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Facilitating conditions for successful adoption of inter-organizational information systems in seaports

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ABSTRACT

Inter-Organizational Information Systems (IOISs) for seaport logistics facilitate monitoring operations, the exchange of information with stakeholders, and meeting regulations of foreign trade. However, seaport contexts entail complexities in terms of stakeholder involvement and business processes that must be considered thoroughly toward the successful adoption of IOISs. This research seeks to identify factors influencing the successful adoption of IOISs in seaports. It follows a grounded theory approach relying on semi-structured interviews and expert opinions to identify facilitating conditions for the adoption of IOISs. Survey research was conducted in order to investigate the appraisal of different ports in Latin America and the Caribbean region regarding the diverse conditions. The results obtained were analyzed descriptively and through a Principal Components Analysis. The latter was conducted in order to discern relevant dimensions influencing the adoption of IOISs in seaports. The results of the study allow deriving managerial insights and practical recommendations to support technological plans at ports and guide the decision-making regarding the digitalization process.

1. Introduction

Global seaborne trade reached 10.7 billion tons in 2017, expanding volumes at a four percent rate, the highest one in the last five years, as reported by the United Nations Conference on Trade and Development (UNCTAD) (UNCTAD, 2018). Global port activity had also a significant expansion in 2017, expanding at a six percent rate regarding world container port throughput (UNCTAD, 2018). Ports are key players in international trade and logistics and critical nodes in global supply chains (UNCTAD, 2018; Rodrigue and Notteboom, 2009), integrating various means of transportation to transferring cargo. In spite of this, trade costs and technological barriers, as well as a lack of standardization in logistics, continue to hinder operational efficiency of ports (Marti and Puertas, 2017). Therefore, technologies aimed at facilitating operations and integration of port logistics play a significant role in expanding the reach and efficiency of global supply chains and international trade (Min et al., 2017).

According to Büyüközkan and Göçer (2018), a digital supply chain is an automated and value-driven process supported by information technologies (Ustundag and Tanyas, 2009; Liang, 2015). Digital supply chain processes are increasingly ubiquitous in port operations worldwide. In this regard, *"Port Inter-Organizational Information Systems (IOISs) aim to deal with environmental uncertainty, and support logistics integration and coordination in the maritime transportation network of physical, information, and financial*

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flows, in which the port is a hub" (Van Baalen et al., 2009). An IOIS is not built only to enable data exchange, but also to improve inter-organizational processes and support decision making. There are different types of port IOISs such as Port Community Systems (PCSs) and Track and Tracing systems to illustrate such systems (Van Baalen et al., 2009).

Implementation of IOISs for seaport logistics is often led by port authorities that act as change agents or orchestrators (Srour et al., 2008; Heilig et al., 2017a). However, in many countries, the benefits of operating IOISs in seaports has not lived up to the stakeholders' expectations (Keretho and Pikart, 2013). IOIS are complex systems that must respond to the needs and intricacies of multiple stakeholders, as well as the demands of sophisticated logistic processes. Therefore, the lack of a holistic approach for dealing with the different dimensions involved in the implementation of IOISs may hamper successful outcomes. Clearly identifying factors and dimensions for successfully implementing IOISs is an endeavor that interests both professional and scholar domains of discourse, and a key element toward implementing these systems to their potential.

In this research, we seek to devise a set of facilitating conditions and dimensions influencing successful implementation of IOISs for seaport logistics. Based on the identified factors and dimensions, we derive managerial implications and recommendations. Accordingly, the main contributions of this research are as follows:

- It identifies and describes a set of facilitating conditions for successful implementation of port IOISs for seaport logistics. Examples of such systems are Tracking and Tracing and Port Community Systems.
- It implements a survey as a case study, considering multiple stakeholders for a total of 21 ports in 13 countries in the Region of Latin America and the Caribbean.
- It discovers underlying dimensions underpinning the facilitating conditions, through Principal Components Analysis (PCA) of survey responses.
- It provides managerial insights and public policies recommendations towards accomplishing the successful implementation of the aforementioned systems.

The paper is structured as follows. The state of the art of port IOISs is discussed in Section 2. Subsequently, the research methodology is presented in Section 3. This includes an interview process with port community experts in Latin America, aimed at identifying a set of facilitating conditions influencing successful implementation of port IOISs (Section 3.1). Next, the results of a survey based on the identified facilitating conditions, covering the region of Latin America and the Caribbean are presented, together with a discussion of dimensions that underpin the conditions identified (Section 4). Lastly, the main conclusions of this study, including recommendations for future developments, are provided in Section 5.

