



Port Technology
International

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2025



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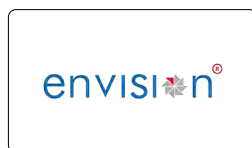
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Margherita Bruno,
Managing Editor

FROM THE EDITOR

In a world of booming trade, rising demands for decarbonisation, and relentless pressure for operational efficiency, **container terminals are turning to automation as a catalyst for transformation.** This edition of Port Technology International's e-Journal explores how automation is reshaping terminal operations across the globe. In particular, we are delighted to welcome our readers in Malaysia to the inaugural Container Terminal Automation Conference Asia! Over the next two days, we hope the conference will spark an inspiring debate and shine a light on the future of port automation.

We open our September edition with the theme of **practical, scalable automation solutions**, as exemplified by **ABB**. Their approach across Asia highlights how technology can be tailored to a terminal's maturity, investment capacity, and local context. From basic optical character recognition (OCR) systems to fully integrated automated operations, ABB emphasises flexibility, showing that automation is not a one-size-fits-all proposition. Case studies from Kerala and Colombo underline the importance of workforce training, change management, and collaboration, while forward-looking AI-driven innovations

such as ABB's QuayPro and advanced OCR are positioning terminals for faster turnaround, higher reliability, and long-term competitiveness before moving to specific technologies and deployments.

Following this theme of practical deployment, we feature **Venti Technologies and their autonomous vehicle (AV)** solutions, illustrating how full-stack autonomy can transform operational productivity. Dr Xinxin Du details Venti's integration of drive-by-wire vehicles, onboard perception and planning systems, and cloud-based fleet management. This article highlights that combining technology with workforce enablement is essential for scalable, commercially viable operations, making it clear that autonomous systems are no longer a distant concept but a tangible operational asset.

Complementing this focus on automation, we highlight **Kaleris' Terminal Truck Optimisation (TT-O)**, which addresses the critical challenge of managing terminal tractor and truck flows. TT-O leverages real-time data, GPS tracking, and intelligent algorithms to optimise scheduling, routing, and dispatching, reducing idle time and empty travel while improving coordination with quay cranes. Its modular, flexible

architecture allows integration with AI, predictive analytics, and third-party data sources, enhancing productivity and workforce collaboration. TT-O demonstrates how automation can optimise human-operated workflows alongside autonomous solutions.

We then explore **equipment-agnostic automation platforms** like **Kalmar One**, presented by Timo Alho and Tomi Tuulkari. Kalmar One integrates TOS, automated equipment, and other systems to optimise container movements, scheduling, and battery charging across diverse operational environments.

With support for megaterminals, multi-site standardisation, and digital twin emulation, the platform demonstrates how technology can deliver operational consistency and enable advanced pre-planning capabilities across multiple sites.

Case studies provide practical insight into automation's impact on terminal performance. The rapid launch of the **Hateco Haiphong International Container Terminal (HHIT)** in Vietnam, led by **APM Terminals**, illustrates the critical combination of technology, people, and process. By deploying Navis N4 4.0 TOS, Autogate systems, and a Truck Appointment System, HHIT reduced truck turnaround times from over 40 minutes



to 16–18 minutes, even during disruptions such as tropical storms. Its integration into the Gemini alliance further emphasises the role of strategic partnerships in delivering reliable, efficient operations.

Building on this, we examine the **convergence of digital technologies**—Computer Vision, IoT, Machine Learning (ML), and Artificial Intelligence (AI)—through the work of Nitin Sirohi and Rajesh Kumar from **CNB Logitech**. These tools enable precise monitoring of containers and equipment, deliver real-time operational insights, and support predictive planning for yard resources and maintenance. CNB also highlights key challenges, including high implementation costs, legacy system integration, cybersecurity, and workforce training, underscoring that successful automation requires investment not just in technology but in people and organisational capability.

Expanding on predictive and intelligent technologies, Dr Zack Lu, Kaj de Groot, and Melvin van Henten from **Portwise** examine the **readiness of AVs in terminals**. While AVs promise flexibility, operational efficiency, and workforce transformation, they are not yet fully deployed in daily operations. Portwise highlights that success depends on more

than navigation: AVs must operate safely alongside human-operated equipment, under dynamic conditions, and within complex terminal environments.

RBS’ Harrison Nguyen’s exploration of **next-generation TOS systems** reinforces this theme, showing how AI, digital twins, and autonomous agents convert operational data into actionable insights, enabling predictive analytics and real-time control. Intelligent 3D systems empower humans and machines alike, enabling predictive analytics, proactive decision-making, and real-time operational control. Processes such as crane scheduling, yard traffic, and resource allocation are continuously optimised, demonstrating that smart, automated ports are no longer a distant vision but a practical reality.

Broader ecosystem-level strategies are represented by Sriram Ramanujam’s article on **PSA Singapore**. Platforms such as iWX, OptETruck, OptEModal, and OptEVoyage illustrate how AI, real-time data, and advanced analytics can optimise container reuse, truck scheduling, intermodal connectivity, and vessel arrivals. By reducing emissions and improving resource utilisation, PSA demonstrates that **technological innovation must be complemented by collaboration,**

continuous adaptation, and integrated operational models to create resilient, sustainable, and data-driven ports.

Finally, our special PTI’s Corner makes a comeback as we turn to **strategic foresight and risk preparedness**, exemplified by **IPCSA’s Foresight** initiative. Workshops in Dubai and Casablanca used structured scenario planning to explore risks, opportunities, and strategies, demonstrating how ports can manage uncertainty while maintaining operational efficiency. By combining diverse expertise, knowledge-sharing, and digital tools, IPCSA provides a practical framework for “dealing with unpredictability in a predictable fashion,” rounding out the edition with a forward-looking perspective.

Across this edition, one message is clear: technology must be paired with human expertise, training, collaboration, and proactive planning to deliver real impact. From tailored automation and autonomous vehicles to truck optimisation, equipment-agnostic platforms, and AI-driven insights, this journal highlights how diverse innovations are reshaping terminal operations. **As ports evolve, success hinges on the synergy between people and machines.**



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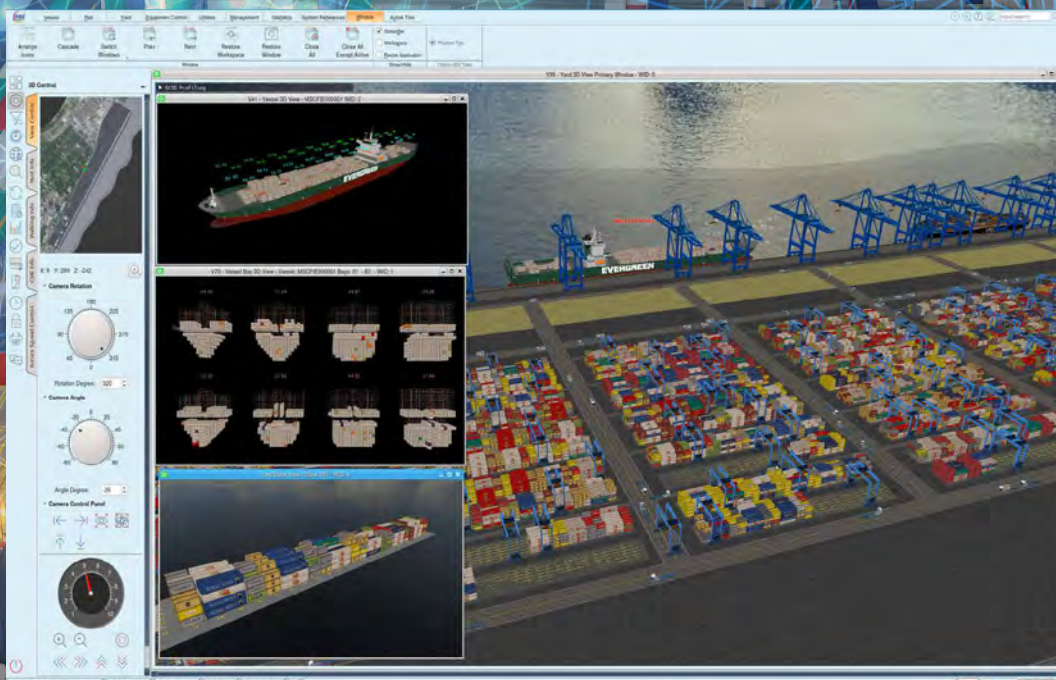
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RBS

RBS specialises in providing software solutions dedicated to the Container Handling Industry. Since its founding in 1991, RBS has committed over three decades to delivering innovative, high-performance software tailored specifically for the unique operational needs of this global sector. With deep industry expertise on terminal logistics, RBS has become a trusted partner for container handling operations worldwide. The company offers both advanced software development and expert consulting services to port, shipping, and rail facilities, helping clients optimise efficiency, streamline workflows, and enhance operational control.

At the core of RBS' offering is its flagship product suite, TOPS Expert, a comprehensive, cutting-edge software solution successfully deployed in terminals across the world. One of its most recent products is TOPX Intelligent 3D, a revolutionary digital twin set to define the future of terminal operations. By combining deep domain knowledge with reliable, scalable technologies, RBS continues to lead the way in transforming container terminal operations around the world.

www.rbs-tops.com



Venti

Based in the US and Asia, Venti is a world leader in autonomous vehicle logistics systems, with particular experience operating in complex logistics environments. Venti's autonomy solution has been demonstrated in large, complex port and intermodal environments with mixed traffic (i.e. no segregation between human-driven and autonomous vehicles).

Venti's proven value proposition of saving costs, increasing vehicle utilisation, and improving safety is recognised by customers and is driving growth. Launched in 2018 by a team with strong MIT roots, Venti has set itself apart in the autonomous logistics space by handing over a fleet of fully driverless autonomous prime movers to a leading port operator for use in a production environment. Their customers operate this fleet self-sufficiently as part of their regular 24/7 terminal operations. Venti has offices in Cambridge (Massachusetts, US) and Singapore – their Asian headquarters.

www.ventitech.ai

SILVER EVENT PARTNERS



AMLab

AMLab is at the forefront of improving container terminal crane operations with cutting-edge automation, enabling remote control semi-automated ship-to-shore (STS) crane operations and equipment positioning systems.

Since 2016, AMLab have been pioneering innovative solutions that enhance efficiency, safety, and productivity in port environments worldwide. Their cutting-edge solutions, powered by 3D LiDAR and machine vision, enable unmatched precision in spreader guidance, waterside automation, and equipment alignment, reducing ship turnaround times and transforming quayside operations. With deep roots in autonomous bulk handling and proven systems deployed at multiple container terminals worldwide, AMLab brings practical expertise to the complex demands of waterside automation.

AMLab collaborates with leading equipment manufacturers, system integrators, and ports to deliver scalable technologies that address today's challenges and tomorrow's opportunities. Their solutions empower operators with real-time insights, precision control, and enhanced safety measures, ensuring seamless and efficient terminal operations.

www.amlab.au



Kalmar

Kalmar (Nasdaq Helsinki: KALMAR) is moving goods in critical supply chains around the world, with the vision to be the forerunner in sustainable material handling equipment and services. The company offers a wide range of industry-shaping heavy material handling equipment and services to ports and terminals, distribution centres, manufacturing and heavy logistics.

Headquartered in Helsinki, Finland, Kalmar operates globally in over 120 countries and employs approximately 5,200 people. In 2024, the company's sales totalled approximately EUR 1.7 billion.

www.kalmarglobal.com

BRONZE EVENT PARTNERS



Camco Technologies

Camco Technologies is recognised as a pioneer and market leader in container terminal automation. Their automation solutions are capable of registering all movements that occur during the container handover processes at various locations, such as the gate, yard, cranes, and rail operations. The data captured by their solutions allows for optimisation of terminal processes, while their software empowers terminals to achieve their digitalisation goals.

The solutions provided by Camco Technologies play a significant role in enhancing operational efficiency, customer satisfaction, and profitability. All the necessary hardware and software for their solutions are developed at Camco Technologies' headquarters in Belgium. Their solutions have already been successfully implemented in over 300 terminals worldwide. With a widespread network of subsidiaries and partnerships, Camco Technologies ensures that its clients are always within easy reach. Currently, the company operates its Asia-Pacific headquarters in Shanghai, China, with additional subsidiaries strategically located in Singapore and India.

www.camco.be

EVENT PARTNERS Continued



CNB

CNB is a pioneer company that has introduced cutting-edge innovative solutions to bring efficiency, transparency and safety in the container operation at ports, container yards and depots. Their proprietary industrial IoT-based solution, clubbed with computer vision, collects the container and crane movement data in real time and uses that to plan the container stacking and movement tasks using AI to bring efficiency in the operation.

The company has automated major container yards in India, and more than 20 per cent of Indian container EXIM volume moves through their solution, having complete visibility in their import/export movements. CNB is also introducing a digital twin-based 3D TOS as “SolonPort” in the region. It is a futuristic and scalable product for any dedicated OR multi-cargo terminal.

www.cnbtek.com/new



Navis

Navis is a leading provider of cloud-based supply chain execution and visibility technology solutions. Many of the world’s largest brands rely on Kaleris to provide mission-critical technology for yard management, transportation management, maintenance and repair operations, terminal operating systems, and ocean carrier and vessel solutions. By consolidating supply chain execution software assets across major nodes and modes, we address the dark spots and data gaps that cause friction and inefficiency in the global supply chain.

www.kaleris.com/

LANYARD EVENT PARTNER



Envision

Envision is excited to showcase its latest advancements in surface and marine logistics technologies, designed to meet the evolving needs of seaports. Their solutions streamline workflows in container, general cargo, and mixed cargo operations – enhancing efficiency and real-time visibility across the port ecosystem.

From intelligent scheduling to real-time tracking, Envision’s tech is built to tackle the complexities of global marine logistics. They also highlight their expertise in IBM Maximo for Enterprise Asset Management (EAM), delivering successful implementations worldwide. With Maximo, Envision help clients extend asset lifecycles, reduce downtime, and stay compliant through predictive maintenance and digital inspections.

Envision’s smart port solutions provide real-time operational visibility and deep insights into asset management. As the industry faces the challenges of modernisation and decarbonisation, the company’s digital and sustainable innovations are paving the way for smarter, more efficient, and greener port operations.

www.envisionsl.com/

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Established in 1952, ICHCA International is an independent, not-for-profit organisation dedicated to improving the safety, productivity and efficiency of cargo handling and movement worldwide. ICHCA's privileged NGO status enables it to represent its members and the cargo handling industry at large, in front of national and international agencies and regulatory bodies, while its Technical Panel provides best practice advice and develops publications on a wide range of practical cargo handling issues. Operating through a series of national and regional chapters, including ICHCA Australia, ICHCA Japan and Correspondence and Working Groups, ICHCA provides a focal point for informing, educating, lobbying and networking to improve knowledge and best practice across the cargo handling chain.

www.ichca.com

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Actualidad Maritima y Portuaria

Actualidad Maritima y Portuaria, digital journal, aims to cover a leading space for News related to maritime, port and logistic activities. Its reach has extended to Spain and all Latin American countries, where it has already established itself as one of the leading professional and specialised media in the maritime, port and logistic sectors.

www.actualidadmp.com



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www.maritimeinformed.com

SPEAKERS



Adel Alsooj, Head of GRC, QTerminals

Adel leads and manages major software and application initiatives across QTerminals, ensuring governance, risk management, and compliance are aligned with operational excellence.



Dato' Azman Shah Mohd Yusof, Chief Executive Officer, MMC Port Holdings Berhad

Dato' Azman was appointed as the Chief Executive Officer of MMC Port Holdings Sdn Bhd ("MMC Ports") on 1 December 2024. MMC Ports, Malaysia's largest port operator, is the holding company for its subsidiaries that operate six ports across Peninsular Malaysia, namely Port of Tanjung Pelepas and Johor Port Berhad in Johor, Northport (Malaysia) Bhd in Selangor, Penang Port Sdn Bhd in Penang, Tanjung Bruas Port in Melaka and ship-to-ship transfer services in Port of Yan, Kedah. Before this role, Dato' Azman served as the Chief Executive Officer of Northport (Malaysia) Bhd from February 2016. He is also currently the Chairman of Port Klang Cruise Terminal.



Richard Butcher, Managing Director, CNB

Richard Butcher is a seasoned leader in container shipping and port technology, serving as a key strategist at CNB for global business development, where he drives strategic partnerships and engagements with the end customers. Richard actively engages with the logistics community, sharing insights on various platforms to connect with industry professionals and drive conversations around container shipping optimisation. His commitment to excellence and innovation continues to position CNB as a leader in transforming the logistics industry.



Joshua Chan, VP Sales Marine and Ports Asia Pacific, Identec Solutions

Joshua Chan is the Vice President of Sales, Asia Pacific at Identec Solutions AG, based in Singapore. He's responsible for the region's sales activities, market development and key account management for the region. Before Identec Solutions, Joshua held various regional roles in sales, commercial, business development, and yard operations for ABB, Konecranes, Portek, and PSA. Joshua brings more than 15+ years of experience in the container ports and maritime sector, and has a B.Sc. in Chemistry from the National University of Singapore.



