



Ministry of Foreign Affairs

STUDY DIGITALIZATION IN PORTS IN THE LATIN AMERICAN REGION

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STUDY DIGITALIZATION IN PORTS IN THE LATIN AMERICAN REGION

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Glossary

AI: Artificial Intelligence
ACP: Panama Canal Authority
AGVs: Automatic Guided Vehicles
ANA: National Customs Authority
AMP: Panama Maritime Authority
BoL: Bill of Lading
B2G: Business to government
CDA: Customs Brokers Center
CNRT: National Transportation Regulation Commission
CLP: Port Logistics Communities
DNP: National Planning Department
ETA: Estimated Time of Arrival
ETD: Estimated Time of Departure
EPV: Valparaiso Port Authority
EPSA: San Antonio Port Authority
EVAPORT: Virtual Assistant
G2G: Government to government
GHG: Greenhouse gases
IMO: International Maritime Organization
IPM: Mexican Port Infrastructure
INCOP: Instituto Costarricense de Puertos del Pacifico
IoT: Internet of Things
IPCSA: International Port Community System Association
IT: Information technology
JAPDEVA: Board of Port Administration and Economic Development of the Atlantic Slope of Costa Rica
LATAM: Latin America
LDP: Logistics Development Program
ML: Machine Learning
MSW: Maritime Single Window
MOPT: Ministry of Public Works and Transportation
NPA: National Port Authority of Perú
OSITRAN: Supervisory Agency for Investment in Public Use Transport Infrastructure
PCS: Port Community System
PNA: Argentine Naval Prefecture
PORTCEL: Technological Portal for Foreign Trade and Logistics
RFID: Radio frequency identification
RTG: Rubber Tyred Gantry
SEP: Public Companies System

SIGA: Customs Management System

SNP: National Port System of Panama

STS: Ship to shore

SW: Single Window

TEU: Twenty-foot Equivalent Unit

UNCTAD: United Nations Conference on Trade and Development

UN-ECLAC: Economic Commission for Latin America and the Caribbean

Executive Summary

With about 80% of world trade carried by sea, ports are an integral part of the global economy as key enablers of international trade. Nevertheless, the negative impacts from port and maritime related activities cannot be overlooked. Particularly those sources resulting from the inefficiencies of port-related activities, which will generally result in congestion or sub-optimal energy consumption, among others. A smarter use of current infrastructure has received increased attention in port communities throughout the past years. With digital technologies as key enablers, a smarter use means to gain competitiveness and reduce inefficiencies, and therefore to reduce negative sustainability impacts. As a result of the COVID-19 pandemic, the digital transformation trend gained further momentum.

With the Dutch expertise as a best practice in the port sector, the purpose of the study herein presented is twofold. First, to assess the state of play of port digitalization in selected countries of the Latin American (LATAM) region, and second, it explores potential market opportunities for Dutch businesses in the field of port digitalization in Latin America. The study was commissioned by the RBD Latam team, and carried out by Holland House Colombia and STC International.

Understanding port digitalization

Considering the lack of consensus around key terminologies within industry and academy, **port digitalization** was considered here broadly as:

The continuous use of technologies to come up with solutions that can help ports and their users to improve some or many of their processes and activities, from an operational, environmental, safety & security, energy, institutional or human resources perspective.

The emerging technologies, which can be digital-based only or combined with physical components and systems, that were considered for this study were: open platforms (SWs, PCSs); automation & robotics, IoT; AI; V/A/M Reality; Blockchain; Big Data; Cloud Computing; 5G; Drones.

Current state in the LATAM region

The term port digitalization was considered broadly as conceptual framework to pivot around throughout the study. Via desk research and interviews with key stakeholders, the current state of ports in the LATAM region was assessed. The countries to consider were Argentina, Chile, Peru, Colombia, Panama, Costa Rica and Mexico.

The institutional framework of these countries, as an important qualitative metric to determine the influence of the State to enable or hinder a digital transition in the port system, is presented in chapter 3.2.

Moreover, via desk research and interviews with key stakeholders, current trends in port digitalization have been identified for the target countries.

Technology	Argentina		Chile		Colombia		Costa Rica		México		Peru		Panama	
	[AR1]	[AR2]	[CL1]	[CL2]	[CO1]	[CO2]	[CR1]	[CR2]	[MX1]	[MX2]	[PE1]	[PE2]	[PN1]	[PN2]
Open Platforms	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Automation & robotics	IP	X	Y	IP	IP	Y	X	X	Y	Y	Y	X	X	IP
Internet of Things	X	X	Y	X	Y	X	X	X	Y	X	Y	IP	Y	Y
Artificial Intelligence (AI)	X	X	X	X	X	X	X	X	Y	Y	IP	X	Y	Y
Virtual/Augmented/Mixed Reality	X	X	X	X	Y	X	X	X	Y	X	X	X	IP	Y
Blockchain	X	X	IP	X	IP	IP	Y	X	X	X	IP	IP	X	X
Big Data	X	X	X	X	X	X	X	X	X	X	IP	X	IP	IP
Cloud Computing	X	X	Y	Y	X	X	X	X	X	X	IP	X	IP	IP
5G	X	X	IP	IP	X	X	IP	X	X	X	X	X	X	X
Drones	X	X	X	X	X	X	X	X	IP	IP	X	X	X	X
Presence of Start-up port accelerators	X	X	X	X	Y	X	X	X	X	X	X	X	X	X
[AR1]: Port of Buenos Aires [AR2]: Port of Rosario	[CL1]: Port of San Antonio [CL2]: Port of Valparaíso		[CO1]: Port of Cartagena [CO2]: Port of Buenaventura		[CR1]: Port of Limon-Moín [CR2]: Port of Caldera		[MX1]: Port of Manzanillo [MX2]: Port Lázaro		[PE1]: Port of Callao [PE2]: Port of Paíta		[PA]: Puerto Balboa [PA2]: Rodman Port			
Y= Found deployed solutions making use of particular technology in port sector X= No Data found on deployed solutions making use of particular technology in port sector IP= Found solutions currently In Progress														

From the table above, the following can be concluded:

- Open neutral platforms, via PCSs and SWs, have been identified as top priority for all targeted ports, both via desk research as well the interviews with stakeholders in the LATAM region. Furthermore, different levels of automation of operations have been identified in countries such as Chile, Mexico, Panama or Colombia. With respect to the new emerging technologies, IoT as understood in the present study is slowly gaining momentum in several countries. Little presence has been found on the remaining emerging technologies.
- Furthermore, it was considered important to assess the entrepreneurial ecosystem, as an important pillar to harness the potential of new ideas and emerging technologies to come up with solutions that solve complex problems in the port sector. Little presence has been found in the LATAM region, with Colombia being the only country currently having incubators related to the port sector. Progress is also under way in Panama, where Dutch accelerators are involved.
- Many of the technologies are labelled with an “X”, meaning that solutions making use of those technologies could not be found throughout the study in the selected ports of LATAM. This does not mean that they are not currently under use, in one

way or another, by one or several users within the port communities in the LATAM sector.

Besides the current state, a scan of open calls and tenders in the field of port digitalization was made. The following have been identified, which again confirms the focus on open platforms in the LATAM region:

Country	Theme	Contracting framework	Potential budget	Source
Colombia	Open Platforms (Maritime Single Window implementation)	To be confirmed	USD\$\$\$	Interviews/ desk research
Chile	Open Platforms (Port Community System San Antonio (PCS) San Antonio Port Authority)	To be opened (2021)	USD\$ 4.200.000 including operational costs, for a 6- year contract	Interviews/internal network
Chile	Open Platforms (Port Community System Valparaíso (PCS) Valparaiso Port Authority)	Opened (23/10/2020)	USD\$ 2.000.000 including operational costs, for a 5- year contract	Interviews /internal network

Opportunities for Dutch businesses in LATAM

Interviews with Dutch organizations were conducted to assess their view on the LATAM region, strengths and possibilities for market entry or expansion in Latin America.

The following were identified as key opportunities for the Dutch businesses:

- *The momentum created by COVID-19*
- *The call for sustainable ports*
- *Technological gap*
- *Knowledge gap*
- *Specific needs and corresponding opportunities as described on page 9-12*

Challenges for Dutch businesses in LATAM

Major constraints hindering the acceptance and adoption of new technologies and digital solutions in the port sector in LATAM were also identified. These bottlenecks were clustered into four domains: technical; economic; institutional & legal; and cultural. Some of the bottlenecks are common in the port industry, while others are more contextual to regions such as Latin America.

Domain	Bottlenecks found for Dutch businesses
Technical	<p>[1] Lack of IT infrastructure capacity in the LATAM region [2] Lack of technology-based qualified personnel in IT by the port users in the LATAM region [3] Digital solution fails to meet the unique context/problem of a particular port [4] Lack of cybersecurity systems</p>
Economic	<p>[5] High import taxes on foreign products/services in LATAM [6] Fluctuating exchange rate for Dutch businesses in LATAM [7] Cheaper labor in LATAM [8] Budget constraints and siloed investments in IT by public/private port stakeholders in LATAM [9] High investment costs</p>
Institutional & Legal	<p>[10] Complex governance structures in port communities in LATAM [11] High turnover of government representatives in LATAM [12] Lack of human resources in the public sector in LATAM [13] Lack of clear strategic vision on port digitalization in LATAM [14] Lack of harmonized regulatory frameworks [15] Contracting with public sector is done in Spanish mainly [16] Contracting with public sector may require local office/representative [17] Contracting in LATAM takes time</p>
Cultural	<p>[18] Lack of understanding of local culture by Dutch businesses [19] Local stakeholders prefer local service providers [20] Skepticism by port stakeholders to implement digital (data sharing) products due to (a) lack of trust and understanding of products and (b) high perceived risks. Change management bottlenecks</p>

Plan of action

Understanding that the opening of business in port digitalization goes beyond an IT “plug-and-play” process, a comprehensive and multidisciplinary plan of action was proposed. These involve the following:

[A1] Promotion of dialogues between Dutch and LATAM stakeholders

[A2] Advice on the establishment of local offices or local agents

[A3] Informal networking

[A4] Promote knowledge building in the LATAM region

[A5] Build a Digital Showcase of the Dutch offering in port digitalization

[A6] Taking advantage of the regional network through RBD LATAM and the Embassies

[A7] Participation in different sector events throughout the region

Action item	Barrier to target				Dutch involvement ¹	
	Technical	Economic	Institutional & Legal	Cultural	Public ²	Private ³
[A1] Promotion of dialogues between Dutch and LATAM stakeholders	✓			✓	High	High
[A2] Advice on the establishment of local offices or local agents		✓	✓		High	High
[A3] Informal Networking				✓	Low	High
[A4] Promote knowledge building in the LATAM region	✓	✓	✓	✓	High	High
[A5] Digital Showcase	✓	✓			Low	High
[A6] Taking advantage of the regional network through RBD LATAM and the Embassies		✓	✓		High	High
[A7] Participation in different sector events throughout the region	✓	✓		✓	High	High
¹ Involvement in terms of time. ² Public Dutch stakeholders may refer to any Dutch governmental organization. ³ Private Dutch stakeholders mainly refer to companies which could potentially start or increase business in the LATAM region.						

Needs based on research and consultation with stakeholders (Latin America)	Identified port (country)	Potential opportunity
<p>Technical advice for the design and implementation phases of Port Community Systems (PCS) and Maritime/Single Windows</p>	<ul style="list-style-type: none"> • Port of Cartagena (Colombia) • Port of Buenaventura (Colombia) • Port of Rosario (Argentina) • Port of Balboa (Panama) • Port of Manzanillo (Mexico) 	<ul style="list-style-type: none"> • Providers of PCS, software and operation systems. • Technical assistance providers for the design of a Port Community System (PCS). • Providers of centralized platforms to share data in real time with the objective of aligning/coordinating actors in the logistics chain.
<p>Technical advice for the improvement/expansion and development phases of Port Community Systems (PCS) and Maritime/Single Windows</p>	<ul style="list-style-type: none"> • Port of San Antonio (Chile) • Port of Valparaíso (Chile) • Port of Buenos Aires (Argentina) • Port of Callao (Perú) • Port of Caldera (Costa Rica) 	<ul style="list-style-type: none"> • Providers of PCS, software and operation systems. • Technical assistance providers for the development/expansion of a Port Community System (PCS). • Providers of centralized platforms to share data in real time with the objective of aligning/coordinate actors in the logistics chain.
<p>Optimization in the planning and control of the arriving vessels process; control over the handling of cargo and access; optimization of operations and performing due diligence.</p>	<ul style="list-style-type: none"> • Port of Cartagena (Colombia) • Manzanillo International Terminal (Panama) • Port of Buenaventura (Colombia) • Port of San Antonio (Chile) • Port of Lázaro (Mexico) 	<ul style="list-style-type: none"> • Providers of TOS / CTOS (Terminal Operating Systems / Container Terminal Operating Systems). • Providers of technical assistance services: maintenance, software upgrades, remote technical services and database administration. • Providers of tools that incorporate solutions to track and trace all logistics processes including cargo containerization activities.

