longshoring, and some were like 'Oh, I don't know if this has a future. They're still using clipboards down here at the truck!'"*

**- Port Authority Leader**

*"To work with the unions, you really have to bring a lot of long-term commitment in and goodwill to the situation, because they're one of the key stakeholders that want to see the franchise thrive"*

**- Port Authority Leader**





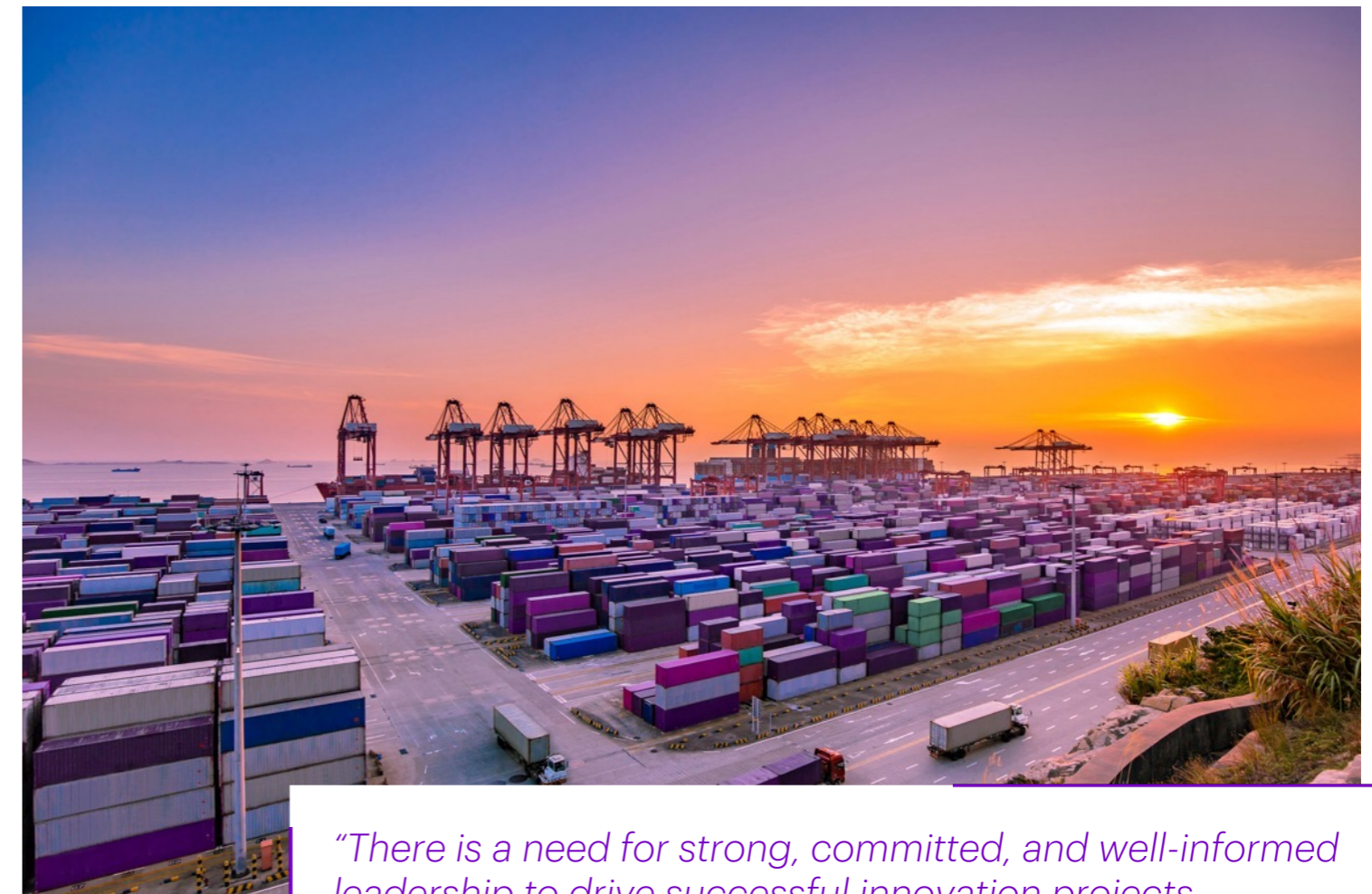


## Build a long-term, scalable vision backed by short-term wins

Challenges addressed: High costs, operational disruption and workforce resistance

