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Americas

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Foreword

Margherita Bruno,
Managing Editor

Automation in container terminals is often framed as a technology question. In reality, it is far more layered. For most operators around the world, the starting point is not a blank canvas but an existing asset: a brownfield terminal shaped by decades of investment cycles, operational habits and regulatory constraints.

In this 159th edition of PTI's journal, we explore what it truly means to modernise within those boundaries. Rather than presenting automation as a single leap towards a fully automated future, our contributors examine how legacy infrastructure interacts with day-to-day operations and with the people who run them. The result is a view of transformation that feels more grounded and closer to operational reality.

We open with the structural foundations of brownfield evolution. In *Brownfield Development: The Terminal Portuario de Paita Case*, the transformation of the Terminal Portuario de Paita in Peru reminds us that modernisation often begins with governance and investment frameworks, not with software or robotics. **Terminales Portuarios Euroandinos** explains how phased infrastructure upgrades were delivered while the terminal remained fully operational. Before automation layers can be introduced in any meaningful way, terminals need physical capability and institutional stability, supported by long-term financial certainty. The Paita example shows how disciplined execution creates the platform on which later automation can stand.

From this macro lens, we move to the institutional and human dimension of change. In *Automation, Institutions and Learning: Rethinking Port Modernisation in Latin America*, **Roberto Paveck** questions the assumption that competitiveness follows automatically from technology adoption. Instead, he argues that ports operating in capital-constrained and institutionally complex environments must embed automation within a broader cycle of learning. Collaboration between ports, universities and the private sector is presented not as theory, but as a practical mechanism for steady improvement. In brownfield settings, where established routines and legacy systems shape behaviour, the ability to organise knowledge and develop talent may matter more than the speed of technological rollout.

The discussion then turns to the architectural foundations required to make brownfield automation viable. In *Brownfield Automation: Standards, AI and Interoperability as Enablers*, contributors from **TIC4.0** address a familiar challenge: how to introduce higher levels of automation into live terminals without triggering disruption. By adapting established industrial frameworks such as IEC 62264 to the port context, they propose a layered model that separates planning, execution and control while preserving compatibility with legacy systems. This makes it possible to automate progressively rather than through wholesale system replacement. Artificial Intelligence, in this framework, is not treated as a standalone solution, but as a capability that matures alongside stable architecture and shared data semantics.

With those foundations in place, this edition turns to the operational realities inside the terminal gate. In *Digital Integration and Interoperability in Modern Container Terminals*, **Marco Fehmer** from DSP focuses on data architecture and system design. Introducing AI, digital twins or advanced analytics into a brownfield environment quickly reveals a simple truth: without interoperability, automation is fragmented. Middleware becomes the essential connector, linking the Terminal Operating System (TOS) with equipment controls and external stakeholders. As Fehmer makes clear, integration is not only a technical challenge; it requires governance and coordinated decision-making across teams.

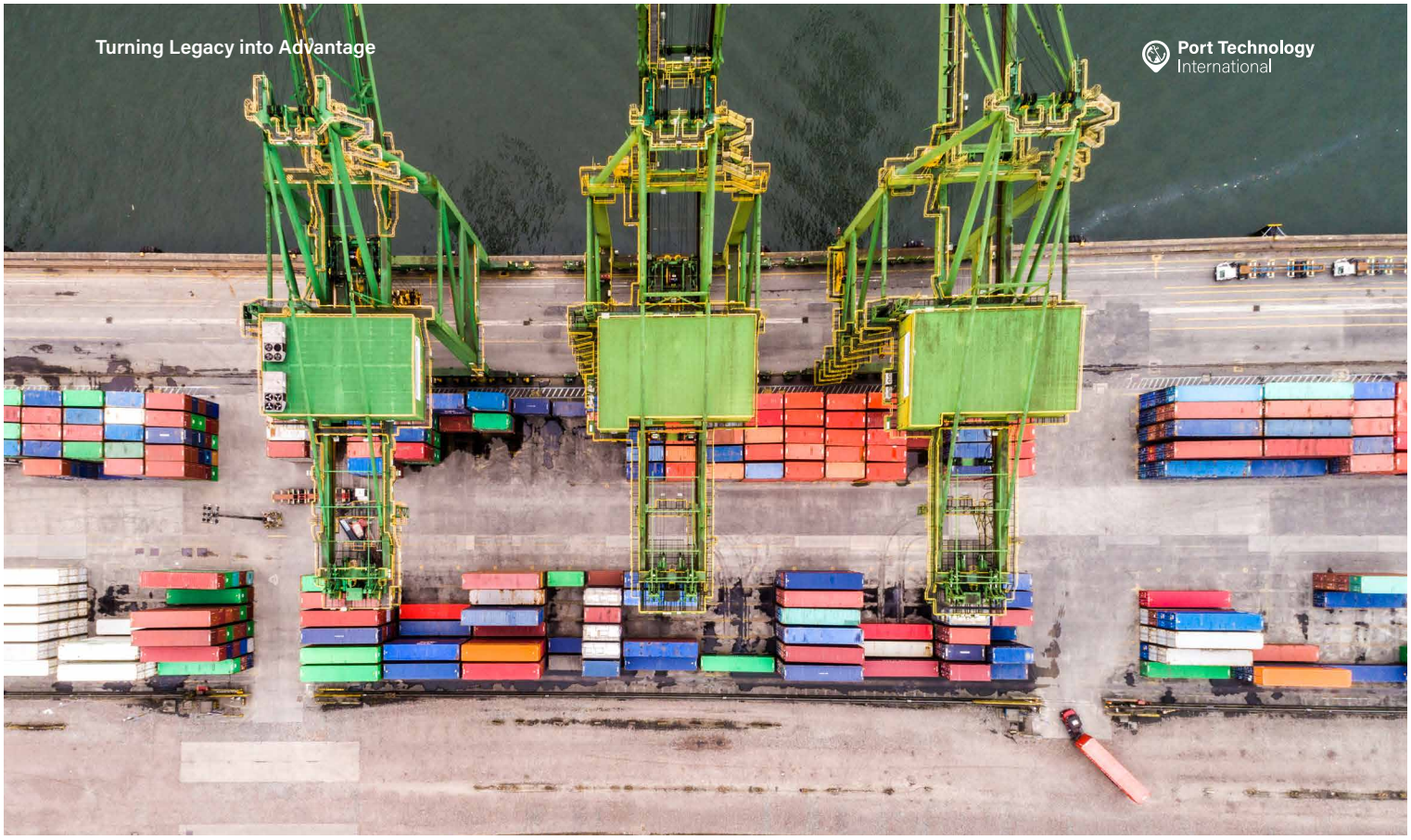
From integration, we move to performance under pressure. In *Autonomous Driving Deployment: Lessons Learned from Simulations*, **Arjen de Waal** from Portwise shares insights from large-scale simulation work on autonomous vehicles in mixed-traffic container terminals. Autonomous fleets perform well in controlled environments, yet congestion and interaction with manned vehicles introduce complexity that cannot be ignored. The research highlights the need for clear traffic logic, central oversight and thoughtful layout design before deployment. Simulation emerges as a practical risk-management tool, enabling operators to test routing strategies and behavioural rules before committing on the ground. In brownfield contexts, validating assumptions in advance can make the difference between disruption and progress.

Who would have thought that a simple coffee could offer lessons on terminal automation? That is exactly what **Marcos Carneiro** from CONROO demonstrates in *Brownfield Automation in LATAM: Why the Espresso Needs Ice*. With a clever anecdote, Carneiro points to a defining feature of many brownfield terminals: the scale of exceptions. In volatile environments, automation must accommodate flexibility rather than attempt to eliminate it. Decision automation, particularly in gate processes and truck flows, can deliver measurable gains without requiring a wholesale redesign of infrastructure. In many terminals, real productivity lies in managing variability with discipline.

Finally, this edition concludes at the quayside. In *Quayside Digitalisation: How Visy Systems See, Validate, and Act*, **John Lund** from Visy Oy explores how AI-based vision systems strengthen operational control. By creating what he describes as "truth under the hook", crane operations become verified, data-rich events aligned with the TOS. This reduces uncertainty at the critical handover between quay and yard. The impact is visible in practical terms: fewer rehandles, shorter cycle times and improved berth performance. Here, automation is not theoretical; it sits at the centre of daily execution.

Taken together, the contributions in this edition show that brownfield automation is rarely a dramatic leap. It progresses in stages through clearer architecture, better data foundations and incremental operational improvements. There is no single template to follow. What emerges instead is a pattern of considered evolution, where existing systems are strengthened before new layers are added.

In that sense, *Turning Legacy into Advantage* reflects a quiet shift in mindset, recognising that what already exists can become the foundation for what comes next.



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Camco Technologies is recognised as a pioneer and market leader in container terminal automation. Their image recognition and location tracking 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. 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 clients are always within easy reach.
www.camco.be

CONROO

CONROO's mission is to drive logistics toward autonomy. The company is redefining how terminals, depots, and the trucking community collaborate by making third-party truck handling faster, safer, and smarter. By transforming truck drivers' mobile devices into intelligent sensors, CONROO seamlessly connects terminals and depots with the trucking ecosystem. Today, CONROO works with more than 35 terminals and depots worldwide, including APMT, EUROGATE, duisport, MGT, Deutsche Bahn, and many others. The CONROO platform supports terminal operations through three integrated modules – Pre-Connect, Gate-Connect (including Gate Pass) and Yard-Connect. Together, they align third-party truck arrival times with terminal capacity by integrating real-time ETAs and live slot availability, enabling more accurate and controlled planning.
www.conroo.com

DSP Data and System Planning

DSP is headquartered in Switzerland and was founded in 1986. Now operating through four business units worldwide, DSP provides business consultancy and IT solutions, taking advantage of its specialised and proven know-how in operations, informatics technologies applied to the shipping industry, port and terminal management and intermodal transportation. DSP focuses its efforts on TOS Consulting, Business Intelligence, Digital Twin and System Integrator, offering solutions and products that are perfectly suited to any marine and inland terminal. With the final aim of enhancing logistics efficiency, sustainability, and performance, DSP has built up Business Intelligence Systems and a Digital Twin Platform enriched by AI technologies.
www.dsp.team

Kaleris

Kaleris is the leading provider of cloud-based supply chain execution and visibility technology solutions. Many of the world's largest brands rely on Kaleris for mission-critical logistics technology in yard management, transportation management, and maintenance and repair operations, as well as terminal operating systems and ocean carrier and vessel solutions from their premier Navis brand. By consolidating supply chain execution software assets across major nodes and modes into a central Execution & Visibility Platform, the company solves for the dark spots and data gaps that cause friction and inefficiency in the global supply chain. Kaleris serves and supports customers in 80 countries.
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Prodevelop is a software company specialised in ports and terminals digitalisation that has a technological alliance with 200+ ports and terminals worldwide. With more than 30 years of collaboration on innovative projects, they offer their clients cutting-edge technology to transform their business through digitalisation, solving complex problems and differentiating them from their competition.
www.prodevelop.es

TMEIC

TMEIC (Toshiba Mitsubishi-Electric Industrial Systems Corporation), headquartered in Roanoke, VA, designs, develops, and engineers advanced automation systems, large AC and DC motors, photovoltaic inverters and variable frequency drives. TMEIC specialises in metals, material handling, oil & gas, renewable energy, mining, testing and other industrial markets worldwide.
www.tmeic.com/americas

Visy Oy

Visy Oy (Visy) provides process automation ecosystems to manage the flow of traffic, cargo and personnel in ports, terminals, and logistics centres. Every asset that goes in or out of a facility, whether by road, rail, or quay, can be managed by Visy technology. Visy's mission is to help its customers save time and money on each transaction, therefore improving operational KPIs. With a history spanning three decades, Visy is a pioneer in Optical Character Recognition, deep learning, and AI-based vision technology for camera systems. Visy ecosystems manage and automate more than 6,000,000 events per day in over 30 countries to improve the quality of the supply chain.
www.visy.fi

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INFORM specialises in AI and optimisation software to improve operational decision-making. Based in Aachen, Germany, the company has been in the optimisation business for 50 years and serves a wide span of logistics industries, including ports, maritime, and intermodal terminals. With a broad range of standalone and add-on software modules, INFORM's unique blend of algorithm-based software expertise, rich industry experience, and big world thinking delivers huge value for its customers. For over 25 years, INFORM's industry-proven optimisation algorithms have been delivering real-world results at the world's most complex ports and terminals, improving everything from yard stacks, vehicle utilisation, crane productivity, and rail processes.
www.inform-software.com/en/solutions/logistics/maritime-terminals-logistics

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Konecranes

Konecranes is a global leader in material handling solutions, serving a broad range of customers across multiple industries, including manufacturing and process industries, shipyards, ports and terminals. The company consistently sets the industry benchmark, from everyday improvements to the breakthroughs at moments that matter most. With around 16,500 professionals in over 50 countries, Konecranes is trusted every day to lift, handle and move what the world needs. In 2024, Group sales totalled EUR 4.2 billion. Konecranes shares are listed on Nasdaq Helsinki.
www.konecranes.com

Exhibitor

ABB

ABB Ports designs and develops intelligent terminal automation and electrification solutions and services for container handling. With its proven technology and thousands of systems implemented worldwide, ABB Ports ensures seamless performance even in the most complex scenarios. The offering includes automation and remote operation for container handling cranes, as well as complete OCR and electrical systems. With its global support network, ABB Ports helps clients ahead of the game, keeping terminals running smoothly amid today's challenges or tomorrow's even bigger ones.
www.abb.com/global/en

Speakers

Adolfo Fabrega, General Administrator, Innovation Authority for the Republic of Panama
Adolfo Fabrega is the current General Administrator of the Innovation Authority, the governing body for technology in the public sector. Fabrega brings 20 years of experience in the technology industry and software development. He graduated from the University of Notre Dame with a degree in Information Systems Engineering. He later founded an ERP systems development company, creating software now used by more than 160 companies across the construction, services, rentals, distribution and banking sectors. Fabrega also served as President of the Chamber of Commerce, Industry and Agriculture of Panama for the 2023–2024 period.

Anton Bernaerd, Business Development Director, Camco Technologies
Anton Bernaerd is Head of Sales and has been part of the Camco Technologies team for almost 20 years. Bernaerd has shared insights on process optimisation and terminal automation at more than 250 terminals worldwide. His expertise in gate and crane automation has made him a recognised authority and prominent speaker at industry events.

Casemiro Tercio, Founding Partner, 4Infra
Casemiro Tercio is a certified Board Member by the IBGC – Brazilian Institute of Corporate Governance – and a PPM candidate with the American Association of Port Authorities (AAPA). Tercio brings over 21 years of experience in infrastructure, with a focus on ports, waterways and logistics. He is recognised for leading strategic reforms and high-impact transformations in Brazil's port sector. His career includes landmark tenures as CEO of the Port Authorities of Santos and São Sebastião, as well as Head of the Tietê-Paraná Waterway, where he advanced multimodal transport policy and execution. Tercio has also served as a Board Member at the Ports of São Francisco do Sul and Imbituba. He is currently a Board Member at the Port of SUAPE; Director of the Logistics & Transport Division at FIESP; MBA Professor in Port Management at FGV; and Associate Professor in the Department of Naval Architecture and Ocean Engineering at the Polytechnic School of the University of São Paulo.