Dr Razon Chandra Saha, Postdoctoral Research Fellow, Malaysia University of Science and Technology

Dr. Razon Chandra Saha, Postdoctoral Research Fellow and adjunct faculty of the Malaysia University of Science and Technology. Currently, he is doing consultancy to explore business opportunities in the port and logistics sector to improve freight transport connectivity. A Ph.D. degree holder in Intermodal Transport, an MBA in Maritime Management, a Master's degree in Port and Shipping Management, and also completed a Bachelor's in Nautical Science and scored First Division First (Academic Distinction). Earlier, he worked for the Saif Powertec, World Bank Group, UNESCAP, the Ministry of Commerce-Bangladesh, DREWRY, CARE, SMEC, OOCL, and others. He has more than 50 original research papers, including peer-reviewed journal publications and book chapters.



Shalev Cohen, Head of Sales, ABB

Shalev Cohen is the Head of Sales at ABB Ports, OCR division. He is responsible for sales, business development, and product management. Shalev joined ABB in 2011 and was responsible for the OCR project management group before moving to his current position. He holds a master's degree in business and a bachelor's degree in mechanical engineering.



Felix Czerny, Co-Founder and CEO, Conroo

As founder and CEO, Felix is dedicated to shaping the company's strategy and operations, focusing on developing innovative AI-powered solutions. At CONROO, Felix and his team bridge the gap between their customers, like terminal, depot and warehouse operators and truckers as well as trucking companies. His goal is to enable efficient logistics with the latest technology available and to drive innovation and productivity in the industry. Before founding CONROO in 2021 together with co-founder Markus Hartung, he gained extensive experience as a consultant at PwC and as a freelance management consultant.



Roy de Haan, Program Director for Feeders and Terminals. DCSA



Chand Dhaliwal, Senior Partner, Argos Partners

Chand Dhaliwal brings 25 years of diverse industry experience spanning Malaysia, Singapore, and Australia. He has held leadership roles across Asia Pacific in corporate and investment banking, project finance, private equity, and Big Four infrastructure advisory. Throughout his career, Chand has successfully delivered major infrastructure projects— including in the port and logistics sector—leveraging funding structures such as PPPs, IPOs, cross-border M&A, RTOs, structured finance, and both conventional and Islamic debt instruments.



Dr Xinxin Du, Chief Scientist/Co-Founder, Venti Technologies

Dr Xinxin Du is a trailblazer in Autonomous Vehicle (AV) technologies and currently serves as the Chief Scientific Officer at Venti Technologies, the global leader in AV logistics systems. At Venti, Dr Du leads product development and drives innovations in AV technology across multiple logistics sectors. In 2017, he co-founded Venti Technologies with Heidi Wyle (CEO) and MIT professors Daniela Rus and Saman Amarasinghe. With his cutting-edge expertise and entrepreneurial vision, Xinxin is spearheading the development of game-changing AV technology for logistics.



Faiq Farras, Consultant, Drewry Maritime Advisors

With over six years of experience in port consulting, including two years at Kuala Tanjung Multipurpose Terminal, a subsidiary of Pelindo, brings deep expertise in maritime operations and logistics. He holds an MSc in Maritime Economics and Logistics from Erasmus University Rotterdam in the Netherlands and a BE in Marine Engineering from ITS Surabaya, Indonesia, combining strong technical knowledge with advanced economic and logistical insight to deliver strategic value in the maritime and port industry.



Captain Allan Gray, Chief Executive Officer, Sentient Ports

Captain Allan Gray, now at the helm of Sentient Ports, a division of Sentient Hubs, brings a wealth of global industry experience and seasoned leadership to his role. As the former President and CEO of the Halifax Port Authority (HPA) since November 2019, Captain Gray led a dedicated team focused on driving economic prosperity for the region through the Port's core businesses: cargo, cruise, and real estate. His strategic vision in digital transformation, decarbonization, and safe, efficient port operations has been instrumental in balancing the needs of the community, economics, and the environment.



Yesim Kayalar, Advisor, Office of the Chief Economist, Asian Development Bank (ADB)

Yesim Elhan-Kayalar is an economist with over 32 years of experience in development and academia. She currently serves as an Advisor to the Chief Economist at the Asian Development Bank (ADB), specialising in digital transformation and market competition. Her expertise is informed by extensive field experience across 31 countries. At ADB, Elhan-Kayalar develops knowledge and policy solutions to address key challenges in Asia and the Pacific, particularly in maritime decarbonization. Her work combines economic research with long-term development strategies, reflecting her commitment to sustainable economic solutions and impactful development in the region.



Mahim Khanna, Regional Director, Portwise

Mahim is the APAC Regional Director for Portwise from the Netherlands. He is a terminal professional who works in port and terminal planning, operations and automation. Portwise is a global leader in terminal design, detailed simulation and automation, having worked on about 80 per cent of automated terminals globally. Mahim is the former Director of Operations for Maersk Line. He holds an MSc and a Master Mariner qualification.

SPEAKERS Continued



Norbert Klettner, VP, TIC 4.0

Norbert has been working for more than 15 years in the port and terminal industry, implementing and integrating Terminal Operating Systems (TOS), initially for the terminal operator EUROGATE, and for several years as the managing director of the RBS EMEA Office, implementing the TOPS Expert system. With akquinet port consulting, he has moved into the area of using data for simulation and emulation purposes on the CHESSCON suite. Norbert has been a founding member of TIC4.0 since 2018 and is the Vice-President of TIC4.0, as well as a member of the Executive and Operations Councils of TIC4.0.



Sangkom Kositwiwat, IT Director, KLN Seaport Limited

Sangkom Kositwiwat is a prominent IT and logistics professional known for his work in digitalising the country's port and supply chain infrastructure. He is the technology expert who has been a key figure in modernising the operations of KLN Seaport (aka Kerry Siam Seaport). As the Regional IT Director, he has been instrumental in leading strategic digital transformation initiatives across the company's regional operations.



See Jean Lau, VP of Sales and GM for APAC, Kaleris

A Global IT and Business Executive with over 25 years of extensive international experience. An all-rounded Executive with exceptional and broad experience in Sales, Account Management and Customer Service in various industries, including E-Commerce Logistics, Container Terminals, Telecommunications and International Banking.



Jawn Looi, Head of Operations, AMLab

Jawn Looi is Head of Operations at AMLab, where he leads the development of cutting-edge automation solutions, including autonomous and remote quay cranes. With deep expertise in systems integration and innovation strategy, Jawn believes that technology solutions must be driven with productivity and safety in mind, which has propelled AMLab to be the leading solution for waterside automation. Jawn brings a unique blend of engineering insight and operational productivity focus to the challenge of transforming terminal operations.



Zack Lu, Senior Project Manager and Consultant, Portwise

Zack Lu (Dr.) is a senior project manager and principal consultant at Portwise, a leading consultancy company located in the Netherlands with the mission to design smarter, more efficient and more sustainable ports and terminals for future-proof logistics. His 10+ years' professional experience includes a broad range of projects related to various types of container handling systems and terminal planning, design, simulation, emulation, consultancy, operation, optimisation, automation consulting, TOS/ECS training, and implementation.



Carlo Mojica, Senior Consultant for Port Solutions, Moffatt & Nichol

Carlo is a Senior Technology Consultant for Port Solutions with Moffatt & Nichol. Based in Singapore, he brings decades of experience in terminal operating systems and overall port operations. Carlo supports Moffatt & Nichol's technology solutions – FlexTerm and NextPort – across the Asia Pacific region, as ports and terminals look to automation and AI to optimise operations and improve efficiency.



Harrison Nguyen, Business Development Manager, Realtime Business Solutions

Harrison is an account executive at Realtime Business Solutions (RBS) and is passionate about how software can revolutionise industries. He graduated from the University of New South Wales with a Bachelor of Commerce and Computer Science with distinctions. With his fresh ideas and burning ambition, Harrison is dedicated to helping terminals find the best solutions to optimise their operations.



Joe Schofield, Senior Director and COO/APMT Rep, Port of Tanjung Pelepas

Joe Schofield's distinguished 30-year career in the port and maritime industry reflects an exceptional journey from a waterfront trainee at Port Botany, Australia, to his current role as Senior Terminal Director and JV Representative at the Port of Tanjung Pelepas (PTP) mega transshipment HUB. Beginning with hands-on experience in lashing, dispatching and crane operations, he now leads one of the world's largest single terminals, handling 12.25 million TEUs annually. An award-winning leader, Joe excels in strategic operations, stakeholder engagement and digital transformation. His tenure with DP World and APM Terminals has shaped his global expertise, positioning him as a pivotal figure in the evolving landscape of maritime logistics.



Muhammed Shafeek, Business Solutions Specialist, QTerminals

Key contributor to the implementation of Navis CTOS at QTerminals and several digital initiatives, including PCS, PMIS, AGMS, Customs and Shipping Line Integrations, RCrane operations, IBM Maximo Cloud, and Oracle Fusion ERP modules. Specialised in automating manual operations and leading AI and Digital Twin projects.



Oskari Tähtinen, Product Manager, Kalmar

Oskari Tähtinen is a highly skilled Product Manager specialising in Automation Software at Kalmar, where he has contributed his expertise for six years. During his time at Kalmar, he has played a vital role in advancing the company's automation software offerings, staying ahead of industry trends, and addressing customer needs. In addition, Oskari has been involved in several automation projects at Kalmar in Europe, Australia and the USA, delivering automated solutions for both marine and intermodal terminals.



HY Thum, CEO, QEL Group of Companies and LKC Shipping Line Sdn Bhd

HY Thum is a seasoned leader in Malaysia's maritime industry, serving as the CEO of QEL Group of Companies and LKC Shipping Line Sdn Bhd. He has transformed his group's shipping agency business into an integrated service provider covering liner - non liner principals, end-to-end logistics services and freight solutions, oversized project handling and management, dry bulk cargo, container feeder, specialised navy ship husbanding providers, liquid cargo ships, and isotank - flexi- packaging segments. As an active and longtime member of SAM, Thum has contributed to many maritime community activities in Malaysia, working hand-in-hand with other like-minded bodies like SFFLA, MASA and other governmental authorities such as Port Klang Authorities/Customs/MOT and other OGAs.



Therry van Vreden, Chief Compliance Officer/Director and Country Manager for Indonesia, Malaysia and Brunei, Ben Line Group

Therry van Vreden is a distinguished maritime industry leader serving as Chief Compliance Officer for the Ben Line Group and Director and Country Manager for Indonesia, Malaysia and Brunei. With nearly 25 years of extensive Maritime and Logistics experience spanning four continents, he has built an impressive career trajectory having started in Hong Kong, Rotterdam, Kuala Lumpur, and Jakarta. As MACN's lead representative in Malaysia and FONASBA Deputy Vice President for Asia, Therry shapes industry standards and regulatory frameworks through collective action between maritime stakeholders, fostering collaboration that drives the entire sector forward.



Anthonie Versluis, Senior Advisor Ports and Maritime, Independent

Anthonie Versluis brings over 30 years of international consulting experience, including more than 20 years in port consulting with a primary focus on port planning and terminal operations. He has contributed to hundreds of port development projects worldwide, working with both strategy consulting firms and engineering-based port consultancy companies. In addition to his extensive port-related expertise, Anthonie has broad consulting experience in the shipping and shipbuilding industries.

SPEAKERS Continued



Boris Wenzel, President, TIC 4.0

Seasoned CEO with a strong focus on strategy and change management. Twenty years' experience in senior leadership positions in Asia and Europe, backed by early experience as a turnaround specialist and proven track record in building successful teams and creating shareholder value. Multi-industry, multi-company and multi-continent experience in diverse cultural environments and solid experience representing the interests of financial institutions and PE-type investors. Passionate communicator able to build trust and to convince stakeholders to envision and support important transformations of the business or of the industry.



Mark Wootton, Associate Director, Haskoning

Mark Wootton is an Associate Director at Haskoning with over 27 years of experience in port consultancy. Specialising in port planning, digitalisation, and automation, Mark has led and delivered major projects worldwide, including digital strategy development, terminal automation, and process optimisation for container terminals. His expertise covers terminal operating system deployment, IT strategy, and the integration of advanced technologies to enhance port operations. Mark's strong background in managing complex, multi-site projects and his focus on innovation make him a trusted advisor in the field of smart ports and terminal development.



Mohd Khairi Yassin, Head of Section - Project Management Office, Johor Port Berhad

Khairi Yassin is a seasoned professional with 17 years of extensive experience in managing container terminals. Currently, he serves as the head of the Project Management Office, where he spearheads initiatives focused on project in terminal automation, digitalisation, and process improvement. Holding a Master of Business Administration (MBA) degree in Logistics and Supply Chain Management, Mohd Khairi brings a wealth of knowledge and expertise to his role.



Wan Ahmed Zaheed, CEO, Mutiara Perlis Sdn Bhd

In 2017, Wan Zaheed co-founded Mutiara Perlis Sdn Bhd, a JV Co between Mutiara Infra Sdn Bhd and the State Government of Perlis in pursuit of developing Perlis Maritime Corridor, which consists of, among others, Perlis Inland Port (PIP), one of the key Federal projects in the Northern Corridor Economic Region (NCER) to enhance cross-border trade. He is now the Group Managing Director and Chief Executive Officer of Mutiara Perlis Sdn Bhd and Executive Vice Chairman of its subsidiary Inland Port Perlis Sdn Bhd.



Abby Zhang, Chief Executive Officer, Camco Asia

Abby Zhang serves as the CEO of Camco Asia, overseeing the management of Camco's largest subsidiary and driving business development across the Asian region. As part of Camco Technologies, a pioneering company in terminal automation solutions and services since 1999, Abby plays a pivotal role in expanding the company's footprint in Asia. With operations spanning all continents and a team of over 280 professionals, Camco Technologies is renowned for its innovative automation solutions tailored to container, RoRo, intermodal, and rail terminals.



AUTOMATION SOLUTIONS FOR CONTAINER CRANES



Autonomous /
Remote Quay Crane



Advanced Cycle
Analytics



Truck Cabin
Protection



Waterside
Automation



Truck / Straddle
Positioning



Load Collision
Protection



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IN CONVERSATION WITH: ABB

SCALING AUTOMATION ACROSS ASIA





Margherita Bruno, Managing Editor, Port Technology International, interviewing **Fredrik Johanson**, Head of Sales, Business Line Ports - Marine & Ports, ABB

Asia presents a wide spectrum of automation maturity. How does ABB tailor its automation solutions to suit such diverse terminal environments, from early adopters to fully automated operations?

ABB has proven capabilities as an automation supplier, enabling terminals to adopt automation gradually, starting at a level that aligns with their specific needs. Our scalable solutions range from stand-alone OCR systems to fully-integrated automated systems, allowing us to support customers throughout their automation journey – whether they are early adopters or pursuing advanced implementations. With a strong local presence, we not only get them up and running but also ensure seamless deployment and ongoing support to help our customers succeed long-term.

There's often concern in emerging markets about the cost and complexity of automation. How does ABB work with terminals to ensure a scalable, phased approach that aligns with their investment capabilities?

Historically, the decision to automate has often hinged on labour costs. Today, terminals increasingly recognise that automation delivers a wide range of benefits beyond cost savings. These include a safer and more ergonomic work environment, reduced equipment wear and tear, enhanced data quality, and accelerated digitalisation for faster access to information. As these



Credit: ABB

advantages become more evident, we see a growing shift toward embracing automated terminal operations.

While some terminals may initially view automation as adding complexity, our global experience demonstrates that it can be introduced in flexible, phased approaches tailored to each terminal's needs.

For example, implementing OCR systems on existing equipment offers a practical entry point into automation, enhancing efficiency, data quality, and safety without major disruption. In greenfield terminals, a phased rollout of crane systems allows operations to begin quickly, delivering early returns on investment while laying the foundation for future expansion and advanced automation stages.

You recently deployed crane automation systems in Kerala and Colombo, the first in their respective countries. What were the key challenges and learnings from these

deployments, and how do they shape ABB's approach in similar emerging markets?

It is important to acknowledge that terminals aiming for advanced operations are more ready to take on the challenge, train staff, and create the right environment for success. Moving from manual operations to automation inevitably means changes to ways of working, but when all parties involved work together towards the same goal, the road to success is open.

The importance of getting the infrastructure needed in place should not be underestimated. A shift towards automated operations also has implications outside the terminal, for example for the trucker community, who will need to learn new processes as well.

India's Maritime India Vision 2030 outlines ambitious goals around port modernisation. How do you see ABB contributing to this roadmap, and what role do you believe automation will play



Credit: ABB

in India's competitiveness as a maritime hub?

To remain competitive in the global market, container terminals must deliver reliable, consistent performance, with high predictability of turnaround time and a safe working environment. Automation plays a key role in achieving this – and increasingly, it's becoming a prerequisite for participating in new services launched by shipping lines. The region is ready for modernisation and technology-driven efficiency gains.

Our experience shows that greenfield terminals in the region can become operational and highly productive in a short time. With digitalised planning and consistently high performance with fast ramp-up time, these terminals are well-positioned for long-term success through enhanced competitiveness and faster cargo movement. The foundation of automation and remote operations enables continuous technological advancement, allowing terminals to evolve from partial automation to fully automated systems.

How does ABB's global experience, for example, in Latin America or Europe, inform the way you approach automation projects in Asia's fast-evolving port landscape?