Digitization can lead ports to enhanced operational efficiency, improved sustainability, strengthened security, regulatory compliance and increased transparency for stakeholders. AI-powered predictive maintenance, for example, allows ports to monitor equipment in real time, using data from IoT sensors to predict when machinery like cranes and conveyor systems will need maintenance. This approach reduces downtime and prevents unexpected failures, increasing operational efficiency.

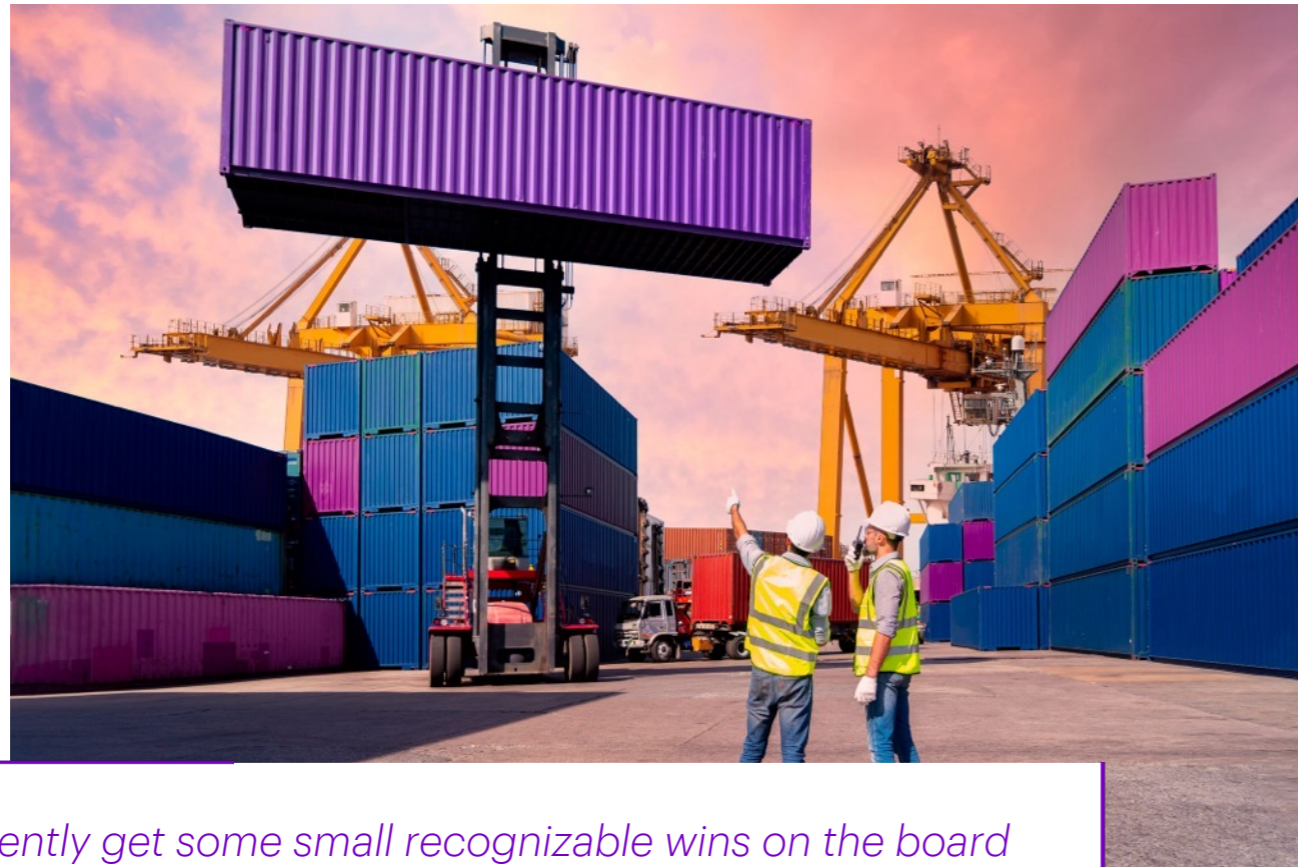
Notably, the level of digital modernization varies significantly among ports, from those still using basic paper-based systems to others using highly automated technologies. This disparity makes modernization ambitions daunting. As a first step, it's crucial for ports to take an outcomes-driven approach, viewing digitization not as the ultimate goal but as an enabler of broader operational objectives.