<p>Implementation of cargo scanners (Non-intrusive inspection system) in ports and borders.</p>	<ul style="list-style-type: none"> • Port of Limón-Moín (APM Terminals, Costa Rica) • Port of Buenaventura (Colombia) • Port of Rosario (Argentina) 	<ul style="list-style-type: none"> • Providers of scanner equipment, software, but also knowledge exchange and capacity building regarding scanning of cargo/custom protocols.
<p>‘Awareness’ training aimed at explaining and understanding the digitalization process: investment by port operators, digital transformation as a development strategy which also has a positive economic, environmental and social impact.</p>	<ul style="list-style-type: none"> • Most of the ports mentioned in Table 3 fit this need as digitalization is still understood as ‘relatively new’ in Latin America and effective change management will be needed. 	<ul style="list-style-type: none"> • Advisory services and training on the importance of digital transformation, so that port workers value the plans that exist in terms of digitalization and understand the benefits they bring in the medium and long term. • Providers of consultancy able to change the concept of digitalization; explain that the process can be much more all-encompassing than today is the case.
<p>Improved efficiency in port operations and modernization of port infrastructure through expansion and automatization.</p>	<ul style="list-style-type: none"> • Port of Cartagena (Colombia) • Port of Callao (DP World terminal, Perú) • Port of Buenaventura (Colombia) • Port of Rosario (Argentina) • Port of Valparaíso (Chile) • Port of Limón-Moín (Costa Rica) • Cristobal Port (Panama) 	<ul style="list-style-type: none"> • Providers of spreaders, cranes, port infrastructure and safety equipment. • Renovation of port maneuvering/infrastructure equipment. • Virtual reality technologies that provide real time information regarding the movement of goods in the terminals.
<p>Other digital solutions that aim to optimize the ‘port call inefficiency’ through information/data exchange.</p>	<ul style="list-style-type: none"> • Port of San Antonio (Chile) • Port of Valparaíso (Chile) • Port of Cartagena (Colombia) • Port of Callao (Perú) • Port of Buenos Aires (Argentina) • Port of Rosario (Argentina) • Port of Manzanillo (México) 	<ul style="list-style-type: none"> • Providers of shared platforms for port operators and users. • Providers of digital technologies for maritime supply chains. • Providers of ‘Travel time predictions’ technologies. • Providers of design and implementation of supply chain predictive systems.

	<ul style="list-style-type: none"> • Colon Container Terminal (Panama) 	
Implementation of cloud computing technologies for ports and terminals internal management.	<ul style="list-style-type: none"> • Port of Limon-Moín (Costa Rica) • Port of Caldera (Costa Rica) • Port of Manzanillo (México) • Port of Lazaro (México) • Port of Rosario (Argentina) • Cristobal Port (Panama) 	<ul style="list-style-type: none"> • Providers of ERPs (Enterprise Resource Planning Systems) and CRMs (Customer Relationship Management Systems) and Bis (Business Intelligence Systems).
Investment in better availability of local networks and the lagging coverage of GPRS, 4G and 5G mobile Broadband for port sector.	<ul style="list-style-type: none"> • Port of Limon-Moín (Costa Rica) • Port of Caldera (Costa Rica) • Port of Buenaventura (Colombia) • Port of Rosario (Argentina) • Port of Buenos Aires (Argentina) 	<ul style="list-style-type: none"> • Telecommunication and IT infrastructure network providers.
Strengthened technical expertise in data analytics, business intelligence capabilities, and artificial intelligence solutions for the port operators/managers.	<ul style="list-style-type: none"> • Port of Rodman (Panama) • Port of Cartagena (Colombia) • Port of Valparaíso (Chile) • Port of Buenos Aires (Argentina) • Port of Callao (Perú) 	<ul style="list-style-type: none"> • Training and consultancy services in data analytics, business intelligence capabilities, and artificial intelligence solutions.

<p>Sustainability policies in the development of port activities, which lead the ports to also focus more on social and environmental issues.</p>	<ul style="list-style-type: none">• Port of Buenaventura (Colombia)• Port of Cartagena (Colombia)• Manzanillo International Terminal (Panama)• Port of Rodman (Panama)• Port of San Antonio (Chile)• Port of Valparaíso (Chile)• Port of Callao (Perú)• Port of Buenos Aires (Argentina)• Port of Rosario (Argentina)• Port of Manzanillo (México)	<ul style="list-style-type: none">• Consultancy for the design and application of sustainability policies and strategies, through training in environmental care, advice on modernization of equipment and technologies, and activities for the development of external community management.
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1. Introduction and Background

With about 80% of world trade carried by sea, ports are an integral part of the global economy. In the past decades, both intra and inter port competition, coupled with increased global container traffic, has significantly influenced the port geography in several regions across the globe. For the case of Latin America (LATAM), ports such as Colon (Panama); Santos (Brazil); Manzanillo (Mexico); Cartagena (Colombia); El Callao (Peru); or San Antonio (Chile) are nodes with strengthened container flows in the region, which shape the transport flow patterns throughout the continent.

Today's maritime supply chains have become increasingly complex, especially due to the large number of processes and stakeholders that need to interact and sometimes communicate in short time spans, for instance during a ship's arrival. Having a high level of manual administrative processing and paperwork, combined with other unpredictable factors, imply that the risk of sub-optimal processes is still substantial, not only in the LATAM region, but across the globe. This has not only an impact from an operational perspective, but also from an environmental point of view. As an example, an inefficient port call process can lead to a "hurry and wait" behavior for ships steaming towards ports, which means an increased use of fuel by the vessels, and therefore of GHG emissions. Studies by the International Maritime Organization (IMO) in 2014 suggested that, under Business as Usual scenarios, emissions from maritime shipping could increase between 50% and 250% in the period up to 2050, being congestion and inefficient port call processes some of the reasons behind this trend.

In this sense, ensuring efficient port operations and processes can ensure sustainable port activities, while attracting cargo, businesses and therefore bringing economic growth. In emerging economies, a common approach of many ports and national strategies has been to increase infrastructure capacity as a way to capture increasing international trade and promote local economic development. Considering that ports are highly asset intensive, investing in greenfield projects can be costly for all users involved, with long payback periods. An increasing and complementary alternative could be making better use of the existing infrastructure, with digital technologies being among some of the key enablers.

1.1. Understanding port digitalization

“Digitalization” has become one of the main keywords around academic and professional port communities. In dynamic markets, businesses seek to embrace digitalization, innovation and technologies in order to stay competitive. To meet current and future challenges, many ports have been embarking in the implementation of digital technologies to transform themselves into “smarter” ports.

This trend has even gained more momentum as a result of the outbreak of the COVID-19 pandemic. Indeed, the need for more resilient supply chains in the form of remote operations, paperless administrative or financial processing, or any other digital exchange of information between companies and authorities has been further emphasized. Not only to ensure benefits of efficient and environmentally friendly operations, but also to ensure safety of port labor.

Despite the hype, there is a lack of internationally accepted definitions around “smart”, “digitization” or “digitalization” (the last two often used indistinctly¹) in the context of ports. For instance, when talking about “smart ports”, many experts look with more detail into a particular element or activity of a port, while some look into a broad picture of the port as a whole cluster, depending on their backgrounds, areas of expertise and particular interests. Others argue that, given the uniqueness of each port, a definition of a smart port is simply not possible. Having the previous in mind, we will refer to the **port of the future** as:

A port that continuously uses, together with educated individuals and skilled workforce, technology as a tool to enable intelligent infrastructures; facilitate data sharing and connectivity; and help the workforce make better informed decisions².

Applying a proper use case of those technologies, by solving complex problems in one or several port domains, can bring one or several of the following benefits to the port as a whole:

- Optimize port operations
- Guarantee safer, more secure and environmentally friendly port activities
- Enhance port resiliency and flexibility in the different port activities

In other words, those technologies can improve current business models and bring additional value to the port community as a whole. Therefore, **port digitalization** will be considered here broadly as:

¹ According to Gartner Glossary, digitization means changing an analog process to a digital form. Conversely, digitalization refers to the use of digital technologies to change a business model and provide revenue and value-producing opportunities. It is important to note that these two concepts are used under the same term in Dutch (*digitalisering*) which can sometimes induce confusion.

² For a good overview on Smart ports, see *Molavi et al (2019), a framework for building a smart port and smart port index*.

The continuous use of technologies to come up with solutions that can help ports and their users improve some or many of their processes and activities, from an operational, environmental, safety & security, energy, institutional or human resources perspective.

Table 1 below summarizes, for display purposes and without being exhaustive, some of the emerging technologies, which can be digital-based only or combined with physical components and systems, that are usually considered when talking about port digitalization. It must be noted that solutions in the port sector can include one or several of such emerging technologies. Use cases that are gaining attention can be AI decision-support tools that assist humans with accurate prediction in real-time of the arrival of vessels. Also, digital replicas of physical assets (digital twins) can make use of other emerging technologies (IoT coupled with AI and cloud) to gain insights into the operation of machines and infrastructure. Port Community Systems (PCS) are also streamlining administrative and financial processes via a single window to exchange information within the port community on a Business to Business (B2B) level and Business to Government (B2G) level. Yet, it is also true that the body of available port digitalization benchmarking studies is still limited. One of the first attempts is seen in Figure 1 where the authors developed, based on desk research and consultations with key stakeholders, a Smart Port Index to compare vis-à-vis the level of digitalization of several ports around the world.

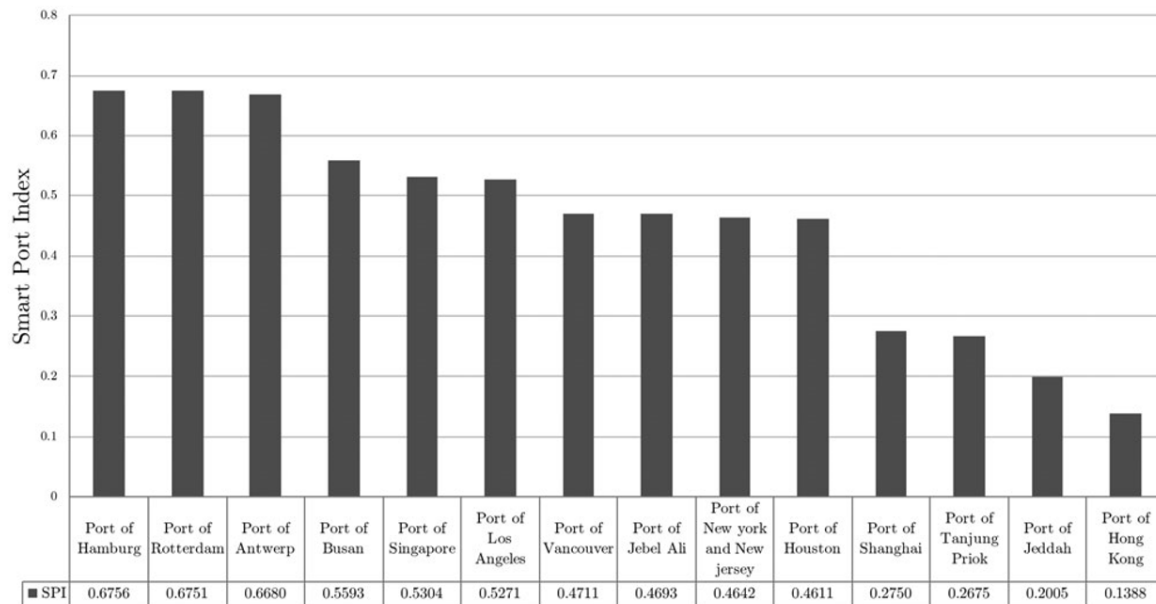


Figure 1. Smart Port Index as a reference of digital maturity around the world. Source: Molavi et al (2019).

Table 1. Overview of emerging technologies and some of their use cases within the port industry.

Technology	Definition	Use cases in ports
Open Platforms	Neutral platforms which enable exchange of information between public and/or private stakeholders.	Port Community Systems, Single Windows, ...
Automation & robotics	Using machines or robots, coupled with control systems and other technologies to perform to automate physical processes.	Automated equipment (cranes, AGVs, ...)
Internet of Things ¹	Network of physical devices which are connected and exchange data. Key enabler of other emerging technologies.	Track & Trace, situational awareness of assets, Environmental control, Maintenance control, safety & security, ...
Artificial Intelligence (AI)	Broad discipline with the goal of creating intelligent machines. Its main engine is Machine Learning (ML).	Event prediction and decision support: (ETA, ETD, planning or route optimization, ...)
Virtual/Augmented/Mixed Reality	Immersive technologies that provide the user with more and real-time information regarding the surroundings and environment of the user.	Training in the port and maritime sector (i.e. accident with dangerous goods)
Blockchain	Open, distributed ledger that can record transactions between parties in a secure and permanent way, providing transparency and traceability.	Smart Contracts, electronic BoL, container release
Big Data	Capability to handle large loads of fast, unstructured data, with the purpose of extracting value from the data.	Handling of web traffic, analytics of data
Cloud Computing	Model for enabling network access to a scalable and elastic pool of shareable physical or virtual resources with self-service provisioning and administration on demand.	Back other technology-led applications (i.e. IoT or AI) by storing and processing large quantities or data/information
5G	"Fifth Generation" of mobile technology, which increases bandwidth for enhanced wireless communication of connected devices.	Enhanced connectivity among users and infrastructure within the port
Drones	Vehicles without human pilot aboard. They can be remotely operated or fully autonomous, and air-based or aquatic.	Infrastructure/superstructure inspections and surveillance, movement of goods
¹ For simplification purposes, the term IoT includes broadly sensing elements (RFID tags, GPS, infrared, cameras, ...) which can sometimes be considered as separate.		