Through our extensive global experience, we've encountered a wide range of terminal operations – from small, manual setups to large-scale, fully automated facilities. This enables us to meet terminals wherever they are on their automation journey and tailor solutions that align with their goals. Whether you're planning to make your cranes automation-ready in the coming years or looking to implement gate and crane OCR systems today, we have the expertise to support you.

With our global presence and strong local support, we guide terminals through each step of automation, ensuring a smooth and scalable transition.

What innovations or enhancements is ABB currently developing that you believe will be particularly relevant to the

next generation of container terminals in Asia?

Artificial Intelligence (AI) continues to reshape terminal operations across container ports, driving both increased automation and enhanced human-machine collaboration. AI is not only enabling the shift toward autonomous operations but also supporting crane operators by reducing workload through, e.g. improved graphical guidance. These advancements contribute to safer, more efficient, and more reliable port operations.

Today, yard operations are already highly automated, with container handling – such as picking up and landing – performed without manual intervention and often being remotely supervised. AI plays a key role in optimising interactions between yard cranes and external objects like chassis, further reducing the need for manual adjustments and increasing operational efficiency.

Beyond current applications, ongoing technological



Credit: ABB

developments will continue to break down barriers to automation. AI will be central to these efforts, introducing smarter systems that enhance safety, streamline workflows, and enable greater autonomy across all areas of container terminal operations.

AI has significantly enhanced Optical Character Recognition (OCR) systems, providing more data points to operators and improving overall system accuracy. With machine learning integration, OCR accuracy has increased from an already high 95 per cent to an impressive 98–99 per cent. OCR technology has evolved beyond simply reading container numbers and license plates – it now plays a vital role in supporting automation and operational safety through real-time data processing and integration with other systems. This advancement allows operators to work more efficiently while benefiting from a safer working environment.

A notable innovation in ABB's Crane OCR portfolio is the QuayPro module. QuayPro verifies the actual stowage position of containers on a vessel during loading and discharge operations. By automating the stowage confirmation process, terminals

can streamline operations, reduce turnaround times, and enable vessels to depart more quickly – making it a key productivity differentiator.

Looking ahead, are there specific countries or ports in Asia you see as key opportunities for ABB's automation portfolio?

Across the region, we are seeing growing interest in automation and OCR systems. In some cases, terminals have already developed concrete plans, while in others, there is strong curiosity to explore and learn more about the possibilities. As previously mentioned, the Indian subcontinent shows particularly ambitious goals, and we are also observing promising developments in other parts of South-East Asia.

We are fully prepared to support terminals throughout the region – whether they are taking their first steps toward automation or scaling up existing systems. Our solutions are adaptable to both small-scale implementations and large-scale transformations, ensuring that each terminal can progress at a pace and scope that suits its operational needs and local context.

ABOUT THE AUTHOR

Fredrik Johanson joined ABB in the mid-80s as a systems design engineer. Over the years, he has gained long and versatile experience in crane systems and automation of container terminals by working in various roles in sales and project execution organisations.

ABOUT THE COMPANY

ABB Marine & Ports drives efficiency, safety, and a clean maritime future through electric, automated, and digital solutions that help cargo terminals optimise performance, increase reliability, and reduce emissions. With experts operating from 26 locations worldwide, we bring over 100 years of industry experience. At ABB, our mission is to help industries outrun–leaner and cleaner.

SCALING AUTONOMOUS FLEETS BEYOND SAFETY IN PORTS



Dr Xinxin Du,
Chief Scientific Officer and Co-Founder,
Venti Technologies



FIG 1.
Part of the APM fleet
before deployment.

Autonomous vehicle (AV) technology is making measurable strides in the logistics sector, particularly in port environments where the benefits of automation are tangible. However, the value of AV systems extends beyond safety alone. For large-scale deployment to succeed, autonomy must translate into uninterrupted, reliable daily operations.

This paper explores the approach taken by Venti Technologies, a leader in autonomous logistics solutions, to deliver commercially viable AV fleets in ports, with a focus on operational integration, reliability, and end-user enablement.

MEETING THE DEMANDS OF PORT OPERATIONS

Ports are among the most dynamic and complex operational environments. The constant movement of containers, heavy machinery, and mixed vehicle

traffic requires highly specialised AV solutions. Venti focuses on deploying AVs in low-speed, confined spaces – ideal conditions for early and impactful autonomy.

At one of the world’s largest and busiest ports, Venti has deployed a fleet of driverless Autonomous Prime Movers (APMs) without human intervention for over a year. These APMs have surpassed human productivity benchmarks, demonstrating that autonomy can improve efficiency while reducing costs. This live deployment also provides valuable insights into the real-world scalability and sustainability of AV systems in the logistics domain.

A FULL-STACK AUTONOMY PLATFORM DESIGNED FOR SCALE

Venti’s full-stack autonomy solution is built from the ground up to address the specific challenges of container terminals. The system

comprises four key elements: the drive-by-wire (DBW) vehicle interface, the onboard autonomy stack, a robust cloud platform, and operational support tools tailored for customer enablement. This integrated architecture ensures end-to-end control and flexibility, allowing deployments to be customised for different port layouts, traffic rules, and infrastructure.

Drive-by-Wire Integration

Venti’s DBW solution enables autonomous control over a wide range of heavy-duty vehicles handling up to 62.5 metric tonnes. It supports both retrofit options for legacy fleets and direct integration with OEMs for DBW-ready platforms. The sensor suite ensures 360-degree coverage with built-in redundancy, maintaining robust performance across various weather and lighting conditions.

To accommodate different vehicle types and site constraints, Venti has developed custom sensor configurations optimised for port-specific blind spots, trailer articulation, and variable payloads. This flexible approach allows ports to modernise their fleets incrementally without major infrastructure overhauls, which in turn accelerates deployment timelines while reducing upfront capital investment.

Core Autonomy Stack

The onboard autonomy system is engineered for industrial-grade performance and is fully self-contained within the vehicle to maximise security and reduce reliance on external connectivity. Key components include perception, mapping, localisation, and planning/control algorithms. Venti's technology is customised to port operations through a modular architecture that allows core autonomy to be extended with port-specific and site-specific features.

This layered approach enables a high degree of reusability and scalability across multiple ports while maintaining local operational fidelity.

ADVANCED PERCEPTION IN COMPLEX ENVIRONMENTS

Ports feature mixed traffic environments with vehicles ranging from small forklifts to large straddle carriers, alongside human activity in unexpected zones. To navigate such complexity, Venti employs a hybrid perception system that combines classical computer vision, point cloud algorithms, and AI technologies. The system has been trained on a proprietary dataset comprising thousands of images and dense LiDAR scans collected from active port operations, ensuring accurate object detection, classification, and tracking.

This proprietary dataset allows the system to distinguish between complex, articulated vehicles and their subcomponents, such as the towing head and trailer of a prime mover. The perception system also handles suspended objects such as containers, hatch covers, or crane spreaders at distances of up to 30 metres, enabling safe stopping behaviour long before a collision risk arises.

Venti's AV system leverages multi-modal sensing using LiDAR and cameras to achieve high reliability across varying weather and lighting conditions. As a result,

operations continue seamlessly during nighttime and heavy rain – common conditions in many global ports.

MAPPING AND LOCALISATION OPTIMISED FOR PORT DYNAMICS

Unlike urban settings, where infrastructure remains relatively static, port environments are highly dynamic. Containers are frequently moved, cranes repositioned, and temporary structures erected. Venti's mapping algorithms are designed to identify and exclude transient features from the navigation map, retaining only persistent reference points such as buildings, lane markings, and dockside anchors.

For localisation, Venti's system fuses data from multiple sensors – including LiDAR, cameras, inertial measurement units (IMUs), RTK GPS, and wheel encoders. This multi-sensor fusion delivers localisation accuracy within ±10 cm in typical scenarios and ±2 cm when performing tasks that demand precision, such as docking beneath quay cranes or aligning with ARMGs.

To ensure continued accuracy, a real-time localisation monitoring module audits positional data

FIG 2.
Venti retrofitted prime mover in operation.



integrity, triggering self-correcting mechanisms or requesting human oversight if anomalies or drift are detected.

PLANNING AND CONTROL FOR SEAMLESS NAVIGATION

Venti's planning module consists of two core layers:

- **Global planning:** Calculates optimal travel paths across the terminal, taking into account lane designations, crane assignments, road closures, and yard accessibility.
- **Local planning:** Controls vehicle behaviour along the chosen path, including speed regulation, obstacle avoidance, compliance with traffic rules (e.g. pedestrian zones), and automatic lane changes when necessary.

A key innovation is Venti's automatic overtaking function, which allows APMs to bypass slower-moving vehicles or temporary obstructions (e.g. parked vehicles), reducing bottlenecks in dense traffic zones. This capability has demonstrated significant gains in average throughput and idle time reduction.

Venti Cloud: The Brain Behind Fleet Operations

The Venti Cloud platform integrates AV fleets with existing port systems and infrastructure, offering APIs and middleware connectors for TOS, Equipment Control Systems (ECS), and Vehicle-to-Infrastructure (V2I) networks.

The cloud platform can be hosted on-site or in a hybrid deployment model, depending on customer security and latency requirements. It forms the digital backbone of coordinated AV deployment, allowing remote updates, real-time telemetry, and analytics to be centrally managed.

FLEET MANAGEMENT SYSTEM (FMS)

At the heart of the Venti Cloud is the Fleet Management System (FMS), which orchestrates the scheduling, task assignment, and live tracking of every vehicle in the fleet. The FMS ingests container job orders from the TOS and uses predictive traffic models to select the optimal vehicle and route for each job.

Key capabilities include intelligent scheduling to avoid vehicle clustering, real-time congestion monitoring and

rerouting, job prioritisation and traffic flow/sequence optimisation, maintenance alerting, and fleet health diagnostics.

Its modular design allows port operators to adapt and scale their operations incrementally. New APMs can be added to the system with minimal onboarding effort, making the entire solution highly extensible.

REMOTE OPERATION SYSTEM FOR EXCEPTION HANDLING

While AVs are designed for autonomy, edge cases do occur. Venti's Remote Operation System enables human-in-the-loop support when the vehicle encounters an unexpected or ambiguous situation. These may include blocked paths, non-standard obstacles, or unclear traffic conditions.

When activated, the system provides the remote operator with contextual data and live visual feeds. The operator can then give high-level instructions to the vehicle based on the situation, e.g. issue a temporary speed restriction, select another safe path around the obstacle, and assign a new destination slot.

Notably, the system does not require direct driving inputs





like throttle or steering. This architectural choice reduces bandwidth requirements and ensures the system remains functional even in high-latency environments such as ports with patchy network coverage.

Unlike other systems, the remote operator is not responsible for the safety of the APMs, but serves purely to improve operational efficiency. Without them, each time a vehicle encounters an exception, someone would need to physically go to the vehicle to recover it. Once the remote operator issues a high-level command, the vehicle manages its own safety autonomously.

Operational Tools for Workforce Empowerment

AV deployment success is not solely technical, but also depends on operator readiness and support. Venti provides a comprehensive suite of enablement tools, including training simulators for operations teams, onboard diagnostics and maintenance tools, recovery tools for service interruptions, and metrics dashboards for engineering and analytics teams.

These tools empower customer teams to conduct first-line support, diagnose issues independently, and maintain system performance

without requiring constant vendor intervention. This reduces operational downtime and supports continuous improvement.

CONCLUSION: BEYOND SAFETY TO DAILY OPERATIONS

After over a year of live deployment, Venti's system has proven that safe and reliable AV operations are achievable in high-demand logistics environments. While safety is foundational, the ultimate measure of success lies in consistent, scalable daily performance.

Successful AV deployment integrates human roles previously filled by drivers – such as verifying load status, communicating with crane operators, troubleshooting issues, and ensuring workflow continuity. Venti's solution integrates these roles into the AV system through a combination of perception, planning, cloud integration, and remote support.

The outcome is a system that doesn't just replace the driver; it redefines port logistics. By delivering autonomous fleets that can operate continuously and safely, Venti helps ports to meet growing global demand while improving productivity, lowering costs, and building resilience for the future.

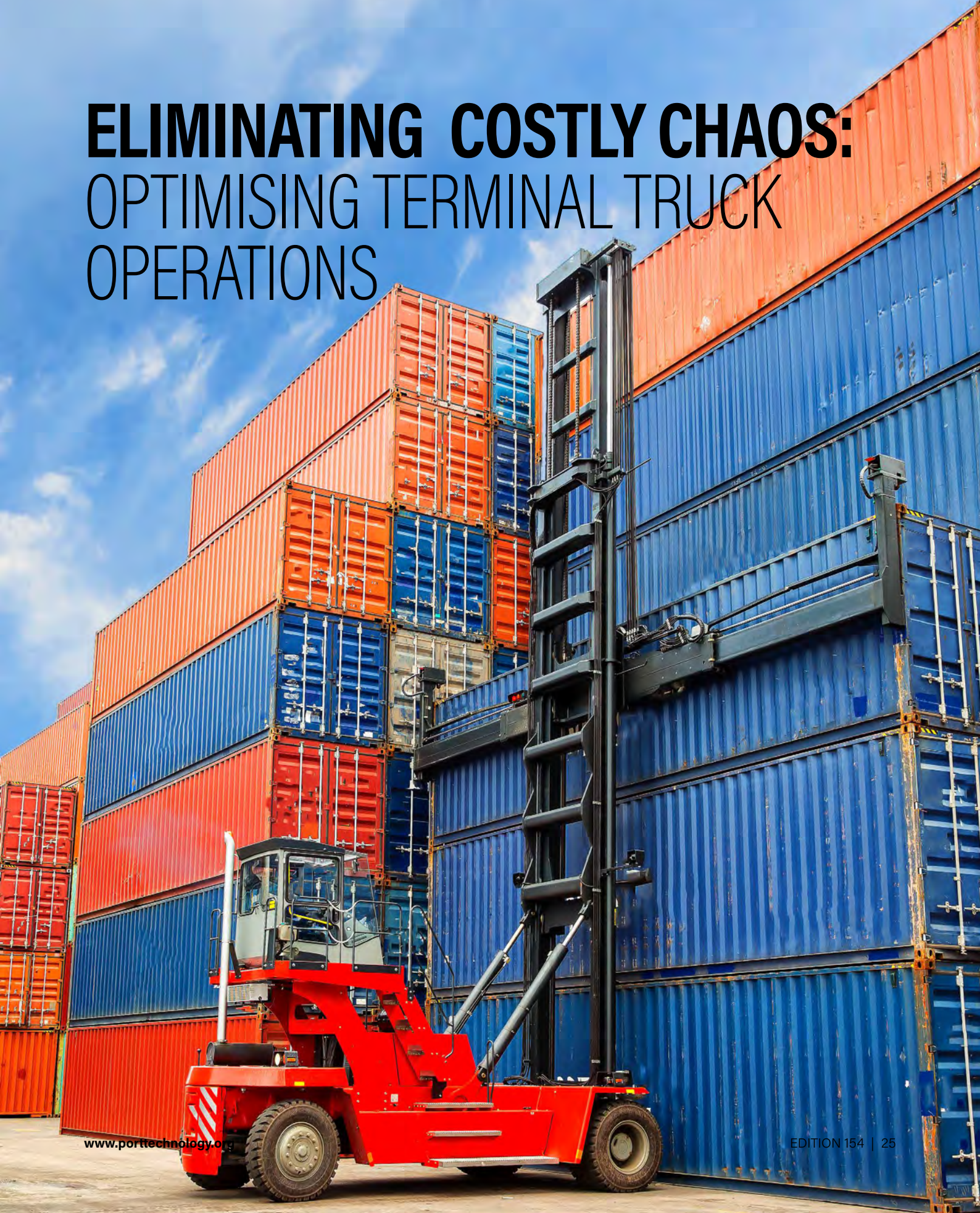
ABOUT THE AUTHOR

Dr Xinxin Du is Chief Scientific Officer and Co-Founder of Venti Technologies. A pioneer in autonomous vehicle systems, he leads product innovation across logistics sectors. With a Ph.D. in AV systems, he combines deep technical expertise with practical deployment leadership.

ABOUT THE COMPANY

Venti Technologies develops autonomous vehicle solutions for logistics hubs, including ports, warehouses, and intermodal yards. With full-stack technology and live deployments at some of the world's busiest ports, Venti enables safe, efficient, and continuous operations – empowering customers to transform supply chains through scalable autonomy.

ELIMINATING COSTLY CHAOS: OPTIMISING TERMINAL TRUCK OPERATIONS





The dynamic environment of a container terminal demands efficient coordination. **Without it, operations descend into chaos that costs terminals time, money, and safety.** Manual processes and outdated systems are often the root cause of the chaos because they cannot compete with the demands of today.

This is especially prevalent for scheduling and dispatching terminal tractors (yard trucks). Manually mapping and messaging dozens of drivers individually results in hundreds of wasted hours and gallons of fuel. **More effective management of terminal tractors is possible - and easier to accomplish than most terminals assume.**

This article examines the operational challenges that complicate effective terminal tractor management. It then explores the advantages and business impact of solving them using advanced optimisation technology.

SETBACKS: OPERATIONAL CHALLENGES HINDER PROGRESS

By observing their current challenges, terminals can determine the key pain points to solve for:

- **Inefficient resource utilisation:** Without an intelligent dispatching system, terminals often assign trucks and drivers inefficiently, causing delays, wasted movements, and increased fuel costs. Poor job allocation directly affects resource utilisation and operational profitability.