*“There is a need for strong, committed, and well-informed leadership to drive successful innovation projects. Technology upgrades need to be backed with a long-term vision about where you’re going with transformation and the ability to layer and adopt future improvements.”*

**- Port Authority Leader**





*“Consistently get some small recognizable wins on the board along the way so that stakeholders feel that it’s worth it to remain involved with the effort”*

**- Port Authority Leader**

## Identify quick wins to nurture stakeholder and workforce adoption

A successful digitization strategy must be both ambitious and executable. Starting with quick wins — foundational efforts that deliver early benefits — helps pave the way for future innovations. Using advanced data for truck gates and deliveries, for instance, can set the stage for future technologies like autonomous vehicles or AI-driven maintenance, and integrating IT into existing capital infrastructure projects is an easy way to deliver high-impact quickly.

The Port of Rotterdam has embedded smart sensors along the quay walls (“smart bollards”) to collect valuable structural data. Integrating a digital solution into existing infrastructure boosted the return on capital investments by providing insight showing that quay walls have a longer lifespan than expected.<sup>12</sup>

Communicating the long-term value and strategy helps maintain support and minimize change fatigue, as there is less resistance to adopting solutions and process changes when they are part of a plan for systems that can be built on rather than replaced.





## Maximize innovation with minimal disruption

The high-volume, low-margin nature of the port industry means that any operational disruption is very costly. As a result, there is often a hesitancy to adopt new technology due to the guaranteed short-term disruption versus uncertain long-term benefits, leading to a "race to be second" where ports prefer to implement proven technologies. When asked how they faced this problem, many leaders we interviewed emphasized the importance of pilot projects.

Pilot testing technologies such as AI-driven supply chain optimization tools or autonomous vehicles, for instance, provided measurable evidence of cost reduction and increased operational efficiency. These benefits then encouraged

larger-scale adoption across multiple terminals. These small-scale initiatives refine solutions in a controlled environment, ensuring that technologies are both effective and scalable before larger rollouts. The leaders we talked to also noted that pilot projects allowed them to thoroughly evaluate performance metrics, including throughput and cost-effectiveness of new technology before wide-scale implementation.







*"We have a platform in which regulators, industry and the tech players come together to trial technologies and processes."*

**- Keneth Lim, Assistant Chief Executive (Industry & Transformation), Maritime and Port Authority of Singapore (MPA)**

*"We have an innovation hub within the port authority designed to do quick win pilot programs. To test: does a solution work or not? If it doesn't, throw it out and move on."*

**- Bethann Rooney, Director, Port Authority of New York and New Jersey**

The Port of Rotterdam Authority demonstrated the value of its smart bollards by first conducting a successful trial of a single smart bollard at a single terminal. Following the positive outcomes from this initial test, the Authority expanded the initiative by installing six additional smart bollards.<sup>13</sup>

Several executives we talked to further highlighted the added value innovation hubs bring to the port ecosystem, where pilot programs can be quickly tested and assessed. Accenture will often use its Innovation Framework (Figure 2) to facilitate cross-functional sessions with clients to more quickly move from ideation to a minimum viable product.