Chris Grimmett, VP Operations, SSA Marine Mexico
Originally from the UK, Chris Grimmett began his career at sea at 16 before moving ashore into line and terminal operations in Belgium, Canada and Egypt, and for the past 24 years, Mexico. Grimmett has nearly 43 years of experience, mainly in operations, and is passionate about adopting technology to improve terminal performance and efficiency while reducing safety risks.

Daniele Labate, Director of Professional Services, DSP Data and System Planning
In 2010, Daniele Labate joined DSP as a Project Manager and TOS Consultant. Labate later became Director of Professional Services, managing projects around the world. He continues to play a key role in supporting the company's growth and development.

David Ames, Technical Director for Latin America, Moffatt & Nichol
David Ames is Technical Director for Moffatt & Nichol's Latin America offices and has more than 30 years of global experience as a civil and marine engineer, construction manager, port planner and regional office manager. Ames' experience spans field investigations, design engineering, and project and construction management at commercial ports and waterfront facilities. His expertise includes structural, civil and coastal design, underwater inspection, terminal planning and marine construction management. He is currently managing three major electrification and automation programmes at container terminals in South America.

Eduardo Cerdeira, CEO, Terminales Portuarios Euroandinos – YILPORT Holding Inc.
Eduardo Cerdeira is a senior maritime and port executive with over 30 years of experience across South America's shipping, port and maritime technology sectors. In 2018, Cerdeira was appointed Director of Operations at YILPORT's Port of Paita in Peru. In 2020, he became Executive Director of Puerto Bolívar in Ecuador, leading the terminal through a period of operational and strategic development. At the end of 2023, Cerdeira returned to Peru as Chief Executive Officer of Terminales Portuarios Euroandinos Paita. Throughout his career, he has developed a comprehensive, hands-on perspective on port operations, maritime logistics and port technology.

Emilio Almeida, Panama Terminal Executive
Emilio Almeida is a Lean strategist and continuous improvement leader focused on transforming complex operations into high-performance systems. Almeida has extensive experience in supply chains, particularly within the port terminal industry, warehousing and distribution. Across the Americas, he has led major transformation programmes delivering cost reductions, improved EBIT, enhanced efficiency and increased customer satisfaction, while building cultures of accountability and teamwork. Almeida has also led digital transformation initiatives across the region.

Enrique Piqueras Bertie, CEO, PSA Panama
Enrique Piqueras Bertie is an experienced leader who has held senior roles in the maritime and port sector across South America, Asia and the Middle East. Piqueras Bertie's strengths include stakeholder management, business strategy, a strong understanding of port operations, including general cargo, and a commitment to workplace safety. Since joining PSA Panama in July 2022, he has led a team of more than 1,000 employees on an organisational optimisation journey centred on continuous improvement and process automation.

Euclides Velazco, Traffic Control and Projects Assistant Manager, SSA Marine MIT
Euclides Alberto Velazco Ramjak, born in Colón, Panama, holds a bachelor's degree in Computer Networks from the Technological University of Panama. Since joining Manzanillo International Terminal, S.A. in 2013, Velazco has progressed to Assistant Manager of ASC Traffic Control, where he leads the automated crane department and supervises operational teams. Since October 2024, he has also served as Assistant Project Manager for ASC Phase II, overseeing the integration of new automated cranes and supporting improvements in operational efficiency and sustainability.

Felix Czerny, Co-Founder & CEO, CONROO
Felix Paul Czerny is Co-Founder and CEO of CONROO, founded in 2021 after he observed long queues of truck drivers at an inland terminal in Germany. Czerny identified inefficiencies in truck handling and built CONROO to automate terminal access and truck processes via drivers' smartphones. At CONROO, he works closely with terminals and depots to automate container logistics and improve coordination of third-party truck movements. The platform digitises truck dispatch and execution, helping reduce congestion and improve planning accuracy. CONROO currently works with 35 terminals and depots worldwide, including APM Terminals, EUROGATE, Deutsche Bahn and duisport.

Gary van Tassel, Director of Sales Terminal and Distribution Center Logistics – North America, INFORM GmbH
Gary van Tassel is a logistics and terminal operations expert with more than 20 years of experience across maritime, intermodal and rail environments. Van Tassel began his career at APM Terminals and later held senior leadership roles at REMPREX and CSX Intermodal Terminals, where he led large-scale automation and transformation initiatives. Since March 2025, he has served as Director of Sales, North America, at INFORM's Terminal & Distribution Center Logistics Division.

Speakers Continued

Guilherme Soares de Sá Peixoto, Regional Director for the Americas, Portwise
Guilherme Soares de Sá Peixoto holds an MSc in Naval Engineering, Port Planning and Logistics from POLI-USP, a degree in Civil Engineering from FEI, Brazil, and a specialisation in Project Management from the University of California, Irvine. Peixoto has worked in the ports and terminals sector since the beginning of his academic career. After ten years in operational management roles at container and general cargo terminals, he moved into consulting engineering and multinational ports and waterways projects. Peixoto is the founding partner of PORTPLAN and serves as Regional Director for the Americas at Portwise Consultancy.

Guimara Tuñón Guerra, Executive Director, Maritime Policy Bureau
Guimara Tuñón Guerra is CEO and Co-Founder of the Maritime Policy Bureau and President of PortMujer. Tuñón Guerra has more than 14 years of experience in maritime governance and port management, including senior roles at the Panama Maritime Authority and Vice President of IAPH for Central and South America. She leads initiatives focused on port modernisation, sustainability and digital transformation in Latin America.

Gustavo Davis, Assistant Vice President & Head (RHQ LATAM), CrimsonLogic
Gustavo Davis is based at CrimsonLogic's Latin America regional headquarters in Panama, where he oversees strategic planning, P&L targets and customer and partner relationships. Davis has more than 20 years of experience across eGovernment, trade facilitation, IT, logistics and transportation. He currently serves as Assistant Vice President and Head of Latin America at CrimsonLogic. From 2019 to 2021, Davis was Vice President of the Maritime and Logistics Development Committee of APEDE.

Hari Srinivasan, CIO, DP World Canada
Hari Srinivasan is a Chief Information Officer with more than 28 years of experience in automation, modernisation and cybersecurity. As CIO of DP World Canada, Srinivasan leads the digital transformation of container terminal operations. He has led large-scale automation, ERP and cloud modernisation programmes and embeds cybersecurity resilience across IT and OT environments.

Ignacio Rodriguez de la Rua Alvarez, Senior Engagement Manager, ALG
Ignacio Rodriguez de la Rua Alvarez has 13 years of experience advising the ports and logistics industry worldwide, with a strong focus on the Americas. Rodriguez de la Rua Alvarez has worked with public and private stakeholders across the value chain and has participated in more than 80 consulting projects in 25 countries. His expertise includes corporate strategy, digitalisation, M&A advisory, port planning and economics.

Ismael Torres, Business Development Manager LATAM, Prodevelop
Ismael Torres is Business Development Manager for Latin America at Prodevelop. Torres has more than 20 years of experience and has been involved in over 200 ports and terminals worldwide. He specialises in digitalisation solutions, including PCS, PMS, Smart Ports and Digital Twins, supporting operational efficiency and real-time visibility.

James Murphy, President, Daybreak Strategies
James Murphy is a government affairs professional with experience across the public and private sectors. Murphy began his career on Capitol Hill as a staff member for U.S. Senator Susan Collins, gaining extensive insight into legislative processes and public policy. He later held senior roles in the U.S. House of Representatives, contributing to legislative development and regulatory matters. In 2018, Murphy founded Daybreak Strategies, a Washington, DC-based government affairs firm. His clients range from technology startups to global logistics providers. Murphy advises on transportation, trade, logistics, taxation, duties and fees, tariffs, foreign direct investment and regulatory compliance, and has worked extensively on state-level issues across 26 states.

John Lund, Sales and Marketing Director – Global, Visy Oy
John Lund is Sales and Marketing Director – Global at Visy Oy. Lund has extensive experience in port technology and automation solutions, supporting global terminal operators with advanced safety and optimisation systems.

Jorge Barnett Lawton, Managing Director, Georgia Tech – Panama Logistics Innovation & Research Center
Jorge Barnett Lawton is Managing Director of the Georgia Tech Panama Logistics Innovation & Research Center. Barnett Lawton leads regional projects related to logistics, digital transformation and supply chain innovation. He holds degrees in industrial engineering and logistics from the Technological University of Panama, Georgia Institute of Technology and the MIT-Zaragoza International Logistics Program. Barnett Lawton has more than two decades of experience across academia and industry in Panama, Spain, Mexico and Argentina.

Juan Marcos Castillo, Director of the Smart Logistics Lab and Professor, Universidad Tecnológica de Panamá
Juan Marcos Castillo is Director of the Smart Logistics Lab and Panamá Perspective Analytics Think Tank at Universidad Tecnológica de Panamá. Castillo is also an Adjunct Professor at the University of Louisville and Quality Leadership University. He holds a PhD in Industrial Engineering from the University of Texas at Arlington and has completed postdoctoral studies in Smart Logistics and Sustainable Supply Chain Management. Castillo's research focuses on digital transformation, AI and ethics, smart warehousing and resilient supply chains.

Julian Galvis, VP Sales and Marketing, Tideworks
Julian Galvis joined Tideworks in 2025 as VP of Sales and Marketing. Galvis has more than 25 years of experience in the maritime sector, including terminal operations, consulting and automation solutions. Before joining Tideworks, he served as VP and Regional Manager Americas at IDENTEC SOLUTIONS and held senior roles at ABB Marine and Ports, APM Terminals, Navis and Maersk Line.

Luis Canto, CEO, Unión Portuaria del Pacifico
Luis Canto has more than 20 years of experience in the port industry, specialising in port equipment for container and general cargo operations. Canto has worked with major crane OEMs and maintenance providers and has led technical initiatives including crane upgrades, electrification, automation and life-extension programmes. He has held senior leadership roles overseeing maintenance, engineering and corporate strategy initiatives within major terminals.

Marcos Carneiro, Solutions Architect, CONROO
Marcos Carneiro brings cross-sector experience spanning SaaS, satellite analytics, agriculture and real estate, giving him a practical understanding of how operations function and where technology delivers measurable impact. At CONROO, Carneiro works within the container terminal and port logistics ecosystem at the intersection of solution design and operations. He collaborates closely with terminal management, IT, operations and security teams to ensure digital solutions align with real-world requirements. Carneiro's work focuses on improving efficiency, predictability and scalability while enabling straightforward adoption for the trucking community.

Speakers Continued

Martin Moreda, Chief Operating Officer, Contecon Guayaquil
Martin Moreda is Chief Operating Officer of Contecon Guayaquil S.A., the container and multipurpose terminal operating at the Port of Guayaquil under the ICTSI Group. Moreda has extensive experience in port operations management and leads initiatives focused on operational efficiency, safety and the implementation of advanced technologies to enhance terminal performance.

Michael Dempsey, Practice Leader – Marine, REMPREX
Michael Dempsey is Global Practice Leader for Marine and Intermodal at REMPREX, a supplier of technology and services for the container supply chain. Dempsey leads teams delivering process automation and technology-enabled integration services. He has more than 30 years of experience in automation technologies and is recognised as a thought leader in the application of technology to shipping, terminal and port operations. Dempsey is a frequent speaker at industry conferences and a past Board member of PEMA.

Norbert Klettner, Vice President, TIC 4.0
Norbert Klettner has worked for more than 15 years in the port and terminal industry, implementing and integrating Terminal Operating Systems. Klettner initially worked with EUROGATE and later became Managing Director of the RBS EMEA Office, implementing the TOPS Expert system. Through akquinet port consulting, he has focused on simulation and emulation using the CHESSCON suite. Klettner is a founding member of TIC4.0 and serves as Vice President, as well as a member of its Executive and Operations Councils.

Peter Knox, VP Business Development, North America, Camco Technologies
Peter Knox is Vice President of Business Development for North America at Camco Technologies. Knox began his career at Marine Terminal Corporation and Ports America in operations and IT before joining Long Beach Container Terminal as part of the DevOps team supporting its automated terminal development. He later worked at Navis as an automation support engineer.

Roberto Paveck, Brazilian Port Executive
Roberto Paveck is an economist and port specialist with more than 20 years of experience across logistics, innovation, applied research and debureaucratisation initiatives. Paveck has led nationally recognised innovation efforts in the Brazilian port sector, advancing operational efficiency and sustainability. He is a Professor at Universidade Santa Cecília, a researcher at CILIP/USP focusing on Port Community Systems, and Coordinator of the Aquaviation Mentoring Programme at SAE Brasil. Paveck also acts as a consultant on port transformation projects and writes regularly for A Tribuna de Santos and Portal Portuario.

Shaleen White, Vice President for Latin America Business Development, S2 Global
Shaleen White is Vice President of Business Development for Latin America at S2 Global, part of OSI Systems. White began her career in logistics within a family-owned freight forwarding company, gaining first-hand experience of maritime operations and customs processes in the United States and Latin America. She later spent nearly 20 years working with the U.S. Department of State, including a decade focused on Latin America, managing programmes that promote best practices for securing international trade.

Starr Long, Executive Producer, The Acceleration Agency
Starr Long has more than 30 years of experience in video games and technology. Long was Project Director of Ultima Online, one of the longest-running MMOs in history. He has held leadership roles at Electronic Arts, The Walt Disney Company and NCSoft. Long currently works at The Acceleration Agency, supporting clients including Carnival Corporation, Universal, Disney and the Port of Corpus Christi.

Stephan Piworus, Co-Founder & CEO, Zenze
Stephan Piworus is Co-Founder and CEO of Zenze, a company building a Cargo Visibility Network in the global supply chain. Piworus is also a strategic advisor and investor at Flagship Founders. With a background in logistics, technology and digital transformation, he has held leadership roles across startups and corporates, focusing on innovation in ports, shipping and supply chain ecosystems. Piworus combines operational experience with a focus on sustainable, long-term solutions.

Tom van Eynde, Director of Terminal Investments, Terminal Investment Limited
Tom van Eynde began his career as a finance manager within the Maersk group before joining the TIL/MSC group nearly 20 years ago. Van Eynde has contributed to TIL's global growth through greenfield developments, acquisitions, lease negotiations and expansion projects across Europe, the Americas, Africa and the Middle East. He currently leads TIL's activities in North America, overseeing operations and development initiatives. Under his leadership, TIL maintains investments and operations in nine U.S. terminals employing more than 3,500 people.

William Elliott, President, Colon Container Terminal
William Elliott has more than 30 years of experience in the shipping and port industry and currently serves as President of Colon Container Terminal and Colon Logistics Park. Elliott began his career as a Merchant Marine Officer after graduating from the Chilean Naval Academy and later joined Maersk Line in 1997. He has since held senior executive roles across Chile, Argentina, Nigeria, Germany and Egypt within Maersk Line and APM Terminals. Elliott has more than 15 years of executive leadership experience and has completed advanced management studies at Lloyd's Maritime Academy in London.

Brownfield Development: The Terminal Portuario de Paita Case

Terminales Portuarios Euroandinos

This article is based on the official PROINVERSIÓN case study Terminal Portuario de Paita: Modelo de Gestión Portuaria en APP para el Desarrollo Logístico del Norte del Perú, which documents the development of the Terminal Portuario de Paita under a self-financed Public–Private Partnership (PPP) framework. The study focuses on the terminal's infrastructure condition prior to concession, the institutional and contractual structure applied, and the outcomes achieved following private sector participation.