- **Lack of real-time operational visibility:** Legacy systems typically cannot track truck positions, job statuses, and operational disruptions in real time. This makes it difficult for operations teams to make informed, timely decisions or respond quickly to delays, crane breakdowns, or traffic congestion within the terminal.
- **Operational inefficiencies:** Managing hundreds of trucks and containers without optimised scheduling leads to longer cycle times, increased crane waiting periods, and poor truck turnaround performance. In high-volume terminals, these inefficiencies can rapidly escalate, causing bottlenecks and service delays.
- **Scalability and flexibility gaps:** As container terminals grow in size and complexity, they require scalable, future-

ready solutions. Many current systems lack flexibility, ease of configuration, and the ability to support integration with modern technologies like AI and real-time analytics, limiting a terminal's ability to stay competitive.

TERMINAL TRUCK OPTIMISATION IN ACTION

Terminal Truck Optimization (TT-O) by Kaleris is an advanced optimisation solution designed to modernise, streamline, and optimise truck scheduling and dispatching operations inside container terminals. Operating as a background service within Kaleris' N4 Terminal Operating System, TT-O leverages real-time operational data and intelligent decision-making algorithms to reduce idle time, improve truck productivity, and enhance operational efficiency.

At its core, TT-O continuously tracks truck positions through integrated GPS systems and evaluates upcoming move priorities within a configured forecasting window. Using this data, the system selects the most suitable and available truck for each job by factoring in proximity, truck status, move urgency, operational constraints, and vessel-specific priorities.

A standout feature, Proactive Scheduling at Quay and Yard, enables TT-O to pre-schedule new jobs for trucks nearing the completion of their current assignments. This

is done by considering the truck's current location at the quay or yard, its eligibility for the next move, and applying configurable rules designed to minimise unladen travel, maximise productive moves, and maintain smooth move continuity. The system also helps balance workloads across quay cranes by managing truck buffers for different vessel types, including deepsea, feeder, barge vessels.

In addition to intelligent scheduling, TT-O enhances real-time operational responsiveness. It automatically re-evaluates move assignments in response to

disruptions such as crane delays, deactivated work queues, or equipment unavailability, ensuring that terminal operations can adapt quickly to evolving conditions.

OPERATIONAL ADVANTAGES OF DEPLOYING TT-O

With any new technology deployment, the main concern is downtime and its impact on daily operations. With TT-O, terminals can have confidence through the implementation, change management, full adoption, and future state.





- **Uncomplicated configuration:** TT-O is built for ease of use, with a focus on operational simplicity and flexibility, allowing terminals to tailor configurations quickly without complex setups.
- **Improved resource utilisation:** By optimising routing and scheduling decisions, TT-O ensures that truck resources are better utilised, reducing unnecessary moves and idle time, ultimately leading to cost savings.
- **Reduced wait times:** By consistently assigning the right truck to the right job at the right time, TT-O minimises driver waiting periods, increases move fluidity, and boosts overall productivity.
- **Increased visibility and control:** TT-O provides terminals with enhanced oversight of their truck operations, enabling dispatchers and planners to make informed, proactive decisions based on real-time operational data.
- **Future-ready capabilities:** With built-in support for external data integration and planned compatibility with future predictive analytics and machine learning tools, TT-O is designed to prepare terminals for next-generation operational demands.

Together, these capabilities advance TT-O far beyond a scheduling tool. As an intelligent, adaptive optimisation engine, TT-O delivers immediate operational benefits while supporting long-term digital transformation.

DEMONSTRATED BUSINESS IMPACT AND MEASURABLE BENEFITS

Since its deployment at customer terminals, TT-O has consistently delivered measurable, operational, and user-experience benefits that enhance both productivity and workplace efficiency. Measurable improvements include:

- **44 per cent faster job assignments.** Jobs were also dispatched to drivers significantly faster, improving responsiveness and minimising delays between job requests and execution.
- **13 per cent reduction in truck cycle times.** Optimised job scheduling and routing have shortened truck turnaround times, reducing congestion and driving smoother terminal operations.
- **14 per cent increase in truck productivity.** More moves were completed per truck per hour, maximising resource utilisation and reducing idle time across the fleet.

- **20 per cent increase in laden truck travel.** TT-O prioritises productive, laden moves over empty travel, increasing operational efficiency and terminal throughput.
- **11 per cent reduction in truck deployments.** By minimising unnecessary truck moves and increasing each truck's productivity, TT-O helps lower fuel consumption, reduce operational costs, and support terminal sustainability initiatives.

Customers also reported streamlined truck and crane coordination. Better alignment between truck dispatching and crane operations has resulted in fewer bottlenecks and better resource balancing across the terminal. Fewer unnecessary truck moves also resulted in less fuel burned and reduced wear on equipment, directly supporting both financial and environmental goals.

WORKFORCE ENGAGEMENT

Beyond the numbers, customers reported that TT-O positively reshaped the working environment:

- **Improved communication between dispatchers, drivers, and crane operators** via integrated, real-time data, which reduced miscommunications, improved reaction times, and kept teams aligned throughout shifts.
- **Reduced idle cranes and waiting time,** leading to better overall asset productivity thanks to smoother coordination between trucks and cranes. This results in higher job satisfaction, reduced fatigue, and increased engagement from drivers following optimised, efficient routes with fewer interruptions and more consistent workloads.
- **Increased decision confidence** from live data. With optimised move scheduling, dispatchers and shift managers feel more in control and make faster, better-informed decisions that improve operational stability.



- **Enhanced cross-team collaboration** thanks to the system's transparent, data-driven workflow, which fosters a more collaborative environment. Breaking down silos between operational teams created a shared sense of purpose in delivering seamless terminal operations.

INTEROPERABILITY WITHIN THE TERMINAL ECOSYSTEM

TT-O is purpose-built to fit within a terminal's operational and digital ecosystem, ensuring a continuous, intelligent flow of data and optimised decision-making across all operational layers. TT-O connects with external GPS tracking systems to capture live truck positions, providing critical input for move prioritisation, real-time routing, and highly accurate dispatch decisions. Designed for native compatibility with Navis N4, TT-O continuously ingests and processes essential operational data, including truck statuses, move times, crane workloads, operational delays, and vessel priorities. This allows the system to deliver smart, context-aware dispatching and workload balancing in real time.

TT-O also integrates seamlessly with business intelligence platforms, operational dashboards, and analytics tools, giving terminal operators complete visibility into live KPIs and operational metrics. **Customers can track improvements such as job assignment speed, cycle**

times, truck productivity, and laden travel percentages directly within their preferred operational views, enabling data-driven monitoring, reporting, and continuous optimisation throughout the day.

With a highly flexible, modular architecture, TT-O integrates seamlessly with emerging AI, machine learning, and predictive analytics engines. In addition, a wide range of third-party systems may also be leveraged to enhance operational decision-making. This includes external data sources such as weather services, traffic and congestion data, IoT sensors, equipment monitoring systems, and terminal gate operations.

By incorporating these additional data streams, TT-O can deliver smarter, context-aware dispatching, predictive disruption management, and optimised routing decisions. This information helps terminals remain agile, efficient, and well-prepared for evolving operational demands.

INNOVATION FORGES AHEAD

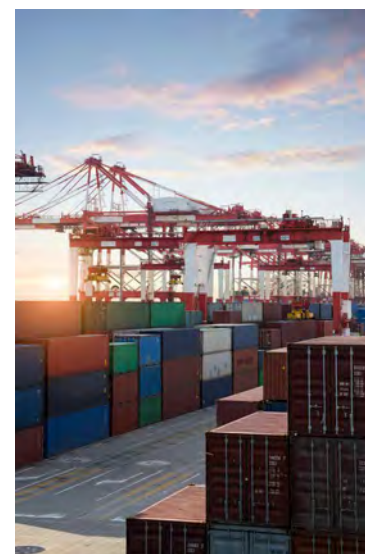
With TT-O, terminals can redefine truck scheduling with an intelligent, real-time, and flexible dispatching tool. Its proven track record of improving operational efficiency, reducing costs, and **future-proofing terminal operations makes TT-O poised to become the industry standard for terminal truck optimisation worldwide.**

ABOUT THE COMPANY

Kaleris is a global logistics software company tackling some of the most complex supply chain execution challenges. Its technology drives mission-critical supply chain operations around the world, transforming time-consuming manual processes into automated, efficient workflows. Kaleris specialises in technology for terminals, yard and transportation management, intermodal and rail shipping, ocean carriers and ship owners, and railcar and chassis repair.

Want to learn more about Kaleris' terminal operating systems and advanced optimisation solution suite?

Visit our website at www.Kaleris.com.



KALMAR ONE: A FLEXIBLE, EQUIPMENT-AGNOSTIC SOLUTION





Kalmar One
Automation for all

Timo Alho, Director Product Management Automation, and **Tomi Tuulkari**, Senior Manager Product Management Automation, Kalmar

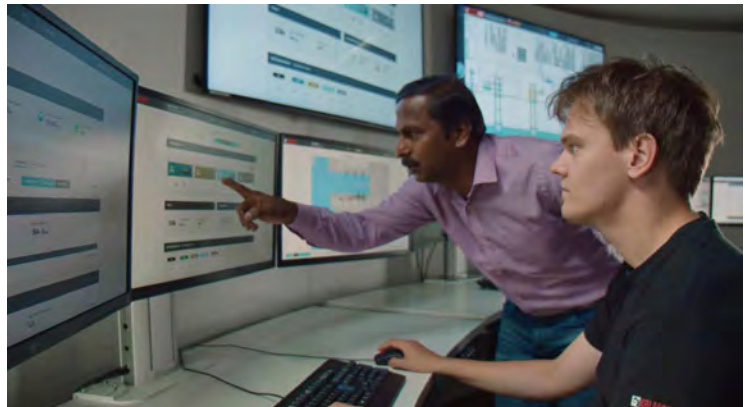
Kalmar One is an open, vendor-agnostic automation system for all automated terminal operations. Seamlessly interfacing between the TOS, automated equipment and other systems, Kalmar One is a flexible platform for the integration, control and optimisation of container movements in automated operations.

"Kalmar One ensures things happen in the right sequence and at the right time, minimising empty driving distances, and enabling terminal operators to do more with a smaller automated fleet," says Timo Alho, Director Product Management Automation, Kalmar. "This drives greater operational efficiencies while lowering costs, offering a proven, scalable and flexible system to optimise the entire terminal operation."

ONE SOLUTION, ANY MACHINE

Kalmar One has been available for several years as part of Kalmar's terminal automation deliveries, but the solution is now offered, for the first time, as a standalone software product. As a solution, Kalmar One is unique in being able to control all automated equipment in a terminal, irrespective of the type and manufacturer of the hardware.

"Along with the standalone availability, the most important thing that we're announcing is that Kalmar One is now fully equipment-agnostic," says Timo Alho. "The system can operate with automated equipment from any vendor, in addition to Kalmar products. To put it simply, you can automate any machine at any terminal, and Kalmar One can be the solution to manage it."



"The ability to procure automated equipment separately from an equipment-agnostic software and automation system also supports our drive towards Automation as a Service offerings in the future," adds Tomi Tuulkari, Senior Manager Product Management Automation, Kalmar. "Our customers have been asking for a different business model that would better align the goals of the automation vendor and terminal operator, and we see Automation as a Service as the next step in helping terminals realise the full value of their automated operations."

Kalmar's recently introduced Automation as a Service model is a subscription-based offering designed for the successful and efficient deployment of automation in marine container terminals and intermodal sites. The service model allows for collaborative design and integration testing of automation systems well before the go-live date so that potential gaps in terms of functionality or operational requirements can be identified,

ensuring a high-performing automated terminal from day one.

OPTIMISE THE WHOLE, NOT THE PARTS

A key factor in successfully deploying a terminal automation solution is optimising the automation system for the operations of the entire terminal. "In other words, you don't want to have a solution in which the cranes are controlled by the crane automation system, the straddle carriers are run by the straddle carrier vendor's software, and so on," says Timo Alho.

"Without a single integrated system, it won't be possible to optimise all components for the actual performance targets of the terminal."

Kalmar One is the ideal solution for terminal operators looking to expand and develop their existing terminal operations, as it enables any brand of equipment to be automated. An added benefit is that the solution allows large terminal operators to standardise their automation across multiple

terminals, irrespective of the operating model of each site.

"A single, standardised automation platform not only makes it easier to deploy automation at individual sites, but also to manage internal technical support and other similar functions across the entire company," says Alho. "Moreover, a common integrated platform facilitates learning from each automation project and reusing successful solutions in the next project, instead of reinventing the wheel for each case."

PROVEN AT MEGATERMINALS

In the latest release of Kalmar One, scalability has been developed significantly, and the solution is already used to control automated fleets reliably and efficiently at some of the largest automated terminals in the world.

"We have invested a lot in ensuring that Kalmar One can scale to the operational volumes required by megaterminal

operations," says Timo Alho. "As an example, our customer APM Terminals Pier 400 in Los Angeles has been using Kalmar One to manage a fleet of nearly 140 Kalmar AutoStrads™, including functionalities such as scheduling, dispatching and routing."

The user interface of the Kalmar One software has also been updated, along with the introduction of more advanced, user-friendly analytics. "The goal has been to give the user a high-level understanding of how the terminal is operating, instead of having to oversee individual container moves," says Tomi Tuulkari. Ultimately, the goal is to provide actionable insights that enable the continuous improvement of efficiency and productivity across the entire terminal."

To support the growing demand for terminal electrification, Kalmar One now also includes a full suite of functionalities to manage the charging of battery-powered equipment of any type or brand.

The scheduling and dispatching functions of Kalmar One can choose the best time for charging the batteries, optimise the use of charging stations and ensure that there is always an adequate number of machines available for operation.

EMULATING FOR SUCCESS

In addition to managing live on-site automation, Kalmar One can be used in a digital twin environment for detailed, highly accurate emulation of terminal operations. This enables terminal operators to pre-plan and configure their terminal and equipment fleets, and to run comprehensive tests of the solution with the actual automation system software well in advance of hardware deployment.

"Based on our extensive experience with terminal automation projects, a common challenge is that hardware and software often proceed with very different development schedules," says Tomi Tuulkari. "Instead of





specifying the hardware fleet and then ordering a software solution to automate it, one would ideally plan the entire terminal operation with automation in mind, and then define the layout and hardware accordingly. Emulation and testing with digital twins are crucial for this process, and Kalmar One has been designed to provide terminal operators with an integrated platform that supports them from the first planning steps all the way to ongoing everyday operations.”

In the latest terminal automation cases that Kalmar has been working on, a digital twin environment has already been built in the terminal design phase. This digital twin has been used to carry out emulation test scenarios with different configurations to ensure the right type of equipment is chosen, and the layout is designed in such a way that the automation solution can fulfil the objectives of the terminal operator.

“The only way to understand how the automation software will perform in the complex operational scenarios is to run those scenarios with the real software and validate the outcomes,” says Timo Alho. “Simplified terminal simulation software will never give the same quality of output as a real digital twin. That’s why we recommend utilising these tools already in the planning phase before the terminal design has been finalised.”

ABOUT THE AUTHORS

Timo Alho leads the Product Management and Business Development function for Automation at Kalmar. He has been with the company for more than 20 years, starting in automation R&D, where he played a key role in developing the AutoStrad solution. Over the years, he has held several leadership positions within the terminal automation business, including Head of the Cranes Business Line and Head of Terminal Design Services. Timo has been closely involved in the majority of Kalmar’s terminal automation projects worldwide.