1.2. Purpose of the study

The knowledge and expertise built in the Netherlands with respect to port digitalization can potentially be used to bridge the digital gap with other regions across the world, including the LATAM region. In this sense, it must be noted that the progressive use of digital technologies in ports is not just an isolated IT project, but rather a continuous, multi-disciplinary and multi-stakeholder process. Having this in mind, Dutch organizations with different angles of expertise have the potential to provide different kinds of services in ports in LATAM. This ranges from IT implementation to capacity building in the sector or other type of consultancy services.

Significant progress is already under way in the LATAM region. Many countries have reported the implementation of National Single Window concepts for G2G and B2G exchange of information³. Moreover, many ports such as the Autoridad Portuaria Nacional (APN) in Peru, are undergoing an ambitious PCS development plan. Other examples can be found for instance in the Empresa Portuaria de Valparaíso (EPV) in Chile. Yet, the lack of benchmarking digital studies in ports in the LATAM region suggest a potential niche for follow-up work.

Against this background, the purpose of this study is to assess the state of play of digitalization in selected ports of the LATAM region, with the goal of exploring potential opportunities and a market niche for Dutch businesses.

1.3. Scope of the study

As already mentioned, this study plans to match the needs and demands for digitalization within the port sector in the Latin American region, with the purpose of identifying opportunities for Dutch companies, as well as potential challenges.

The sample and information gathered from the following selected countries is considered for this study to be broad enough to extract general conclusions in Latin America: Mexico, Costa Rica, Panama, Colombia, Peru, Chile and Argentina. Moreover, supply and demand of solutions making use of the technologies from Table 1 will be tentatively targeted, making use of the methodology outlined below.

³ UNECLAC (2017). Trade facilitation and paperless trade implementation in Latin America and the Caribbean. Available at: https://www.unece.org/fileadmin/DAM/trade/TF_JointUNRCsApproach/ECLAC-RegionalReport_2017.pdf

1.4. Methodology

The study herein presented is divided into three phases, which will combine desk research and consultations with key stakeholders both from the LATAM region as well as the Netherlands and other international organizations, whenever necessary.

Phase 1: Understand & Define

This phase consists of mapping and understanding the state of play in Latin America by performing desk and field research. This includes conducting interviews from which different perspectives will be obtained.

Phase 2: Analyze

In this phase, the challenges and possibilities in the market for digitalization in Latin America will be analyzed and the possible shortages and inefficiencies will be identified. The objective of this phase is to formalize observations and data in a structured way, using different formats to convey the information. All information found in phase 1 will be compared and interpreted to identify opportunities and challenges for Dutch businesses.

This phase will result in a profound analysis and connections that will be used as input for the report, describing the main issues and all relevant content and answers to the research questions.

Phase 3: Conclude

In the last phase, the team will come to conclusions, based on the feedback from the embassies on the previous phases, and determine the way forward for Dutch businesses and other stakeholders. A comprehensive roadmap will be proposed in order to offer Dutch businesses the right guidelines.

For the desk research, major sources will come from academic papers, public articles or reports from companies, port authorities, government bodies or international organizations (i.e. Interamerican Development Bank, IPCSA, UNCTAD, etc.), as well as online webinars which in one way or another can add value to the present study. Regarding the interviews, key stakeholders in the LATAM region come from port authorities as well as institutions, public or academic organizations. Multilateral organizations will be tentatively targeted as well. An overview of the main stakeholders to target is given in Chapter 3. Regarding the Dutch stakeholders, more detail can be found in Chapter 4.

2. The impact of COVID-19 on world trade

The global pandemic caused by COVID-19 has been reflected in major media headlines all around the world through most of 2020. Apart from the concerning health challenges, the spread of the virus sequentially caused a complete lockdown of many countries, first in PR China and then in the rest of the world.

Due to the configuration of global trade flows, with the Asian Giant playing a pivotal role and therefore a state of dependency, the pandemic created a reaction chain that has completely shaken flexibility, predictability and resiliency of global supply chains.

As a result, world trade fell sharply during part of 2020. Figure 2 depicts the evolution of world trade, and the expected forecasts under different scenarios.

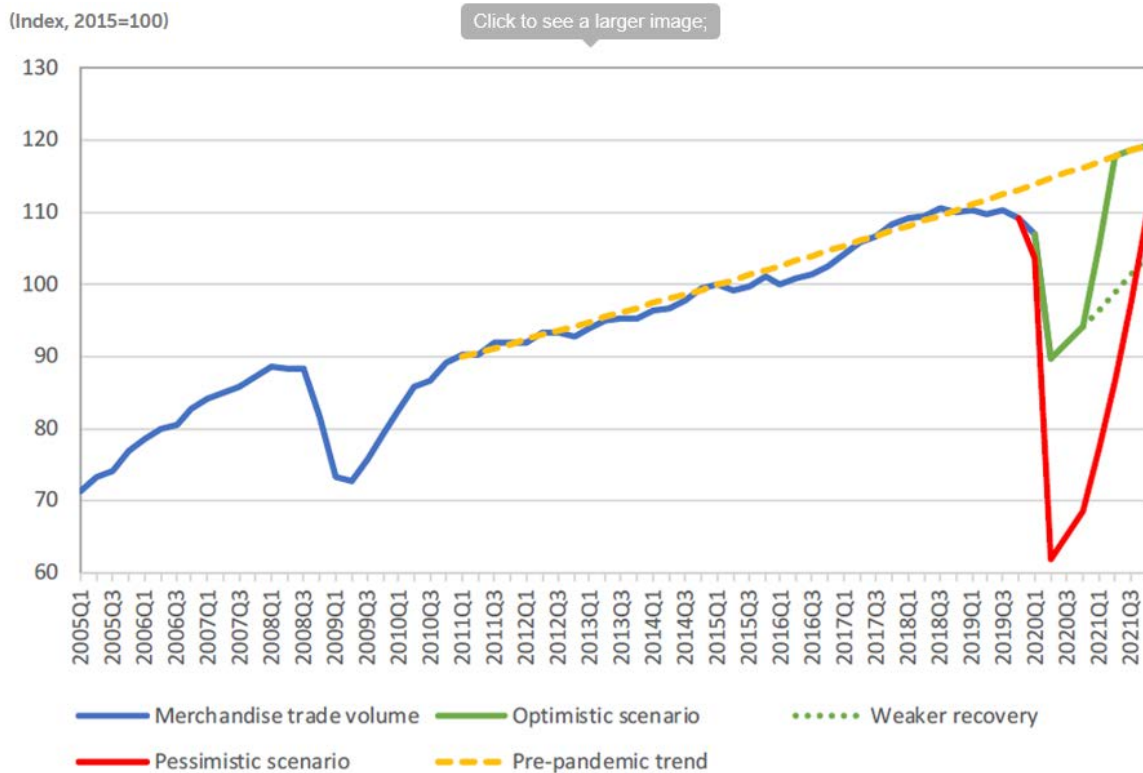


Figure 2. World merchandise trade volume estimates up to Q4 of 2021. Source: WTO Secretariat.

2.1. The impact on port throughput in LATAM

This drop in world trade has impacted shipping, and therefore the number of port calls and port throughput. According to an UN-ECLAC report⁴, container throughput in Latin America and the Caribbean, between January and June of 2020, has fell sharply by an average of 7% compared to the same period in 2019.

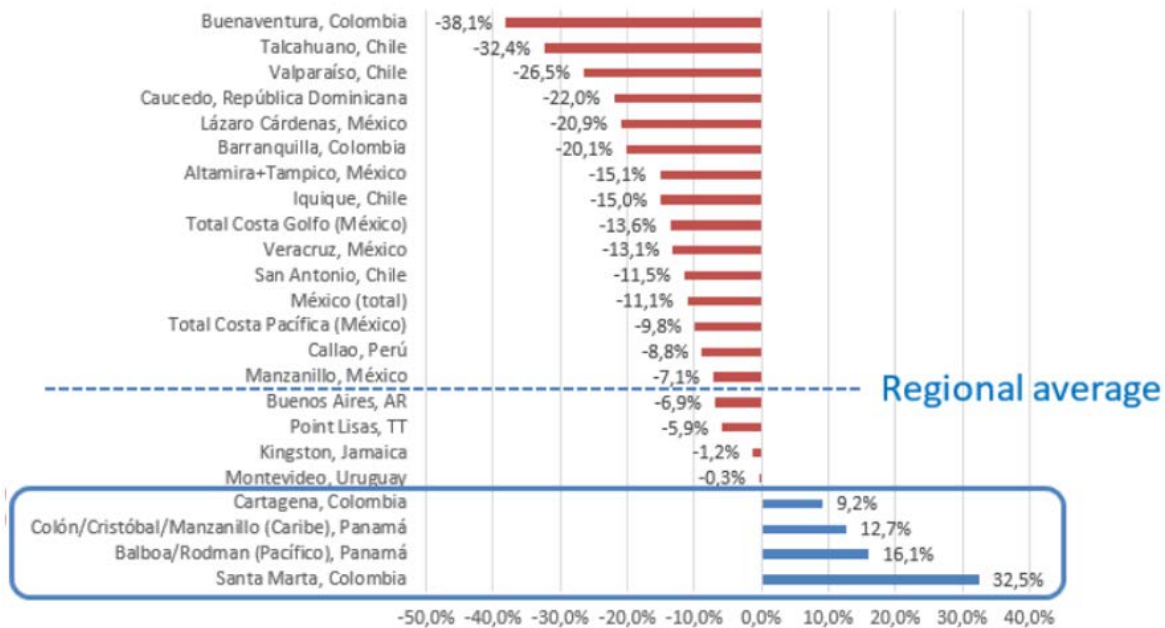


Figure 3. Throughput change in selected ports of Latin America and Caribbean, comparing June-July periods in 2020 and 2019. Source: UN-CEPAL.

2.2. COVID-19 as new Driving Force of digitalization?

Aside from potential discussions on world trade flows, there is general consensus that ports should make use of digital-based technologies to ensure they can act as resilient and vital nodes in supply chains⁵.

This seems to have translated into a higher attention among management bodies of port stakeholders. Such trend is to be confirmed with the interviewed stakeholders in the LATAM region.

⁴ See UN-CEPAL, *La calma antes de la tormenta: comportamiento del movimiento de contenedores en los Puertos de América Latina y el Caribe en 2019 y de los principales puertos durante los primeros meses de 2020*, available at [link](#).

⁵ For some references, see links [1](#), [2](#), or [3](#).

3. Current state in the Latin American region

This chapter starts by presenting a brief diagnosis of the port sector, for each of the countries, based on desk research and interviews with main stakeholders from the LATAM region. For each country, the LPI (Logistics Performance Index) score is presented as a point of analysis for its efficiency in logistical terms. The LPI is taken from an average of six variables, including customs performance, infrastructure quality, and timeliness of shipments, among others.

The current institutional framework of each of the countries has been identified: Government Stakeholders, Regulatory Laws in relation to the port sector and the Port Authority Contracting framework. At the end of this chapter, current trends in port digitalization that have been adopted by each country are identified.

As preliminary finding, it should be highlighted that each port has a particular context and characteristics.

In this study we will not describe the port system and framework per country in detail, but build upon the already existing information. Several studies have been executed by the Embassies of the Kingdom of the Netherlands in Latin America and other organizations (such as third parties contracted by RVO) in past years. These give a general overview and can be consulted by interested Dutch companies.



3.1. Port diagnosis

3.1.1. Peru

The port logistics node plays an essential role in Peru's exports and imports. It is estimated that approximately 72% of exports, in value terms, and 85% of imports are carried out by sea.

The total cargo handled by these terminals varied 2.0% in the last year, going from 51.74 million tons in 2018 to 52.77 in 2019. Of that total, 49% corresponded to containers, and the remainder to non-containerized merchandise, solid bulk, liquid bulk or rolling cargo (Desarrollo Portuario, 2020).

The National Port System has 60 port terminals and 41 piers. Of the 60 terminals, 14 are for public use (12 multipurpose and 2 specialized). In addition, 46 of the 60 terminals are for private use (44 specialized and 2 multipurpose).

Most advanced ports in digitalization:

- Puerto El Callao
- Puerto Paita

LPI Score (2018): 2.69



3.1.2. Argentina

According to the Chamber of Port and Maritime Activities of Argentina, the country has an extensive maritime coastline and a waterway of relevant importance (made up of the De la Plata, Paraná and Paraguay rivers). On this space, there is a set of port facilities that are part of the network for Public and Private use. Most of the country's foreign trade is carried out through this route, it is estimated that approximately 93% of exports, in value terms, and 75% of imports are carried out by sea.

The total cargo handled by these port terminals varied -15,2% in the last year, going from 2,0 million TEU in 2018 to 1,7 TEU in 2019. (CEPAL, 2019).

Most advanced ports in digitalization:

- Port of Buenos Aires
- Port of Rosario

The main cargo activities of the Argentine ports include operations with liquid bulk cargo (mainly hydrocarbons and their derivatives); solid bulk cargo (including largely minerals and grains) and container cargo.

LPI Score (2018) of Argentina: 2.89



3.1.3. Chile

According to the Ministry of Transport and Telecommunications of Chile, the port system is made up of 56 ports: 10 state ports for public use, 14 private ones for public use and 32 private ones for private use. Each port plays a leading role in the economic development of their respective regions, serving the foreign trade and cabotage needs of several cargo generators.