Within the broader context of this journal, which examines automation and digital transformation in terminal environments, the Paita case is used editorially to illustrate the structural and institutional foundations that are typically in place before such initiatives can be pursued.

Strategic Role Within Peru's Port System

The Terminal Portuario de Paita is located in the Piura region in northern Peru and serves as a key maritime gateway for a wide hinterland that includes the regions of Amazonas, Cajamarca, Lambayeque, Piura, Tumbes and San Martín. The terminal handles containerised cargo, general cargo and bulk cargo, with a strong concentration in agricultural and fisheries exports, reflecting the economic profile of northern Peru. Its geographic position on the Pacific coast has historically given it a strategic role within the national port system, supporting both domestic supply chains and export-oriented industries.

"Infrastructure works were executed while the terminal remained operational, with cargo handling continuing alongside construction activities."

As documented in the PROINVERSIÓN case study, the terminal's relevance extends beyond its immediate footprint. It forms part of a broader logistics network that connects coastal production zones with inland regions, and its performance has direct implications for the competitiveness of regional exporters. This strategic role meant that limitations in port infrastructure had a disproportionate impact on regional economic activity, particularly as export volumes increased over time.

Infrastructure and Operations Prior to Concession

Before its concession, the Terminal Portuario de Paita was publicly owned and operated by Empresa Nacional de Puertos S. A. (ENAPU), the state-owned entity responsible for managing Peru's public ports from 1970 onwards. The terminal's core infrastructure dated back to 1966 and reflected the characteristics of port development under a predominantly public investment model, where capital expenditure was constrained, and modernisation occurred incrementally.

The port consisted of a pier-type structure approximately 365 metres in length and 36 metres in width, with four berthing positions. Water depths ranged from 6 to 9 metres at the inner berths and up to 10 metres at the outer berths. These physical characteristics limited the size of vessels that could be accommodated, restricting operations largely to ships of up to approximately 25,000 deadweight tonnes. As a result, operational flexibility was constrained, and the terminal's ability to respond to changes in vessel deployment and cargo demand was limited.

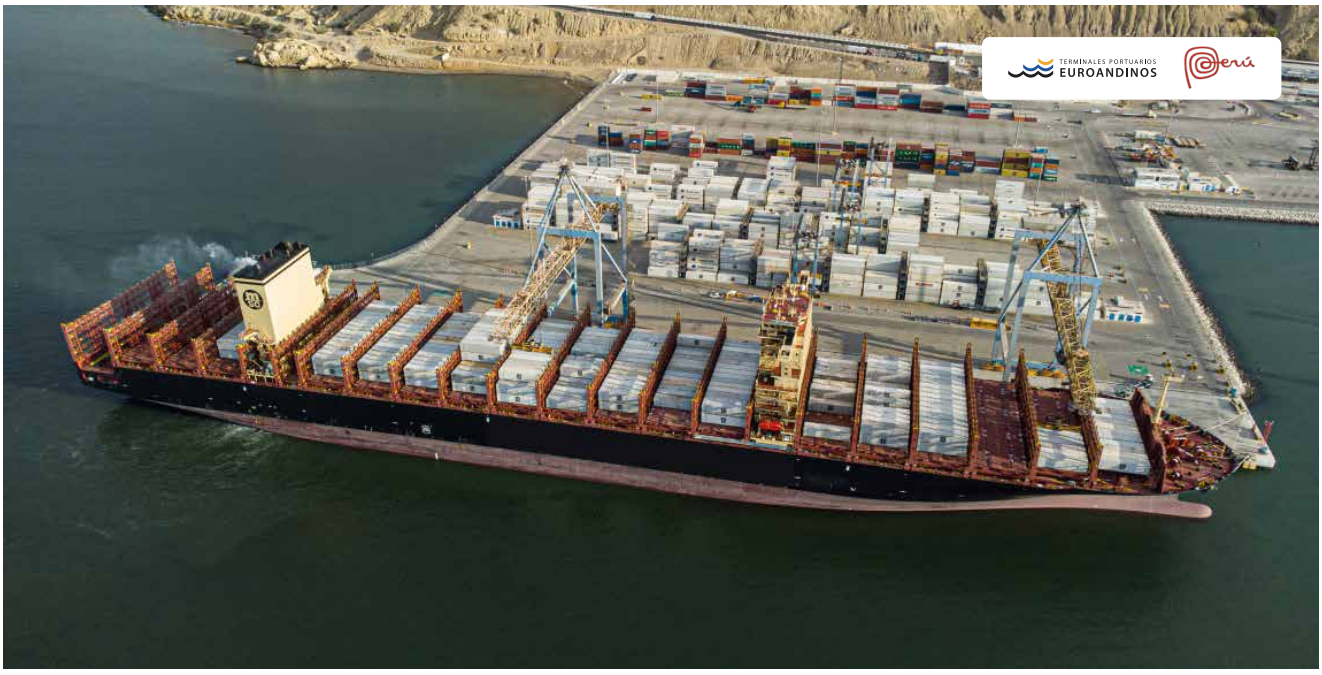
Onshore infrastructure presented similar challenges. Container handling relied on two principal yards with a combined nominal capacity of fewer than 2,500 TEUs, which constrained throughput and stacking flexibility. Handling equipment, including yard tractors, forklifts and cranes, was ageing and offered limited productivity compared with contemporary standards. Utility systems for electricity, water supply and fire protection were not autonomous and did not meet the requirements associated with modern port operations. Landside connectivity was also restricted, with access limited to a two-lane road connection and no rail link to support efficient hinterland integration.

Between 2000 and 2005, ENAPU carried out a series of maintenance and rehabilitation works aimed at preserving operability. These included quay reinforcement, rehabilitation of pavement areas, improvements to support refrigerated containers, and upgrades to storage and handling facilities. While these interventions were necessary to maintain day-to-day operations, they did not address the terminal's underlying structural limitations or provide a pathway for sustained capacity expansion.

Demand Growth and Structural Constraints

National assessments cited in the PROINVERSIÓN case study identified widespread deterioration and obsolescence across publicly owned port infrastructure in Peru. In the case of Paita, these challenges became increasingly significant as export-oriented activity expanded across northern Peru. Growth in the agricultural, fisheries and manufacturing sectors placed increasing pressure on port infrastructure that had not been designed to accommodate modern throughput volumes or evolving vessel characteristics.

The terminal was also identified as a strategic component of the IIRSA Norte multimodal corridor, which aimed to strengthen connectivity between the northern Peruvian coast, inland regions and Brazil through road and fluvial transport links. This corridor was intended to support regional integration and facilitate trade flows across borders. Without substantial infrastructure modernisation, however, the Terminal Portuario de Paita faced limitations in its ability to support the logistical requirements associated with this broader transport strategy, risking the emergence of a structural bottleneck within the corridor.



Adoption of a Public–Private Partnership Model

In response to these challenges, the Peruvian state adopted a Public–Private Partnership approach as a mechanism to modernise port infrastructure without drawing on public fiscal resources. For the Terminal Portuario de Paita, a self-financed PPP was selected as the preferred model, reflecting both the scale of investment required and the potential to mobilise private sector expertise.

The concession was awarded in 2009 to Terminales Portuarios Euroandinos Paita S. A. for a period of 30 years. The project was structured under a Design, Build, Finance, Operate and Transfer (DBFOT) model, transferring responsibility for infrastructure development, operation and maintenance to the private sector, while ownership and regulatory oversight remained with the state. This structure was designed to align investment obligations with long-term operational performance and to ensure continuity of service throughout the concession period.

A key feature of the concession framework was the use of phased investment obligations. Rather than requiring a single, large-scale redevelopment, the contract allowed infrastructure upgrades to be implemented progressively. This approach reflected both operational realities and the need to maintain service continuity in a live, brownfield terminal environment.

Governance, Tendering and Contractual Evolution

The concession process was led by PROINVERSIÓN in coordination with the Ministry of Transport and Communications and the National Port Authority, with regulatory oversight provided by Ositrán. Competitive variables in the tender process included tariff proposals and commitments to additional investment in works and equipment, reflecting a balance between service affordability and infrastructure development.

Over the life of the concession, three contractual addenda were incorporated. The first focused on ensuring the financial bankability of the project, addressing conditions required to secure long-term financing. The second enabled the acquisition and installation of a gantry crane to support container operations, responding to specific operational needs identified during the concession period. The third replaced the LIBOR benchmark with a new financial reference rate, maintaining the project's economic and financial equilibrium in response to changes in global financial markets.

These contractual adjustments, as documented in the case study, illustrate the importance of adaptive governance mechanisms in long-term infrastructure concessions, particularly in brownfield environments where operational and financial conditions evolve over time.

Infrastructure Investment and Execution

Following the award of the concession, the Terminal Portuario de Paita underwent a series of infrastructure and equipment upgrades aimed at addressing its most pressing constraints. These included dredging works to improve nautical access, reinforcement and extension of quay infrastructure, and the incorporation of specialised handling equipment to improve operational capacity.

According to Ositrán data cited in the PROINVERSIÓN case study, cumulative investment under the concession reached approximately $290.7 million by 2024, including value-added tax. This represented more than 93 per cent of the total committed investment of $311.6 million. Infrastructure works were executed while the terminal remained operational, with cargo handling continuing alongside construction activities. This sequencing allowed the terminal to maintain service continuity while progressively enhancing capacity.

Operational Outcomes and Performance

The infrastructure improvements implemented under the concession contributed to increased handling capacity and improved service levels. National port statistics cited in the case study indicate that by 2024 the Terminal Portuario de Paita ranked third nationally in terms of containerised cargo movement, handling approximately 1.89 million metric tonnes.

These outcomes reflect the cumulative impact of infrastructure investment and operational management within the framework established by the concession. While the case study does not frame these changes in terms of automation or digitalisation, it documents measurable improvements in capacity and performance resulting from the modernisation of physical infrastructure and equipment.

Social Fund and Regional Impact

The concession structure also incorporated the creation of the Fondo Social del Terminal Portuario de Paita. Since 2009, this mechanism has funded projects in areas such as health, education, nutrition and social welfare within the surrounding community. Initiatives supported through the fund have included healthcare equipment, educational infrastructure and programmes targeting vulnerable populations.

By 2024, cumulative contributions to the social fund exceeded $15 million, underscoring the role of the concession in supporting regional development beyond core port operations.

About the company

Terminales Portuarios Euroandinos (TPE) is the concessionaire and operator of the Port of Paita, the main gateway for containerised and refrigerated cargo in Northern Peru. With over $245 million invested in port infrastructure and equipment, the terminal offers a capacity of 550,000 TEUs, more than 3,000 reefer plugs, and modern facilities supporting container, bulk, and breakbulk operations.

The Port of Paita has been ranked among the world's most reliable ports, reflecting TPE's strong focus on operational efficiency, safety, and continuous improvement. Through ongoing investments and international cooperation initiatives, TPE plays a strategic role in strengthening supply chains and connectivity between Peru and global markets.

Find out more

Automation, Institutions and Learning: Rethinking Port Modernisation in Latin America

Roberto Paveck,
Economist & Port Specialist

In port environments, modernisation should not be understood merely as the introduction of new technologies, but as an opportunity to promote the continuous evolution of infrastructure, processes, and the people already integrated into the system. This perspective shifts the focus away from a purely technological lens towards a strategic approach in which institutional, organisational, and historical factors determine the pace and depth of modernisation, with a direct impact on port competitiveness.

This logic applies particularly to brownfield ports, where automation extends well beyond straightforward technological replacement. Unlike greenfield developments, where systems and processes can be designed in an integrated manner from the outset, modernising an established port requires new technologies to be aligned with existing physical, operational, and organisational structures, while ensuring

"Port competitiveness is driven less by isolated adoption of advanced technologies and more by the ability to organise knowledge, attract talent, and connect institutions."

the continuity of critical operations. This calls for an incremental approach, combining technical adjustments, process reorganisation, and the progressive development of the skills of personnel already operating within the system.

In developing regions such as Latin America, port modernisation faces particularly complex challenges. Much of the existing infrastructure was designed for regulatory, technological, and operational contexts that are now outdated, meaning that systems, layouts, and processes were never intended to support automation or digital integration. These constraints are compounded by insufficient investment in logistics infrastructure, as well as institutional and bureaucratic hurdles such as lengthy procurement procedures, regulatory instability, and short political cycles. Together, these factors reduce the effectiveness of resources applied at terminals and limit the potential impact of modernisation initiatives.

As a result, connectivity remains limited and multimodal integration weak, contributing to consistently lower performance in international logistics efficiency rankings. Automation initiatives that fail to account for these local operational realities risk falling short of expectations, inadvertently relocating inefficiencies rather than resolving them, and generating organisational resistance to change.

The central challenge, therefore, lies in managing the evolution of existing ports rather than attempting to replace them entirely. This requires maintaining operational continuity while implementing modernisation and automation in a coordinated manner across terminals, logistics operators, and regulatory frameworks. Without such alignment, improvements tend to remain isolated, structural bottlenecks persist, and port systems struggle to meet the efficiency and reliability demands of global supply chains.

Against this backdrop, the discussion around automation and port competitiveness in Latin America needs to be reframed. The core issue is not the replication of models designed for different institutional contexts, but the creation of conditions that allow existing structures to evolve in a coordinated and functional manner. In environments characterised by capital constraints and high institutional complexity, automation is less a one-off project and more a continuous process, supported by incremental progress and organisational learning.

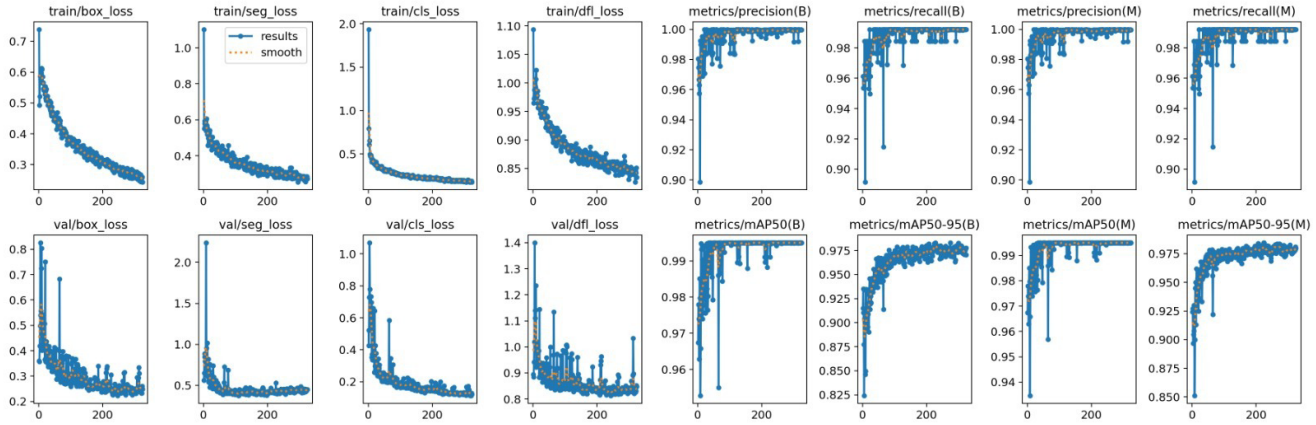
It is within this context that closer collaboration between ports and universities emerges as a viable path for sector modernisation. Beyond serving as sources of technological solutions, such partnerships enable the integration of methodology, critical analysis, and continuous learning into everyday port operations. By leveraging existing scientific infrastructure such as laboratories, research centres, computing capacity, and technical expertise, a permanent environment is created in which decisions relating to infrastructure, processes, and workforce development can be tested, adapted, and refined.