2. Literature review

With the emergence of technologies as well as domain-specific standardization initiatives, ports and the maritime industry have new opportunities to increase the productivity and efficiency of their operations (Chituc, 2017; Heilig et al., 2017a). This section is structured as follows. Tables 1 and 2 present an overview of the literature that have been grouped into four categories. First we present the surveys that is developed in the area of Information Systems and the digitalization of maritime transport and ports. The next category addresses those contributions related to PCSs and the third category those related to Tracking and Tracing systems.

Table 1
Survey of IOISs Literature- Categories 1 and 2.

	Cat. 1: Information Systems and Technologies in ports					Cat. 2: Port Community Systems (PCSs)			
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
Heilig et al. (2017a)	✓			✓	✓				
Heilig et al. (2017a), Heilig et al. (2017b)	✓			✓		✓			
Heilig et al. (2017b)	✓			✓		✓			
Heilig et al. (2017b)	✓			✓		✓			
Aydogdu and Aksoy (2015)		✓							
Carlan et al. (2016)	✓		✓	✓	✓		✓		
Ghazanfari et al. (2014)				✓	✓		✓		
Keceli (2011)			✓	✓				✓	
Long (2009)			✓	✓		✓			
Smit (2004)									✓
Tijan and Aksentijević (2014)				✓		✓	✓		
Tsamboulas and Ballis, 2013				✓		✓	✓		
Tsamboulas et al. (2012)			✓	✓	✓				
Moros et al. (2019)			✓	✓	✓				
Van Baalen et al. (2009)	✓		✓	✓	✓		✓	✓	
Chandra and van Hillegersberg (2018)			✓	✓		✓		✓	

(a) Survey and categorization(b) Standards(c) Case study application(d) Applications in maritime transport and ports(e) Quantitative assessment(f) Descriptive (concepts, implementation, history)(g) Functionalities and characteristics(h) Strategy, governance and innovation(i) Comparative analysis of two or more PCSs.

Table 2
Survey of IOISs Literature- Categories 3 and 4.

	Cat. 3: Track and Trace Systems							Cat. 4: IOISs and other Information Systems Adoption			
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)
Van Baalen et al. (2009)												✓
Chandra and van Hillegersberg (2018)												✓
Van Dorp (2002)				✓		✓						
Königs et al. (2012)	✓											
Ketzenberg and Bloemhof-Ruwaard (2009)		✓					✓					
Badia-Melis et al. (2015)	✓						✓					
Bibi et al. (2017)	✓	✓					✓					
Dabbene et al. (2014)	✓			✓		✓	✓					
Cruz Introini et al. (2018)	✓	✓					✓					
Ringsberg (2014)	✓			✓		✓	✓					
Mirzabeiki et al. (2016)			✓		✓							
Fishbein and Ajzen (1977)								✓				
Davis (1985)								✓				
Venkatesh and Davis (2000)								✓				
Schumacker (2015)								✓				
Venkatesh et al. (2003)								✓				
Dwivedi et al. (2011)								✓				
Denolf et al. (2015)										✓		
Coronado Mondragon et al. (2017)												✓
Erumban and De Jong (2006)									✓			
Lima et al. (2018)											✓	

(a) Surveys(b) Functionalities and characteristics(c) Impact assessment(d) Descriptive (concepts, implementation)(e) Applications in ports(f) Applications in the logistics sector(g) Applications in the agri-food systems(h) General studies and concepts(i) Adoption in general(j) Adoption in the logistics sector(k) Adoption in the agri-food sector(l) Adoption in the maritime and port sector

IOISs are illustrated mainly in the applications related to the maritime and port sector, supply chain and logistics and in the agrifood industry. The last category presents the contributions related to Information Systems and Technology adoption.