The total cargo handled by these port terminals varied -4,0% in the last year, going from 3,16 million TEU in 2018 to 3,03 TEU in 2019. (CEPAL, 2019)

Most advanced ports in digitalization:

- Port of San Antonio
- Port of Valparaíso

LPI Score (2018) of Chile: 3.32



3.1.4. Colombia

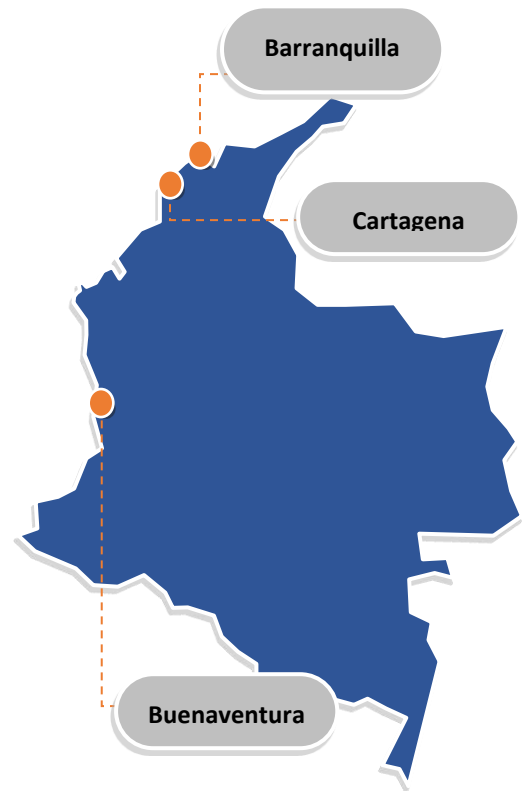
Currently in Colombia there are ten maritime port areas, which handled 195.2 million tons in 2019. However, nine of these port areas handle all the maritime cargo of Colombian foreign trade. The tenth port zone located on the Magdalena River, which includes the ports that operate on the river, mobilize internal cargo. For the nine port zones located in coastal areas, there are 78 port concessions that move different types of cargo.

Most advanced ports in digitalization:

- Cartagena Port Area
- Buenaventura Port Zone

According to the number of concessions per port area, the Cartagena Port Area is the one with the largest number of concessions and port terminals. At present, it has 29 concessions and 21 active port facilities, which represent 37% of the total maritime concessions from Colombia. In second place is the Barranquilla Port Zone, with 19 concessions and 10 active port terminals, which represent 24% of the total concessions. Finally, in third place is the Buenaventura Port Zone, which with 8 concessions and 5 port facilities represent 10% of the country's total maritime port concessions.

LPI Score (2018): 2.94



3.1.5. Costa Rica

Costa Rica has a complex port system that serves the movement of people within the country, fishing activities, and leisure and tourism activities. Its maritime sector has ports with international traffic, port facilities dedicated to cabotage traffic and inland water traffic. There is a balanced number of fishing ports and a small number of sports marinas, in contrast to the importance of tourism. Costa Rica has 7 ports with international traffic, five of which are on the Pacific side and are managed by INCOP (Puerto Caldera, Puntarenas, Fértica, Punta Morales, Puerto Golfito) and two on the Atlantic side which are managed by JAPDEVA (Puerto Limon and Puerto Moín).

Most advanced ports in digitalization:

- Limon-Moín Port Complex
- Puerto Caldera

The two main ports are Limón and Moín (generally seen as a single port complex) on the Caribbean coast and Puerto Caldera, on the Pacific coast. Limón-Moín handles more than twice as much cargo as Puerto Caldera, respectively 11.5 million tons versus 5.2 million tons. During 2018, the Limon-Moin port complex and Puerto Caldera handled 97.4% of the merchandise traffic; 67.1% of this traffic took place in the Limon-Moin port complex. Both ports suffer from congestion and infrastructure limitations (water depth, number of berths), although more frequently in Limón-Moín than Puerto Caldera. The distance by road from Puerto Caldera to the Metropolitan Area of San José, is shorter than from Limón-Moín and also less congested. In Moín, APM Terminals is developing the Moín Container Terminal (TCM). This project will provide Costa Rica with a deep-water container terminal capable of receiving large container ships.

LPI Score (2018): 2.79



3.1.6. Mexico

According to the Mexican Port System, Mexico has 117 ports and 15 terminals outside the port areas. These are distributed in the 11,500 kilometers of national territory that connect with more than 145 countries. In these ports, commercial, industrial, oil, fishing and tourist activities are carried out, and they are also used for military purposes (national navy).

During the past year, it is estimated that the cargo tonnage in Mexican ports was 302.93 million tons, almost 13.5 million tons less than in 2018. The panorama for 2020 is not encouraging, since reports show that the port system operated 7.7% less compared to the same period (January-December) of 2019 (93 million 551 thousand 487 tons of cargo, compared to 101 million 337 thousand 266 tons in 2019) (Dripcapital, 2020).

Most advanced ports in digitalization:

- Manzanillo
- Lázaro Cárdenas

LPI Score (2018): 3.05



3.1.7 Panama

Panama is the main entrance to South America, with a network of seaports that provide a wide range of containerized, bulk, general and liquid cargo services.

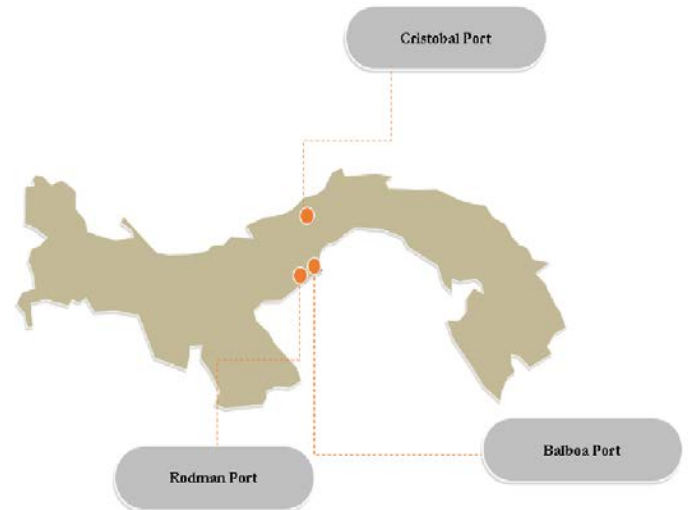
The Panamanian port system closed 2019 with a transfer of 7.31 million TEU. The total cargo handled by the port system was 84,597,799 tons in 2018, making Panama one of the busiest ports in Latin America.

The National Port System of Panama (SNP) is divided into two categories: state ports and private ports. It is made up of 41 ports, of which 22 are managed by the Panama Maritime Authority through the General Directorate of Auxiliary Ports and Maritime Industries.

Most advanced ports in digitalization:

- Balboa Port
- Rodman Port

LPI Score (2018): 3.28



3.2. Institutional framework and stakeholders in LATAM

The following table shows the different laws and Government Stakeholders of the seven countries that are the object of this study. The normative base and the laws that have promoted the modernization processes and, in some cases, the digitalization of the different port systems is then explained. This information can help determine the influence of the State to enable or hinder a digital transition in the port system, and it therefore gives a first look into the legal/institutional framework in each of the countries.

Table 2. Institutional framework and stakeholders in LATAM.

Country	OECD Digital Government index 2019	Regulatory Laws	Government stakeholders	Port Authority Contracting framework
Argentina	0,35	<ul style="list-style-type: none"> - Law 24.093 for port activities in Argentina. - Decree 1029/92 promulgating the Port Activities Law. 	<ul style="list-style-type: none"> - Ministry of Transport - National Directorate for Shipping and Port Policy - Ministry of Economic Development of the City of Buenos Aires 	<ul style="list-style-type: none"> - Federal system and province ports depend of the provinces. - Concessions, tendering, contracting and leasing processes in charge and through the General Administration of Ports of Argentina.
Chile	0,42	<ul style="list-style-type: none"> - Law 19.542 (December 1997) of State port modernization of Chile. - Guidelines of the first National Policy of Artificial Intelligence (AI). 	<ul style="list-style-type: none"> - Ministry of Transport and Telecommunications - Ministry of Science, Technology, Knowledge and Innovation - Ministry of Education 	<ul style="list-style-type: none"> - Public and Private Model with a total of 56 ports, of which 10 correspond to public ports for public use, 14 to private ports for public use and 32 to private ports or private piers. - Concessions in charge and through the 10 Port companies of Chile.
Colombia	0,72	<ul style="list-style-type: none"> - Law No. 1 (January 1991) for maritime ports. - National Development Plan 2018-2022. - National Economic & Social Policy Council (CONPES) No. 3982 on Logistics National Policy (2020). 	<ul style="list-style-type: none"> - Ministry of Environment and Sustainable Development - Ministry of Transport - National Planning Department (DNP) 	<ul style="list-style-type: none"> - Public and Private model. - Concessions in charge and through the General Superintendence of Ports.
Costa Rica	N/A	<ul style="list-style-type: none"> - Law No. 8461 (December 2005) for port activities in Costa Rica. *Updated in 2005 -Bicentennial 4.0 Digitalization Strategies - Institutional Strategic Plan 2019-2022. 	<ul style="list-style-type: none"> - Ministry of Public Works and Transportation (MOPT) - INCOP - JAPDEVA - National Council of Concessions (CNC) 	<ul style="list-style-type: none"> - Public and Private model. - Concessions in charge and through the National Council of Concessions. - Publications of tenders through the Integrated System for Procurement (SICOP) - https://www.sicop.go.cr/index.jsp.
Mexico	N/A	<ul style="list-style-type: none"> - Ports Act (July 1993) *updated in 2014. - Regulation of the Ports Law. 	<ul style="list-style-type: none"> - General Directorate of Ports - Integral Port Administrators (API) 	<ul style="list-style-type: none"> - Public and Private model. - Concessions in charge and through the Secretariat of communications and transport.

		<ul style="list-style-type: none"> - National Port Development Program – PNDP. 	<ul style="list-style-type: none"> - Ministry of Communications and Transportation - General Directorate for Port Development and Administration 	<ul style="list-style-type: none"> - Publications of tenders through the Official Gazette of the Federation - https://www.dof.gob.mx/.
Peru	N/A	<ul style="list-style-type: none"> - Law No. 27943, Law of the National Port System (2004). - Port Development Plan (2012) - National Exporting Strategic Plan: PENX 2025 (2013). 	<ul style="list-style-type: none"> - Ministry of Transport and Communications (MTC) - National Port Authority (APN) - Supervisory Agency for Investment in Public Use Transport Infrastructure (OSITRAN) - Regional Port Authorities (APR) 	<ul style="list-style-type: none"> - Landlord model. - Concessions in charge of the General Directorate of Transport Concessions of the MTC. - Supervision of contracts by OSITRAN. - Publication of tenders and bidding process through PROINVERSIÓN - http://www.proinversion.gob.pe/.
Panama	0,35	<ul style="list-style-type: none"> - Law No. 56 (2009) General Law of Ports. - Law 144 use of electronic means for procedures. - Port Maritime Development Plan by 2040. 	<ul style="list-style-type: none"> - Panama Maritime Authority (AMP) - National Customs Authority - Panama Maritime Chamber - AIG (National Authority for Government Innovation) - ACP (Panama Canal Authority) - Logistic Cabinet and Georgia Tech 	<ul style="list-style-type: none"> - Private and public model (from 41 ports in total, 22 are managed by the Panama Maritime Authority). - Concessions in charge of: Panama Maritime Authority.

3.3. Port digitalization trends in LATAM

Argentina

Argentine ports have made progress in identifying the needs to adopt port digitalization practices such as the Maritime Single Window and the implementation plans for Port Communities, as in the case of the Port of Buenos Aires.

The efforts by the General Administration of Ports promote the interoperability of its systems in the first prototype of a new Port Community System in 2019. Likewise, in the modernization and implementation of the Single Window for Foreign Trade. These initiatives also include important stakeholders such as the National Transportation Regulation Commission (CNRT), the Customs Brokers Center (CDA), the MSW, Customs, Port Terminal Operators, Productive Simplification, Navigation Center and PNA (Argentine Naval Prefecture).

However, achieving a digital transformation in the maritime and port industry still represents a fairly important challenge since it is understood that the new 'digitalization' criterion also incorporates new nuances such as user experience. The more active participation of actors from all over the world, e.g. the logistics-port chain, implies change management directing the business model to the end user. Since the lack of financing is relevant, adoption of new technologies is generally delayed and pricing is considered to be a key element for decision making.

Chile

The ports of Chile are making progress in digitalization processes to maximize the competitive value of the port sector. An important focus is the work that is being done with the implementation of the PCS in the Port of Valparaiso and the major progress in the Port of San Antonio.

The Ministry of Transport and Telecommunications, through the Logistics Development Program (LDP), together with the Chilean Foundation for the Logistics Efficiency Project, has supported the creation of Port Logistics Communities (CLP) so that all stakeholders can analyze if particular technological solutions are implemented in accordance with their different realities. Also, the SEP (Sistema de Empresas Públicas) has been organizing workshops recently for all ports on digitalization developments.