The value of this collaboration extends beyond the production of academic studies. It establishes a continuous environment for testing, adaptation, and applied learning, allowing technologies, processes, and operational models to be evaluated under real-world conditions before large-scale adoption. This approach reduces risks, improves solution design, and increases the likelihood of successful automation initiatives. It also supports the development of professionals equipped to address the specific challenges of port modernisation, ensuring that projects deliver not only operational gains but also long-term human capital development.

A practical example of this approach can be found in a programme launched in 2023 by the Santos Port Authority to promote applied research focused directly on the port's operational challenges. The initiative funded studies addressing real-world problems, providing scholarships, research inputs, and access to data and port infrastructure. Universities seeking access to these resources were required to undergo an accreditation process, creating a mechanism

Image of the intelligent camera project for operational optimisation.

Source: Center for Innovation in Logistics, Infrastructure and Planning (CILIP), University of São Paulo (USP).



that combined dedicated funding with a commitment to deliver results and contribute their own technical capabilities.

As a result, the programme significantly expanded the port's access to specialised knowledge across multiple disciplines, introducing analytical approaches that had previously been underutilised in day-to-day operations. It currently involves more than a dozen institutions, including leading regional universities such as the University of São Paulo and Presbyterian Mackenzie University, which are actively developing research directly relevant to port operations.

Research areas include the use of artificial intelligence to optimise traffic flow in congested areas, energy efficiency and the adoption of alternative fuels, image analysis for productivity improvements, the implementation of Port Community Systems, and dredging, among other initiatives with strong potential to enhance operational performance.

Beyond its technical outcomes, the programme has generated broader strategic effects by integrating new talent into the port sector. It brings young researchers closer to operational realities and helps create career pathways aligned with the sector's needs. In parallel, it encourages universities to develop specialised courses and advanced, practice-oriented programmes, contributing to the continuous strengthening of skills tailored to port environments.

However, the Santos experience also demonstrates that collaboration of this kind must be intentionally structured to deliver tangible results. Researchers engage more consistently when presented with clearly defined challenges, reliable data, and predictable resources over time. Rather than funding isolated studies, the goal should be to create a framework

that organises the interaction between academia and operations, transforming concrete demands into agendas for learning and incremental system evolution.

Private-sector engagement represents another critical element. Historically, companies and universities have operated in largely disconnected spheres. Industry is typically driven by deadlines, costs, and risk management, while academia prioritises theoretical and methodological inquiry, which does not always align with market needs. Bridging this divide requires the formulation of shared, well-defined challenges that allow companies to contribute practical relevance and process knowledge, while academia provides analytical rigour, methodological depth, and systematisation.

In practice, this collaboration can be structured as a continuous cycle. It begins with mapping critical bottlenecks and opportunities for modernisation or automation, translated into clear applied research challenges. A strategic portfolio of academic partners is then established, capable of converting operational problems into projects with direct application potential. The cycle is completed through private-sector participation, contributing data, operational experience, and validation of developed solutions.

This framework must be supported by clear governance and communication mechanisms that systematically connect research outcomes with strategic and operational decision-making within the port. This includes establishing forums, routines, and responsibilities to ensure that generated knowledge is integrated into planning, asset management, and continuous process improvement, rather than remaining confined to academic settings.

The final element of the cycle is talent development and retention. Structured professional pathways allow students and researchers involved in applied projects to progress into technical and managerial roles within the port ecosystem. In this way, knowledge generated through research becomes embedded in operational routines and decision-making processes, enabling continuous learning, incremental innovation, and increased adaptive capacity over time.

Implementing this collaborative cycle does not remove the region's structural challenges, nor does it replace the need for larger-scale investment. It does, however, offer a pragmatic route to support gradual and sustainable automation and modernisation in complex environments. By anchoring research in real operational challenges and engaging the private sector from an early stage, this approach reduces the risk of misaligned or impractical solutions and increases the likelihood of successful implementation.

Ultimately, experience suggests that in regions characterised by capital constraints and established infrastructure, port competitiveness is driven less by isolated adoption of advanced technologies and more by the ability to organise knowledge, attract talent, and connect institutions. Bringing ports, universities, and companies into closer collaboration creates a multiplier effect in which each applied project strengthens capabilities, generates learning, and stimulates further innovation. For Latin American ports, and for developing regions more broadly, this represents not only a response to current limitations but a robust strategy for maintaining long-term strategic relevance.

About the author

Roberto Paveck is an economist, executive, and port specialist with over 20 years of experience in logistics, innovation, and applied research. He has led nationally recognised innovation initiatives in the Brazilian port sector and currently works as a professor, researcher and consultant, connecting strategy, operations and institutional development.

Brownfield Automation: Standards, AI and Interoperability as Enablers





Boris Wenzel, President, **Norbert Klettner**, Vice President, **José Giménez**, Secretary General, **Luisa Kempf**, Operations Council Vice Chair, and **Francisco Blanquer**, Operations Council Chair, TIC4.0

The Brownfield Automation Dilemma

Port terminal automation is no longer a theoretical ambition or a niche experiment limited to a handful of greenfield mega-terminals. It has become a strategic objective for operators seeking higher and more stable productivity, improved safety, greater predictability, and a pathway towards decarbonisation.

Yet, while new terminals can be designed from the ground up around automated concepts, most of the world's container terminals are brownfield facilities: complex, live operating environments shaped by decades of incremental investments, legacy systems, and deeply rooted operational practices originally designed for manual execution.

For these terminals, the challenge is not whether automation makes sense in principle, but how it can be introduced without disrupting ongoing operations, exposing the business to excessive risk, or triggering long payback periods that are difficult to justify. Brownfield terminals typically rely on Terminal Operating

"Standards are not an alternative to AI, but a prerequisite for its meaningful deployment within brownfield automation strategies."

Systems (TOS), bespoke interfaces, siloed data infrastructures, and a corporate culture closely linked to manual or semi-manual decision-making. In many cases, the holistically designed operational process differs from the reality observed in day-to-day execution. As a result, automation is often perceived as an all-or-nothing leap rather than a progressive evolution.

This perception is one of the main barriers to adoption. The key question facing brownfield terminals is therefore how to evolve step by step towards higher levels of automation while preserving operational continuity and controlling cost, time and risk. Digital standards, interoperable interfaces and the smart use of Artificial Intelligence (AI) emerge as critical enablers in addressing this challenge.

Digital Standards, Interoperable Interfaces and AI: Building Blocks for Evolution

Terminal automation is not simply about replacing human operators with machines. It is about restructuring how decisions are made, how information flows across systems, and how physical execution is coordinated with planning and control. In brownfield terminals, these dimensions are often misaligned. Legacy TOS platforms have frequently grown organically, with customised modules and point-to-point integrations reflecting historical operational needs rather than a coherent architectural vision. As a result, introducing new automated equipment or AI-driven tools frequently requires costly and fragile custom integrations.

Digital standards address this structural weakness by providing a shared language and a common framework for interaction between systems. Standardised interfaces define what information is exchanged, when it is exchanged, and how it is interpreted, independently of the specific technology or vendor involved.

For brownfield terminals, this represents a fundamental shift. Rather than tightly coupling new automation solutions to existing systems, standards allow functions to be decoupled and integrated through stable, well-defined interfaces.

Interoperability is the direct consequence of this approach. When planning systems, execution control, equipment automation and monitoring tools can interoperate through standardised interfaces, automation can be introduced incrementally. A terminal may begin by automating a specific function, such as yard equipment dispatching or condition monitoring, without redesigning the entire IT and OT landscape. Over time, additional automation layers can be added, building on the same interface foundations.

AI plays a complementary but crucial role in this evolution, as it is particularly well-suited to environments characterised by variability, uncertainty and complex trade-offs. In brownfield terminals, AI can augment human decision-making before full automation is achieved, for example, by providing predictive insights to planners, optimising equipment allocation, or detecting anomalies in real time.

However, AI systems are only as effective as the data they can access and the actions they can influence. Without standardised data models and interfaces, AI tools risk remaining isolated add-ons that struggle to scale or gain operational trust. Digital standards provide the semantic consistency that enables AI algorithms to consume data from heterogeneous sources, understand operational context and interact reliably with control and execution systems. In this sense, standards are not an alternative to AI, but a prerequisite for its meaningful deployment within brownfield automation strategies.

The benefits of adopting standardised interfaces as part of an automation roadmap include:

- **Risk reduction:** Standard interfaces reduce dependency on bespoke integrations and single vendors, lowering both technical and commercial risk.
- **Scalability:** Automation can be extended function by function and area by area, avoiding architectural dead ends.

- **Time-to-value:** Shorter implementation cycles enable earlier benefits, which is critical in brownfield business cases.
- **Cultural transition:** The gradual introduction of decision-support and semi-automated functions allows organisations to adapt operational mindsets over time.
- **Creation of a common baseline:** A shared data language across equipment and planning or execution processes links equipment behaviour and condition directly to planning and automated execution.

This progressive, standards-led approach aligns with the findings of the BCG–TIC4.0 joint benchmarking on port digital maturity, published in Digital Transformation and the Next Wave of Port Efficiency. Based on assessments of container terminals across multiple regions and operating profiles, the study highlights that most terminals, particularly brownfield assets, struggle not with the availability of technology but with fragmented architectures, inconsistent data definitions and a lack of interoperable foundations.

The benchmark indicates that terminals achieving the highest operational and productivity gains are those that first establish common data models, standardised interfaces and a clear functional separation between planning, execution and equipment control, before scaling advanced automation or AI-driven optimisation. This reinforces the case for treating digital standards and interoperability not as an end state, but as a prerequisite for sustainable, incremental automation in brownfield environments.

TIC4.0 Standards and Semantics for Terminal Automation

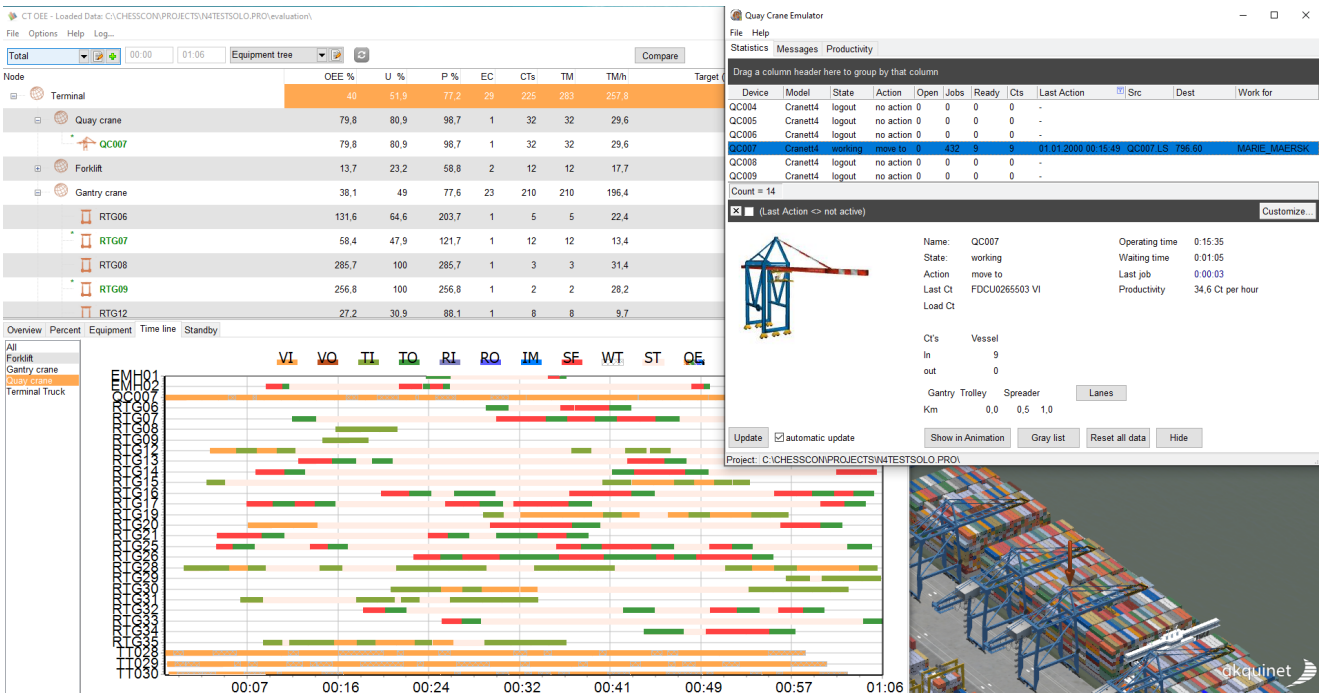
In this context, the White Paper Terminal Automation Topology according to IEC62264 (ISA-95) & Definitions of Automation Levels developed by the Terminal Industry Committee 4.0 (TIC4.0), provides a concrete, industry-driven response to the challenges of brownfield automation. TIC4.0 positions itself as a neutral, vendor-agnostic association focused on developing shared digital standards, semantics and reference models for the cargo handling and port terminal industry.

One of TIC4.0's key contributions is the adaptation of the IEC 62264 (ISA-95) standard to the port terminal context. Originally developed for manufacturing industries, IEC 62264 defines a structured model for integrating enterprise and control systems through clearly delineated functional levels and standardised information exchanges. TIC4.0 translates these principles into the operational reality of port terminals.

Within the TIC4.0 automation framework, terminal functions are organised across hierarchical levels, ranging from business planning and logistics, through operations management and supervision, down to machine control and physical execution. This layered approach is not prescriptive in terms of technology or organisational responsibilities. Instead, it provides a common reference for understanding where decisions are made, how information flows and how different systems interact.

Crucially for brownfield terminals, the model is designed with compatibility and flexibility in mind. It acknowledges that terminals operate at different levels of automation maturity and that legacy systems will remain part of the landscape for years to come. By defining standard semantics for functions such as planning, scheduling, dispatching, execution control and asset supervision, TIC4.0 enables terminals to map existing systems onto a shared framework without forcing disruptive replacement. Terminals can establish a common communication baseline across processes and equipment, enabling staged implementation approaches.

A further important dimension of TIC4.0's work is the development of consistent data semantics. Automation is not only about



connecting systems, but about ensuring that data carries the same meaning across them. TIC4.0's semantic model establishes common definitions for operational concepts, events and states, which are essential for reliable interoperability and effective AI deployment.

Within this framework, AI can be introduced progressively at different levels. At higher levels, it can support business intelligence, planning and resource forecasting by analysing historical and real-time data. At operational levels, AI can assist scheduling and dispatching by optimising sequences, predicting congestion or managing exceptions. At lower levels, it can enhance equipment supervision through predictive maintenance, anomaly detection and adaptive control strategies.