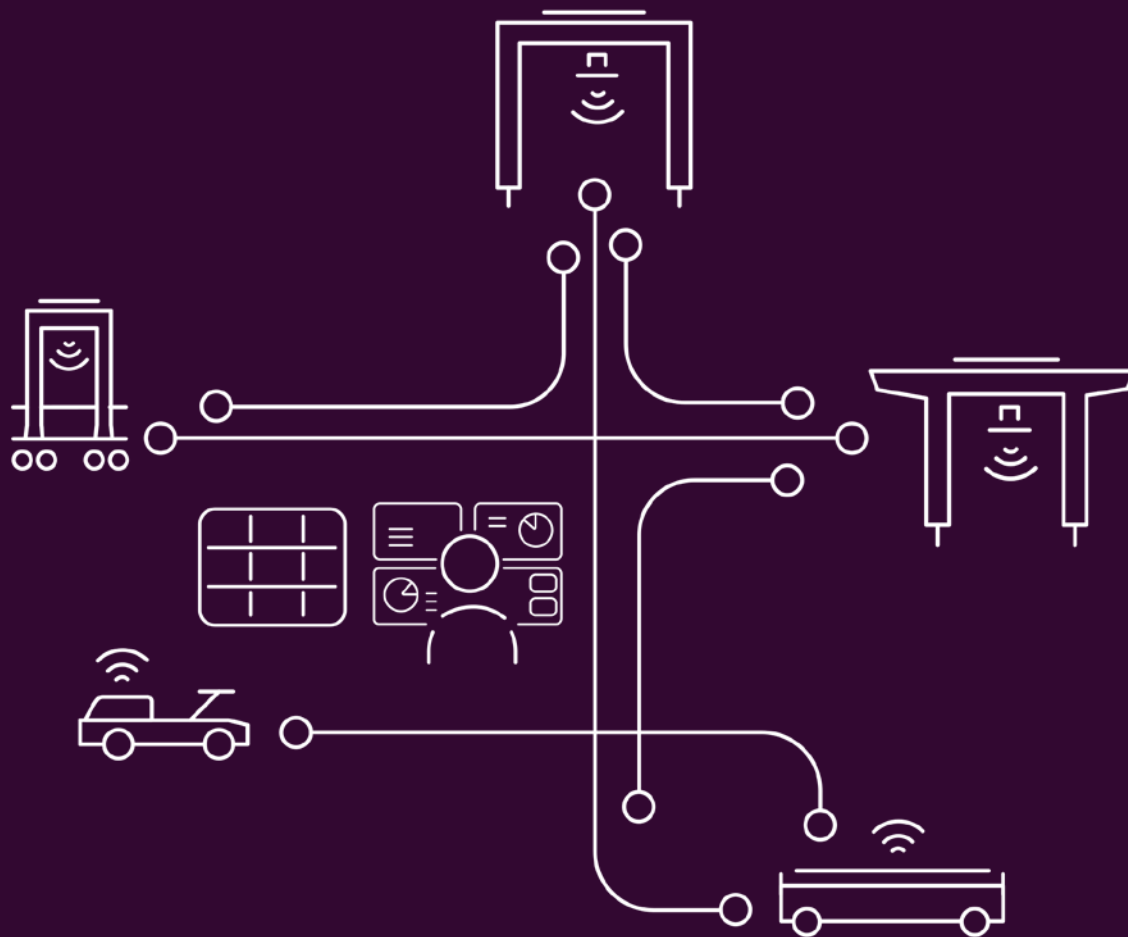
Tomi Tuulkari works as Senior Manager Product Management Automation at Kalmar. Tomi’s expertise comes from delivering multiple Automatic Stacking Crane projects, extensive customer collaboration, as well as from Product Management, including ensuring that the developed yard cranes fulfil the needs of the industry and that they can be maintained easily during the product’s lifetime.

Today, Tomi focuses on the product management tasks dedicated to Kalmar AutoStrads and Kalmar One. He spends his time communicating with Kalmar’s customers and partners, steering product development, as well as designing and scouting new technologies that can help customers operate automated sites even more safely while increasing productivity.

ABOUT THE COMPANY

Kalmar (Nasdaq Helsinki: KALMAR) is moving goods in critical supply chains around the world, with the vision to be the forerunner in sustainable material handling equipment and services. The company offers a wide range of industry-shaping heavy material handling equipment and services to ports and terminals, distribution centres, manufacturing and heavy logistics. Headquartered in Helsinki, Finland, Kalmar operates globally in over 120 countries and employs approximately 5,200 people. In 2024, the company’s sales totalled approximately EUR 1.7 billion.

www.kalmarglobal.com

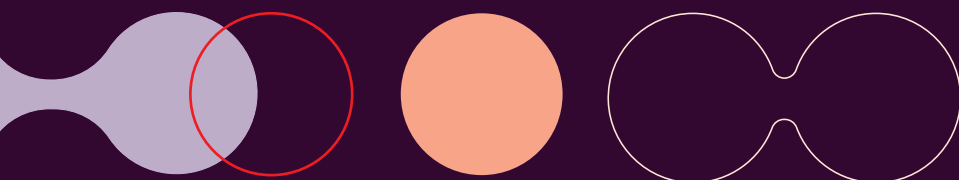


Kalmar One

Automation for all

Kalmar One is an automated fleet management system that can be integrated with your TOS and work with any type of automated equipment, from any OEM. Giving you one tested, scalable and flexible system that focuses on optimising your entire fleet and container flow. Driving greater operational efficiencies and lowering your costs.

Kalmar, making every move count.



TRANSFORMING HAI PHONG: HHIT'S SMART PORT SUCCESS





Jon Goldner,
Chief Executive, APM Terminals Asia & Middle East

There was a time when global trade and the terminal business operated quietly in the background, but today, the port industry finds itself in the spotlight more than ever. A port is part of a nation's critical infrastructure. The COVID-19 pandemic, geopolitical conflicts, and changing trade landscapes have exposed supply chain vulnerabilities, and disruptions have become the new normal we must work with.

For APM Terminals, this means that within the current state of global trade, there are two important things to deliver on from a terminal's perspective, no matter where we operate: reliability and flexibility.

Delivering on this can make all the difference to customers in a situation where there are major uncertainties and abrupt shifts. However, as a global company with more than 60 terminals in 33 countries, it is important to recognise that one size does not fit all, and thinking beyond the gates of the container terminal should be part of our approach when designing, developing, and running both new and existing terminals. Combining our global mindset with local expertise is central to integrating mental agility and multi-perspective thinking, ensuring we build a successful terminal that will support the growth and logistics flow of each country we serve.

PARTNERING FOR SUCCESS

A recent example of this is the opening of the Hateco Haiphong International Container Terminal (HHIT) in Haiphong, Vietnam, in early February 2025. HHIT's successful go-live, under the leadership of its CEO,



Mr. Nguyễn Văn Tiến, is the most recent illustration of a successful strategic partnership where each party contributes their expertise.

In 2023, APM Terminals committed to being a strategic partner of the deep-water port, using our global expertise and best practices to advise Hateco on developing a successful container terminal that could attract and service mega-vessels of up to 18,000 TEU in size, thereby reducing import and export costs in an area of crucial importance to Vietnam's growth and to intra-Asian and Transpacific trade.

Analysing how the terminal and its teams succeeded in making a record-fast delivery – from the beginning of land reclamation and construction to go live in only 30 months, followed by a rapid ramp-up – it is evident that the combination of the right partnership, modern technological solutions, and putting people at the centre was the recipe for success.

HARNESSING DIGITAL FOR SMOOTHER SUPPLY CHAINS

HHIT has deployed several digital solutions worth highlighting as important enablers. One is the use of Navis N4 4.0 TOS, another is the Autogate and Truck Appointment System (TAS) combination. The latter is a first for North Vietnam; no other terminal in the area has implemented it, and it has demonstrably impacted the entire supply chain, not just port flow.

HHIT is situated in the emerging strategic logistics hub of Lach Huyen, where communities have experienced significant congestion, especially during peak hours. For those unfamiliar with the area, it is largely defined by its network of islands and rivers flowing into the Red River Delta, with historically few key access routes for heavy transportation. The area surrounding Haiphong is home to many of the region's larger production facilities, exporting



goods such as textiles, automotive products and electronics. As 97 per cent of containers entering HHIT arrive or depart via truck, addressing truck congestion from the outset was a priority for the terminal partnership.

TIMING TRUCKS, SKILLSETS, AND SYSTEMS

To ensure traffic was more evenly distributed over time, the decision was made to use the Truck Appointment System (TAS). It requires trucks to choose an available timeslot to enter the terminal, thus levelling peaks. In addition, all required documents are also uploaded in advance. This is a system that we at APM Terminals have used with success across the globe, minimising congestion at ports, in hinterland logistics, and even for local commutes.

In December, HHIT's Gate Supervisor Bùi Nhật Anh attended a week of training at APM Terminals Bahrain, where a similar system is already live. There, Nhật Anh learned that the greatest challenge in implementing the TAS and Autogate was not the technology itself, but the change management and the transformation of local logistics. Here, collaboration proved to be a game-changer. The HHIT team invited local communities to the terminal before the go-live to run through the systems and provide

a thorough introduction to the processes.

It was decided to run both manual operations (using traditional paperwork) and the automated system in parallel at first, allowing the faster turnaround time of the automated process to become clear, while giving truckers the opportunity to choose until they were comfortable with the new setup. Our experience shows that full adoption of new systems like this one can take up to two years. In Haiphong, it took less than five months, underlining HHIT's strong engagement with local stakeholders before, during, and after implementation, and their tireless work with different layers of stakeholders until the new way of working became seamless.

These joint efforts are already showing results. Waiting time for trucks and congestion in the area have been significantly reduced thanks to the combination of the automated gate and the TAS. HHIT is averaging truck turnaround times as short as 16 minutes during the summer of 2025. In comparison, other terminals in the area are experiencing turnaround times of above 40 minutes.

A very telling illustration of the impact of such a system came in mid-July, when a tropical storm hit the region – a regular occurrence during the rainy season. Due to the severe weather conditions, all terminals in the area had to shut down for 48 hours. When they

reopened, a 15-kilometre traffic jam formed. However, only a few hours later, the traffic was running smoothly again, and HHIT's final average truck turn time for the week was 23 minutes.

We strongly believe that better planning through the appointment system and smoother Autogate operations played a significant role in this recovery, enabling HHIT to serve customers' trucks more quickly.

TERMINALS ADAPTING FOR SHIPPING ALLIANCES OF THE FUTURE

ABOVE

The HHIT gate is fully automated, allowing for faster and safer gate-ins. In July, HHIT processed 43,000 transactions (76,000 TEUs) with an average Truck Turn Time of 18 minutes.

The new terminal was chosen to be part of Gemini, a cooperation between Maersk and Hapag-Lloyd, and the alliance's new East-West network. The network set an ambition to deliver reliability of above 90 per cent when fully phased in by July 2025. The go-live date for the network was set for 1 February – the same month the terminal opened – requiring delivery from day one. Reliability, productivity, and resilience of the port infrastructure behind the network were key enablers to achieving this target, while Gemini also meant a significant boost in volumes compared to initial assessments made during the development phase.

Planning, optimising container flows, and mitigating the risk of congestion on both landside and ocean were key priorities to deliver from the terminal perspective. In Haiphong, the aim was to deliver 28 container moves per hour per crane by the end of 2025, but the HHIT Operations team had already reached this target by May 2025. In the first week of July, the team delivered 126 port moves per hour when Gemini's CCNI Angol called at HHIT, and 131 port moves per hour for the MSC Gaia.

This was largely due to the collaboration in using the Navis N4 4.0 TOS. Here too, our experience proves that change management and putting people at the centre of development and execution are key.

What the TOS provides is a better overview of the terminal's flow. The software optimises container move planning and calculates holistically to optimise and run operations beyond what we can do manually and visually.

The software can, however, be ineffective if operators are not properly onboarded. With the short lead time from concept to operational terminal, and with the advice of APM Terminals, HHIT opted for hypercare with a focus on upskilling the operational control room. In practice, HHIT expanded the standard training plan with additional material sessions, including in-person best practice sharing, interface training, system shortcuts, and guidance on managing yard and vessel operations with the new system.

Visitors to HHIT will notice fewer people outside in the yard, as more functions have moved indoors, providing a better working environment, improved safety, and digitised communication, administration, and planning. This pans out in productivity and reliability in production, enabling the terminal to meet the Gemini

target. The latest numbers from Sea-Intelligence show that Gemini reached 93.2 per cent reliability for the East-West Network for May-June 2025.

PEOPLE AT THE CENTRE WITH TECH AS THE ENABLER

Concluding this case study on HHIT, one thing is clear in a world where disruptions are the new normal and the speed from groundbreaking to go-live is critical: tech solutions are vital enablers to avoid congestion and optimise productivity, but they only work fully when we put people first.

In Haiphong, it started with HHIT having a masterplan ready to deploy, a team of local experts, and the right contractors lined up from the start. Pain points were identified as they appeared, and timely action was taken to deliver training and build capacity where needed. Close collaboration with shipping line customers to plan vessel calls, combined with smooth gate operations, has helped maintain a steady flow and ensured capacity was utilised as efficiently as possible.

MAIN

Since its go-live in February, HHIT has leveraged the skill of its operators and the effectiveness of the latest technology (Navis N4 4.0) to ramp up fast, serving 29 vessels in May, for 48,000 quay moves (85,900 TEUs)

ABOUT THE AUTHOR

Jon has been part of the A.P. Moller-Maersk organisation for over 28 years. He is currently a member of the APM Terminals Executive Team and serves as Chief Executive - Asia & Middle East. In this capacity, he is responsible for APM Terminals' operations, JV investments, and supports our new investment initiatives across the region. He sits on the Board for multiple entities across Asia and the Middle East.

Prior to his appointment as Chief Executive in September 2021, Jon was Chief Commercial Officer for APM Terminals globally and was responsible for contracting and pricing for APM Terminals' Key Client Program.

ABOUT THE COMPANY

APM Terminals develops and operates advanced container terminals around the world and has been lifting standards in the industry for more than half a century. The company is an independent division in A.P. Moller-Maersk, and has facilities in 60 key locations in 33 countries around the globe - with several in development. About 33,000 people work for APM Terminals, and in 2024, there were +27,000 vessel calls and 23.2 million moves in its hubs and gateway terminals.



ENHANCING PORT PRODUCTIVITY WITH COMPUTER VISION, IOT, ML, AND AI





Nitin Sirohi and Rajesh Kumar,
Co-Founders, CNB Logitech

Container ports are the lifeblood of global trade, handling over 800 million TEUs annually, according to the World Bank. As trade volumes surge, supply chains grow increasingly complex, and environmental regulations tighten, ports face immense pressure to optimise operations, reduce costs, and enhance sustainability.

The integration of computer vision, the Internet of Things (IoT), Machine Learning (ML), and Artificial Intelligence (AI) offers a transformative solution by leveraging real-time data and advanced imaging to streamline processes. These technologies are not futuristic ideals but practical tools already reshaping the maritime industry, enabling ports to achieve unprecedented levels of efficiency, security, and resilience.

This editorial explores how these technologies, working in concert, are revolutionising container port operations and positioning ports to thrive in a rapidly evolving global economy.

COMPUTER VISION: PRECISION IDENTIFICATION AND MONITORING

Computer vision is a cornerstone of modern port operations, providing unparalleled accuracy in identification and monitoring. By deploying high-resolution cameras and sophisticated image-processing algorithms, ports can identify containers, vehicles, and equipment in real time, ensuring seamless tracking and verification. These systems also inspect containers for visible damage, such as dents or compromised seals, flagging issues before they disrupt operations.



Beyond identification, computer vision enhances security by detecting anomalies. Using deep learning models, it can identify unauthorised personnel, suspicious cargo, or equipment malfunctions, such as a misaligned crane hook. By automating these tasks, computer vision minimises human error and accelerates workflows, laying a robust foundation for integration with other technologies.

Moreover, computer vision enables real-time monitoring of operational environments. Cameras mounted on cranes and drones capture live footage of port activities, allowing operators to assess congestion, monitor stacking areas, and ensure compliance with safety protocols. This visual intelligence integrates seamlessly with other data streams, creating a comprehensive operational picture that enhances decision-making.

IOT: THE REAL-TIME DATA BACKBONE

IoT serves as the connective tissue of smart ports, enabling real-time data collection across the entire operational ecosystem. IoT devices, including sensors on cranes, trucks, containers, and vessels, monitor a wide range of parameters, such as equipment health, cargo conditions, and environmental factors.

For example, smart containers equipped with IoT sensors track location, temperature, humidity, and even shock events, ensuring the integrity of sensitive goods like pharmaceuticals or perishables.

IoT provides accurate information on container locations within stacks. This, in turn, improves accurate planning, reduces wasted crane movements, and minimises human error, significantly lowering turnaround times for container

movements inside the port. The result is greater productivity across all aspects of port operations.

IoT further enhances asset management by monitoring equipment performance. Sensors on cranes detect vibrations, temperature changes, or wear, alerting maintenance teams to potential issues before they escalate. This real-time visibility reduces downtime and extends equipment lifespan. By creating a digital ecosystem where every asset communicates, IoT provides the data foundation necessary for advanced analytics and automation.

The scalability of IoT is another key advantage. Ports can deploy sensors incrementally, starting with critical assets like cranes and expanding to entire fleets. This flexibility allows even smaller ports to adopt IoT without prohibitive upfront costs. As IoT networks grow, they generate vast datasets that fuel ML and AI, unlocking deeper operational insights.

MACHINE LEARNING: PREDICTIVE POWER FOR OPTIMISATION

ML thrives on the data generated by IoT and computer vision, transforming raw information into predictive and prescriptive insights.

ML algorithms analyse historical and real-time data to forecast equipment maintenance needs, preventing unexpected breakdowns. These models identify patterns in sensor data, such as temperature spikes or unusual vibrations, to predict when maintenance is required, allowing ports to schedule repairs during off-peak hours.

ML also optimises yard management, a critical aspect of port operations. By analysing container movement patterns, ML algorithms forecast optimal stacking configurations, reducing the number of moves needed to retrieve a container. This efficiency is vital in high-volume ports, where even small delays can cascade into significant bottlenecks.

Demand forecasting is another powerful application of ML. By analysing historical cargo volumes, global trade trends, and real-time shipping data, ML models predict cargo surges, enabling ports to allocate resources effectively. This foresight prevents overstaffing during quiet periods or understaffing during peaks, optimising labour costs and operational efficiency. ML's ability to uncover hidden patterns ensures ports remain agile in the face of unpredictable demand.

AI: THE BRAIN BEHIND INTELLIGENT AUTOMATION

AI takes port operations to the next level by enabling intelligent automation, strategic decision-making, and real-time planning for port activities. AI-powered systems optimise complex processes like vessel scheduling, berth allocation, and cargo handling with minimal human intervention.

AI also enhances operational resilience through digital twins. These models simulate scenarios such as equipment failures, extreme weather, or peak traffic, allowing managers to test contingency plans without risking real-world disruptions. AI-driven automation extends to robotic systems, such as autonomous guided vehicles (AGVs), which transport containers within the port, reducing reliance on manual labour and increasing precision.