One of the most important digitalization projects led by the Ministry of Transport and Telecommunications, through the LDP, is the Maritime Single Window (MSW), which digitizes the procedures associated with the reception and dispatch of ships that arrive in the country. This is a concrete example of digitalization that generates significant savings in procedures that must currently be submitted to all the public services involved (Agricultural and Livestock Service, Investigative Police, National Fisheries Service, Health, Customs and the Maritime Authority).

Lastly, the Port of Valparaíso has implemented a Smart Port toolkit to facilitate the monitoring and evaluation of the transformation process of the port into a Smart Port⁶.

Colombia

In Colombia, governance and differences between maritime authorities have been obstacles in the implementation of digitalization projects. However, both the public and private sectors have worked on the development of some tools for port digitalization. On the one hand, the public sector launched the Single Window for Foreign Trade in 2004, in order to channel foreign trade procedures for 62,000 users linked to 21 state entities. Within the structure of this single window, a module called the Integrated Simultaneous Inspection System was created. With this tool, the computer systems of the different Colombian foreign trade and port control entities are automated and integrated.

On the other hand, the private sector has been developing a Blockchain-type platform in order to be implemented in the ports of Cartagena and Buenaventura. With the support of the company IBM®, the TradeLens tool is being created, a system to which the 7 shipping companies that handle 87% of world container traffic are registered. The main objective of this tool is to make container and cargo handling processes in general safer, emphasizing the fight against smuggling through ports.

Also, the port of Cartagena together with the corporate accelerator of the Port of Cartagena Group, "DeltaX Ventures", promotes the participation of startups to improve the port logistically. Through contests, this accelerator seeks for startups which offer unique and innovative technological solutions to transform Colombia's foreign trade. These solutions must address port logistics challenges such as connecting land carriers with cargo owners, connecting the supply and demand of services for empty containers, facilitating the logistics of refrigerated cargo through technology, among others.

Costa Rica

In Costa Rica there are several tools and certain digitalization plans that are used to make port operations more efficient. At the state level, there is the Single Window for Foreign Trade updated to version 2.0, which aims to centralize, streamline, simplify and automate foreign trade procedures in Costa Rica. This system allows the automatic approval of export and import permits, availability 24/7, 365 days a year, use of digital signatures, electronic payments, process traceability, and national and international interoperability.

In addition, there is the Japdeva Integrated Port Operations System, a tool that manages all the information of the operations carried out in the ports of Limón and Moín. This covers processes such as the receipt of prior information on the services requested until the departure of the ship. Moreover, the system continues to process information after the ship

⁶ See [Smart Ports Toolkit to transform the Port of Callao \(Peru\) and Port of Valparaíso \(Chile\)](#), presented by another European player.

departure, as it performs the evaluation of the ship's performance, the analysis of the amount of services provided and the collection and settlement of the services provided.

from a more regional point of view, customs offices in Central America are notoriously slow, and there is a lack of coordination between them. Digitalization of customs offices, including their integration into a common systems platform, would significantly speed up the transportation process and reduce waiting times at borders. Customs offices should have a list of "known shippers" and receive digital cargo documents ahead of time, akin to the US-Mexico Free and Secure Trade (FAST) Card program, "a commercial clearance program for known low-risk shipments entering the United States from Canada and Mexico." This would allow for contactless and uninterrupted flow through the borders, while enhancing traceability and collection of duties.

Companies have to pay, at each national border, taxes for services, transit, import duties, and value-added taxes—and they have to pay differently in each country. Of course, the optimal result would be achieved with a customs union in which goods can move freely and be exempt from heterogeneous duties. At a minimum, a unified value-added tax code would reduce the complexities and economic distortions of having different rates and exempt goods. Lastly, there should be no retention of income tax or double taxation for services provided to other companies, or even among subsidiaries of the same company within a region.

Peru

Taking into account the importance of the modernization and transformation of the country's logistics system defined in the National Exporting Strategic Plan 2015-2025 (PENX 2025), the country has been implementing different tools in the area of open platforms such as; VUCE, Port Community System and PortXchange[®] represented in Peru by the consulting firm FIS[®]; as well as Port Management Systems that works as a standard software for each port authority in the country.

In the case of Blockchain there are some initiatives together with IBM[®] in the Callao, Paita and Lázaro Cardenas ports, as well as modernization processes of the Callao port in terms of infrastructure and equipment with Post Panamax and Super Post Panamax type ships. Lastly, the government of Peru has presented, as mentioned for the case of Chile, the "Smart Port Toolkit" project for the digital transformation of the Callao Port, which lays the foundations for its implementation.

Mexico

In order to support the country's business development, the Federal Public Administration promotes the use of information technologies. To achieve this, the Mexican government gives operational continuity to its single window (VUCEM) with the aim of strengthening logistics and facilitating foreign trade operations. While in the case of the Port Community System, the Mexican government continues working on its application to continue with the

“Paperless port” (“Puerto sin Papeles”) Program, which refers to the exchange of information in real time between the different actors involved in the management and review of cargo in ports.

On the subject of automation & robotics, it is important to mention that Kalmar announced that it had signed a contract with the Mexican Port Infrastructure (IPM), consisting of providing two STS dock cranes and three-yard cranes RTG for the Altamira port, same case for the ports of Manzanillo and Lázaro Cardenas, which add automation tools to their fleets. Now, with the aim of being closer to the users of the Port of Altamira and facilitating the procedures that they carry out daily, the Integral Port Administration of Altamira and the Port of Manzanillo, offers users, companies, employees, visitors, students and the community in general, a mobile application to be in close contact with port and industrial activities; situation that makes them leaders in Paperless Ports.

On the other hand, in the ports of Manzanillo and Lázaro Cardenas a technological solution in the cloud that makes use of Artificial Intelligence and Machine Learning called EVAPOR is being used; as well as the recognition and start of the implementation of drones in these two ports who intend to use this type of technology for reconnaissance exercises and scans.

Panama

In Panama, the presence of larger vessels on the region's routes has generated an indirect pressure on the ports for a technological update, design and procedures operating in the container terminal facilities, in order to have the capacity of serving more than 13,000 TEU capacity (ANDI, 2019). For this reason, the national digitalization tendencies are proposed by various organizations and authorities in order to improve and develop the maritime and logistics industry.

Panama has had close relation with the implementation of digital tools, for example, the National Customs Authority (ANA), modernized its registration platform Integrated Customs Management System (SIGA), so that it will be known in advance where the cargo that will enter the country comes from, as well as the electronic route that it will have. As well, since 2017, Panama implemented the single window (VUMPA) which streamlines and shortens processes regarding the reception, stay and dispatch of international trade vessels. It is estimated that the VUMPA saves around 3,260 hours of time per year in general for transshipment. Likewise, they implemented the integration of the Technological Portal for Foreign Trade and Logistics (PORTCEL) with VUMPA to share the data required by other Government entities, which are previously approved through confidentiality agreements between the actors.

On the other hand, taking into account the inauguration of the Expanded Panama Canal in 2016, the logistics cabinet of the Republic of Panama and the Inter-American Development Bank carried out a national logistics strategy for Panama for the year 2030. One of the pillars of the project is the “technological bet”, which consists of implementing the information systems in the logistics ecosystem of the digital platform, and thus reducing the existing

“technological gap”. Among the elements to be implemented are Big Data in logistics, Fleet of vehicles and autonomous equipment, UBER for trucks, or Smart commerce using Blockchain, among others.

Alongside, in 2017 there was a concluded digitalization project in which the Panama Canal Authority bought DELMIA Quintiq licenses to support their planning process, in order to further optimize costs, improve safety and increase the efficiency and reliability that this service provides (The Logic Factory).

Conclusions port digitalization trends in LATAM

Table 3 below summarizes the current status on port digitalization in the selected countries of the LATAM region.

As can be seen, open neutral platforms, via PCSs and SWs, have been identified as high priority for all targeted ports, both via desk research as well the interviews with stakeholders in the LATAM region. Furthermore, different levels of automation of operations (automated operations in container terminals) have been identified in countries such as Chile, Mexico, Panama and Colombia.

With respect to the new emerging technologies, IoT as understood in the present study is slowly gaining momentum in several countries. This is in line with evidence from desk research, where IoT is receiving the largest investment across different industries, as key data capturing element⁷. Little presence has been found on the remaining emerging technologies.

Furthermore, albeit not being strictly a technology, it was considered important to assess the entrepreneurial ecosystem, as a relevant pillar to harness the potential of new ideas and emerging technologies to come up with solutions that solve complex problems in the port sector⁸. Little presence has been found in the LATAM region, with Colombia (via DeltaX) being the only country currently having incubators related to the port sector. Progress is also under way in Panama, where Dutch accelerators are involved.

It must be noted that many of the technologies below are labelled with an “X”, meaning that solutions making use of those technologies could not be found throughout the study. This however does not mean that they are not currently under use, in one way or another, by one or several users within the port communities in the LATAM sector. Some of them are implemented by private stakeholders and for private users, therefore access to this information, potentially considered as sensitive, can be challenging to find. Port Community Systems or Single Windows, on the other hand, tend to be public-led initiatives, and therefore access to information with respect to these projects is easier.

Lastly, recent developments identified in some of the ports in the field of port digitalization suggest that other European players are also looking at Latin America as a potential niche for business development.

⁷ See Global Digital IQ Survey (2017) by PriceWaterhouseCoopers, also [see](#) IoT is key element in the DIKW model .

⁸ For the purpose of this study, the entrepreneurial ecosystem was assessed based on the presence (or not) of start-up accelerators and incubators in the port sector in LATAM.

Table 3. State of play of port digitalization found in selected countries of the LATAM region.

Technology	Argentina		Chile		Colombia		Costa Rica		México		Peru		Panama	
	[AR1]	[AR2]	[CL1]	[CL2]	[CO1]	[CO2]	[CR1]	[CR2]	[MX1]	[MX2]	[PE1]	[PE2]	[PN1]	[PN2]
Open Platforms	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Automation & robotics	IP	X	Y	IP	IP	Y	X	X	Y	Y	Y	X	X	IP
Internet of Things	X	X	Y	X	Y	X	X	X	Y	X	Y	IP	Y	Y
Artificial Intelligence (AI)	X	X	X	X	X	X	X	X	Y	Y	IP	X	Y	Y
Virtual/Augmented/Mixed Reality	X	X	X	X	Y	X	X	X	Y	X	X	X	IP	Y
Blockchain	X	X	IP	X	IP	IP	Y	X	X	X	IP	IP	X	X
Big Data	X	X	X	X	X	X	X	X	X	X	IP	X	IP	IP
Cloud Computing	X	X	Y	Y	X	X	X	X	X	X	IP	X	IP	IP
5G	X	X	IP	IP	X	X	IP	X	X	X	X	X	X	X
Drones	X	X	X	X	X	X	X	X	IP	IP	X	X	X	X
Presence of Start-up port accelerators	X	X	X	X	Y	X	X	X	X	X	X	X	X	X
[AR1]: Port of Buenos Aires [CL1]: Port of San Antonio [CO1]: Port of Cartagena [CR1]: Port of Limon-Moín [MX1]: Port of Manzanillo [PE1]: Port of Callao [PA]: Puerto Balboa [AR2]: Port of Rosario [CL2]: Port of Valparaiso [CO2]: Port of Buenaventura [CR2]: Port of Caldera [MX2]: Port Lázaro [PE2]: Port of Paita [PA2]: Rodman Port														
Y= Found deployed solutions making use of particular technology in port sector X= No Data found on deployed solutions making use of particular technology in port sector IP= Found solutions currently In Progress														

Based on the current status, the consortium scanned for particular open calls and tenders in the field of port digitalization that could be potential leads for the participating Dutch businesses. Via desk research, the interviews with LATAM stakeholders, and the existing network of the team of this study, the following have been identified: (see table for referencing technologies)

Table 4. Upcoming port digitalization leads in the LATAM region.

Country	Theme	Contracting framework	Potential budget	Source
Colombia	Open Platforms (Maritime Single Window implementation)	To be confirmed	USD\$\$\$	Interviews/ desk research
Chile	Open Platforms (Port Community System San Antonio (PCS) San Antonio Port Authority)	To be opened (2021)	USD\$ 4.200.000 including operational costs, for a 6-year contract	Interviews/internal network
Chile	Open Platforms (Port Community System Valparaíso (PCS) Valparaíso Port Authority)	Opened (23/10/2020)	USD\$ 2.000.000 including operational costs, for a 5-year contract	Interviews /internal network

As already described previously, the National Port Authority of Perú presented the Smart Port Project for the digital transformation of the Callao port. The project has been coordinated by the NPA in Perú and financed by the IDB. This project will result in a roadmap for 2020-2025; which has not yet been published by the NPA but from which different concrete tenders will result⁹. Furthermore, all the tenders related to the port sector will be published through the Proinversion portal (www.proinversion.gov.pe).

In line with what was already mentioned above, only information on open platforms (Maritime Single Windows and Port Community Systems) has been found, based on the publicly available data from desk research as well as the input from the interviews with LATAM stakeholders. In addition, in order to obtain a general idea of port related budgets in each of the seven countries, it is recommendable to revise annex 5 Estimated National Budgets for the Maritime and Port sector (Latin America).

⁹ See Agencia de Promoción de la Inversión Privada by the Peruvian government for potential calls.