As it can be observed in Table 1, comprehensive studies of information systems and technological solutions used in seaport operations and their digital transformation are presented by Heilig and Voß (2017), Heilig et al. (2017a), Heilig et al. (2017b), Fruth and Teuteberg (2017), who point out the need of theoretical and empirical work in this area. One of the main focus of interest in the literature about IOISs is on PCSs, that is the second category in Table 1. A PCS is an electronic platform that connects the multiple systems of the different stakeholders of a port community as a single window, avoiding bilateral data transfer (Van Baalen et al., 2009). This facilitates electronic data interchange and transactions management along with the critical business processes of the port and the associated services in a centralized scheme. Beyond this, PCSs are a general platform enabling information exchange and technical functionalities that provide services to the stakeholders of the port community and its users, and should include regulations that enable its operation and associated tariffs (Aydogdu and Aksoy, 2015; Carlan et al., 2016; Ghazanfari et al., 2014; Keceli, 2011; Long, 2009; Smit, 2004; Tijan and Aksentijević, 2014; Tsamboulas and Ballis, 2013; Tsamboulas et al., 2012; Moros et al., 2019; Van Baalen et al., 2009). In this regard, Carlan et al. (2016) present a comprehensive analysis and categorization of literature regarding PCS development (e.g. Chandra and van Hillegersberg, 2018; Keceli, 2011; Long, 2009; Smit, 2004; Tsamboulas et al., 2012). Van Baalen et al. (2009) on the other hand, present a comprehensive study of port IOISs capabilities to sharing information to support collaborative planning and execution of container transport, with an emphasis on the role of PCSs.

Another type of port IOISs are cargo tracking and tracing systems, that corresponds to the third category of Table 2 (Van Dorp, 2002; Königs et al., 2012). Cargo tracking and tracing are value-added services to the various stakeholders of a supply chain, and commonly include the real-time capability of informing (alerting) the status of cargo shipments (Ketzenberg and Bloemhof-Ruwaard, 2009). Given the importance of tracking and tracing in the agri-food industry, several studies related to applications and impacts assessment of such systems have been conducted. The reader can refer to the surveys presented by Badia-Melis et al. (2015),Bibi et al. (2017), Dabbene et al. (2014),Cruz Introini et al. (2018), Ringsberg (2014). Nonetheless, it is important to consider that tracking and tracing systems are very relevant in another type of cargo as well. In the context of the port and maritime supply chain, tracking and tracing systems provide stakeholders with an awareness of cargo flows and support decision making. As indicated by Van Baalen et al. (2009), PCSs provide transparency and real-time information to facilitate tracking and tracing of cargo. For this reason, tracking and tracing systems can be implemented as part of a PCS or standalone, and both systems are partially overlapping subsets of IOISs. One recent related contribution is presented by Mirzabeiki et al. (2016), in which they propose an RFID based tracking and tracing system for a dry port.

With regard to the adoption of IOISs in industries, that is the last category in Table 2, several models have been proposed in the literature to understand the factors influencing the acceptance of such systems, namely, the Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1977), the Technology Acceptance Model (TAM) proposed by Davis (1985) and its extended version TAM2 (Venkatesh and Davis, 2000), the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) and its extended version UTAUT2 (Venkatesh et al., 2012), among others. Such models consider various constructs and mediating variables

to predict users' behavioral intention to adopt the technology. Their practical use requires administering psychometric measurement based on questionnaires, and empirical validation of the respective theoretical models requires utilizing techniques such as factor analysis and structural equation modeling (SEM) (Schumacker, 2015).

Venkatesh et al. (2003) defined facilitating conditions in the context of UTAUT as the degree to which an individual believes that an organizational and technical infrastructure exists to support technology use. They identified that behavioral intention and facilitating conditions were two direct determinants of adoption behavior. However, while models such as the UTAUT and UTAUT2 comprise a facilitating conditions component, the definition of this component and its related psychometric measurements is general and not specific to a particular technological or socio-cultural domain (Dwivedi et al., 2011). Measurement of facilitating conditions through the respective instruments and scales comprises a reduced set of items, which do not take into account the context and needs of IOISs for seaport logistics. Therefore, further research efforts are required to define and characterize the facilitating conditions component that is specific to these settings. This could facilitate further studies with regard to technology adoption, based on current technology adoption theories.

In relation to the above, thirteen facilitating conditions denoted as "Critical Success Factors" (CSFs) for the implementation of supply chain information systems are identified by Denolf et al. (2015), which are grouped into five categories: project strategy, management processes, structure, information systems and people. Coronado Mondragon et al. (2017) on the other hand, propose a framework based on Institutional Theory, TAM and Supply Chain, and Institutional Isomorphism, to analyze and explain technology adoption in intermodal terminals, particularly considering seaports. However, their study focused on technologies utilized by stevedores in port terminal operations, such as Terminal Operating Systems (TOS), rather than IOISs, such as PCSs or Track and Tracing Systems. Their framework was derived from case studies from Europe and Asia, conducted by means of qualitative research based on interviews. Chandra and van Hillegersberg (2018) on the other hand, present a study to explain the governance of IOISs as port collaborations, using the life cycle paradigm. They consider as a case study the PCS of the Port of Rotterdam.