Furthermore, AI integrates data from computer vision, IoT, and ML to provide holistic insights. For instance, AI can correlate visual data on container conditions with IoT sensor data on location, real-time planning on movement/stack allocation, and ML prediction on maintenance needs, enabling proactive interventions. This



integrated approach ensures that decisions are data-driven and optimised across the entire port ecosystem.

SYNERGY: A UNIFIED ECOSYSTEM

The true power of computer vision, IoT, ML, and AI lies in their synergy, creating a unified ecosystem that maximises productivity. Computer vision ensures accurate identification and monitoring, IoT provides real-time data, ML delivers predictive insights, and AI drives automation. For example, computer vision verifies container identities at gates and during crane handling. IoT tracks their movement through the port, ML predicts congestion patterns, and AI dynamically adjusts crane schedules while carrying out real-time planning. This seamless coordination reduces errors, accelerates processes, and enhances scalability.

This synergy also enables adaptive operations. For example, during a sudden cargo surge, computer vision detects increased truck arrivals, IoT reports higher crane usage, ML forecasts potential bottlenecks, and AI reallocates resources to prevent delays. This real-time adaptability is critical in high-stakes environments where delays can cost millions. By integrating these technologies, ports can handle growing trade volumes without proportional increases in infrastructure or labour costs.

CHALLENGES AND THE PATH FORWARD

Despite their transformative potential, these technologies face significant hurdles. High initial costs for hardware, software, and integration can be prohibitive, particularly for smaller ports. Interoperability challenges arise when integrating legacy systems with modern IoT or AI platforms. Cybersecurity is

another concern, as connected devices are vulnerable to hacking, potentially disrupting operations or compromising data.

Workforce training is equally critical. Employees must be skilled in operating and maintaining digital systems, requiring investment in education and upskilling programmes. Resistance to automation, driven by fears of job displacement, can also slow adoption. However, these technologies often augment rather than replace human roles, creating opportunities for higher-skilled positions in data analysis and system management.

To overcome these challenges, governments and port authorities must prioritise digital infrastructure investments. Public-private partnerships can offset costs, while international standards for interoperability and cybersecurity can ensure seamless integration.

CONCLUSION

The integration of computer vision, IoT, ML, and AI is redefining container port operations, transforming them into intelligent, data-driven hubs. Computer vision ensures precision in identification, IoT delivers real-time connectivity, ML provides predictive insights, and AI drives automation – together creating a synergy that boosts efficiency, security, and sustainability. Ports like Rotterdam, Singapore, and Los Angeles illustrate the tangible benefits: faster turnarounds, lower costs, and reduced environmental impact. As global trade continues to grow, ports that invest in these technologies will not only enhance productivity but also secure a competitive edge in the maritime industry. The future of container ports is visually intelligent, connected, predictive, and automated – now is the time for stakeholders to embrace this digital revolution and shape a smarter, more resilient global supply chain.



ABOUT THE AUTHOR

Nitin Sirohi and Rajesh Kumar, engineering graduates from the esteemed Indian Institute of Technology (IIT) Kanpur, have dedicated over a decade to tackling the container shipping industry's challenges through their venture, CNB Logitech. As early adopters of cutting-edge technologies, they have pioneered innovative solutions to enhance efficiency, visibility, and safety in container logistics. They have received several accolades in the Indian container market.

ABOUT THE COMPANY

CNB Logitech Pvt Ltd is a Bengaluru, India-based Tech company, a leader in container logistics innovation. With over a decade of expertise, CNB harnesses computer vision, IoT, ML, and AI to transform manual port yards into smart, automated systems. Their flagship solutions, like SmartPort, SmartYard, SmartTransport and iHawk, optimise cargo handling, enhance visibility, and improve safety, serving major ports and logistics firms globally. They handle about 20% of India's container import/export volume at different yards across India.

BRINGING AUTONOMY TO DAILY CONTAINER TERMINAL OPERATIONS: THE ROLE OF ADVANCED MODELLING





Dr Zack Lu, Senior Project Manager,
Kaj de Groot, Director of Automation Projects, and
Melvin van Henten, Senior Automation Consultant,
 Portwise



AUTONOMY FROM PROMISE TO PRACTICE: ARE WE FULLY READY?

Autonomous vehicles (AVs, e.g., Figure 1) offer exciting potential for terminal logistics. They are expected to transform the industry with their flexibility and potential for operational efficiency, workforce evolution, and cost optimisation. Although not yet fully applied in day-to-day full-scale operations, sensible use cases are already foreseen with most short- to medium-term feasibility and business viability (see Portwise publication *“Autonomous vehicles – the holy grail?”* in PTI Journal Edition 140). Tremendous progress has been achieved with technological developments, site proof-of-concept pilots, as well as terminal (partial) adoptions.

Yet, the question remains: are we fully ready for AVs in practice? Success depends on far more than simply navigating from A to B. In complex port environments, these systems must operate safely and efficiently alongside other equipment, under real-world

constraints, in diverse operational contexts (e.g., severe weather conditions) and within the dynamics of a container terminal. Gaps still exist before AVs are fully ready for live operation. Challenges and hurdles are faced at different levels.

To address these, at Portwise we believe that advanced modelling via simulation and emulation can play a highly beneficial role. In the remainder of the article, we will present our perspective on the importance of such a role, drawing on our experiences and lessons learnt, as well as insights and feedback from many solution providers, industry peers, ports, and terminals.

KEY CHALLENGES AND HURDLES – A SELECTION:

- **Technical challenges:** Precision and accuracy are not the only requirements. The checklist also includes localisation (in dense port environments), reliability (in various weather conditions), redundancy (in

FIGURE 1: Cases with autonomous intelligent guided vehicles (IGVs) in a non-mixed traffic operation environment with perpendicular ASC yard (left) and autonomous terminal trucks in an intermodal site (right)

- case of breakdowns), and interoperability (with legacy systems) for vehicle mapping, sensor fusions, and navigation.
- **Regulatory concerns:** Regulations and standards are required to ensure no safety compromise for AVs operating in human-accessible environments. Although standards such as the EU Machinery Directive (2006/42/EC) exist, there is still arguably no unified regulatory framework for AVs in ports. International differences create uncertainties and ambiguities around compliance, certification, operational boundaries, liability, and insurance.
- **Operational complexity:** Container terminals are highly dynamic and subject to changing vessel schedules, yard configurations, and cargo flows. Advance planning is not feasible, as it requires robust safety protocols, fail-safe mechanisms, and real-time adaptability for AV implementation.



- Performance challenges:**
 To ensure AVs can safely and efficiently drive from A to B does not guarantee performance. It is a balancing act of job dispatching, equipment assignment, routing planning, traffic distribution, congestion mitigation, deadlock avoidance, priority ruling, and sequence management. It is about managing an entire fleet, not just a handful of vehicles; about handling exceptions, not just "happy day" flows; and about managing interactions with manned vehicles, quay cranes, yard cranes, and human workers. Questions remain as to whether full autonomy will be able to address all use cases or whether a centralised fleet management system will still be required.

ADDRESSING THE CHALLENGES AND THE ROLE OF ADVANCED MODELLING BEFORE PROOF-IN-OPERATION

Achieving full readiness for day-to-day autonomy requires addressing these challenges and solutions at different levels, too. Greater collaboration between various stakeholders

(ports and terminals, technology providers, and governments) is what is needed to develop more harmonised policies and standards for AV certification, operation, and data governance. Rapid developments and increasing trials and pilot programmes continue to improve the fundamental technical functionalities of AVs towards full implementation. From an operational and logistical standpoint, however, the industry does require more insights and experiences. These aspects remain the most complex within the entire puzzle, given the highly dynamic operational conditions within terminals and the need for tailored solutions. Here, advanced modelling approaches become essential. They are cost-effective and beneficial for:

- Risk-free testing and improvement** of AV behaviours and logic under various operational scenarios and dynamic environments (layout changes, peak and average conditions, adverse weather, equipment failure, interaction dynamics, etc.) without the need for real facilities disruption of live operations.

FIGURE 2:
Modelling of autonomous terminal trucks mixing with road trucks in RTG yard (example of a 3D visualisation)

- Operation and performance evaluation** of AVs in simulation benchmarking manual operations to assess efficiency, safety, and cost-effectiveness.
- Robustness and scalability planning** of how AV fleets will perform as terminal volumes grow, fleet size increases, and the interactions with manual traffic intensify.
- Phased integration and implementation** with simulation and emulation tools to enable stepwise testing of real hardware and software system components – not just for functionality but also for performance of individual system components.
- Visualisation and observations** of behaviours and operation of AV in driving, routing, interactions with other equipment, manned vehicles, etc., for validation and demonstration.

KEY ELEMENTS FOR AV MODELLING

Simulation and emulation have proven their benefits to support the successful development and implementation of technologies within our industry in the past (e.g., TOS, ECS, automated guided vehicles). The same concept and

principles can be well replicated in a similar fashion to support the industry's adoption of AVs.

However, there are many nuances within the concept of simulation and emulation. To reap the benefits, it is critical to have the right AV modelling in simulation and emulation, in terms of the modelling scope, the level of details, and the setups and external factors to be built within the model. Simply put, garbage in is garbage out, and simulation/emulation is not just for the sake of modelling and animations. Past lessons are therefore still applicable; yet new features of AVs require additional attention:

- **Clear level definition for modelling:** The purpose of modelling should always be clarified. Emulation, intended as linking simulated/emulated system components with the real counterparts, may be a clearer concept; simulation can often be ambiguous. Depending on the purpose, simulation could range from AV vehicle motions, sensor simulation (camera/lidar/radar), AV navigations and routings, as well as a full-

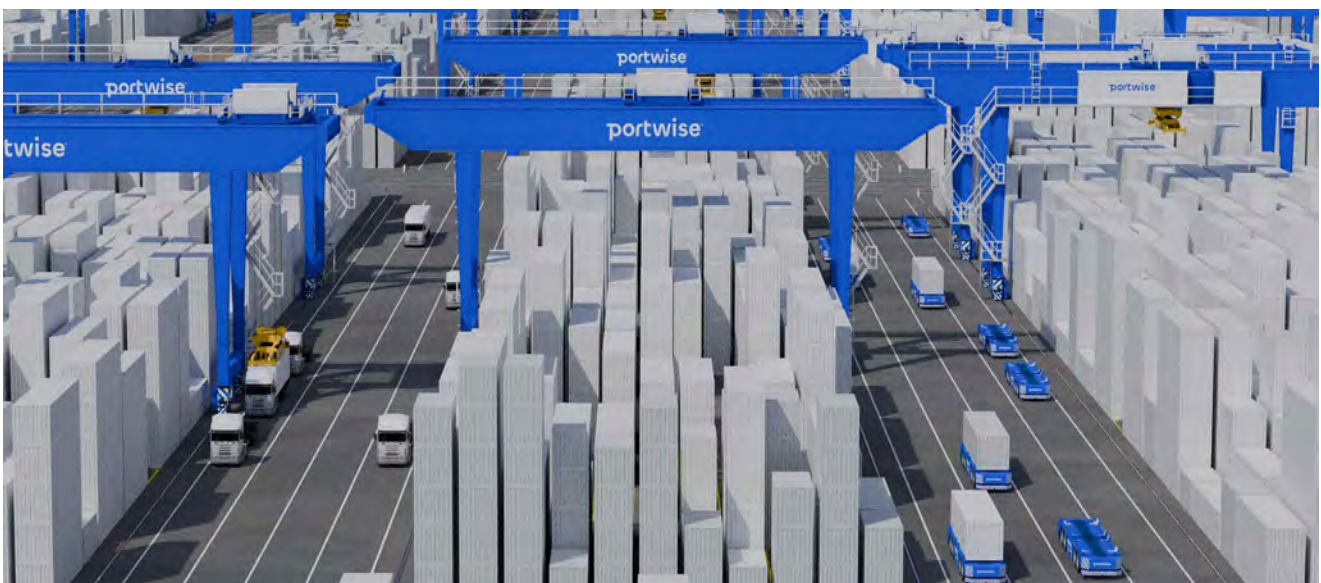
fledged terminal operation and performance simulation with AVs and other equipment. These consequently lead to different considerations of the simulation approach and tooling.

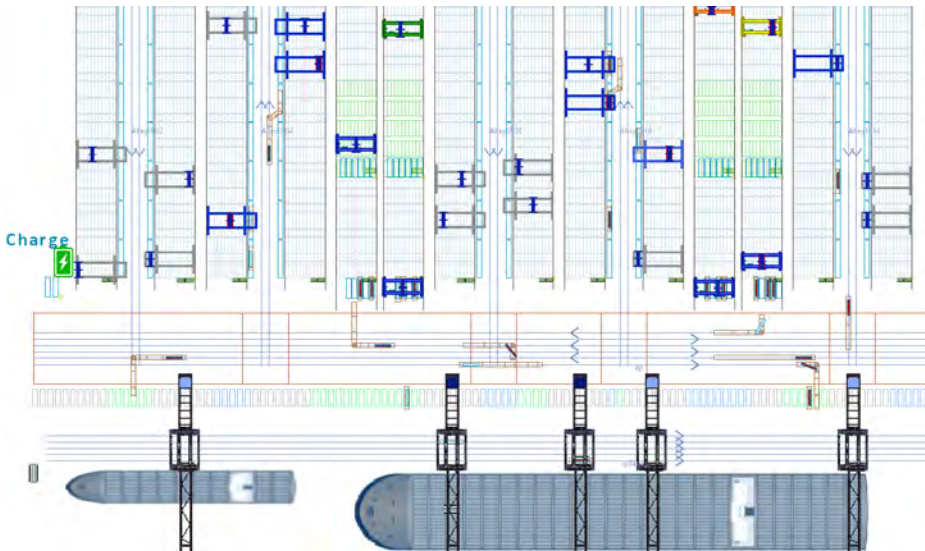
- **Scope and elements in modelling:** Even with clearly defined simulation levels, the question of what elements are relevant to include (or not) matters. This refers to both internal and external elements. For motion simulations, the scope may be limited to the AV vehicle and hardware. For sensor, navigation and routing, terminal layout, infrastructure, obstacles, environment, and weather conditions become relevant. A full terminal operation and performance simulation requires additional external elements such as the terminal's operation conditions, cargo workflows, full-scale interactions between all terminal equipment and external traffic, and the logic of the TOS and EMS for job planning, order assignment, etc.
- **Continuous validation in modelling:** Model validation is essential to ensure the reliability

FIGURE 3: Modelling of interchange between IGVs and road trucks with a cantilever RMG yard (example of a 3D visualisation)

of modelling outcomes for decision-making. While many modelling components have been validated against real data, real benchmarks and empirical data remain scarce for the validation of AV modelling. Continuous validation will be necessary for realistic, state-of-the-art AV modelling over the long term.

- **Level of autonomy in modelling:** Unlike conventional AGVs, AVs are designed to navigate autonomously using sensors, whereas AGVs are centrally orchestrated by ECS for AGVs' routings. This naturally requires different vehicle modelling approaches. However, debate remains as to whether full autonomy of AVs is sufficient, or a central software layer would be beneficial for efficient management of container loading and vehicle sequence, route planning and priorities, transfer points, handshakes between different equipment, etc. A clear definition of the autonomy level becomes, therefore, a prerequisite before AV modelling.





INSIGHTS FROM RECENT PORTWISE'S AV MODELLING

Through modelling and studying various AV concepts using simulation tools, Portwise has gathered valuable insights, including:

- The importance of having a **centralised software layer** to define routes, manage sequencing, and support container handover processes to facilitate higher efficiency and performance, especially for large fleet operations.
- **The need for a unified traffic rule** set for both AV and manned traffic within the terminal, and **a need for clear crossing priorities**, to achieve more safety and more efficiency in interactions, as compared to a free flow or first-come, first-served setup at junctions.
- **Different driving directions** within the terminal could lead to a trade-off between driving distance and traffic crossings. For example, a one-way traffic setup between waterside and yard with fewer crossings results in less vehicle hindrance, smoother overall traffic flow, and higher performance, even if the setup causes longer vehicle

driving distances.

- The value of configuring both **no-stop areas** to disallow conflicts at critical points and **waiting positions** to allow for independent AV waiting and buffering, within AV route segments.
- The benefits of limiting interactions between AVs and other vehicles as much as possible via **layout configurations** in the first place (e.g. dedicated zones and lanes, yard interchange separations, etc.), to minimise congestion and dead-lock sensitive situations.

CONCLUDING REMARKS

AVs have the potential to transform container terminal operations. However, many unknowns remain – both in virtual labs (via modelling) and in reality (via trials and pilots) – for AVs' full readiness. We believe advanced modelling via simulation and emulation will play a key role in this journey. Yet, to reap the benefits to support development and implementation, it is a prerequisite to have the right AV modelling approach. By sharing Portwise's experiences and lessons learnt, this article summarises what we believe are the essentials for effective AV modelling.

FIGURE 4:

Modelling of autonomous IGVs in a perpendicular Cantilever RMG yard (example of a 2D visualisation)

ABOUT THE AUTHORS

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Kaj de Groot works as Director of Automation Projects at Portwise. He has worked in the ports and terminals field for about a decade and has been involved in many different terminal design and automation implementation projects.