4. The Dutch perspective

One of the main conclusions that could be extracted from Figure 1 is that the Hamburg-Le Havre range, where the Dutch ports are located, is considered one of the most advanced port regions in the world in terms of digitalization. In fact, Port of Rotterdam Authority developed a step-wise strategy for ports to become more digital, first starting at a local and individual level, and then progressively scaling up to the port community and hinterland levels, and finally to a regional or global level (see Figure 4).

Albeit acknowledging that every port has a unique context and circumstances from a technological, financial, legal, environmental or societal perspective, the model below can serve as an orientation:



Figure 4. Digital Maturity Model of ports, step-by-step approach. Source: Port of Rotterdam.

Rotterdam can be considered one of the big frontrunners. It is home to one of the smartest ports and one of the richest maritime clusters in the world. The collaborative, research and innovation driven approach of this large cluster composed of port authority and users, government, universities, start-ups and private companies (from IT providers to consultancies) result, in the longer run, in a myriad of digital-based solutions in all domains of the maritime sector that are increasingly being embraced and adopted by different stakeholders.

Some of the success cases in the Netherlands can be Portbase[®], the Dutch Port Community System (PCS) and a resulting alliance between Port of Amsterdam and Port of Rotterdam. As founding member of the International Port Community System Association (IPCSA), Portbase is considered an international best practice globally. Another example can be the shared platform of PortXchange[®], which allows all actors (shippers, terminals, agents, ...) to exchange information about the port call process, therefore increasing efficiency of operations and reducing global shipping emissions. Resulting from Port of Rotterdam and the industry standards provided by the International Taskforce Port Call Optimization (ITPCO), waiting time has been reduced by an average of 20% in the port of Rotterdam.

Also, start-up and corporate accelerators such as PortXL® or the Rotterdam Logistics Lab, enable an ecosystem of digital-led opportunities in the port and maritime sector.

4.1. Interviewed companies

Considering the previous, major sources of companies and contacts mainly came from: the existing port and maritime network of the consortium involved in this study; Dutch embassies in LATAM; and start-up accelerators such as PortXL. Companies were screened according to the following conditions to be met:

- They must be Dutch legal enterprises, either local or with international presence in the port and maritime sector, and
- They must be offering technology-based products and/or services that can be applied to the port context.

Aside from that, international and neutral organizations involved in what was considered here as port digitalization were targeted as well, with the purpose of getting insights into their view of the LATAM region.

A total of 16 Dutch companies and 1 international non-profit organization were addressed and interviewed via phone/e-mail, where they were provided with a background and purpose of the study, as well as a qualitative questionnaire to fill in.

The full list of participating Dutch companies, including their core business and contact details can be found in the Annex 2.

5. Opportunities for Dutch businesses in LATAM

Several opportunities have been identified for Dutch companies, some of which are external and others are related to the unique selling points of the Dutch stakeholders. These are clustered into the following elements:

The momentum created by COVID-19

As already mentioned, the context of the global pandemic seems to have translated into higher attention, among management bodies of port stakeholders, with respect to port digitalization. This trend has been confirmed by the consultations with stakeholders from the LATAM region.

All interviewees, from management roles within the port sector, reported a higher interest and attention to explore digital solutions to ensure a safe and smooth flow of cargo within the port. Moreover, neutral bodies have reported that port regulations towards digitalization are becoming, or in the process of becoming, generally less restrictive.

The call for sustainable ports

As already mentioned, ports are key enablers of global trade, and therefore of economic growth. However, many of the port activities can be harmful for the environment and surrounding livable areas. Major sources can be vessel emissions, effluent discharge, excessive noise or light.

In this sense, ports have for some time been under pressure to comply with tightening regulatory and societal requirements for sustainability of port-related activities. The smarter use of the current infrastructure via digital solutions can indeed reduce impactful elements such as congestion or sub-optimal use of fuel consumption. Given the increasing pressure by society, government and international organizations not only in LATAM, but also in several regions of the world, the demand for digital products and services have increased, where the Dutch business can step in.

Technological Gap

During the interviews, LATAM stakeholders mainly pinpointed at neutral platforms such as Single Windows or PCSs as major trends and needs on *port digitalization* within their ports. This could on the one hand suggest a significant digital gap between the LATAM region, still in a niche phase, and the Netherlands, where interviewed companies have reported offering products and services involving one or several of the technologies discussed previously.

The first-class expertise of the Dutch businesses could be justified in several ways. For instance, many of the interviewed companies have participated, in one way or another, in international webinars on port digitalization during 2020. Others are members of PortXL[®], the largest start-up accelerator in the port and maritime sectors worldwide. In this sense, it

can be argued that, on a purely technical level, the Dutch businesses have enough expertise to fill the technological gap.

Knowledge Gap

On the other hand, and related to the previous point, a knowledge gap has been identified between the port sector of the LATAM region and the Netherlands.

The role of research and knowledge infrastructure can be one the basic elements supporting innovation, and therefore digital development¹⁰. This approach can be seen in clusters such as Rotterdam, which involves not only the port community, but also a larger ecosystem of companies, education centers, research institutions, start-up accelerators, and other stakeholders, which can in one way or another increase the technical capabilities of the human capital in a port as a whole. The success case of Rotterdam is a good example of how strong knowledge can yield results over time.

A replication of this formula could bring large benefits for the different port communities in the LATAM region. Not only would it help them embrace digital technologies, but also build the necessary knowledge to assess, define and execute their own technological solutions, which can address their unique contextual circumstances.

In this sense, Dutch businesses, mainly coming from the maritime cluster, could play a key advisory role enhancing and strengthening the capabilities of the different port communities in the field of port digitalization.

Potential opportunities for Dutch business in LATAM

With the purpose of adding more granularity to the assessment, concrete opportunities have been identified and are shown in below table 5. For each need found throughout the study, the relevant ports have been mapped, as well as the potential scope of expertise needed for each particular case. For privacy reasons, the names of the Dutch stakeholders are not included, understanding that it will be their decision to assess the convenience of the opportunity.

It must be noted that, albeit some of the needs found being potentially applicable to more ports of the study, the table shows only those which actively identified the needs, as a measure of demand by the LATAM stakeholder to cover the need.

¹⁰ For a thorough discussion on the role of education to promote technological innovation See Doloreux (2002), 'What we should know about regional systems of innovation'.

Table 5. Needs based on research and potential opportunities for Dutch business in LATAM.

Needs based on research and consultation with stakeholders (Latin America)	Identified port (country)	Potential opportunity
Technical advice for the design and implementation phases of Port Community Systems (PCS) and Maritime/Single Windows	<ul style="list-style-type: none"> • Port of Cartagena (Colombia) • Port of Buenaventura (Colombia) • Port of Rosario (Argentina) • Port of Balboa (Panama) • Port of Manzanillo (Mexico) 	<ul style="list-style-type: none"> • Providers of PCS, software and operation systems. • Technical assistance providers for the design of a Port Community System (PCS). • Providers of centralized platforms to share data in real time with the objective of aligning/coordinating actors in the logistics chain.
Technical advice for the improvement/expansion and development phases of Port Community Systems (PCS) and Maritime/Single Windows	<ul style="list-style-type: none"> • Port of San Antonio (Chile) • Port of Valparaíso (Chile) • Port of Buenos Aires (Argentina) • Port of Callao (Perú) • Port of Caldera (Costa Rica) 	<ul style="list-style-type: none"> • Providers of PCS, software and operation systems. • Technical assistance providers for the development/expansion of a Port Community System (PCS). • Providers of centralized platforms to share data in real time with the objective of aligning/coordinate actors in the logistics chain.
Optimization in the planning and control of the arriving vessels process; control over the handling of cargo and access; optimization of operations and performing due diligence.	<ul style="list-style-type: none"> • Port of Cartagena (Colombia) • Manzanillo International Terminal (Panama) • Port of Buenaventura (Colombia) • Port of San Antonio (Chile) • Port of Lázaro (Mexico) 	<ul style="list-style-type: none"> • Providers of TOS / CTOS (Terminal Operating Systems / Container Terminal Operating Systems). • Providers of technical assistance services: maintenance, software upgrades, remote technical services and database administration. • Providers of tools that incorporate solutions to track and trace all logistics processes including cargo containerization activities.
Implementation of cargo scanners (Non-intrusive inspection system) in ports and borders.	<ul style="list-style-type: none"> • Port of Limón-Moín (APM Terminals, Costa Rica) • Port of Buenaventura (Colombia) • Port of Rosario (Argentina) 	<ul style="list-style-type: none"> • Providers of scanner equipment, software, but also knowledge exchange and capacity building regarding scanning of cargo/custom protocols.
'Awareness' training aimed at explaining and understanding the digitalization process: investment by port operators, digital transformation as a development strategy which also has a positive economic,	<ul style="list-style-type: none"> • Most of the ports mentioned in Table 3 fit this need as digitalization is still understood as 'relatively new' in Latin America and effective change management will be needed. 	<ul style="list-style-type: none"> • Advisory services and training on the importance of digital transformation, so that port workers value the plans that exist in terms of digitalization and understand the benefits they bring in the medium and long term.

environmental and social impact.		<ul style="list-style-type: none"> Providers of consultancy able to change the concept of digitalization; explain that the process can be much more all-encompassing than today is the case.
Improved efficiency in port operations and modernization of port infrastructure through expansion and automatization.	<ul style="list-style-type: none"> Port of Cartagena (Colombia) Port of Callao (DP World terminal, Perú) Port of Buenaventura (Colombia) Port of Rosario (Argentina) Port of Valparaíso (Chile) Port of Limón-Moín (Costa Rica) Cristobal Port (Panama) 	<ul style="list-style-type: none"> Providers of spreaders, cranes, port infrastructure and safety equipment. Renovation of port maneuvering/infrastructure equipment. Virtual reality technologies that provide real time information regarding the movement of goods in the terminals.
Other digital solutions that aim to optimize the 'port call inefficiency' through information/data exchange.	<ul style="list-style-type: none"> Port of San Antonio (Chile) Port of Valparaíso (Chile) Port of Cartagena (Colombia) Port of Callao (Perú) Port of Buenos Aires (Argentina) Port of Rosario (Argentina) Port of Manzanillo (México) Colon Container Terminal (Panama) 	<ul style="list-style-type: none"> Providers of shared platforms for port operators and users. Providers of digital technologies for maritime supply chains. Providers of 'Travel time predictions' technologies. Providers of design and implementation of supply chain predictive systems.
Implementation of cloud computing technologies for ports and terminals internal management.	<ul style="list-style-type: none"> Port of Limon-Moín (Costa Rica) Port of Caldera (Costa Rica) Port of Manzanillo (México) Port of Lazaro (México) Port of Rosario (Argentina) Cristobal Port (Panama) 	<ul style="list-style-type: none"> Providers of ERPs (Enterprise Resource Planning Systems) and CRMs (Customer Relationship Management Systems) and Bis (Business Intelligence Systems).
Investment in better availability of local networks and the lagging coverage of GPRS, 4G and 5G mobile Broadband for port sector.	<ul style="list-style-type: none"> Port of Limon-Moín (Costa Rica) Port of Caldera (Costa Rica) Port of Buenaventura (Colombia) Port of Rosario (Argentina) Port of Buenos Aires (Argentina) 	<ul style="list-style-type: none"> Telecommunication and IT infrastructure network providers.
Strengthened technical expertise in data analytics, business intelligence capabilities, and artificial intelligence solutions for the port operators/managers.	<ul style="list-style-type: none"> Port of Rodman (Panama) Port of Cartagena (Colombia) Port of Valparaíso (Chile) Port of Buenos Aires (Argentina) Port of Callao (Perú) 	<ul style="list-style-type: none"> Training and consultancy services in data analytics, business intelligence capabilities, and artificial intelligence solutions.
Sustainability policies in the development of port activities, which lead the ports to also	<ul style="list-style-type: none"> Port of Buenaventura (Colombia) Port of Cartagena (Colombia) 	<ul style="list-style-type: none"> Consultancy for the design and application of sustainability policies and strategies, through

focus more on social and environmental issues.	<ul style="list-style-type: none">• Manzanillo International Terminal (Panama)• Port of Rodman (Panama)• Port of San Antonio (Chile)• Port of Valparaíso (Chile)• Port of Callao (Perú)• Port of Buenos Aires (Argentina)• Port of Rosario (Argentina)• Port of Manzanillo (México)	training in environmental care, advice on modernization of equipment and technologies, and activities for the development of external community management.
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6. Challenges for Dutch businesses in LATAM

The acceptance and adoption of new technologies can be a challenging endeavor not only for firms in general, but also for societies and countries as a whole. This can be exacerbated in port clusters and communities, which are highly complex systems and completely unique from one another, both within and between countries and regions. In this sense, it becomes relevant to define major constraints hindering the adoption of digital solutions. Making use of technology acceptance theory¹¹ and tailoring into the context of this study, four main barrier domains are identified:

Technical barriers

This domain refers to the feasibility of making use of technological (digital-based) solutions in the port sector in LATAM, in terms of IT infrastructure requirements, capacity of IT skilled workforce, and (mis)alignment of the solution to target a contextual problem.

Economic barriers

This domain refers to economic barriers, both from the perspective of the local port users and authorities as well as from Dutch private and public organizations, to invest, adopt and implement digital-based solutions in the port sector in LATAM. The momentum created by COVID-19, identified as an opportunity previously, has also resulted in budgetary challenges for diverse stakeholders in LATAM. External funding from for instance multilateral institutions could be needed to bridge financial gaps in the region.