Projects managed within innovation hubs can allow for continuous exploration of new technologies while minimizing risks. Often, innovation hubs run numerous pilot programs annually, using the port as a testbed for various technological solutions, and collaborating with vendors, academics and think tanks to evaluate which innovations are worth commercializing and scaling.





## The Accenture Innovation Framework

Port ecosystems can employ processes like this innovation framework (Figure 2) to help identify or target areas that can move from rapid ideation to MVP (minimum viable product) to ultimately scale broadly.

Projects managed within innovation hubs can allow for continuous exploration of new technologies while minimizing risks. Often, innovation hubs run numerous pilot programs annually, using the port as a testbed for various technological solutions, and collaborating with vendors, academics and think tanks to evaluate which innovations are worth commercializing and scaling.

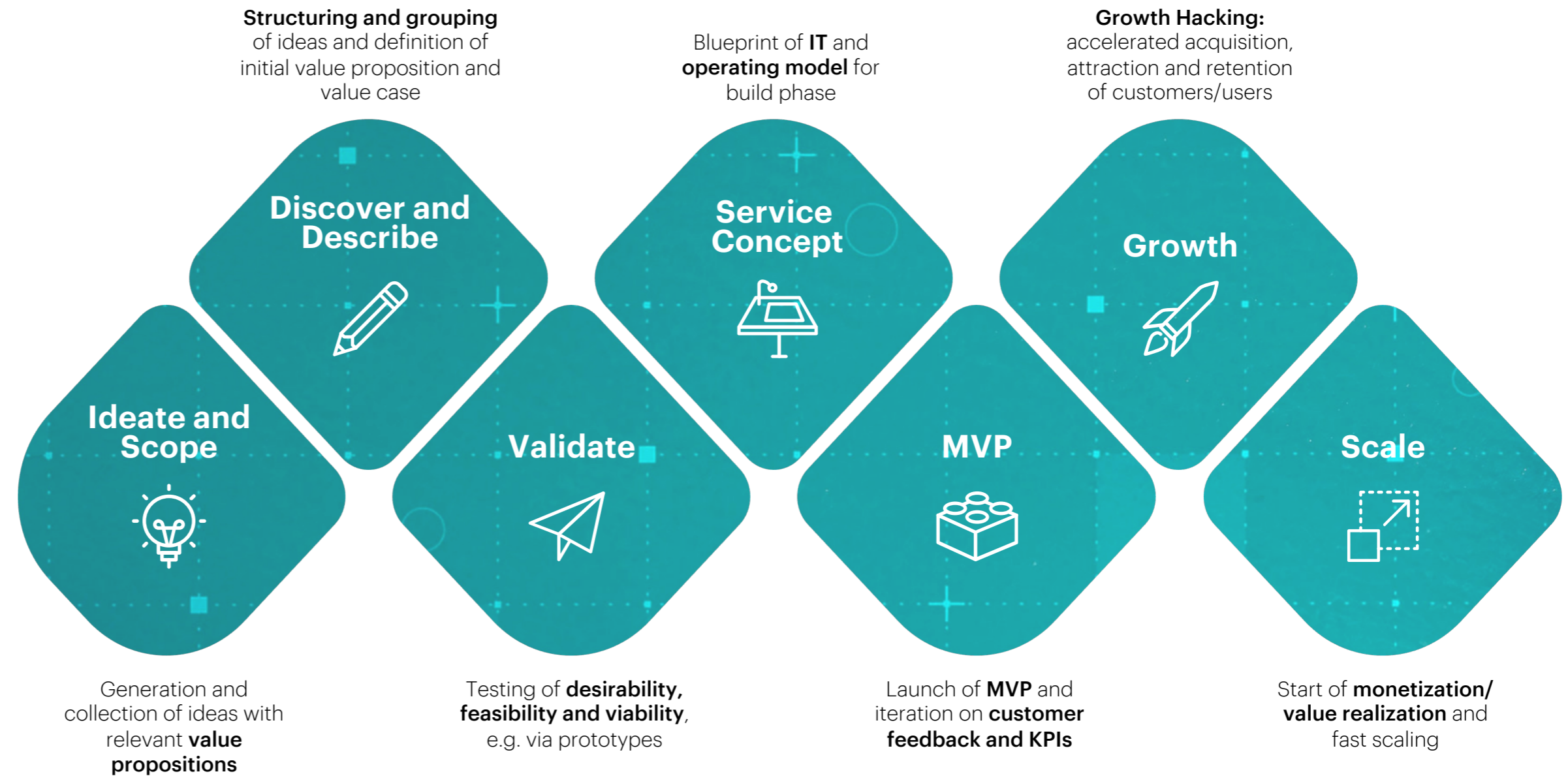


Figure 2: The Accenture Innovation Framework



## Case study

# Port Innovation, Engagement and Research (PIER) Center

The Port Innovation, Engagement and Research (PIER) center at the Port of Halifax is a collaborative hub designed to foster innovation and collaboration across various stakeholders in the maritime industry. The center provides a neutral space for port operators, researchers, industry partners and government entities to collaborate on cutting-edge pilot projects and technology-driven initiatives. PIER allows participants to test innovative ideas in a controlled environment, enabling them to explore the potential of new technologies with minimal operational disruption. Projects include data-sharing initiatives between terminal operators, railways and port authorities, which are designed to streamline information exchange and enhance operational efficiency.

By offering a platform for shared governance, resources and infrastructure, PIER has been instrumental in scaling pilot

projects that meet the operational needs of multiple stakeholders, positioning the Port of Halifax as a leader in maritime innovation. Notable projects include implementing AI for real-time emissions monitoring and deploying autonomous surface vessels like the WasteShark to remove floating pollution from waterways.<sup>14</sup>