Melvin van Henten works as a Senior Automation Consultant specialising in port operations and automation. He has supported implementations, go-lives and operations focusing on process optimisation, equipment control, and performance improvements across semi- and fully automated terminals.

ABOUT THE COMPANY

Portwise, formerly part of TBA Group, is a world-leading consultancy and simulation firm that combines extensive automation and operational knowledge with proven simulation tools to create a future-proof plan for your port, terminal or warehouse operation.

REIMAGINING PORT OPERATIONS: SUPERINTELLIGENT SYSTEMS AND THE FUTURE OF DIGITALISED TERMINALS





Harrison Nguyen,
Business Development Manager,
Realtime Business Solutions

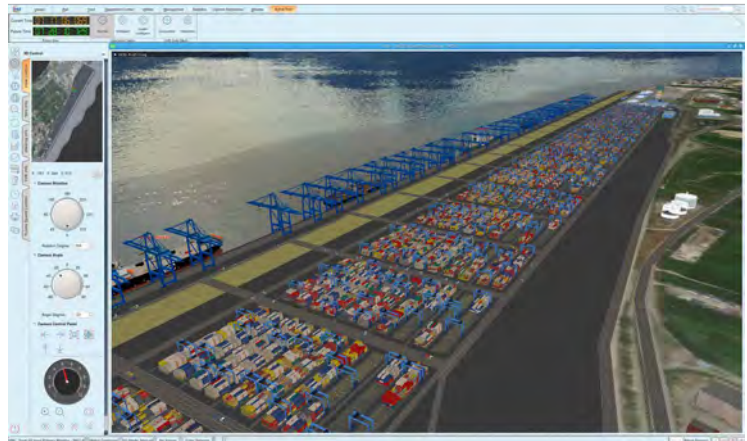
The global maritime industry is on the edge of a revolutionary shift. As port congestion, rising container volumes, and complex supply chain dynamics challenge traditional terminal operations, the demand for intelligent, autonomous, and efficient solutions has never been greater. Terminal Operating Systems (TOS) are evolving from static data-entry systems into dynamic, real-time, 3D systems. This evolution is being driven by breakthroughs in artificial intelligence (AI), digital twin technologies, and autonomous agents, heralding the arrival of the smart digital port of the future.

FROM INFORMATION TO KNOWLEDGE: THE ROLE OF SUPERINTELLIGENCE

In today's port environment, information alone is not enough. While TOS platforms collect vast amounts of operational data, their ability to transform that data into actionable knowledge determines their effectiveness. In traditional systems, information refers to raw data generated by crane activities, gate movements, yard positions, and vessel schedules. However, knowledge is the insight extracted from this data, used to reduce dwell times, anticipate congestion, and allocate resources proactively.

Superintelligent digital twin systems push this boundary by converting raw information into actionable knowledge. These systems leverage past data, current real-time inputs, and predictive modelling to build an overall understanding of terminal operations. With the help of AI

RIGHT
Image of RBS TOPX
Intelligent 3D system



agents embedded within a TOS, terminals can execute predictive analytics, self-corrective actions, and continuous learning, thereby achieving a level of operational intelligence previously unattainable.

THE INTELLIGENT 3D SYSTEMS: FUSING VISUALISATION WITH EXECUTION

Central to this transformation is the use of Intelligent 3D Systems in combination with TOS. This refers to a state-of-the-art system that combines the digital twin concept with real-time operational control and 3D visualisation. This immersive visualisation ensures AI agents are not operating in a data vacuum. Instead, knowledge is validated through a dynamic 3D representation of the terminal, which provides visual context and enhances decision-making accuracy.

Unlike conventional systems, where decisions often rely purely on datasets, an Intelligent 3D System

offers a holistic view of terminal activity, from berth operations to yard container flow. This visualisation enables both human operators and AI agents to collaborate on high-impact decisions, creating a hybrid model of autonomous and assisted operations.

AUTONOMOUS AI AGENTS: REVOLUTIONISING TERMINAL FUNCTIONS

Autonomous AI agents represent the functional core of a smart digital port. These entities operate across various domains by continuously analysing operational inputs and adjusting strategies to optimise performance. Key areas of influence include equipment control, traffic flow, and resource planning.

For equipment control, AI agents manage crane scheduling, automate container lifts, and monitor machinery health. Predictive models regulate truck entries, gate queues, and in-terminal routing for smoother



traffic management. AI agents also support resource planning, dynamic allocation of labour, equipment, and yard space based on real-time demands and future forecasts.

What distinguishes these agents is their ability to operate without direct human intervention. From predicting cargo delays to assigning cranes in real-time, they can execute complex tasks autonomously, improving throughput and reducing bottlenecks.

BEYOND AI: THE SUPERINTELLIGENT AGENT

While AI agents perform specific tasks with efficiency, superintelligent agents surpass human capabilities in reasoning, decision-making, and learning. These agents do not simply react; they anticipate and evolve. With access to trillions of parameters derived from historical data, real-time sensor feeds, and simulated future outcomes, superintelligent agents can: detect unseen patterns

ABOVE

Image of RBS TOPX Intelligent 3D system

in terminal behaviour; resolve complex interdependencies in crane-vessel-truck workflows; and continuously refine their logic to improve performance autonomously.

Superintelligent knowledge is not confined to any one human operator's experience. It is democratised, scalable, and available to assist any stakeholder at any time, ensuring operational resilience and continuity.

PREDICTIVE ANALYTICS AND PROACTIVE DECISION-MAKING

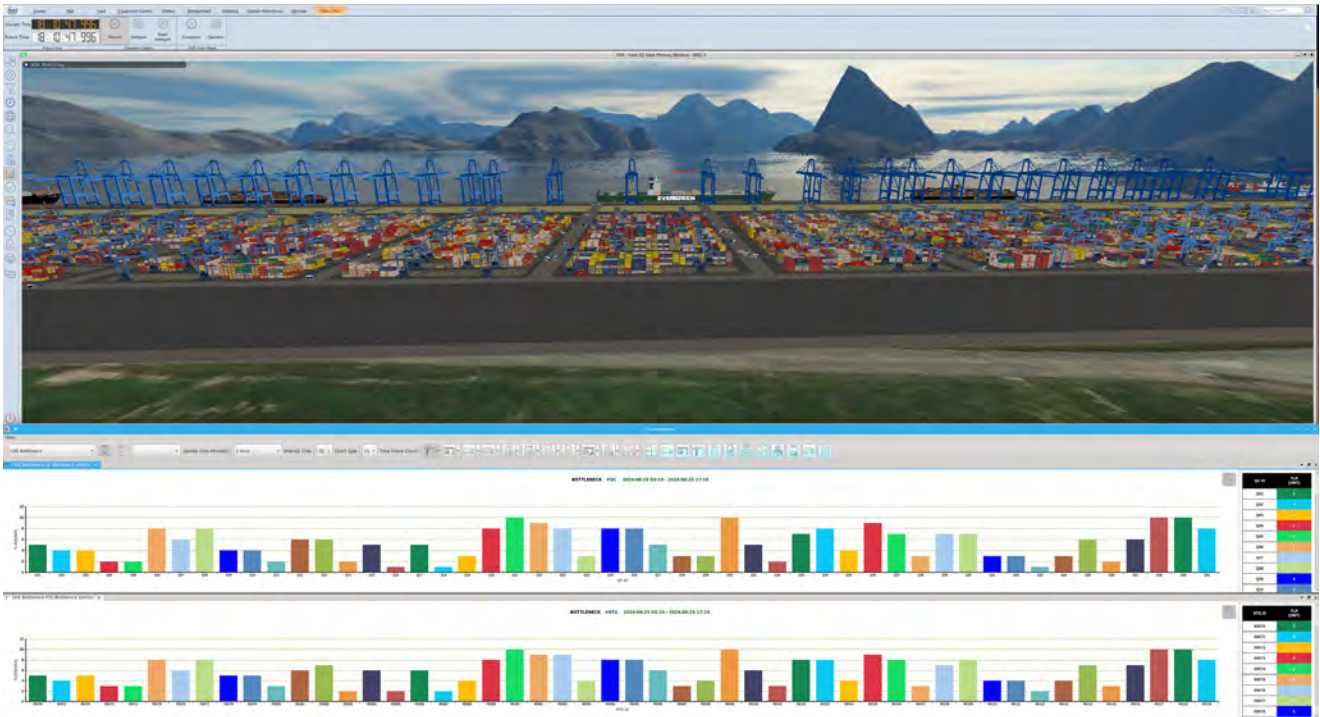
Modern ports face a wide range of challenges, from weather disruptions to equipment breakdowns. Predictive analytics, powered by AI and machine learning, offers a way forward. By forecasting disruptions before they materialise, terminals can initiate preventive actions such as rerouting traffic, rescheduling cranes, or notifying carriers in advance.

In a smart digital port, proactive decision-making is key. AI agents continuously monitor conditions, simulate outcomes, and recommend real-time interventions



LEFT

Image of RBS TOPX Intelligent 3D system



to maintain optimal flow. This results in fewer delays, better berth utilisation, and enhanced customer satisfaction.

SEAMLESS INTEGRATION AND IOT CONNECTIVITY

A key enabler of superintelligent terminal operations is seamless integration with IoT devices and external platforms. From smart gate systems to yard sensors, the TOS must act as a central nervous system that consolidates separate inputs into a cohesive operational picture.

AI agents interface with IoT sensors for equipment tracking and maintenance alerts, as well as with external systems for real-time collaboration with shipping lines and customs authorities. This integration ensures AI decisions

are based on accurate, timely, and complete data – a prerequisite for self-governing systems.

CONCLUSION: TOWARDS THE SMART DIGITAL PORT OF THE FUTURE

The container terminal industry is on the cusp of transformation. With the introduction of Intelligent 3D TOS, autonomous AI agents, and superintelligent digital twins, the vision of a fully optimised, self-governing terminal is no longer a concept; it is an imminent reality. For port and terminal operators, embracing these innovations is not just about staying competitive; it's about unlocking unprecedented efficiencies, resilience, and sustainability. Ports of the future are here, and they are powered by intelligence, not intuition.

ABOVE
Image of RBS TOPX Intelligent 3D system

ABOUT THE AUTHOR
Harrison is a Business Development Manager at Realtime Business Solutions (RBS), and is passionate about how software can revolutionise industries. He graduated from the University of New South Wales with a Bachelor of Commerce and Computer Science with distinctions. With his fresh ideas and burning ambition, Harrison is dedicated to helping terminals find the best solutions to optimise their operations.

ABOUT THE COMPANY
Realtime Business Solutions (RBS) specialises in developing state-of-the-art TOS solutions and has worked exclusively in the Container Handling Industry for over 30 years. Over this period, RBS has carried out the installation of the RBS TOPS software in many Container Handling operations around the globe. RBS' most recent products include TOPS Expert and TOPX Intelligent 3D, which is a super-intelligent digital twin, now with a Superintelligent Agent.

For more information, please visit our website www.rbs-tops.com



PSA SINGAPORE: DRIVING A SMARTER, SUSTAINABLE PORT ECOSYSTEM



S2409

S2406



2411

Credit: PSA Singapore





Sriram Ramanujam,
Vice President of Digital Products,
Regional IT Southeast Asia, PSA

Amid growing global supply chain complexities and intensifying climate challenges, the port and logistics industries stand at a pivotal crossroads. The path forward is clear: to remain resilient, efficient and relevant, we must embrace digital transformation not merely as an option, but as a core strategy.

At PSA Singapore (PSA), home to the world's largest transshipment hub, we are proud to lead the evolution of global port operations, driving transformation through purposeful innovation, smart digital solutions, and an unwavering commitment to sustainability. Over the years, digital technology has reshaped our port operations – from vessel arrivals and container handling to truck trip planning. Digital solutions are now deeply embedded in PSA's DNA. Yet, these advancements go beyond productivity and efficiency; they are about future-proofing the supply chain ecosystem for generations to come.

THE iWX PLATFORM: A DIGITAL LEAP TOWARDS INTELLIGENT CONTAINER REUSE AND RETURN

A key example of digital transformation at PSA is the launch of Intelligent Warehouse Exchange (iWX), a digital platform designed to streamline container reuse and return operations. Developed by PSA, it optimises workflows while concurrently enhancing coordination and communication among stakeholders – including ports, warehouses, trucking companies, and shipping lines.

Traditionally, a significant number of trucks make multiple trips between warehouses



© PSA Singapore

(including PSA's Keppel Distripark) and external depots in western Singapore (Penjuru and Tuas). This inefficiency in container movements and utilisation not only results in operational waste but also contributes significantly to carbon emissions. iWX offers a smarter, more sustainable alternative.

By harnessing real-time data integration, artificial intelligence (AI), and machine learning, iWX streamlines container reuse and return workflows. It facilitates the reuse and exchange of containers by matching tenants needing to export cargo with returning empties, thereby reducing unnecessary trips. When reuse is not feasible, iWX redirects empty containers to the nearest depot, significantly cutting travel distances.

iWX has immense potential to drive both operational efficiency and environmental sustainability, saving more than 1,000 tCO2e. Its capabilities will expand further with the PSA Supply Chain Hub @ Tuas, due in 2027, advancing our vision

for a more integrated and seamless cargo flow across Singapore.

OPTETRUCK: SMARTER TRUCKING FOR EFFICIENCY AND A GREENER TOMORROW

Digital innovation is also reshaping Singapore's road haulage sector – a major contributor to carbon emissions due to frequent empty truck trips and underutilised resources. To address fragmentation and inefficiencies, PSA developed OptETruck, a cloud-based transport management platform that streamlines truck trip planning and reduces waste. Globally, trucking accounts for 34 per cent of transport sector emissions, underpinning the urgency of such innovation.

Through extensive studies, interviews, and collaboration with government agencies and trade associations, PSA identified key operational pain points and co-developed OptETruck to address them. Powered by AI and data



analytics, it provides a common platform for truck scheduling and coordination, streamlining operations across ports, logistics facilities, and container depots, and overcoming the fragmentation of traditionally siloed operations.

The platform enables hauliers to automate scheduling, pool resources, and reduce empty trips. The results have been remarkable. Haulier companies using OptETruck have reported over 50 per cent reduction in empty truck trips. This translates to annual savings of 10,000 tCO₂e, equivalent to planting 300,000 trees each year.

Beyond emissions reduction, OptETruck supports small and medium enterprises (SMEs) in the logistics industry by improving their competitiveness. In a sector often challenged by limited resources, the ability to share assets and optimise routes levels the playing field and helps these businesses

pursue their sustainability goals. Recognised with the Excellence Award at the 9th Annual Singapore OpenGov Leadership Forum, OptETruck is more than just a technological breakthrough – it is a catalyst for sustainability and industry collaboration.

Most importantly, OptETruck is part of PSA's broader vision to build an intelligent logistics and supply chain ecosystem. Together with our other digital tools such as SmartBooking™ and iBOX™, we are digitally connecting terminals, depots, hauliers, and logistics facilities to enable end-to-end visibility and coordination. This ecosystem approach is how we envision the future of logistics – one that is collaborative, data-driven, resilient, and sustainable; one that supports Singapore's vision of a low-carbon logistics ecosystem and sets a new benchmark for AI adoption in the transport and logistics sector.

OPTEMODAL: SEAMLESS SEA-AIR INTERMODAL CONNECTIVITY

Building on these innovations, PSA and Cargo Community Network (CCN) recently launched OptEModal, a next-generation digital platform that enables faster, smarter, and more coordinated sea-air intermodal transshipment.

Co-created with maritime and air cargo stakeholders, OptEModal integrates real-time data streams across PSA terminals, ground handlers, and airline partners to enable seamless cargo movement between vessel and aircraft, typically within 24 hours of arrival. Its capabilities include multi-party visibility, AI-driven Estimated Time of Arrival (ETA) predictions, proactive delay identification, and smart flight recommendations.

This digital corridor, which provides end-to-end tracking, simplifies complexities, reduces costs, and enhances reliability

for shippers and logistics providers, supporting high-value and time-critical industries such as electronics, healthcare, and e-commerce. OptEModal represents a blueprint for the future of global logistics, where connected nodes come together to form intelligent, adaptive networks that drive efficiency and resilience across supply chains.

OPTEVOYAGE: OPTIMISING PORT CALLS AND DRIVING EFFICIENCY AT SEA

Efficiency doesn't stop at the shoreline. As part of our broader digital transformation, PSA is extending innovation seaward through OptEVoyage, a solution aimed at reducing bunker fuel consumption and emissions by optimising vessel arrivals.

Traditionally, vessels race to port only to end up waiting at anchorage. OptEVoyage flips this conventional model on its head by introducing the concept of Agreed

Berthing Time (ABT). This enables shipping lines to plan their voyages at optimal speeds, arriving just in time when the berth is ready. This reduces unnecessary fuel burn and vessel bunching.

The scale of our OptEVoyage has expanded significantly, growing to more than 3,000 port calls across more than 150 services. The impact has been substantial: over 180,000 metric tonnes of bunker fuel saved and nearly 564,000 tCO₂e emissions reduced in a single year.

Beyond the environmental benefits, this initiative enhances PSA's service reliability and reinforces Singapore's position as a smart, sustainable global maritime hub.

