Classification of Port Systems for Port Competitiveness

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Abstracts: The general objective of the research was to classify port systems for competitiveness by implementation criteria, continents and port functional competitiveness indicators. This research used the qualitative approach and was applied. The thematic narrative research design due to the variety of information used in reference documents based on the topic of classifying port systems for competitiveness. A classification with 18 criteria was constructed by evaluating their fulfillment in the different port systems based on the literature reviewed. They were also classified by level of implementation, by countries in which they have been implemented, and by port competitiveness indicators. The port community and the automatic identification system are focused on improving the flow of information, while the terminal operation system, the automated gate system and the truck appointment system are focused on optimizing the operations performed at ports.

Keywords: Classification of Port Systems, Port Competitiveness, Automation, Digitization, Technology.

1. INTRODUCTION

The world has been globalizing and has had to adapt to changes, which has not been alien to ports. Since the beginning of containerization in the 1960s, the adoption of information technology (IT) and information systems (IS) has become a success factor for the competitiveness of ports (Heilig, Schwarze & Voß, 2017). Thus, an almost total dependence of daily port operations on IT/IS can be recognized. Consequently, these systems have become an indispensable element of ports and play a key role (Heilig & Voß, 2017).

On the other hand, port competitiveness is based on the current situation of port development and the relevant supporting environment, relying on infrastructure, technical equipment, resource investment and operations management, aiming at the future development of the port (Tang, Zhang & Du, 2020). Therefore, proposals for strategic plans have been developed to improve the efficiency and competitiveness of the port, encouraging the inclusion of new technologies in its operations (Durán, Palominos & Cordova, 2017).

In highly developed economies, different types of interorganizational information systems, called IOS, have been successfully established and used in different and specific areas for trade and transport facilitation, such as: Port Community Systems and Maritime Single Window (Palacios & González, 2018). Therefore, these systems seek to create interests between the port community and logistic actors to ensure reliability, continuous service and an adequate level of productivity (Caldeirinha, Felício, Salvador, Nabais & Pinho, 2020).

2. MATERIEL AND METHODS

The general problem of the research was that no classification of port systems for port competitiveness has been found, which has limited the adequate knowledge of the systems implemented for port operations and the information used by the port community. The general objective of the research was to classify port systems for port competitiveness, by criteria, by level of implementation, by continents and port competitiveness indicators.

This research used the qualitative approach and was of the applied type. Applied research: "is characterized because it seeks the application or utilization of the knowledge acquired (...) all applied research requires a theoretical framework (...) what interests the researcher, fundamentally, are the practical consequences" (Muñoz, 2012, p. 6).

The research design was the thematic narrative design due to the variety of information used in the reference documents based on the theme of port systems classification for port competitiveness. The narrative design, according to Creswell (2005) cited in Salgado (2007) mentioned: "is a mode of intervention, because it processes issues that were not clear, and its objective is usually to evaluate a series of events". In addition, the topical narrative design according to Hernández, Fernández & Baptista (2014) detailed: "it focuses on a theme, event or phenomenon". Therefore, the research was based on the identified problem and to meet this need, information was collected from various sources on port systems, which are the basis of the research.

3. RESULTS

According to Table 1, it is possible to identify in the first column the name of the main port systems: (a) single window system; (b) port community system; (c) terminal operating system; (d) automatic identification system; (e) automated gate system; and (f) truck appointment system. Horizontally, 18 criteria were detailed, marking which criteria each system meets and showing that some systems have the same criteria.

The research results in Table 2 showed the three most relevant criteria for each port system, which were (a) simplify trade procedures, (b) reduce transaction costs, (c) optimize and facilitate the ship announcement and registration process, (d) optimize information flows, (e) enable better control of information and export activity, (f) generate greater competitive advantage for the port, (g) report container status in real time, (h) optimize space, (i) monitor container terminal services, (j) improve safety and shipping efficiency, (k) track traffic patterns, (l) monitor vessels in real time, (m) improve efficiency when entering the facility, (n) reduce manual information processing time, (o) verify container damage, (p) manage congestion, (q) minimize queue length at the gateway, and (r) reduce terminal operating costs; and is detailed in countries that have implemented such as: Germany, Holland, Singapore, Chile, Peru, Colombia, among others.