Institutional & Legal barriers

This domain refers to local or national barriers hindering the implementation and adoption of digital-based solutions in the port sector in LATAM from an institutional or legal perspective. That refers, among others, to the conclusion of contracts between private or public LATAM stakeholders and Dutch businesses, whether it concerns digital-based solutions in the port sector or any other type of business.

Cultural barriers

This domain broadly refers to societal and cultural organizational barriers, where users may willingly accept (or not) the adoption of new technologies. Variables such as perceived usefulness, ease of use perception of problems, and perception of potential benefits and especially risks can highly influence the way different stakeholders, particularly the management units, embrace new technologies and digital-based solutions.

It must be noted that the previous domains can be interlinked, and therefore play an influence on each other. For instance, in the context of port clusters, local organizational groups, as well as local government legislation, can lobby and dominate the state of play on digital adoption in port communities. From the interviews, desk research, and the team's

¹¹ See Technological Acceptance Model by Fietelson and Salomon (2004) in the Annex.

experience in the region, bottlenecks have been identified, labelled and grouped into a particular domain. Moreover, they have been classified based on the influence that Dutch (public or private) organizations can have on breaking those barriers.

Table 6. Major challenges to do business for Dutch companies in the port sector in LATAM, based on the interviews, desk research and team's expertise.

Domain	Bottlenecks for Dutch businesses found	Capacity of Dutch stakeholders to influence barriers [1 to 5] ⁽¹⁾	
		Dutch public organizations (embassies, government, ...)	Dutch businesses
Technical	[1] Lack of IT infrastructure capacity in the LATAM region [2] Lack of technology-based qualified personnel in IT by the port users in the LATAM region [3] Digital solution fails to meet the unique context/problem of a particular port [4] Lack of cybersecurity systems	3	5
Economic	[5] High import taxes on foreign products/services in LATAM [6] Fluctuating exchange rate for Dutch businesses in LATAM [7] Cheaper labor in LATAM [8] Budget constraints and siloed investments in IT by public/private port stakeholders in LATAM [9] High investment costs	4	2
Institutional & Legal	[10] Complex governance structures in port communities in LATAM [11] High turnover of government representatives in LATAM [12] Lack of human resources in the public sector in LATAM [13] Lack of clear strategic vision on port digitalization in LATAM [14] Lack of harmonized regulatory frameworks [15] Contracting with public sector is done in Spanish mainly [16] Contracting with public sector may require local office/representative [17] Contracting in LATAM takes time	2	1
Cultural	[18] Lack of understanding of local culture by Dutch businesses [19] Local stakeholders prefer local service providers [20] Skepticism by port stakeholders to implement digital (data sharing) products due to (a) lack of trust and understanding of products or (b) high perceived risks, among others. Change management bottlenecks	4	3
⁽¹⁾ 1: Very low capacity; 2: Low capacity; 3: Medium capacity; 4: High capacity; 5: Very high capacity. Capacity is meant to have the resources to effectively exert an influence towards removing those barriers.			

It must be noted that some of the previous bottlenecks are common in the port industry (for example [3] and [20]), while others are more contextual to regions such as LATAM (for example [7], [10], [11], or [15]).

7. A comprehensive plan of action

What can be concluded from the findings above is that doing business on port digitalization in the LATAM region is more than a matchmaking, “*plug-and-play*” process between a Dutch company and a port in LATAM. Opening businesses is a result of a complex, multidisciplinary and long process that would involve breaking several barriers (both from the Dutch side and the LATAM side) along the way.

Considering the previous barriers, as well as general and specific opportunities already identified, this section aims to provide an action plan of concrete actions involving both public and private Dutch stakeholders. From desk research, as well as the interviews with the different Dutch entities, the following steps for the Dutch actors have been identified and grouped to target the main challenges identified:

[A1] Promotion of dialogues between Dutch and LATAM stakeholders

Enhancing active and continuous engagement between Dutch players and national and local public/private stakeholders in the LATAM region has been identified as an essential action item. These dialogues, which could be easily done online, should promote the exchange of information and experiences in both ways.

That is, not only should products, services or expertise be showcased by the Dutch stakeholders to the LATAM stakeholders. Also, experiences, best practices and challenges in the port sector in LATAM could be provided by stakeholders in the region, from a technical, economic, institutional or cultural barrier. Such bidirectional approach could enhance:

- Better alignment between problem and solution, since Dutch companies can better understand the contextual unique issues in the LATAM ports
- Better understanding of the local culture, leading to higher trust between parties
- Increase the understanding of the digital solutions by the LATAM stakeholders, and therefore get a more realistic perception of risks

[A2] Advice on the establishment of local offices or local agents

Given the economic barriers (i.e. import taxes) as well as the “*local first*” approach in many countries of the LATAM region, it is recommended for Dutch companies to establish either contact with local agents or assess the feasibility of opening local offices (should the Dutch entity be interested).

In this sense, Dutch companies could find assistance via (1) local embassies which provide contacts with local agents; and (2) look for advice on the entire (administrative and financial) process for establishing local branches, including contextualized challenges in the particular target country. Among others, major benefits could be:

- Better understanding of the local culture, leading to higher trust between parties
- Better price competitiveness via reduced import taxes or adjusted labor costs
- Ease contracting processes for the Dutch companies in LATAM

Dutch representative entities in Latin America such as the Embassies, NBSO's and Bilateral Chambers play an important role when contacting stakeholders in the region. Not only do they have important in-depth information on the port sector, but they also have certain action plans to encourage Dutch involvement in Latin American countries. Approaching them can add an invaluable advantage in connecting with the region's port sector, whilst providing support for the formulation of effective strategies leading to entry into the Latin American market.

[A3] Informal Networking

While it is true that the previous two points can enhance contact with stakeholders from the port sector in LATAM, establishing a more personal relationship in the LATAM region, while being a time-consuming process, can help build trust, lower cultural barriers and therefore open room for business opportunities.

Given the contextual situation brought about by the COVID-19 pandemic, most of the networking opportunities have been changed to an online format. Yet, the consortia involved in the present study highly advises participating Dutch companies to strengthen more ties with local stakeholders on a personal basis, once intercontinental business travelling resumes to a certain extent to pre-COVID levels. This can be done either (1) on an individual basis by the Dutch companies, or (2) via joint company missions promoted by both the Dutch government and the Embassies in the target countries.

[A4] Promote knowledge building in the LATAM region

Given the identified knowledge gap between the Netherlands and the LATAM region in terms of port digitalization, it is paramount for the latter to enhance knowledge building in its port communities. As already mentioned, the role of research and knowledge infrastructure can be one of the basic elements supporting innovation, and therefore technological development. In this sense, the port clusters in LATAM should enhance continuous innovation, promotion of start-up accelerators, investment in research, and (re) training of the human capital as a well-encompassing approach to embrace and implement digital solutions.

From the Rotterdam experience (see figure 5), as well as other geographical digital-related business hubs in the port sector (i.e. Singapore), it is known that clustering related businesses together is a well-established practice for enabling business growth. These benefit from sharing expertise, (human) capital, and infrastructure.

Besides all the potential short-term benefits that the replication of this success formula could have in different LATAM countries, perhaps one of the most notorious (long term) benefits could be their increased knowledge independence. That is, they could have

strengthened human and technical capital to come up with their own digital products or services which fit their unique circumstances in the future.

It is important to remark from the previous that this knowledge building process, since initial, multi-stakeholder discussion rounds until implementing and starting to yield results, can take several years. An interesting selling point for the Dutch stakeholders could be their involvement in this multidisciplinary and multi-stakeholder process. Knowledge building on port digitalization could be tailored to either, or a combination of the following, focus areas:

- Research institutes: Universities and other knowledge institutes
- Vocational training: Simulation centers and training on the port and maritime sector
- Innovation Centers: Start-up incubators and accelerators tailored to the maritime sector

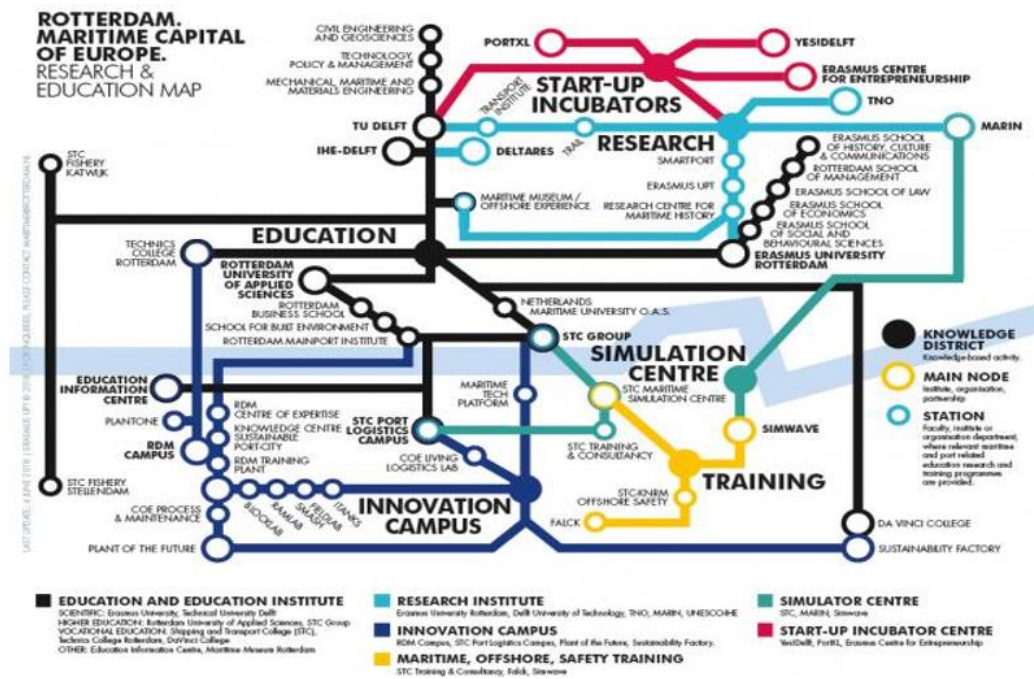


Figure 5. Example of knowledge port and maritime cluster, case of Rotterdam. Source: Rotterdam Maritime Capital of Europe.

[A5] Digital Showcase of Dutch offering

During the research, an important finding has been that Latin American stakeholders are not always familiar with the Dutch offering, e.g. are only aware of one of two actors, consider it to be fragmented, or have a fairly limited vision of what digitalization could imply. The Netherlands is home to well-established providers of solutions, but also to many innovative SMEs. Comprehensive solutions tailored to the circumstances in the different LATAM countries could be offered when the former and latter are combined.

Therefore, with the objective of establishing and strengthening commercial relations between the Netherlands and the LATAM region, the development of a digital showcase

would be important and feasible. A portal where the stakeholders in the seven countries can find the Dutch offer gathered in one place. This will allow them to connect directly with Dutch companies that are looking for partners in the region.

Some of the benefits of the development of this initiative are:

- The Dutch offer becomes visible and tangible
- Networking and consortium building will be enhanced
- Exchange of knowledge and experiences
- Collective presentation of the Dutch offer for the maritime digitalization sector

[A6] Taking advantage of the regional network through RBD LATAM and the Embassies

The Regional Business Development (RBD) team for Latin America, together with each of the Royal Netherlands Embassies in the seven countries, are in constant contact with the stakeholders mentioned in this study. With their support, it is possible to work together on joint strategies for the LATAM countries and, in this way, to enter the market as a block and not through isolated actions. “Go together and go far” seems to be the way forward in the complex and multi-disciplinary field of port digitalization in LATAM.

[A7] Participation in different sector events throughout the region, such as:

- AAPA Latino 2021 - Cartagena, Colombia (From November 29 till December 1, 2021)
<https://www.aapalatioamerica.com/es/>
- Maritime Week Americas 2021 - Panama City (From May 24 to 27, 2021)
<https://www.petrosport.com/events/mwa2021-panama>
- VII International Exhibition and Congress of the Maritime-Port Industry for Latin America Trans-Port 2021 “Digitalization and Sustainability: The Challenges of the Maritime Port Industry” (From August 31 to September 2, 2021), organized in Chile
<https://www.trans-port.cl/>
- RBD digital trade missions to several LATAM countries in 2021

Table 7 below summarizes the overall action items, including the identified barriers that could potentially be targeted, as well as the expected involvement of (public and private) Dutch stakeholders.

Table 7. Barriers to be targeted by each action item.

Action item	Barrier to target				Dutch involvement ¹	
	Technical	Economic	Institutional & Legal	Cultural	Public ²	Private ³
[A1] Promotion of dialogues between Dutch and LATAM stakeholders	✓			✓	High	High
[A2] Advice on the establishment of local offices or local agents		✓	✓		High	High
[A3] Informal Networking				✓	Low	High
[A4] Promote knowledge building in the LATAM region	✓	✓	✓	✓	High	High
[A5] Digital Showcase	✓	✓			Low	High
[A6] Taking advantage of the regional network through RBD LATAM and the Embassies		✓	✓		High	High
[A7] Participation in different sector events throughout the region	✓	✓		✓	High	High
¹ Involvement in terms of time. ² Public Dutch stakeholders may refer to any Dutch governmental organization. ³ Private Dutch stakeholders mainly refer to companies which could potentially start or increase business in the LATAM region.						