The key point is that TIC4.0 does not treat AI as a standalone solution, but as an evolving capability that can move across functional layers as terminals mature. By anchoring AI integration in standardised interfaces and semantics, the framework ensures that intelligence can gradually shift from centralised decision-support systems towards more autonomous equipment-level control, without compromising interoperability.

For brownfield terminals, this translates into a practical pathway. Automation projects can be scoped around functions and interfaces rather than monolithic system replacements, procurement can be aligned with shared standards, and future upgrades can build on a stable architectural foundation.

From Disruption to Evolution

Digital standards and interoperable interfaces are central to enabling the automation transformation of brownfield terminals. They convert automation from a disruptive, high-risk endeavour into an evolutionary process, where capabilities can be added incrementally and aligned with existing operations, adapting to current and future working conditions and professional profiles.

AI, when grounded in standardised data models and interfaces, becomes a powerful enabler of this evolution, supporting decision-making today and paving the way for higher levels of autonomy tomorrow.

The work of TIC4.0 demonstrates how an industry-driven, vendor-neutral approach to standards can create tangible value for terminal operators. By adapting proven industrial frameworks to the specificities of port operations and by focusing on semantics, interoperability and flexibility, TIC4.0 provides brownfield terminals with a credible roadmap towards automation.

For terminal operators, the message is clear: the path to automation does not start with machines, but with architecture, standards and shared understanding. Those who invest early in digital foundations will be best positioned to harness AI, integrate automation technologies, and evolve their terminals with confidence, speed and resilience.

About the authors

Boris Wenzel is a former CEO of Noatum Ports, Terminal Link SAS, and Yilport Holding, and the founder & President of TIC4.0. Currently, Boris serves as a Senior Advisor to the 3 Seas Initiative Investment Fund, Amber Infrastructure, MTBS BV, and Boston Consulting Group, and is a Non-Executive Chairman of BMF Port Burgas.

Norbert Klettner is a driving force in global port and terminal innovation. Active since 2003, he was in the digital solution implementation at EUROGATE and changed in 2008 to AKQUINET, building up and driving the port and logistics cluster. Now shapes the industry as Managing Director of RBS EMEA and Akquinet port consulting, while driving the digital language of the industry as Member of the Executive Council and Vice-President of TIC4.0.

José Giménez is an Industrial Engineer and Director of Port Logistics at the Valenciaport Foundation. For 20 years, he has been developing innovation and research projects focused on the fields of port logistics and maritime transport, with a focus on the application of digital and operational emerging technologies. He is also Secretary General of the international association TIC4.0, and Vice-President of the Spanish Technology Platform for Logistics, Transport and Mobility (LOGISTOP).

Luisa Kempf is driven by a passion for digital innovation and decarbonisation. She is Senior Manager Sustainability & Energy Transition at EUROGATE Technical Services GmbH. A former CTO and Site Director, she combines technical leadership with a forward-looking vision. Luisa also serves as Vice Chair of the Operations Council of TIC4.0, where EUROGATE was a founding member advancing terminal digitalisation.

Francisco Blanquer (CMA CGM R&D Terminals Director) has extensive experience in the industry sector that has given him the ability to perform complex multidisciplinary projects. During the last 16 years, he has developed functions of innovation and development engineer in the port sector, managing the greenfield projects and disseminating the digital culture in their terminals. During the last eight years, he has developed BigData and decarbonisation projects for CMA CGM and supported the container terminal industry as Chair Operations Council of TIC4.0.

About the organisation

The Terminal Industry Committee 4.0 (TIC4.0) is an international non-profit association established in 2019 and based in Brussels, dedicated to defining digital-based standards for enabling faster and more efficient digital transformation of the cargo handling industry.

TIC4.0 currently gathers more than 70 companies of the worldwide terminal and port industry, connecting experts in operations, engineering, IT, data and AI scientists as well as port equipment specialists.

Find out more

Digital Integration and Interoperability in Modern Container Terminals

Marco Fehmer, CEO, DSP

Container terminals are undergoing a profound digital transformation, driven by the need to increase productivity, safety, sustainability and operational resilience. Central to this transformation is the challenge of digital integration and system interoperability, particularly when introducing new automation and AI layers alongside legacy Terminal Operating Systems (TOS), industrial control systems and existing data architectures. This challenge is especially pronounced in brownfield terminals, where automation must be introduced into live operations without disrupting established systems and processes.

This article explores practical lessons from real-world terminal projects carried out by DSP Data and System Planning SA, highlighting the critical role of middleware in enabling smooth integration and operational efficiency.

Interoperability: The Heart of Modern Terminals

A container terminal is a complex ecosystem in which information systems such as TOS, ERP and gate systems coexist with automation technologies, including quay cranes, ASC and AGV or AMR fleets, alongside IoT sensors and advanced AI and analytics platforms.

Interoperability is not merely a technical requirement; it is a key enabler of operational efficiency. Many terminals operate a mosaic of best-of-breed solutions acquired over time, often with proprietary interfaces and inconsistent standards, a typical characteristic of brownfield environments where systems have evolved incrementally. The introduction of AI

“Integrating new automation and AI layers with legacy systems is achievable, but it requires a pragmatic, modular and professionally managed approach.”

optimisation, digital twins or predictive maintenance platforms frequently exposes integration gaps, latency issues and data inconsistencies.

Data Integration: Feeding the Digital Engine

AI and automation are only as effective as the data they consume. Container terminals generate data from multiple sources, including TOS, sensors, machines, OCR, GOS and VBS, often in inconsistent or siloed formats.

Technical best practice includes:

- Establishing a unified data layer or data lake
- Defining common data models and a single source of truth
- Implementing data governance and quality management processes

This journey is demanding and requires sustained investment and strong executive sponsorship. However, it can be approached in phases through modular and hybrid architectures.

Standardisation plays a critical role in a global industry. Initiatives such as the Terminal Industry Committee 4.0 (TIC 4.0) contribute significantly to the standardisation of data semantics across the sector.

Membership of the TIC 4.0 association provides access to international institutions such as the UN and ISO, enabling contributors to support policy direction through concrete, hands-on industry knowledge and technical expertise.

TIC 4.0 currently includes 75 members, among them global and regional terminal operators, equipment manufacturers and system vendors, representing over 400 terminals worldwide.

As a TIC 4.0 Ambassador, I strongly believe that participation allows industry players to:

- Contribute to the definition of common data entities
- Align with best practices in data organisation and interoperability
- Collaborate across disciplines, gaining insights that may be overlooked when focusing solely on individual systems or equipment
- In this context, it is worth highlighting Business Intelligence solutions such as DSP DATAVIEW. DATAVIEW collects data from multiple sources, including TOS, WMS and GOS. Production systems normalise the data and present transparent KPIs and metrics for live operational monitoring, analytics and forecasting, translating them into TIC 4.0 semantics to ensure shared understanding of data meaning.

Middleware: The Integration Backbone

Beyond the data layer, operations require immediate orchestration of systems to ensure that processes managed by different solutions are seamlessly integrated.

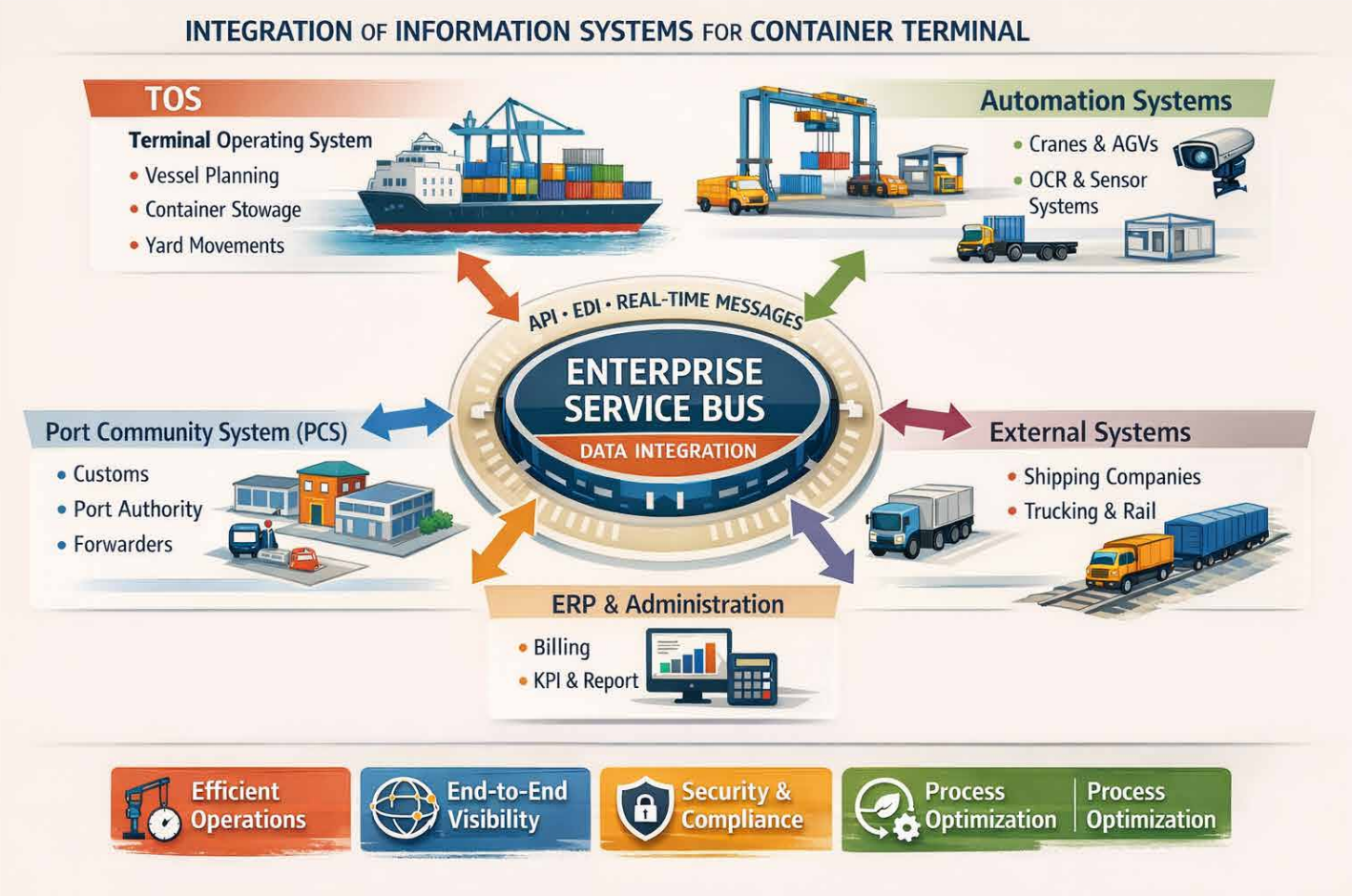
Once the strategic objectives of terminal digitalisation are defined, whether financial, operational or technical, the overall systems architecture should be reviewed to map the responsibilities assigned to each software component. This is the first fundamental step.

There is no single optimal solution. Each business case results in a different architecture, as initial objectives and drivers vary. One consistent lesson from DSP projects is that integration of multiple systems is always required.

Although the TOS remains the operational "brain" of the container terminal, many relevant functionalities remain outside its scope, and it may not be designed to natively interact with highly automated processes, IoT or AI algorithms.

An integration layer, or middleware, enables new optimisation and AI modules to operate as a decision-support layer on top of the TOS without compromising its integrity.

Integration challenges are not limited to equipment, process automation or AI. They are central to almost every operational process. While the TOS manages



operational data, planning and control, but its interaction with public entities such as customs, port authorities and coast guard bodies, as well as with vehicle booking systems, ERP systems, access control, HR, rostering and logistics stakeholders, including shipping agents, trucking companies, rail operators and freight forwarders, typically relies on integration systems or middleware.

By definition, middleware is process-agnostic and does not make operational decisions. However, the complexity of data exchanges requires domain-expert analysts and software architects to ensure successful and timely implementation.

Why Middleware Matters

- **Process-agnostic bridge:** Ensures systems speak the same language without taking operational decisions
- **Vendor neutrality:** Reduces dependency on specific suppliers and supports future integration
- **Scalability and modularity:** Enables progressive integration of AI, predictive analytics and automation modules

IT-OT Integration and Cybersecurity

Automation and AI require continuous and reliable data exchange between IT and OT systems, including PLCs and industrial controllers.

Cybersecurity is critical in this context. Segregating different system layers, controlling access to sensitive data and protecting both IT and OT networks are essential to prevent potential breaches that could disrupt terminal operations. Cybersecurity must be embedded from the design phase to ensure operational safety and compliance with regulatory standards.

This approach ensures operational safety, cybersecurity, and system certification compliance, while enabling AI and automation to function reliably.

Change Management and Skills Development

Digital integration affects roles, procedures and responsibilities. Successful projects involve:

- IT and OT teams
- Terminal operations personnel
- Maintenance and safety personnel
- Management

Training and development of hybrid IT, OT and data skills is essential to unlock the

full potential of automation and AI.

Often, terminals are not structured to manage complex innovation projects. Key individuals responsible for daily operational performance may also be expected to lead transformation initiatives. If they shift into full project mode, short-term operational performance may be affected.

Digitalisation programmes, therefore, require a dedicated team. Organisations must prepare by leveraging internal skills and partnering with experienced consulting firms such as DSP to bring experience and best practices to anticipate risks and reduce project timelines.

The "DSP School of TOS" is the education division created to support knowledge development in systems and emerging technologies. Workshops, classes and academic courses are organised in collaboration with SUPSI University of Lugano.

Conclusion

In the context of container terminals, digital integration and interoperability are the true differentiators between successful automation projects and initiatives and isolated or ineffective projects. Integrating new automation and AI layers with legacy systems is achievable, but it requires a pragmatic, modular and professionally managed approach.

Gradual implementation is essential, particularly in brownfield contexts where operational continuity is non-negotiable. Progressive integrations, tested in simulation or digital twin environments, drastically reduce operational disruptions.

DSP provides simulation and automated testing solutions designed to mitigate risk and reduce the total cost of ownership.

Key Takeaways

- Treat digitalisation as an evolutionary process, not a one-time event
- Deploy progressively
- Involve domain-expert analysts and software architects to manage complex data flows
- Invest in data quality and governance
- Adopt open standards and vendor-neutral approaches
- Use middleware strategically to connect legacy systems, automation, AI and stakeholders without replacing core systems
- Integrate cybersecurity measures from the outset to safeguard operations
- Establish a dedicated professional team
- Align digitalisation with structured change management

About the author

Marco Fehmer is a chartered civil engineer with container terminal operations experience. He is DSP CEO, the Swiss-based consulting company leader in port operations efficiency and automation and developed vertical business intelligence and digital twin solutions. Since 2025, Marco has been nominated official TIC 4.0 Ambassador.

About the company

DSP is headquartered in Switzerland and was founded in 1986. Now operating through four business units worldwide, DSP provides business consultancy and IT solutions, taking advantage of its specialised and proven know-how in operations, informatics technologies applied to the shipping industry, port and terminal management and intermodal transportation.

DSP focuses its efforts on TOS Consulting, Business Intelligence, Digital Twin and System Integrator, offering solutions and products that are perfectly suited to any marine and inland terminal. With the final aim of enhancing logistics efficiency, sustainability, and performance, DSP has built up Business Intelligence Systems and a Digital Twin Platform enriched by AI technologies.