According to the classification in Table 3, four levels of port transformation can be identified: (a) internal level; (b) port level; (c) port community level; and (d) hyperconnected port level, then the objective of each one was considered, and it was specified which systems are implemented at each level. According to Table 4, the first column specified the port competitiveness indicators: (a) port costs, (b) proximity to the hinterland, (c) connectivity with the hinterland, (d) geographical location of the port, (e) port infrastructure, (f) operational efficiency, (g) quality of port service, (h) maritime connectivity, (i) nautical accessibility, (j) port enclosure and (k) technical and operational innovation within the port, the second column detailed their main factors and then some countries along with the position they occupied in the world competitiveness ranking 2020.

Table 1 Classification of port systems by criteria

N°	Port systems	Criteria								
		Simplificar los procedimientos comerciales	Reduce transaction costs	Optimize and facilitate the process of vessel announcement and registration	Optimize information flows	Enable better control of import and export activity	Generate a greater competitive advantage for the port	Inform about the status of containers in real time	Optimize space	Control container terminal services
1	One-stop shop system	X	X	X	X	X	X			
2	Port community system	X	X		X	X	X			
3	Terminal operating system			X	X	X	X	X	X	X

4	Automatic identification system			X			X			
5	Automated gate system						X	X		
6	Truck appointment system						X			X

Note: (Kartyshev, 2018; Ivanova & Latyshov, 2018; Torlak, Tijan, Aksentijević & Oblak, 2020; Carlan, Sys & Vanelslander, 2016; Kubowicz, 2019; Hervás-Peralta, Poveda-Reyes, Molero, Santarremigia & Pastor-Ferrando, 2019; Dursun y Güngör, 2020; Yaacob y Koto, 2018; Fournier, Hilliard, Rezaee y Pelot, 2018; Heilig, Stahlbock y Voß, 2019; Shook, 2017, Neagoe, Nguyen, Taskhiri y Turner, 2017, Heilig y Voß, 2017, Jovanovic, 2018, Lange, Kühl, Schwientek y Jahn, 2018).

N°	**Port systems**	**Criteria**								
		Improve navigational safety and efficiency	**Monitoring of traffic patterns**	**Real-time vessel tracking**	**Improve efficiency when entering the facility**	**Reduce manual information processing time**	**Verify container damage**	**Manage congestion**	**Minimize queue length at the gateway**	**Reduce terminal operating costs**
1	One-stop shop system					X				
2	Port community system					X				
3	Terminal operating system		X	X	X		X	X		X
4	Automatic identification system	X	X	X				X		
5	Automated gate system				X	X	X	X	X	
6	Truck appointment system				X	X		X	X	X

Note: (Kartyshev, 2018; Ivanova & Latyshov, 2018; Torlak, Tijan, Aksentijević & Oblak, 2020; Carlan, Sys & Vanelslander, 2016; Kubowicz, 2019; Hervás-Peralta, Poveda-Reyes, Molero, Santarremigia & Pastor-Ferrando, 2019; Dursun & Güngör, 2020; Yaacob & Koto, 2018; Fournier, Hilliard, Rezaee & Pelot, 2018; Heilig et al., 2019; Shook, 2017, Neagoe et al., 2017, Heilig & Voß, 2017, Jovanovic, 2018, Lange et al. 2018).

Table 2 Classification of port systems according to the most relevant criteria

N°	**Port system**	**Description**	**Most relevant criteria**	**Country**
1	One-stop system	This system is a key tool for the implementation of the trade facilitation principle and the main means of modernizing customs procedures. (Brachuk, 2018, p. 95)	Simplify commercial procedures (Kartyshev, 2018, p. 91)	Costa Rica (Agencia Empresarial de los Países Bajos, 2020, p. 32)
				Croacia (Torlak et al., 2020, p. 332)
				Mexico (Agencia Empresarial de los Países Bajos, 2020, p. 33)
				Italy (Torbianelli, 2016, p. 3)
				United States (Sholihah, Bahagia, Cakravastia & Samadhi, 2017, p. 267)
			Reduce transaction	Ukraine (Brachuk, 2018, p. 94)