In addition to its work at Halifax, PIER is now part of a broader bilateral initiative with the innovation hubs at the Port of Hamburg (homePORT) and the Port of Valencia (Opentop), forming the first international port innovation hub network. This collaboration aims to create a global alliance of port innovators for sharing technological advancements and best practices across ports globally, further accelerating maritime innovation.<sup>15</sup>







*“There are a lot of challenges. But for each challenge, I've seen an example where people are making it work by working with other players in the sector, and, to a certain extent, putting a degree of competition aside to grow a market instead of grow our market share”*

**- Maritime & Ports Accelerator Director**

## If not now, when?

The time for modernization is now. By embracing the strategies outlined—cultivating collaboration, investing in workforce development and building a long-term scalable vision—ports can retain and even grow their crucial position as anchors of resilient global trade networks. Those that delay risk losing profitable trade flows to competitors that are adopting smarter, more efficient technologies. The opportunities for increasing capacity, boosting efficiency and building resilience are too significant to ignore. Ports that act decisively today will position themselves as leaders in global trade, securing their status as preferred hubs.

While the modernization journey presents challenges, it also offers huge opportunity. By embracing digital transformation and collaboration, ports can expect to see significant increases in capacity, enabling them to handle larger volumes of cargo more

efficiently. Additionally, investments in digital infrastructure and innovation can lead to faster processing times and more predictable schedules, directly improving buyer value by reducing delays and ensuring more reliable delivery timelines.

Ports that seize this moment will not only position themselves as essential hubs in global shipping routes but also contribute to local and national economic growth by driving job creation, boosting trade volumes and fortifying supply chains. Moreover, modernized ports play a critical role in maintaining the flow of goods, even in times of disruption. Those who innovate today will not only thrive but also shape the future of the industry, securing economic growth and a pivotal role in the global economy for years to come.



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