Find out more

Autonomous Driving Deployment: Lessons Learned from Simulations

Arjen de Waal, Manager, Simulation Department, Portwise

Challenges in Deploying Autonomous Vehicles

While Autonomous Vehicle (AV) technology shows strong potential to improve operational efficiency and reduce costs, its integration into large-scale, mixed-traffic environments remains challenging. Portwise uses advanced simulation models to test layouts, traffic logic, and operational strategies prior to real-world implementation.

Innovation Background

Portwise leverages its expertise in terminal design, operational data, and simulation tools to explore innovative solutions. Previous studies have covered automated straddle carriers, high-bay storage systems, and alternative transport concepts.

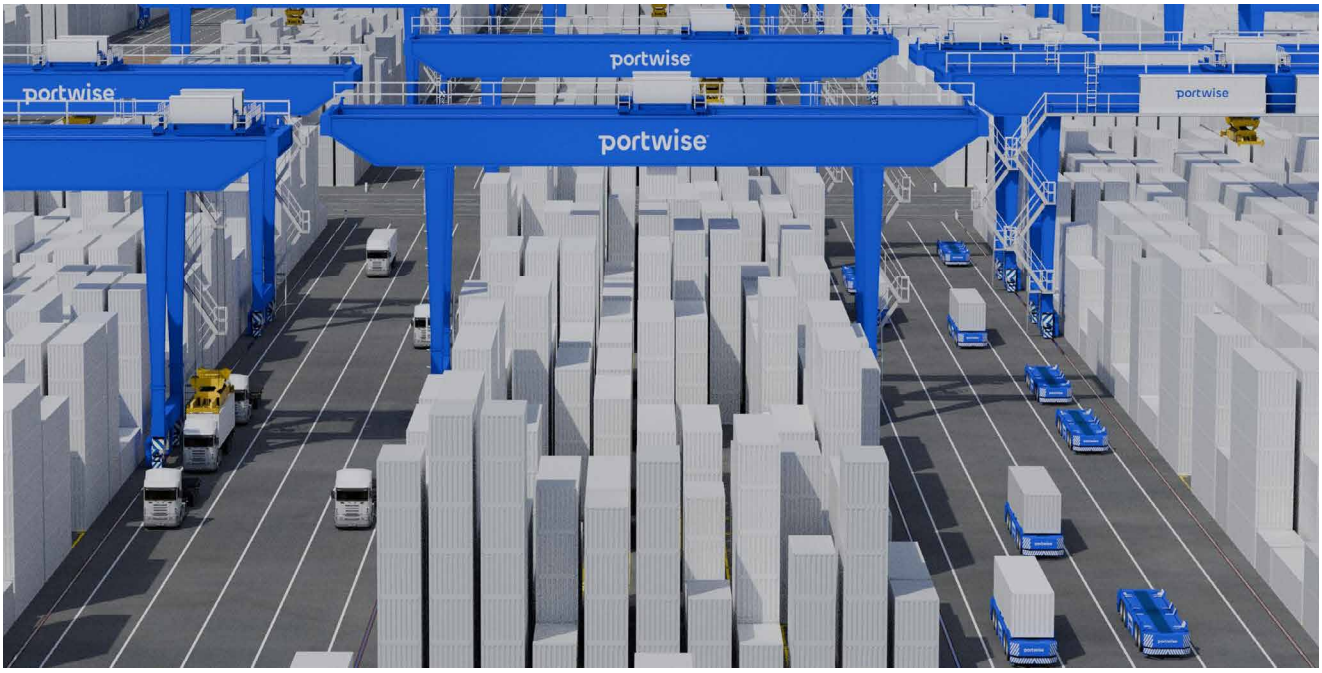
The current simulation focus is on AV deployment. Portwise has been investigating how AVs can be efficiently introduced in container terminals, aiming to answer:

- Which operating strategies or rules are required to make efficient use of the AV concept?
- Under which conditions does an AV system perform effectively, and how does the concept impact terminal productivity?

Large-Scale AV Simulation

Various suppliers offer autonomous driving solutions. AVs can drive routes accurately, detect obstacles and other

"Simulation models support the evaluation of solution effectiveness across layouts and operational scenarios."



Example of road-truck handling on one side of a stack and AV handling on the other. Vehicles operate separately in this space but interact on shared roads where separation is not possible.

vehicles, and respond by braking or rerouting. While this performs well in smaller and relatively simple environments, the intention is to deploy large AV fleets in terminals where additional challenges arise that are not yet fully resolved by suppliers, such as:

- Large-scale mixing between AVs and manned trucks
- Operation in heavily congested layouts with multiple crossings
- Sequencing AV arrivals in the correct order at quay cranes or other handling locations

Autonomous driving is not yet widely applied in day-to-day, full-scale terminal operations. However, Portwise already operates large fleets of autonomous vehicles within its simulation models. A wide range of layout options, driving strategies, conflict responses, and other behaviours have been designed and tested in the simulation lab.

This article summarises some of the key findings from Portwise's recent research activities.

Fundamentals for AV Deployment

Portwise has identified several core principles for safe and efficient AV operations in mixed or dense terminal traffic. These principles are consistently applied in design decisions:

- **Unified traffic rules for AVs and manned vehicles**. AVs consistently follow defined rules when interacting with each other. In mixed-traffic environments, it is equally important that human drivers understand traffic situations and know how to respond. Rules must be clear to both AVs and manned trucks, for example, through traffic lights, stop signs, or no-stop markings.
- **Clear signalling from AVs to human drivers**. AVs should indicate intended movements, such as direction of travel or when yielding to a truck. This behaviour creates trust among drivers and supports safer manoeuvring and improved traffic flow.
- **Layout optimisation to minimise AV-human interactions and deadlock situations**.
- **Centralised control systems (ECS/FMS) to support decision-making and streamline operations**, including:
  - Defining routes and issuing route instructions to AVs to reduce congestion and avoid complex crossings
  - Supporting container handover processes to and from quay cranes, rail cranes, and yard cranes, including sequencing and assignment of handover positions

Findings from Simulation Studies

The findings are presented in two parts. The first addresses generic AV traffic behaviour and explores how AVs can operate safely and efficiently within terminals, either in fully automated or mixed-traffic environments. The second focuses on the use of AVs in RTG terminals, which represent some of the most complex operating environments for AV deployment, but also offer significant potential benefits.

Traffic Insights

AVs can manoeuvre precisely in all directions, particularly in low-traffic environments. As congestion increases and crossings become more frequent, AVs are more prone than manned trucks to becoming delayed while merging, yielding, or navigating intersections.

To improve AV performance in these conditions, several mitigation measures were evaluated through simulation, including layout design, routing strategies, and driving behaviour adjustments:

- **Priority rules:** A well-designed set of rules helps vehicles recognise which party has priority under specific conditions. This includes priority roads, go=go rules, and location-specific priorities.
- **Layout optimisation:** Reducing the number of conflict points encountered during vehicle movements helps mitigate queuing and congestion, sometimes at the cost of minor detours.
- **Traffic lights:** Installation at busy crossings significantly improves traffic flow.
- **Smart rerouting:** Certain terminal roads consistently experience higher congestion. Introducing alternative routes allows AVs to be rerouted onto less busy roads, occasionally at the expense of storage space or small detours.
- **Quay crane buffer management:** Where apron space allows, buffer positions near quay cranes enable AVs to wait without obstructing other vehicles. Portwise developed a buffer-selection strategy that reduces route conflicts when AVs travel to and from these buffers, resulting in significantly reduced delay times in busy simulation scenarios.

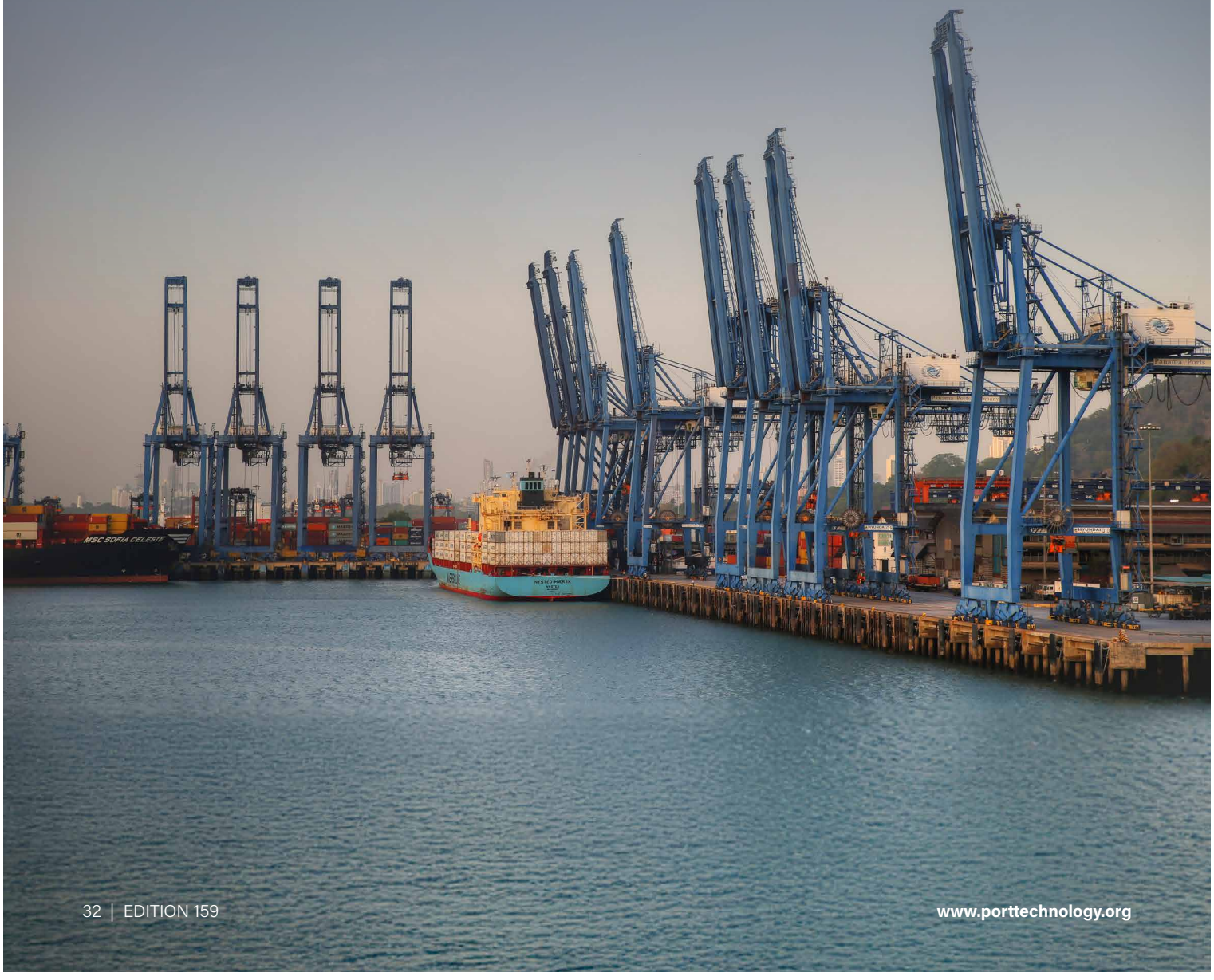
RTG Terminal Insights

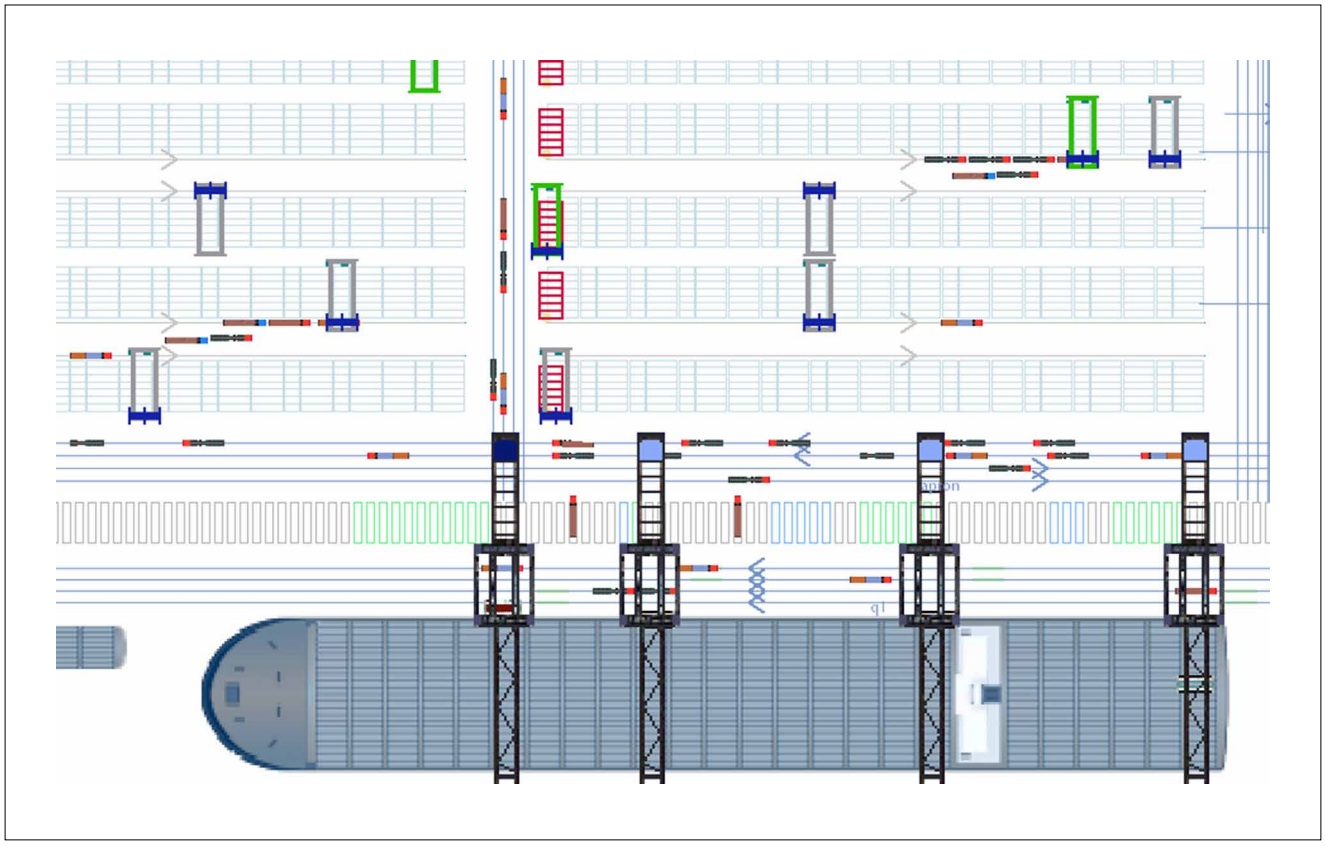
Deploying AV fleets in RTG terminals introduces additional challenges compared with other layouts:

- Limited space between RTG blocks, restricting queuing and waiting areas
- Frequent interactions between AVs and manned trucks
- The need to avoid RTG legs when AVs transition between interchange lanes and driving lanes alongside RTG blocks

Based on these studies, Portwise identified the following key takeaways:

- Active control of AV volumes and positioning near RTG blocks helps prevent queuing at block entrances or along travel lanes. A central decision tool can assess whether additional AVs should be dispatched to specific positions.
- Logic is required to relocate AVs away from RTG blocks when no new job is assigned by the terminal operating system. This prevents blockages that could impact both AVs and trucks.