			costs (Ivanova y Latyshov, 2018, p. 220)	Kazakhstan (Ivanova & Latyshov, 2018, p. 219)
				India (Joshi, 2017, p. 7)
			Optimize and facilitate the process of vessel announcement and registration. (Torlak et al., 2020, p. 333)	Chile (Agencia Empresarial de los Países Bajos, 2020, p. 31)
				Colombia (Agencia Empresarial de los Países Bajos, 2020, p. 32)
				Panama (Agencia Empresarial de los Países Bajos, 2020, p. 34)
2	Community port system	Electronic platform linking different systems operated by various organizations that make up a maritime or inland port community. (IPCSA, 2015, p. 3)	Optimize information flows (Carlan et al., 2016, p. 52)	Croacia (Torlak et al., 2020, p. 334)
				Germany (Constante, Lucenti y Deambrosi, 2019, p. 46)
				United Kingdom (Long, 2009, p. 63)
				Italy (Torbianelli, 2016, p. 4)
			Enabling better control of import and export activity (Carlan et al., 2016, p. 52)	Netherlands (Sholihah et al., 2017, p. 266)
				Italy (Nota et al., 2018, p. 11)
			Generating a greater competitive advantage for the port (Carlan et al., 2016, p. 52)	Singapore (Sholihah et al., 2017, p. 265)
				Poland (Marek, 2018, p. 376)
3	Terminal operating system	Computerized system designed to plan, track and manage the movement and storage of all cargo, covering a wide range of technologies (Min, Ahn, Lee y Park, 2017, p. 431).	Real-time container status reporting (Kubowicz, 2019, p. 490)	Poland (Kubowicz, 2019, p. 490)
				Germany (Kubowicz, 2019, p. 490)
				Reino Unido (Kubowicz, 2019, p. 490)
				Italy (Kubowicz, 2019, p. 490)
			Optimizing space (Hervás-Peralta et al., 2019, p. 7)	Singapore (Heilig & Voß, 2017, p. 193)
			Controlling the services of container terminals (Dursun & Güngör, 2020, p.83)	Kenya (Gekara & Nguyen, 2020, p. 53)
4	Automatic identification system	Automated on-board vessel monitoring system to automatically transmit vessel information to other vessels and coastal authorities (Zhou, Daamen, Vellinga & Hoogendoorn, 2020, p. 2)	Improving the safety and efficiency of navigation (Yaacob y Koto, 2018, p. 233)	United States (Asborno, Hernandez & Yves, 2021, p. 5)
				Luxembourg (Šakan, Rudan, Žuškin & Brčić, 2018, p. 212)
				Canada (Šakan et al., 2018, p. 212)
			Follow traffic patterns (Fournier et al. 2018, p. 319)	South Africa (Šakan et al., 2018, p. 212)
			Real-time vessel tracking (Heilig et al., 2019, p. 9)	Norway (Šakan et al., 2018, p. 212)
5	Automated door system	System that verifies container damage and cargo hazard classifications, as well as the driver's permissions to	Improve efficiency when entering the facility (Shook, 2017, párr. 4)	Germany (Heilig & Voß, 2017, p. 194)

		enter/leave the terminal with a given container (Heilig & Voß, 2017, p. 194)	Reducing manual information processing time (Neagoe et al., 2017, p. 4)	
			Verify container damage (Heilig & Voß, 2017, p. 194)	
6	Truck appointment system	Vehicle reservation system used by trucking companies to reserve time slots within the operating hours of container terminals. (Lange et al., 2018, p. 43)	Managing congestion (Neagoe et al., 2017, p. 2)	United States (Ramadhan & Wasesa 2020, p. 82)
			Minimize the length of the queue at the entry door (Jovanovic, 2018, p.1)	Australia (Neagoe et al., 2017, p. 6)
				London (Koroleva, Sokolov, Makashina y Filatova, 2019, p. 6)
				Indonesia (Nasution & Arviansyah, 2019, p. 3)
				Peru (Autoridad Portuaria Nacional, 2019, p. 56)
				United Kingdom (Koroleva et al., 2019, p. 6)
			Reducing the operating costs of terminals (Lange et al. 2018, p. 41)	Canada (Heilig & Voß, 2017, p. 194)