INNOVATION AS A CATALYST FOR INDUSTRY TRANSFORMATION

Initiatives like iWX, OptETruck, OptEModal, and OptEVoyage reflect a clear strategic purpose: to drive meaningful transformation across the port, supply chain, and

logistics sectors and build greater resilience for the future. At PSA, we are committed to working closely with our stakeholders to innovate, collaborate, and lead the industry into a new era defined by operational excellence, sustainability, and agility.

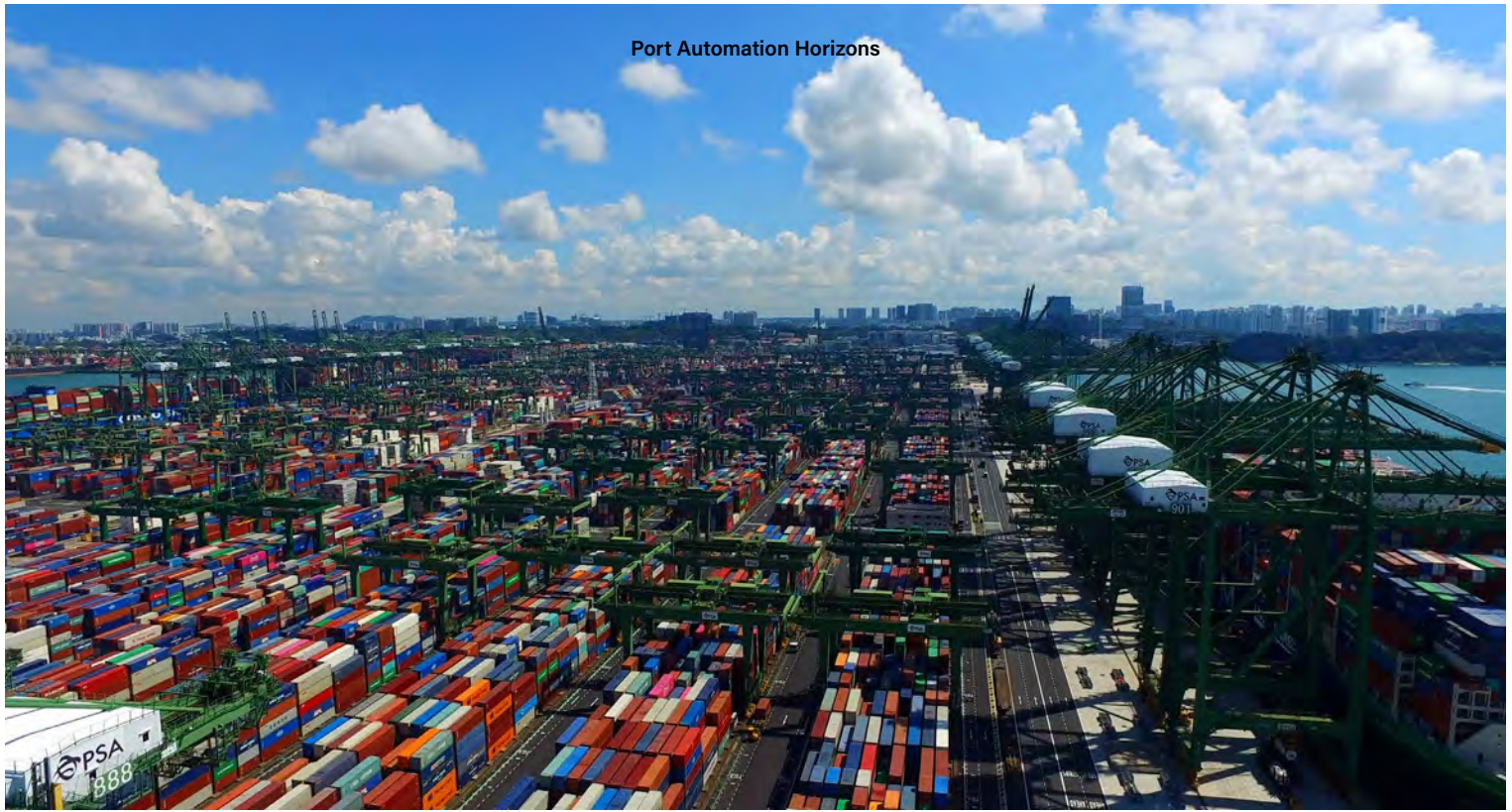
Our approach is rooted in real-world impact. Every digital solution we develop is designed with tangible outcomes in mind – reducing carbon emissions, improving asset utilisation, enhancing berth planning or increasing transparency across the supply chain. In doing so, we are not only elevating our own performance but also helping to catalyse progress across the wider logistics ecosystem.

THE JOURNEY AHEAD

As we continue our journey of innovation and digital transformation, we remain firmly anchored in collaboration, sustainability, and agility.

Credit: PSA Singapore





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We believe that no single organisation can transform the industry alone. The complexities of today's supply chains require collective vision, shared responsibility, and coordinated action. That is why we are deeply committed to fostering meaningful partnerships and building seamless connections among stakeholders across the supply chain. By creating digital linkages that connect ports, shipping lines, logistics players, and cargo owners, we can unlock greater value and drive transparency, efficiency, and resilience at every node of the supply chain.

At the same time, we recognise the need to decarbonise and safeguard the environment for future generations. By embedding environmental stewardship into our innovations, we are making measurable progress and promoting greener operations across our network.

In today's BANI (Brittle, Anxious, Non-Linear, and Incomprehensible) world, adaptability is not just

an advantage; it is essential. By leveraging real-time data, AI, and advanced analytics, we empower our people and our partners to anticipate disruptions, adapt quickly and stay ahead of evolving trade dynamics.

Digital transformation is not a destination, but rather a journey of continuous learning, experimentation, and evolution. What inspires us is not just the technology itself, but the immense possibilities it unlocks when the industry comes together. When we move in unison, the impact is more than incremental; it is exponential.

In PSA's digital evolution, we see a blueprint for the future. One where operations are automated, decisions are data-driven, resources are optimally deployed, and emissions are significantly reduced. It is a future we are actively shaping, one innovation at a time.

We welcome the world to join us on this exciting journey. Together, we can create a smarter, more connected and more sustainable world of trade.

ABOUT THE AUTHOR

Sriram Ramanujam, Vice President of Digital Products for PSA Southeast Asia, leads a team of over 240 professionals in innovating and scaling port and logistics digital solutions globally. Since joining PSA in 2000, he has spearheaded flagship systems, automation initiatives and ecosystem partnerships, driving PSA's vision to transform the port and supply chain landscape by connecting individual nodes into a coordinated, intelligent network.

ABOUT THE COMPANY

PSA Singapore, the world's largest container transshipment hub, handled 40.9 million TEUs in 2024. With connection to 600 ports worldwide and operating 24/7, PSA offers port adjacency services and digital solutions, delivering end-to-end supply chain visibility and reliability, making it the partner of choice in global port and logistics operations.

FORESIGHT FOR PORT COMMUNITY SYSTEMS: "DEALING WITH UNPREDICTABILITY IN A PREDICTABLE FASHION"

Inga Mortona,
General Manager,
IPCSA



In a global landscape increasingly characterised by volatility, complexity, and rapid change, the capacity to anticipate future shifts, effectively manage inherent risks, and proactively seize emerging opportunities is no longer a strategic advantage – it has become an absolute prerequisite for sustained survival and robust growth.

The International Port Community Systems Association (IPCSA) is spearheading this critical imperative through its comprehensive **Foresight initiative**. This series of specialised workshops is designed to empower its diverse membership, encompassing Port Community Systems (PCS), Single Windows, and the broader ports and shipping sectors, to actively shape the future of global trade rather than merely reacting to its uncertainties. The initiative provides essential strategic tools for understanding and navigating the myriad unknowns that lie ahead.

Building upon the foundational insights gained from its inaugural Foresight workshop in Dubai – which meticulously explored the dynamics and drivers of change, identifying key issues and high-impact uncertainties – IPCSA convened

its **second intensive two-day Foresight workshop in Casablanca, Morocco**. This pivotal event was **graciously hosted and sponsored by Morocco's Single Window operator, Portnet**.

Youssef Ahouzi, CEO of Portnet, expressed profound satisfaction with the workshop, noting its provision of **"excellent insights which helped us to consider how businesses can stay relevant and develop services for customers"**.

The Casablanca workshop, skilfully facilitated by Will Sambrook of Akenham, employed the renowned **'Copenhagen method'**. Day one was dedicated to a deep dive into the critical issues initially identified during the Dubai workshop. Participants explored these potential scenarios in depth, evaluating their implications for business against a backdrop of global tensions and accelerating change, ultimately constructing **"pictures of 'potential futures'"**. Day two focused on identifying specific strengths, weaknesses, opportunities, and threats (SWOT) stemming from these scenarios that could exert the most significant impact on PCS and Single Window operators. The objective was to **gather actionable**

ideas and concrete proposals for strengthening operations to effectively address these challenges, rendering the discussions **"very real"** for the participating organisations.

PREPARING FOR THE UNPREDICTABLE: STRATEGIC PREPAREDNESS AND COLLECTIVE BRAINPOWER

The workshop generated **"very intensive discussions and debates"** as participants grappled with the challenge of anticipating future developments in a highly unpredictable world. Javier Gallardo, Chairman of IPCSA and CEO of Portic (Spain), acknowledged this inherent unpredictability, stating, **"We don't know where we will arrive because the world is unpredictable, but we worked to explore different potential scenarios and evaluate probabilities"**.

Gallardo delivered a particularly thought-provoking presentation titled **"How to face critical situations"**. Drawing from his personal experience during a major power blackout that impacted Spain and Portugal, Gallardo powerfully emphasised the critical importance of strategic preparedness in



handling crises. His narrative underscored that while technology is crucial, robust contingency plans and structured approaches are essential for maintaining focus and effectiveness under pressure. He emphasised the need for clear communication, prioritising actions, and continuous learning, noting that even minor issues can trigger substantial ripple effects within complex systems.

This discussion resonated deeply with participants, who explored various strategies for handling critical situations. Notable themes included the necessity of reliable information and communication during crises and the risks posed by over-reliance on technology. Participants stressed the importance of backup plans and redundant systems, drawing parallels with traditional preparedness methods. The consensus was clear: governments must lead narratives during crises, and learning from past experiences is invaluable for enhancing disaster response strategies.

As **Alexandre Sánchez, Port Community System Manager at the Port Authority of Valencia**, reflected, a key takeaway was that preparedness for unexpected events, like a blackout, comes from actively imagining what could happen,

making organisations "stronger and safer".

Mona Swoboda, Program Manager of the Inter-American Committee on Ports (CIP), Organization of American States (OAS), stressed the **critical role of governments in leading the narrative and serving as a reliable source** to prevent confusion. **Youssef Ahouzi** further pointed out that the lack of backup internet links for communication companies exacerbated information access problems, contributing to the spread of misinformation.

John Bescec, Chair of the International Chamber of Commerce (ICC) Global Customs and Trade Facilitation Commission, aptly summarised this approach as identifying ways to "deal with unpredictability in a predictable fashion".

Steve Lamb, CEO of MCP (UK) and Deputy Chairman of IPCSA, described the Foresight workshop as "**extremely stimulating**," emphasising that while many future developments "**cannot predict or influence**," the industry can "**certainly plan for them**".

Uwe Liebschner, representing IPCSA and Kale Logistics Solutions, powerfully articulated the heightened relevance

of the Foresight exercise, given recent geopolitical tensions and trade and tariff uncertainties that have unfolded since the Dubai workshop. He emphasised the increasing urgency to monitor global events and prepare businesses for long-term market presence and sustainability.

Echoing this sentiment, **Magdalena Rzczkowska, Director of the Federation of Polish Entrepreneurs**, observed that in just six months the world had become "even more unknown" and "totally unpredictable," moving far beyond "business as usual". She added, "**It has become even more difficult to imagine what might happen, because we already know that our imagination is not big enough. This shows it is really important to think outside the box**".

John Bescec underscored the crucial value of collective brainstorming within the IPCSA community. He defined Foresight as "identifying ways to deal with unpredictability in a predictable fashion". Bescec further explained that the workshop enabled participants to "look at threats and potential shocks, considering a scenario that is an 'unknown' and make it work in a model that is well managed". He cited Canada's disruptive neighbour to the south,



noting that "things that were taken for granted are now changing". He questioned how to make sound investments when dealing with such pervasive uncertainty, and affirmed that while "Technology doesn't address all the uncertainty that arises, but Foresight exercise is all about how it can be managed, how you can plan, and how you prioritise". He passionately concluded that **"When you have multiple individuals globally coming together and trying to forecast what a solution could look like, that is where brainpower can be at its most powerful"**.

Several participants echoed the sentiment of **never taking things for granted**, particularly concerning potential economic disruptions, rapid innovation, and the impacts of climate change.

Tarik Maaouni, Chief Information and Digital Officer at Morocco's National Ports Agency (ANP), found the discussions on critical issues **"extremely valuable"**, underscoring a vital message: **"be sure not to take things for granted, especially with economic disruptions, innovation and climate change"**.

Alexandre Sánchez drew a profound lesson from the blackout experience, stating, **"If we imagine what could happen in the future, we will be stronger and safer"**.

Stephanie van den Berg, Strategy & Innovation Portfolio Manager at Portbase

(The Netherlands), articulated the crucial role of Foresight within IPCSA, explaining that it **"enables us to proactively anticipate the changes that will impact global trade and Port Community Systems"**. She emphasised its role in identifying trends, managing risks, and seizing opportunities within the rapidly evolving spheres of sustainability, digitalisation, and globalisation, thereby positioning IPCSA to "take a leading role in shaping a sustainable and efficient trading environment".

Riasat Ali, Group Head of IT of RAK Ports (UAE), particularly valued the workshop's **"very diverse group"** of participants from a wide array of professional backgrounds and industries, which fostered a **"unique combination of viewpoints"**. He highlighted the impact of the latest technologies like agentic AI, IoT, and digitalisation, revolutionising port communities by enhancing transparency, efficiency, and security, while streamlining logistics processes and improving supply chain visibility.

Jan Hoffmann, Global Lead for Maritime Transport and Ports at the World Bank, offered a comprehensive virtual overview of global shipping. He reviewed past developments, underscored positive long-term trends in trade facilitation – supported by indicators from organisations like WTO, OECD, and UNCTAD – and presented

valuable data on port efficiency and modernisation. Hoffmann also courageously addressed the critical challenge of emissions from shipping, a significant concern for the industry. He posed essential questions about setting standards for future digitalisation in maritime transport, highlighting the rapid pace of technological change, and briefly mentioned a "10-point action plan" for adapting to challenges posed by COVID-19. In his closing remarks, Hoffmann left the audience with a thought-provoking question on the delicate balance between controls and trade facilitation, offering a holistic perspective on the industry's trajectory from the World Bank's vantage point.

KEY TAKEAWAYS AND IPCSA'S FORWARD PATH

The Casablanca workshop reinforced several **critical messages** for the industry to embrace and carry forward:

- **Digitalisation is paramount for building resilient and efficient port systems**, particularly in regions most vulnerable to disruption.
- **Collaboration and knowledge-sharing are not optional** for advancing Port Community Systems and achieving global interoperability.



- **An inclusive and sustainable digital transformation must prioritise capacity building**, ensuring that no port or community is left behind.
- **Anticipating future trends is essential for the success of the PCS sector**, demanding a united, collective effort.
- **The industry must never take things for granted**; instead, it must continuously plan for unpredictability and diligently prepare for disruptions ranging from economic shifts to the profound impacts of climate change.

Nico De Cauwer, Secretary-General of IPCSA, expressed pride in the diverse participants, praising the **"perfect blend of members and external experts who have all contributed to the success of this workshop"**. He recognised this diversity as IPCSA's greatest strength, enabling a meaningful progression from the broad global issues discussed in

Dubai to the more focused, industry-pertinent discussions in Casablanca.

IPCSA extends its heartfelt gratitude to Portnet for their invaluable and incredible support and warm hospitality. Hosting the workshop in Morocco was an amazing experience, and it was an honour to have such a dedicated partner, making this pivotal event possible. The organisation remains steadfast in its leadership role, committed to convening diverse stakeholders and leveraging collective wisdom to forge a more resilient, sustainable, and efficient trading environment for the decades to come. While the future is inherently uncertain, through dedicated foresight and collaborative efforts, IPCSA is actively making it more manageable and undeniably more promising – for everyone.

A full report on the Casablanca workshop will be made available on the IPCSA website.

ABOUT THE AUTHOR

Inga Mortona is General Manager of the International Port Community Systems Association and a Member of the ICC Legal Reform Advisory Board. A specialist in European Union and international law, she provides administrative support and expertise relating to policymakers. Inga Mortona has extensive knowledge and experience across legislative, finance, data protection, competition law and strategic planning issues, having worked at a high level in both governmental and commercial sectors.

ABOUT THE ORGANISATION

IPCSA is an international association of Sea and Air Port Community System operators, sea and air port authorities and Single Window operators that is recognised across the globe for providing advice and guidance on the electronic exchange of information across borders and throughout the whole supply chain.

IPCSA focuses on supporting and facilitating systems and innovations for Port Community System members and users, and promoting the use of international data standards in sea and air ports, at border crossings and via Single Window systems around the world. IPCSA is a recognised NGO with consultative status at UN ECOSOC and IMO.