Example of a generic RTG terminal in a Portwise simulation model, used to test alternative AV layouts and routing strategies.

- Direct entry into RTG interchange lanes is often easier to implement than merging from driving lanes. Depending on AV maturity, routing AVs directly onto the interchange lane at the start of an RTG block may reduce conflicts, although this can limit flexibility and performance. Simulation models can be used to evaluate this trade-off.
- RTGs should only initiate jobs for specific AVs when AV arrival is guaranteed.

Ongoing Research

Portwise continues to refine AV deployment strategies, recognising that each terminal layout presents unique challenges. Solutions that perform well in one environment may require adjustment in another or may not be suitable at all. Simulation models support the evaluation of solution effectiveness across layouts and operational scenarios, and help determine which logic should reside within the TOS, ECS, FMS, or on the AV itself.

Key Takeaways

- AVs have the potential to transform terminal logistics but require careful planning and validation through simulation.
- Clear traffic rules, effective signalling, and selective centralised control are critical to successful deployment.
- Simulation-driven design enables congestion and deadlock issues to be identified and addressed before real-world implementation.

About the author

Arjen de Waal is Manager of the Simulation Department at Portwise, as well as a simulation expert and product owner of the company's simulation library. He has been involved in terminal design and optimisation projects worldwide and has led the simulation department since August 2011.

About the company

Portwise is a global consultancy and simulation firm combining deep automation and operational expertise with proven simulation tools to support future-proof planning for ports, terminals, and warehouse operations.

Find out more

Brownfield Automation in LATAM: Why the Espresso Needs Ice

Marcos Carneiro,
Solutions Architect, CONROO

Sometimes, a good lesson about terminal automation starts in a coffee shop.

My wife ordered an espresso in Germany. It was one of those unexpectedly hot days, and she asked the lady at the counter whether she could add a bit of ice, not to change the drink, just to make it bearable. The first answer was a polite "no" because "this is not on our menu".

Fair enough.

But there was a bucket of ice right there. So, my wife tried again: "I understand, but would it be possible to give me just a bit of ice so I can have it with my coffee?" The lady hesitated, then said yes, she could do it, but it was not their procedure. My wife smiled and asked if she could "break the rule this time". The lady agreed.

It is a small story, but it maps surprisingly well to brownfield automation, especially when comparing Europe and Latin America.

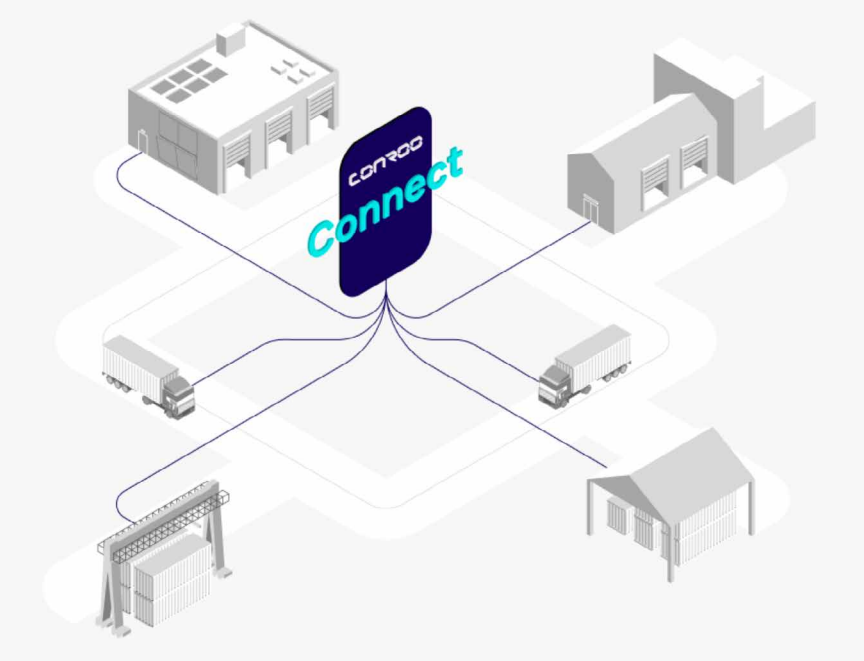
If we had ordered the same espresso in most LATAM countries, the answer about the ice would probably have been an automatic yes. Not because people are careless, but because the environment is dominated by uncertainty. We are used to dealing with exceptions as if they were the rule.

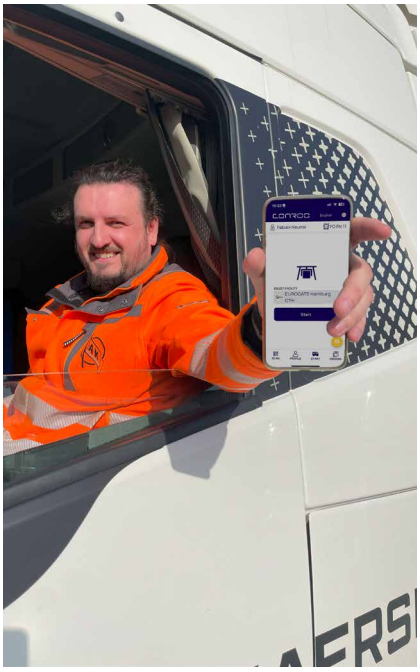
And that is exactly what you encounter when discussing brownfield automation in LATAM ports and terminals.

Brownfield Is Not Only Infrastructure; It Is Behaviour

Brownfield automation is usually described as an engineering challenge: legacy gates, mixed equipment, fragmented systems, and the reality that operations cannot stop. All of that is true.

"For brownfield terminals, especially in LATAM, the most valuable automation is often "decision automation."





But in LATAM, there is another layer that is just as decisive: culture, in the most operational sense of the word.

Culture shows up in:

- how strictly procedures are followed when the yard is under pressure,
- how often "special cases" appear in the truck flow,
- how quickly supervisors improvise to protect service levels,
- how much performance depends on experienced people rather than systems.

In Europe, implementing change often feels like a structural problem. The rules are clear, responsibilities are defined, and compliance is the baseline. The change path is to understand the rules, build on them, and make them more efficient without breaking them.

In LATAM, implementing change can feel more like a reality problem. Systems exist, and best practices exist, but the environment around the terminal is volatile. Congestion, documentation quality, customs, security, and the wider trucking ecosystem create daily conditions that no standard workflow fully anticipates.

The question then becomes: how do you automate without removing the flexibility that keeps the terminal running?

The Hidden Cost of "Exceptions as a Feature"

Most terminals do not struggle because they lack a TOS. They struggle when exceptions scale.

In a brownfield terminal, the truck flow is full of "almost standard" visits:

- the truck arrives early or late because the road was blocked,
- the driver shows up with incomplete documents,
- the booking exists, but the cargo status has changed,
- the container is on hold, but the customer insists,
- someone calls the gate because "this one needs to go first".

Each case makes sense in isolation. The problem is volume. A terminal can handle 20 exceptions a day with good people. It cannot handle 400 exceptions a day without turning the whole process into a negotiation.

This is why many LATAM terminals look like operational miracles. Teams compensate for volatility with effort, coordination and experience. The downside is that the "human buffer" becomes expensive and fragile. It increases pressure, increases rework, and makes the operation dependent on a few key individuals.

Automation, done well, should not remove human capability. It should remove the waste that forces humans to act as firefighters all day.

A Practical Mindset: Automate the Decision, Not Just the Step

A common trap is to digitise a step without changing the decision behind it.

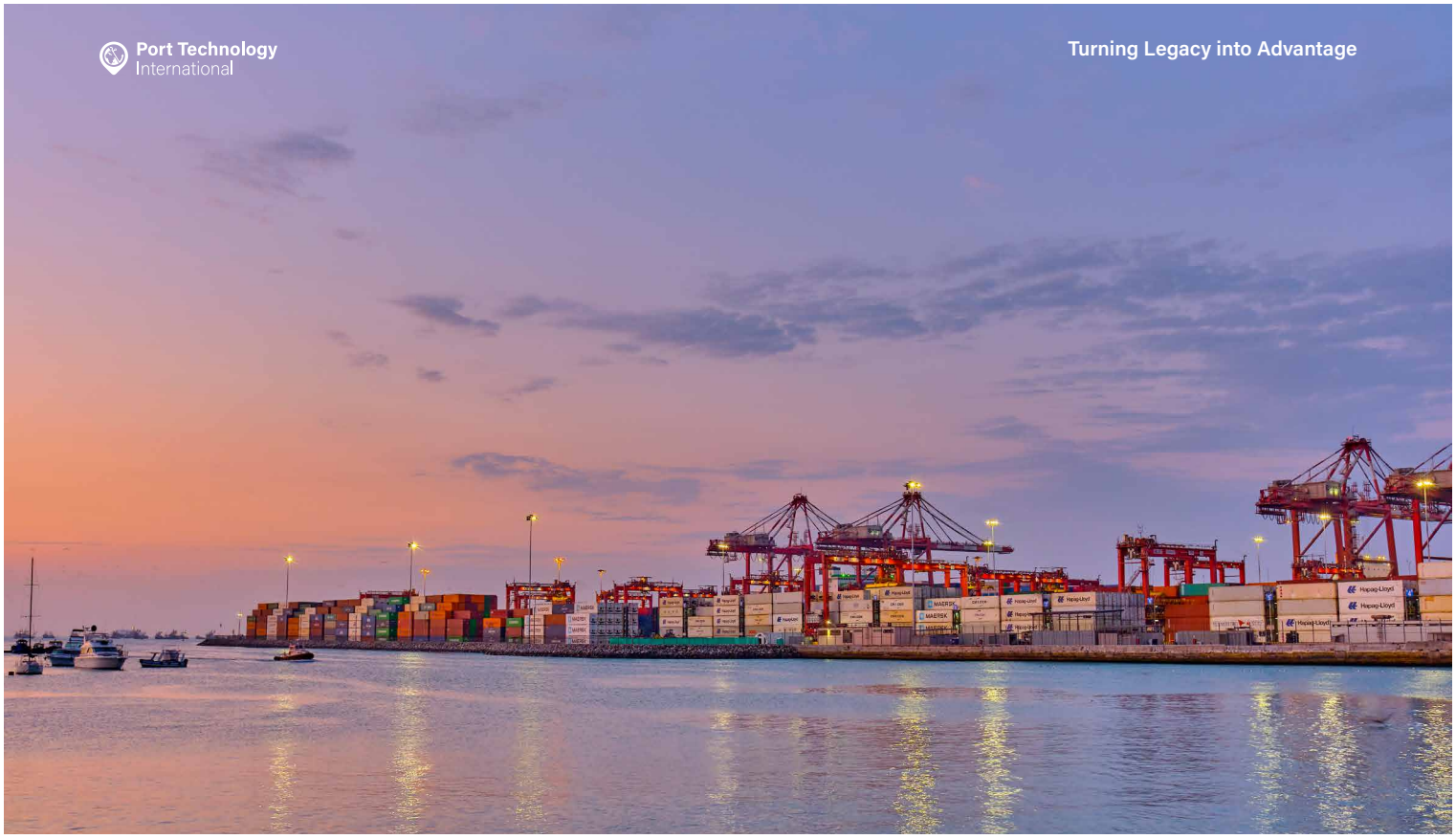
Turning a paper check-in into a digital form is useful, but if the terminal still needs to call three people to confirm whether the truck can enter, the real bottleneck remains.

For brownfield terminals, especially in LATAM, the most valuable automation is often "decision automation". This means:

- clarifying what should happen in a specific scenario,
- making that scenario visible early enough,
- guiding the driver and the gate team with simple options,
- allowing a controlled override when reality demands it.

The goal is not to eliminate exceptions. The goal is to process exceptions quickly, consistently and with traceability.

This is where lightweight, driver-centred tools become powerful. Not because they are fashionable, but because they sit exactly at the boundary where most exceptions begin: outside the gate, with the truck driver.



Why "Lighter" Automation Often Wins in LATAM Brownfields

Not every terminal needs, or can justify, Rotterdam-level infrastructure. Many LATAM terminals must be pragmatic about investment capacity, space constraints and the maturity of the trucking ecosystem.

In these contexts, the highest ROI is usually not a large-scale overhaul. It is a thin digital layer that makes existing processes predictable enough to scale.

What does a "thin digital layer" mean in practice?

1. Communication that actually reaches the driver

A surprising amount of delay is not caused by equipment, but by misunderstanding.

Drivers arrive without knowing which lane to use, what documents are required, whether the booking is valid, or where to go once inside. At scale, "ask the guard" becomes chaos.

A low-friction driver channel, in the driver's language, with clear instructions, reminders and status updates, is a foundational automation step.

2. Identity and access without drama

Brownfield gates often rely on a mix of cards, paper passes and manual identity checks. In volatile environments, it can also become a security and compliance risk.

A modern approach is to use what drivers already carry: a smartphone. It can support secure identification, access tokens and audit trails, without forcing the terminal to install new hardware in every lane.

The key is reducing the number of moments when people must "bend the rule" just to keep trucks moving.

3. Visibility focused on decision points

Every terminal wants real-time visibility of trucks, but brownfields rarely have perfect sensor coverage.

A practical approach is "good enough visibility", focused on the moments that matter:

- arrival in the pre-gate area,
- waiting time at the gate,
- entry into the yard and assigned zone,
- deviations suggesting a truck is stuck.

This is often enough to reduce calls, reduce guesswork, and improve planning, without demanding a full instrumentation project.

4. A controlled override, because reality will win

LATAM operations need flexibility. But flexibility cannot mean that "anything goes". It needs boundaries.

In workflow design, define:

- who can override,
- which overrides are permitted,
- what must be captured when an override occurs,
- how often overrides happen, and why.

This turns improvisation into a managed tool. It respects the culture of solving problems quickly, while building a feedback loop that gradually reduces volatility.

Three Experience-Led Principles for Brownfield Automation in LATAM

1. **Start with friction, not ambition.** Begin where the terminal loses time every day: pre-gate confusion, gate rework and driver instruction gaps.
2. **Design for exceptions from day one.** If the system only works when everything is perfect, it will fail in the first week. Build an exception catalogue early and embed those scenarios as clear options, not hidden workarounds.
3. **Make adoption easier than avoidance.** If using the tool feels slower than calling a contact at the gate, people will bypass it. Adoption is a product challenge, not simply a training issue.

What Success Looks Like in Operational Terms

When brownfield automation is working, you can feel it in daily operations:

- fewer calls between gate, yard and customer service,
- fewer manual re-entries of the same data,
- fewer "where is this truck?" moments,
- fewer surprises in the appointment plan,
- a calmer gate team because decisions are clearer.

The strongest KPI is not a dashboard. It is the shift from firefighting to control.

If the espresso story teaches anything, it is this: in a procedure-driven environment, you improve by standardising and optimising the rule. In an uncertainty-driven environment, you improve by making the exception safe, fast and visible.