Table 3 Classification of port systems by level of implementation

Levels	Description		Purpose	Systems	Port / Country
Level 1 - Internal level	The companies and organizations involved in port activities are working to improve their processes.	Members of the port community are isolated.	To achieve at the individual level that the internal systems maximize the value of the company and make it more competitive. (Fundación Valenciaport, 2020, p. 9)	Terminal operating systems	
	Digital transformation at the individual and internal level. (Fundación Valenciaport, 2020, p. 9)	Internal processes are carried out through ICT systems. (Tijan, Agatić y Hlača, 2012, p. 308)		Automatic door access systems (Fundación Valenciaport, 2020, p. 50)	
Level 2 - Port level	The digitization of ports goes beyond the internal boundaries of each organization.	Computerization through an EDI system in the community and users of port services. (Tijan et al., 2012, p. 308)	Increased efficiency and cost reduction.	One-stop systems Customs systems Automatic door access systems Intelligent transportation systems	Port of Callao - Peru Port of San Antonio - Chile Port of Cartagena - Colombia Port of Limón - Costa Rica Port of Manzanillo - Mexico
	Focus on the port facility.		Replace manual processes with electronic and		

	(Fundación Valenciaport, 2020, p. 10)		automatic processes. (Fundación Valenciaport, 2020, p. 10)	Truck appointment Systems (Fundación Valenciaport, 2020, p. 50)	
Level 3 - Port community level	Evolution of the previous level, seeking to achieve an alliance of the entire port community.	Computerization of the port community.	Synergies beyond the company itself.	Port community systems	Port of Valparaiso - Chile Port of Buenos Aires - Argentina Port of Cartagena - Colombia Port of Genoa - Italy
	Creation of a connected and coordinated logistics node. (Fundación Valenciaport, 2020, p. 10)	Creation of special communities, together with inland and maritime carriers. (Tijan et al., 2012, p. 308)	Joint benefit of the port community and the public services of the State administration. (Fundación Valenciaport, 2020, p. 10)	Transportation Systems (Fundación Valenciaport, 2020, p. 50)	
Level 4 - Connected port community worldwide	Higher degree of digital transformation in a port.	Integration and computerization of a port community.	Operational efficiency and cost reduction at the individual level.	Automatic door access systems Intelligent transportation systems Truck appointment systems Blockchain Internet of things Ports 4.0 Big data, or artificial intelligence Virtual and augmented reality (Fundación Valenciaport, 2020, p. 50)	Port of Rotterdam - Netherlands Port of Hamburg - Germany Port of Singapore - Singapore
	People, organizations and objects are connected to each other. (Fundación Valenciaport, 2020, p. 11)	Complete replacement of paper processes with electronic processes and full integration with external entities.	Improvement of prevention, control, safety, security and environmental protection measures.		
		IT cooperation between ports. (Tijan et al., 2012, p. 308)	Connection of the port with maritime and land corridors, and with global logistics chains. (Fundación Valenciaport, 2020, p. 11)		

Tabla 4 Indicadores de competitividad portuaria

N°	Port competitiveness indicators	Factors	Country	World Competitiveness Ranking 2020
1	Port costs	Port and terminal rates (Khalid & Al-Mamery, 2019, p. 464)	Singapore Switzerland Netherlands Hong Kong Sweden Norway Germany United Kingdom China Chile Peru Mexico Colombia Brazil Argentina (IMD, 2020, p. 1)	1 3 4 5 6 7 17 19 20 38 52 53 54 56 62 (IMD, 2020, p. 1)
		Impuestos (Khalid & Al-Mamery, 2019, p. 464)		
		Direct costs: port, storage and stevedoring fees (Fri, Douaioui, Mabrouki & Semma, 2020, p. 366)		
		Indirect costs resulting from long stops at the port (Fri et al., 2020, p. 366)		
2	Proximity to the interior of the country	The second most important factor, just after port costs (Zanne, Twrdy & Beškovnik, 2021, p. 1)		
		Geographical proximity to the main inland markets (Parola et al., 2017, p. 48)		
3	Connectivity with the interior of the country	Commercial activities originate in this area (Indriastiwi & Hadiwardoyo, 2021, p. 5)		
		Port catchment as the origin/destination points of cargo moving through a given port (Indriastiwi & Hadiwardoyo, 2021, p. 5)		
4	Geographical location of the port	Port accessibility (Peng, Yang, Lu, Cheng, Mou y Yang, 2018, p. 856)		
		Network status using the automatic identification system (Peng et al., 2018, p. 856)		
		Favorable geographical distance from production facilities (Hales, Chang, Lee, Desplebin, Dholakia & Al-Wugayan, 2017, p. 365)		
		Ease of entry to the port (Hales et al., 2017, p. 365)		
		Expansion potential (Hales et al., 2017, p. 365)		
5	Port infrastructures	Storage availability (Khalid & Al-Mamery, 2019, p. 464)		
		Availability of assembly/testing/distribution facilities (Khalid & Al-Mamery, 2019, p. 464)		
		Proximity to manufacturing facilities (Khalid & Al-Mamery, 2019, p. 464)		
		Size of cranes/docks/yard and other terminal infrastructures (Khalid & Al-Mamery, 2019, p. 464)		
6	Operational efficiency	Port productivity (Khalid & Al-Mamery, 2019, p. 464)		
		Port reliability (Khalid & Al-Mamery, 2019, p. 464)		
		Flexibility in case of delay (Khalid & Al-Mamery, 2019, p. 464)		
		Container dwell time (Khalid & Al-Mamery, 2019, p. 464)		
		Investment in port infrastructure (Peng et al., 2018, p. 856)		
		Congestion (Peng et al., 2018, p. 856)		