8. Conclusions & recommendations

Ports are essential elements of economic activity given their role as key enablers of international trade. Nevertheless, the negative environmental impacts from port and maritime related activities cannot be overlooked. Major sources come inherently from the nature of their activities, while others are a result of inefficiencies in the processes. In this sense, the use of digital technologies in port communities have gained particular momentum as a way to capture market share while reducing inefficiencies, and therefore negative impacts. Especially as a result of the disruptions brought about by the COVID-19 pandemic, which has highlighted in 2020 the need for resilient operations in ports as vital nodes in global supply chains.

With the Dutch experience as a recognized best practice in digital transformation in the port field, the purpose of this study, based on desk research and interviews, was twofold. First, to assess the state of play of port digitalization in the Latin American region, and second, to explore potential market opportunities for Dutch businesses.

Due to the vagueness of several terms, a concrete definition around port digitalization was made to serve as a starting point for the rest of the study. For the countries of Argentina, Chile, Peru, Colombia, Panama, Costa Rica and Mexico, a brief port diagnosis was presented. Moreover, their institutional framework and digital trends were presented. The scope of port digitalization in the LATAM region focusses on the use of open platforms such as Single Windows and Port Community Systems.

At the same time, interviews were conducted with Dutch organizations to assess their view on the LATAM region, their main strengths and possibilities to expand or open room for business.

Major contextual ongoing trends, as well as overall gaps in the region, were identified as key opportunities for the Dutch businesses. These were the COVID-19 momentum, the social and political call for sustainable ports on the one side, and the technical and knowledge gap on the other side. Especially the later elements can be considered strengths of Dutch organizations. Particular opportunities in specific ports were also identified. Moreover, bottlenecks from a technical, economic, institutional and legal, and cultural perspective were also identified based on the feedback from both Dutch and LATAM stakeholders.

Having the previous in mind, and understanding that the opening of new business in port digitalization goes beyond an IT “plug-and-play” process, a comprehensive and multidisciplinary plan of action was proposed. For those items concerning an active involvement from Dutch private businesses, informal networking and the promotion of knowledge building in the region were identified as main action points.

During the research, an important finding has been that Latin American stakeholders are not always familiar with the Dutch offering, e.g. are only aware of one of two actors,

consider it to be fragmented, or have a fairly limited vision of what digitalization could imply. The Netherlands is home to well-established providers of solutions, but also to many innovative SMEs. Comprehensive solutions tailored to the circumstances in the different LATAM countries could be offered when the former and latter are combined.

Therefore, with the objective of establishing and strengthening commercial relations between the Netherlands and the LATAM region, the development of a digital showcase would be important and feasible. A portal where the stakeholders in the seven countries can find the Dutch offer gathered in one place. This will allow them to connect directly with Dutch companies that are looking for partners in the region. Also, under the premise of “Go together and go far”, the Dutch companies could take advantage of the regional network through RBD LATAM.

Based on the methodology used throughout this study, it must be noted that findings have been subject to the availability of data. In some cases, it has been challenging to collect data from different stakeholders. For instance, from all Dutch private companies that were initially targeted, only a proportion of them accepted to be part of the study. From the non-respondents, some referred to not being incentivized enough to openly share information. This was especially the case for big players which are trying to expand business in this niche market. Other companies answered the questionnaires after the deadline, while others simply did not respond. This is however common in consultation-based approaches.

While acknowledging the potential limitations of the methodology used, major points can be reflected on. First of all, it can be concluded that there is a growing market niche on port digitalization in Latin America. Second of all, such gap can be filled by Dutch companies, given their knowledge and expertise. This brings however to the third point, which deals with the fact that port digitalization is more than an IT project, and therefore several dimensions need to be considered. Not only throughout the execution phase of a particular digital project, but also on previous network building phases which are of so much importance in the LATAM region.

It is important to remark that progress is already being made in some of those countries, where other European Non-Dutch players are also setting strong foundations given their expertise and reputation. In this sense, time is key, and therefore the roadmap presented in this study should be carried out collectively as soon as possible.

9. ANNEXES

Annex 1. Contacted stakeholders in LATAM.

Country	Ports, terminals and Port Societies	Port institutes, chambers and unions	Public Organizations	Academic Organizations
Argentina	- Port of Buenos Aires - Port of Bahía Blanca	- Chamber of Port and Maritime Activities	- Ministry of Transport; Ports, Waterways and Merchant Marine.	- Buenos Aires University
Chile	- Port of Valparaiso - Port of San Antonio - Port of Ventanas - Port of Mejillones CPMSA	- Solar & Partners	- Ministry of Transport and Communications	- University of Santo Tomás
Colombia	- Port of Cartagena - Port of Barranquilla - Port of Buenaventura	- ANDI Chamber of Maritime and Port Secto - NEXTPORT	- Ministry of Transport - DNP	- CEDEX - University of the North
Costa Rica	- Port of Limón - Port of Calderas - APM Terminals - SAAM Port	- INCOP	- Japdeva - Cocatram - MOPT	
Mexico	- IPA Manzanillo - IPA Lázaro Cardenas	- Federal Comprehensive Port Administrations - Secretary of Communications and Transportation	-Coordination of ports and merchant marine - SEMAR	-Trainmmar -CEAS International
Peru	- Port of Callao - APM Terminals	-ADEX	- APN - Ministry of Transport and Communications - OSITRAN	- ENAMM - University of Lima - University of Páficico - COMMPE
Panama	- Balboa Port - Port of Rodman	- Panamá Canal	- National Customs Authority	UMIP

Annex 2. Participating Dutch Companies.

Company name	Nature	Core business	website	phone	email
Semioticlabs	Start-up	predictive maintenance	https://www.semioticlabs.com/	+31 85 303 1178	info@semioticlabs.com
Sensar	Start-up	Predictive maintenance with sensing technologies	https://www.sensar.nl/	+31 (0)15 262 98 89	info@sensar.nl
Aquasmartxl	Start-up	Inspection and maintenance via aquatic drones	http://aquasmartxl.com/	+31 (0)6-57567791	info@aquasmartxl.com
Port of Rotterdam International	Port Authority	Provider and advisor of broad digital solutions and services in port communities	https://www.portofrotterdam.com/en/port-forward/products	+31 (0) 10 252 10 10	info@portofrotterdam.com
Port of Amsterdam International	Port Authority	Strategic consultancy in port development and management	https://www.portofamsterdaminternational.com/	+31 (0)20 523 4500	info@portofamsterdam.com
TBA	SME	Design, simulation and automation of port terminals and equipment	https://tba.group/en	+31 15 380 5775	info@tba.group
Teqplay	SME	Digital tools to improve decision making in the port	https://teqplay.nl/	+31 (0)10 3006737	support@teqplay.nl
Terberg	SME	Providers of port terminal equipment	https://www.terbergspecialvehicles.com/	+1 786 452 9790	info@terbergspecialvehicles.com
Stinis Holland B.V.	SME	Providers of port terminal equipment	https://www.stinis.com/	+31 (0)180 514655	sales@stinis.com
Houcon	SME	Providers of port terminal equipment	www.houcon-group.com	+31 (0) 186 620 930	info@houcon-group.com
OptiPort (PortX)	Start-up	Provider of planning and optimization tools for port call process	www.optiportonline.com	+31 (0) 6 8379 4850	info@optiportonline.com
PortXL	SME	Start-up Accelerator and incubator in the port and maritime sector	www.portxl.org	+31 (0) 639586058	info@portxl.org
TLF – The Logic Factory	SME	development of advanced software solutions	www.thelogicfactory.com	+31 (0)73-2004385	info@thelogicfactory.com
Experion Global	SME	development of advanced software solutions	www.experionglobal.nl	+31 6 511 00 981	info@experionglobal.nl
PortXchange	SME	Digital tools to improve decision making in the port	https://port-xchange.com/	NF	support@port-xchange.com
Arcadis	SME	Design, engineering and management consulting	https://www.arcadis.com	+31 (0)20 2011 011	info@arcadis.com

Annex 3. Interview form for stakeholders (Netherlands).

Question	Answer
1. From desk research, we have noted there is asymmetry in what “port digitalization” means. Could you kindly provide to us what it means to you?	
2. From your knowledge and expertise, what perspective do you see in the implementation of technologies and strategies in port digitalization for Dutch companies in the Latin American region?	
3. Do you know of any case of a port digitalization product / service in Latin America?	
4. If any, what experience does your organization have in the Latin American market?	
5. What digital products or services could your organization offer to the Latin American market? Could you briefly explain how they could solve a potential problem in LATAM ports?	
6. What advantages do you think your product or solution could have for the Latin American market.	
7. In your opinion, what are the biggest problems and challenges you see in doing business in the port sector in general?	
8. Perhaps related to the previous, what are the biggest problems and challenges you see in working in the Latin American market, and how could the Holland House and or the Dutch Embassy, especially for the Colombian market, help or be of assistance?	
9. What do you think are the most important needs of the country in terms of port efficiency?	
10. 9. Do you have a website so participants in this project can learn more about your products and organization.	
11. Do you have an agent in this region?	
12. Anything else that you would like to share or tell us?	

Annex 4. Interview form for stakeholders (Latin America).

Question	Answer
1. What have been the factors that have prevented the implementation of port digitalization processes/strategies (political, economic, education / research, geographic ...)	
2. What port digitalization strategies are being carried out in the country?	
3. Currently, what level of digitalization have the ports in the country?	
4. Is there any public policy or key points within the institutional framework of the country that promote digitalization in the port sector?	
5. Do you think that there are factors that boost the change of port operations towards a digital model? (Covid-19, for example)	
6. Do you think that the digital transformation in the port sector would contribute significantly to the economic development of the country?	
7. Do you know of any Foreign Direct Investment project aimed at developing new technologies for the port sector? If so, which case?	
8. What perspectives does the country have in the short and medium term in the development of port digitalization projects or strategies?	
9. What do you think are the most important needs of the country in terms of port efficiency?	
10. Do you consider that there are entry barriers for this type of technology in the country?	
11. Do you know about innovative business models within the port sector that have been implemented in your country?	
12. In what aspects do you find a clear opportunity to work with the Netherlands? (Transfer of knowledge, some specific technology that is being required).	

Annex 5. Estimated National Budgets for the Maritime and Port sector (Latin America).

Country	Budget (USD)	Info	Source
Panama	\$270,000	The estimated investment for the implementation of the strategy to 2040 is USD 270,000	Banco de desarrollo de America Latina (https://www.caf.com/es/actualidad/noticias/2019/05/plan-maritimo-portuario-panameno-promueve-la-integracion-regional/)
	\$239,347,733	National Customs Authority (2020 national budget)	Presupuesto nacional Panamá 2020
México	\$122,123.803	Investment for 12 ports in 2020	Portal portuario (https://portalportuario.cl/mexico-destinara-2-609-millones-en-proyectos-de-inversion-para-12-puertos-en-2020/)
Peru	\$159,000.000	Peruvian port sector will receive investments of 159 million dollars in 2020	Agencia peruana de noticias (https://andina.pe/agencia/noticia-invertiran-mas-159-millones-este-ano-puertos-concesionados-802754.aspx)
Costa Rica	\$415,032.934	For the Port of Caldera, it aims to modernize the facilities and not to build a new port, so as not to be able to make the recent investments.	Portal portuario (https://portalportuario.cl/costa-rica-incop-presenta-plan-de-inversion-de-%E2%82%A1-250-millones-para-puerto-caldera/)
Colombia	\$1,610.000.000	Colombia needs to invest by 2025 (to increase the maritime and port sector)	La república (https://www.larepublica.co/economia/colombia-debe-invertir-us1610-millones-en-puertos-para-aumentar-competitividad-2745577#:~:text=Para%20aumentar%20la%20competitividad%20en,de%20Am%C3%A9rica%20Latina%20(CAF).)
	\$6,756.886	Maritime transport infrastructure (2020 national budget)	Presupuesto nacional Colombia 2020
	\$449,696.302	In Sociedad Portuaria Regional De Buenaventura S.A. - SPRBUN, has established the execution of an investment plan that is for the period from 2007 to 2033	Presupuesto nacional Colombia 2021
	\$250,000.000	Barranquilla - the purchase of springs by Maersk	Presupuesto nacional Colombia 2020
	\$5,980.024	Construction, improvement and maintenance of maritime accesses to the nation's ports. (national budget 2020)	Presupuesto nacional Colombia 2021

	\$310,744	State support to ports at the national level (2020 national budget)	Presupuesto nacional Colombia 2022
	\$776,862	Recovery and environmental mitigation in the area of influence of the port area of Santa Marta - Caño Clarin. Magdalena department (2020 national budget)	Presupuesto nacional Colombia 2023
Argentina	\$9,879.398	Jurisdiction 57, budgeted policy for the Coordination of Fluvial and Maritime Transport Policies and the executing entity Undersecretary of Ports and Inland Waterways	https://www.economia.gob.ar/onp/documentos/presutexto/proy2020/jurent/pdf/P20J57.pdf
Chile	NF	There is a deficit in investment in information technologies in ports. 72.7% invest between 0 and 5.99% of their budget (Smartport study and employability, 2019)	Camara de diputados y diputadas de Chile - Institucionalidad laboral portuaria (https://www.camara.cl/verDoc.aspx?prmID=180624&prmTipo=DOCUMENTO_COMISION)

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