LATAM terminals do not need less discipline. They need tools that respect their reality and help their people turn flexibility into repeatable performance.

Brownfield Automation Is a Partnership with the Operation

Automation is not a box you install. It is a change you absorb.

In LATAM, that absorption depends on trust. Trust that the system will not collapse at the first exception. Trust that the vendor understands yard reality. Trust that the operation will not be exposed when things go wrong.

If that trust is built, brownfield automation becomes feasible, not because the terminal suddenly becomes "perfect", but because it becomes more resilient.

And resilience is what wins in volatile environments.

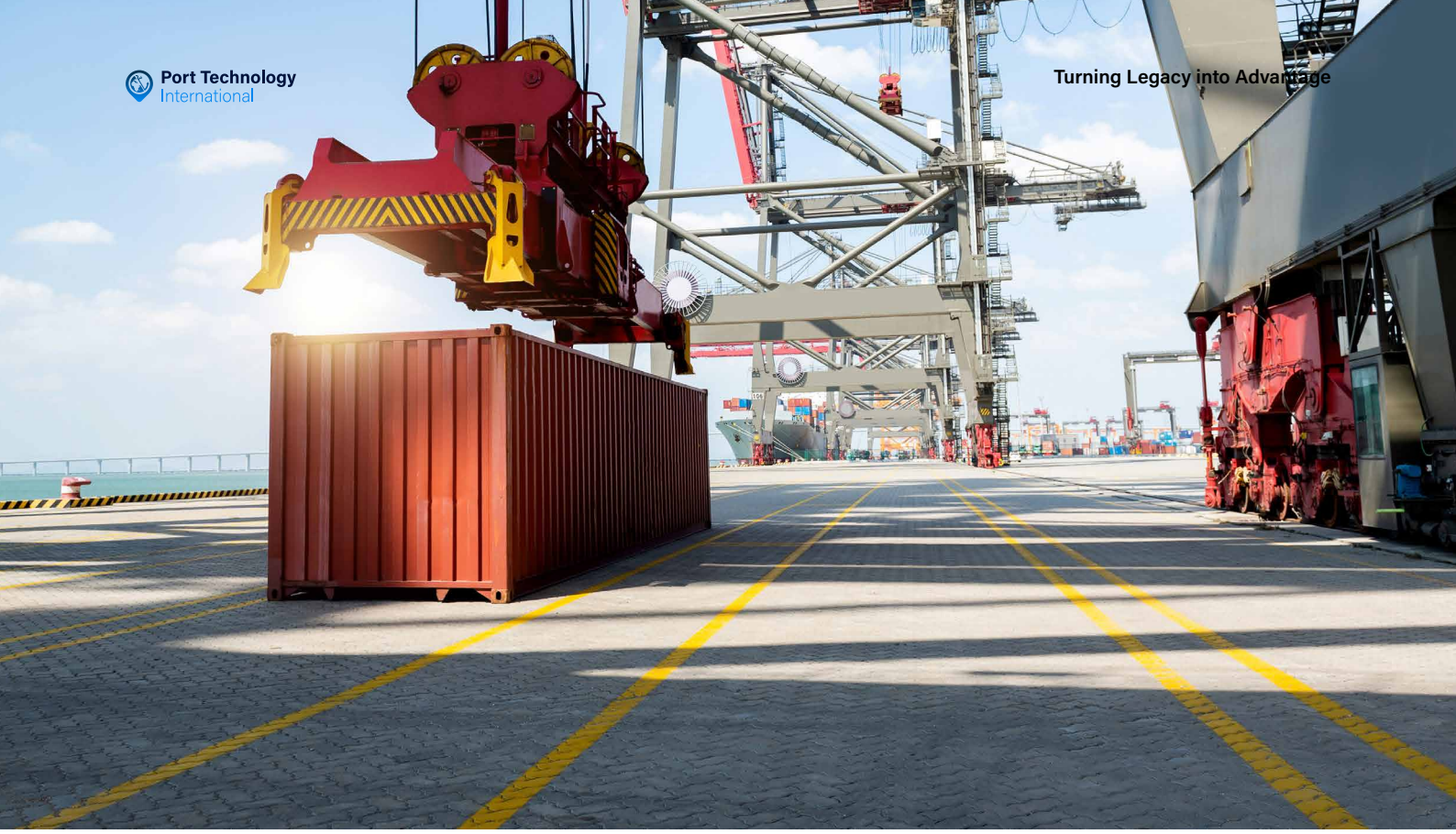
About the author

Marcos Carneiro is a Solutions Architect at CONROO, working with terminals and depots across Europe and Latin America to digitise truck flows. He focuses on pragmatic automation for brownfield sites, integrating drivers through the smartphone. Based in Munich, he supports projects from pre-gate planning to gate and yard execution.

About the company

CONROO is a software platform that connects terminals and the trucking community via the driver's smartphone. It enables digital pre-arrival communication, secure access, and on-site coordination without new gate hardware. CONROO helps operators reduce manual work, improve planning, and raise safety and compliance in both brownfield and greenfield environments.

Find out more



Quayside Digitalisation: How Visy Systems See, Validate, and Act

John Lund, Sales & Marketing Director, Visy Oy

AI Vision and Data-Driven Operations for Brownfield Sites

Brownfield container terminals are under increasing pressure to modernise their operations and match the productivity of fully automated facilities. While upgrading an existing terminal presents clear challenges, transformation is both achievable and commercially viable. One of the most effective ways operators can improve performance and strengthen competitive advantage is by adopting a holistic approach to operational optimisation, particularly at the quayside.

In modern container terminals, ship-to-shore (STS) crane speed alone is no longer the defining performance metric. While traditional KPIs such as Gross Moves Per Hour (GMPH) remain relevant, competitive differentiation increasingly depends on how efficiently and predictably containers move between the quay and the yard, and how accurately physical execution aligns with planning in the Terminal Operating System (TOS). This broader view of quayside performance encompasses metrics such as internal truck turnaround times, yard productivity, and rehandle rates, all of which can be significantly improved through digitalisation.

Ultimately, efficiency between the quay and the yard is achieved by eliminating unnecessary work and

"Efficiency between the quay and the yard is achieved by eliminating unnecessary work and reducing uncertainty at handover points."

reducing uncertainty at handover points between STS cranes, internal transport, and yard operations. Visy addresses these challenges through AI-based vision technology and a software platform that transforms every container move into a verified, data-rich event aligned with the TOS plan. These solutions, including AI-powered crane Optical Character Recognition (OCR), dedicated pinning stations, and remote wharf management tools, demonstrate how digitalisation strengthens quayside KPIs while enhancing a terminal's profitability and market position.

Using Quayside Data Collection to Improve KPIs

At the core of Visy's quayside offering is an AI-based OCR engine that processes images captured by pan-tilt-zoom cameras mounted on crane structures such as portal beams and sill beams. These cameras capture images of the container end or door and long sides, in flight, during loading and discharge operations. In addition, cameras can be mounted directly on the spreader as part of Visy's proprietary TopView Spreader OCR application.

By capturing container identification and event data as soon as the twistlocks engage, TopView transforms the spreader into a smart device, making it the first point of operational truth. Combined, the frame-mounted cameras and TopView system capture images of five sides of each container during single lifts and four sides during twin lifts.

The Visy OCR engine automatically detects and classifies a wide range of attributes critical to quay-yard coordination, including:

- Container ID and ISO codes
- Door orientation
- Seal presence
- IMO hazardous labels
- Unconventional lifts such as hatch covers, out-of-gauge cargo, and lashing gear boxes
- Internal terminal tractor number detection
- Automatic Damage Detection System (ADDS)

Through automated data collection, container attributes and lift types are confirmed immediately, eliminating the need for manual checks on the quay or vessel. For planning teams, this means all moves are digitised and verified before the container leaves the crane's operational sphere. For clerks, camera-based verification enables remote working in safe conditions, away from heavy equipment. Across the quayside, data is shared in real time to remove waste from operational processes and support consistent KPI standards.

From Detection to Decision: Real-Time Load and Discharge Validation

Data capture delivers the greatest value when it supports real-time operational decision-making. The Visy Crane Gate platform provides a quayside operations management layer by automatically converting OCR event data into structured, bi-directional communication with the TOS. As no terminal operation is free from exceptions, real-time data exchange between Visy Crane Gate and third-party systems enables operators to make fast, informed decisions.

During container handling, Visy Crane Gate:

- Generates real-time load and discharge events with container IDs and associated data
- Links cargo information with terminal tractor assignments
- Updates and validates execution against the TOS for move confirmation and upstream planning

Conversely, Visy Crane Gate creates exception-handling events when it detects:

- A mismatch between container ID and the vessel bay plan
- An incorrect terminal tractor positioned under the STS crane

- An unreadable container ID or asset damage exceeding acceptable limits
- Discrepancies between load lists and OCR data, including IMO placards, seal presence, door direction, and weight

These exceptions are immediately visible to remote operators, who can resolve issues without dangerous or time-consuming physical intervention on the quay. On-the-fly plan changes are simplified because all stakeholders operate from a single, digitised source of truth.

While Visy Crane Gate validates lift data and provides a comprehensive overview of quayside operations, the new Visy Wharf App supports crane operators directly by delivering clear audio and visual instructions for executing planned moves.

During crane operations, the Visy Wharf App:

- Displays the real-time move sequence
- Links each container ID to an accurate stowage position
- Validates execution against the TOS vessel bay plan and work order
- Delivers real-time updates from office coordinators

This immediate validation is critical during high-intensity vessel operations. When a physical move deviates from the planned bay, row, or tier, discrepancies are detected instantly and corrected before incorrect stowage occurs. Shipping lines and terminal operators benefit from digitised evidence of every move, validating both productivity and execution accuracy.

TopView: A Rooftop Perspective That Enhances Visibility

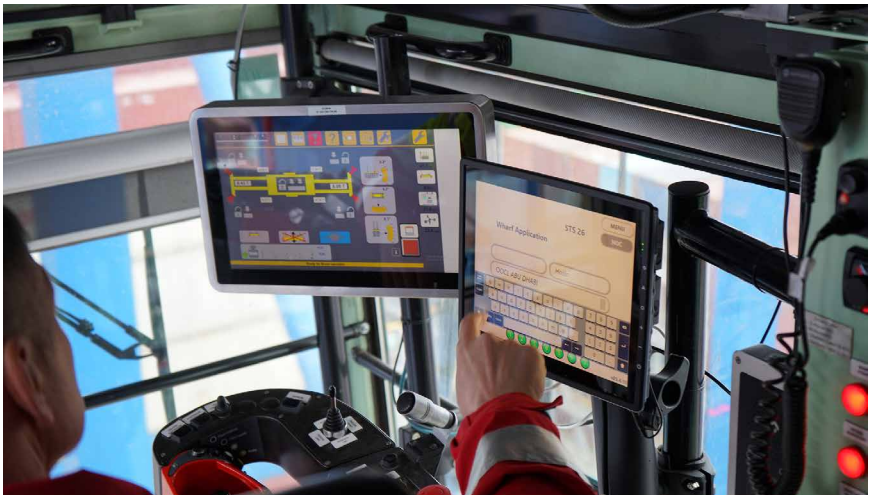
By transforming the spreader into a smart device, TopView automatically identifies container IDs and references the TOS as soon as the twistlocks engage. The system also captures high-resolution images of the container roof before contact, providing evidence of pre-existing damage not caused by terminal operations.

In addition, TopView detects unconventional lifts such as out-of-gauge cargo and hatch covers, and automatically identifies twin-20 configurations, ensuring lifts are correctly processed without operator input. Because the spreader is the common denominator in all container moves, enabling it with AI-driven intelligence and TOS connectivity helps prevent lifting errors and costly rehandles.

During twin-lift discharge operations, each container is individually recognised, linked to its specific work order, and associated with the correct internal transport task. If an operator attempts to lift two 20-foot containers while the spreader remains in a 40-foot configuration, TopView alerts the operator before the industry-dreaded "twin-20" failed pick occurs.

For terminals, this delivers measurable operational value:

- Higher crane utilisation
- Reduced rehandle rates
- Improved yard resource planning



The result is not only faster and more accurate lifting, but smoother downstream execution and sustained KPIs based on "truth under the hook".

Pinning Stations: Controlled Handover Between Yard and Quay

At some terminals, the quayside digital ecosystem is complemented by dedicated pinning stations used during loading operations. Located at either end of the quay, these stations serve as controlled buffer points where containers are verified and pinned according to vessel requirements.

Using a handheld device with the new Visy Pinning App graphical interface, clerks confirm container IDs and terminal tractor numbers, identify the required pin type, and verify correct attachment. The terminal tractor then proceeds to the assigned crane, where servicing occurs once the unit is in sequence. This controlled handover significantly improves both safety and operational efficiency.

KPIs That Translate into Competitive Advantage

When AI-based vision technology, intuitive operator applications, and streamlined exception handling are fully integrated across quay-yard workflows, their impact is reflected in core operational KPIs, including:

- Net STS crane productivity
- Reduced vessel berth times
- Faster quay-to-yard cycle times
- Improved work order and inventory accuracy
- Lower rehandle rates
- Faster exception resolution
- Enhanced labour safety
- Overall operational efficiency

These improvements compound over time. Faster and more reliable quay-yard execution increases berth throughput and schedule reliability, enabling terminals to deliver a consistently higher standard of service, which is critical for winning and retaining shipping line business.

Data-Driven Control at the Heart of the Terminal

The future of quayside operations lies in adopting a holistic view of waterside performance that extends beyond crane productivity alone. AI-based vision technologies provide terminals with real-time operational control, improved KPI performance, and greater execution accuracy. Through continuous, digitised data collection and sharing, the performance of the entire wharf is elevated.

By combining vision-enabled automation with data-driven operational control, modern terminals are transforming the quay-yard interface into a powerful source of competitive advantage. In an industry defined by thin margins and high reliability demands, the ability to instantly see, validate, and act on every move is essential. Through the latest advances in AI and process modernisation technology, brownfield sites can now match productivity levels previously only associated with fully automated facilities.

About the author

John Lund brings over 20 years of experience helping marine and intermodal terminals achieve their operational goals through digitalisation and process modernisation. He has led numerous initiatives that enhance safety, efficiency, and profitability, guiding operators through every stage of digital transformation. Passionate about building a more dependable, sustainable, and resilient industry, John bridges advanced technology with real-world operational insights.

Originally from Boston, USA, and now based in Tampere, Finland, John holds an MBA and a law degree and is currently pursuing a master's degree focused on how digitalisation and process modernisation can reduce the industry's environmental footprint. Outside of work, he is a world champion rower and a member of Finland's Athletic Hall of Fame for the sport of wife carrying (eukonkanto).

About the company

Visy provides process automation ecosystems that manage the flow of traffic, cargo, and personnel in ports, terminals, and logistics centres. Every asset entering or exiting a facility by road, rail, or quay can be managed using Visy technology. Visy's mission is to help customers save time and money on every transaction while improving operational KPIs.

With over 30 years of experience, Visy is a pioneer in OCR, deep learning, and AI-based vision technology. Visy ecosystems manage and automate more than six million events per day across over 30 countries, improving visibility, accuracy, and performance throughout the global supply chain.

Find out more