N°	Port competitiveness indicators	Factors	Country	World Competitiveness Ranking 2020
		Cargo damage (Peng et al., 2018, p. 856)		
7	Port service quality	Digitization process (Agatić & Kolanović, 2020, p. 93)		
		Reliability (Agatić & Kolanović, 2020, p. 96)		
		Flexibility (Agatić & Kolanović, 2020, p. 96)		
		Safety and security (Agatić y Kolanović, 2020, p. 96)		
		Digital-based infrastructure and superstructure (Agatić y Kolanović, 2020, p. 96)		
8	Maritime connectivity	Efficiency of maritime transport networks (Fri et al., 2020, p. 367)		
		Degree of connection of the country to the rest of the world through maritime routes (Instituto Mexicano del Transporte, 2016, p. 13)		
9	Nautical accessibility	Physically house the megabuques (Instituto Mexicano del Transporte, Klimek, 2020, p. 8)		
		Affected by natural factors (Parola et al., 2017, p. 49)		
10	Port site	Extension of the entire port area (Fri et al., 2020, p. 367)		
		Quality of the layout of terminals and common areas (Fri et al., 2020, p. 367)		
		Adequacy to the needs of port users (Fri et al., 2020, p. 367)		
11	Technical and operational innovation at the port	Development and implementation of information technologies for the national port system (Autoridad Portuaria Nacional, 2019, p. 95)		
		Facilitating interoperability and administrative simplification (Autoridad Portuaria Nacional, 2019, p. 95)		

4. DISCUSSION

The 18 criteria and the 6 main port systems are detailed in Table 1. This classification with the 18 criteria was developed by the authors, with the aim of providing a basis on which it can be observed that the systems do not necessarily meet all the criteria, but rather that they are focused on different aspects of a port. In the case of the single window system and the port community system (PCS), it was observed that they were similar, since they met almost the same criteria, except for optimizing and facilitating the process of announcing and registering ships. This result could be contrasted with that "a PCS lays the foundation for establishing a one-stop shop or can be integrated into one taking into account certain standards, or interfaces" (Heilig & Voß, 2017, p. 123). According to Torlak et al. (2020) "PCS constitutes an important building block and participant of the single window platform" (p. 333), as concluded in several previous studies (Varbanova, 2017; Tijan et al., 2018; Caldeirinha et al., 2020; Marek, 2018; Torbianelli, 2016).

On the other hand, the automated gate system and the truck appointment system were also similar, as they coincided on several criteria: (a) generating a greater competitive advantage for the port, (b) improving efficiency when entering the facility, (c) reducing manual information processing time, (d) managing congestion, and (e) minimizing queue length at the gate. In addition, the system that met most of the above criteria, 13 out of 18 criteria (see Table 1) was the terminal operating system, the criteria it did not meet were: minimize queue length at the gate, reduce manual information processing time, improve safety and efficiency of navigation, reduce transaction costs, and simplify business procedures.

It was agreed that all systems meet the criterion of generating greater competitive advantage for the port. According to Heilig et al. (2019) "due to its [digitization's] important role in achieving competitive advantage, a large number of information systems and technologies have been adopted in port operations in recent decades" (p. 2). As Bisogno et al. (2015) say "coordination between the partners of a PCS (...) plays a crucial role in supporting the competitiveness and efficiency of the port itself with a reduction of both costs and time" (p. 2).

Table 2 details the most relevant criteria of each system and in which countries they have been applied. Thus, in the case of the single window system, it was observed that the criteria seek to speed up the customs clearance of goods and reduce the costs of foreign economic activity; being very similar to the port community system which also helps stakeholders to reduce logistics costs through a faster flow of information. On the other hand, the terminal operation system is based on the optimization of operations and the control of the services developed in the terminal. The automatic identification system focuses on navigation and real-time vessel tracking, as mentioned by Šakan et al. (2018) "improves the safety and efficiency of navigation, environmental protection, traffic and coastal zone surveillance" (p. 211). And the last very similar systems were the automated gate system and the truck appointment system, as they both reduce time when entering the site, manage congestion, and minimize queues at the entrance gates. Therefore, all systems complement each other for a port to develop optimally, efficiently and to improve the indicators that make a port competitive.

Table 3 details the 4 levels of implementation of the systems, these levels have been based on previous studies (Tijan et al., 2012; Fundación Valenciaport, 2020). In the first level called, internal level, it is sought that the systems provide greater competitiveness with improvements in the internal processes of the ports, being the systems that fulfill this purpose, the operating system of the terminal, and the automatic access system at gates. Then there is the port level, where it is possible to replace manual processes with electronic processes, this through the implementation of the single window system, truck appointment system, intelligent transport system, some ports that are at this level are the Port of San Antonio (Chile), Port of Cartagena (Colombia), Port of Callao (Peru). At level 3, a connected logistics node has already been created, which benefits the port community and public services of the State, implementing the port community system, such as the Port of Valparaiso (Chile), the Port of Buenos Aires (Argentina), the Port of Genoa (Italy). Finally, the hyper-connected port level, where absolutely everything is connected and computerized cooperation between ports, such as the Port of Rotterdam (Netherlands), the Port of Hamburg (Germany) and the Port of Singapore (Singapore). The implementation of these tiered systems "seeks to create interests among the actors of the port and logistics community to ensure reliability, continuity of service and an adequate level of productivity" (Caldeirinha et al., 2020, p. 163).

It is worth noting that some ports started to implement these systems since about 1983 and are currently considered smart ports, such as the port of Hamburg (Germany) and Rotterdam (Netherlands), which achieved improvements, as mentioned by Gardeitchik and Buck (2019): "Portbase (port community system) drastically reduced (...) the traffic load on the roads, by 30 million truck kilometers per year" (p. 3). In Asia, the port of Singapore is one of the ports that has implemented the most systems, thus improving its operations and this was reflected in the World Competitiveness Ranking 2020, prepared by the International Institute for Management Development of Switzerland, where it is placed in first place, and in the port of Busan in South Korea "logistics cost savings of up to $100 million were achieved, mainly due to the reduction of personnel and paperwork, harmonization and automation of port-related systems" (Tapaninen and Posti, 2011, p.24). In the case of South America, one of the first countries to start implementing these systems was Chile with the ports of Valparaiso, Arica and San Antonio.

Table 4 detailed the port competitiveness indicators, based on previous studies (Parola et al., 2017; Kotowska et al., 2018; World Economic Forum, 2019) and detailed the factors that influence each of them. Thus, according to the criteria that port systems meet, it was observed that in the case of the single window system, it is related to the port cost indicator, since this system is based on the fact that documents are presented in a standardized manner, which streamlines procedures and reduces costs. In the case of operational efficiency factors, they are related to the port community system since, by improving information flows, the port becomes more productive by connecting each of the members of a port, improving quality standards and reliability. Therefore, from these rankings, it was observed that these systems not only improve the conditions of a port, but also contribute to improving its competitive position in relation to other ports.

CONCLUSIONS

Conclusions for future research are the following (a) include new port systems that can expand the classification, which are focused on information flows, or the operations of a port; (b) investigate the barriers that are specifically presented in the development, or implementation of each of the port systems, depending on the ports in which they have been implemented, since the reality, or need of each one is different; (c) expand the research by conducting interviews with the actors of a port community such as: Customs agents, ports, port or maritime terminals, inland carriers, public entities, among others that directly use these port systems and, based on their experience, triangulate the data; and (d) compare the improvements that ports have achieved, either in costs, times, connectivity, optimization and/or automation of their operations, or other indicators of port competitiveness, after having implemented these systems.

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