As indicated by Van Baalen et al. (2009), the main challenge of the adoption of an IOIS is that the organizations that are participating in the process differ with respect to the benefits and the resources available for them. Hence, the implementation of an IOIS in port communities may be a long and complex negotiation process. As an example, Van Baalen et al. (2009) quote the case of the Port of Rotterdam, where it took almost 20 years for the implementation of a PCS.

System adoption processes are known to be influenced by socio-demographic conditions, financial resources and the size of the involved organizations (Lima et al., 2018). Following Erumban and De Jong (2006), who discerned geographical differences in technology adoption, this research is contributing to the existing literature, focused on the study of facilitating conditions for the adoption of port IOISs in the region of Latin America and the Caribbean (LAC). To the best of the knowledge of the authors, this is the first comprehensive study focusing on understanding facilitating conditions in this region. Furthermore, we are addressing the case of IOISs adoption that is a very complex process because several stakeholders are involved in the process, both public agencies and private companies, and that nowadays is an important matter of discussion in the ports and public agencies in the region. Semi-structured interviews were conducted with stakeholders in selected ports to validate a list of preliminarily selected facilitating conditions. Later, a survey instrument based on the validated conditions was administered to a sample composed of experts in 21 ports in 13 countries in the region. Results of the survey permit identifying underlying dimensions influencing successful implementation of IOISs in seaports, and provide useful insights with managerial implications.

3. Research methodology

In this manuscript, an empirical and exploratory study attempts to capture the particular factors that influence the successful implementation of port inter-organizational systems in the LAC region. Our research method is qualitative, based on Grounded Theory (GT). According to Moghaddam (2006), given a phenomenon under study, GT seeks to establish a set of relationships among data and categories that proposes a plausible and reasonable explanation for the phenomenon. As described by Cohen et al. (2011), patterns and theories that arise in GT research are expected to be implicit in data; therefore, theory building is possible through systematic data collection and analysis. Fig. 1 summarizes the methodology research in five main steps.

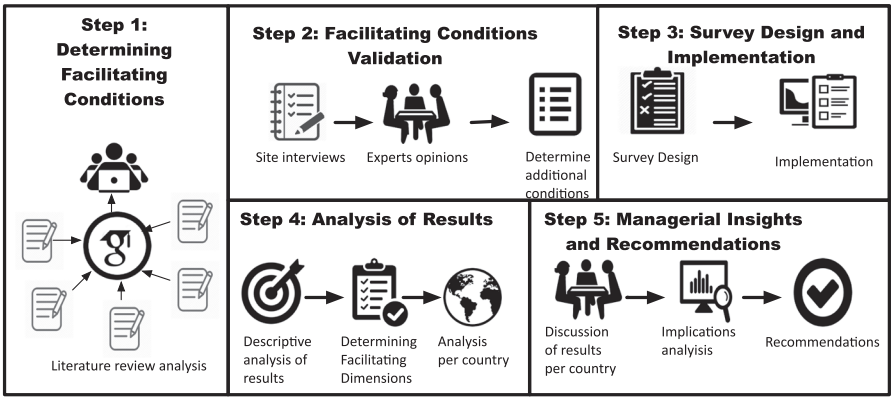


Fig. 1. Methodology research.

Step 1 considers the analysis of relevant references of port IOISs implementations and related studies in the literature, with the aim of determining a set of conditions that facilitate the implementation of IOISs at seaports. This enables us to define a set of preliminary facilitating conditions to be further validated in Step 2. This second step considers site interviews at each port community that also allows to identify the current situation of those ports and validate the list of facilitating conditions defined by the literature review. Furthermore, experts in the field were also consulted (academics and consultants) to validate the facilitating conditions preliminarily defined. Additional conditions were determined and summarized according to their occurrence during the interviews with stakeholders of the participating ports.

Step 3 considers the survey instrument design, according to previously collected information with the aim to analyze the set of identified facilitating conditions for IOIS implementation. Step 4 consists of the analysis of results. In this case, a statistical analysis per type of respondent is considered, as well as a categorization of such conditions into dimensions per country. For this, we use the PCA methodology (Principal Components Analysis). Lastly, Step 5 considers the discussion of results to derive managerial insights and recommendations for both government agencies and logistics stakeholders.

The implementation of the first three steps is further described in the following subsections, while Section 4 presents the results obtained (Steps 4 and 5).

3.1. Step 1: identifying facilitating conditions

The initial set of facilitating conditions for successful adoption of IOISs was identified by means of a literature review conducted by the present authors. These are as follows:

- **F1: Political Willingness**: Cooperation among governmental agencies and institutions in the implementation process of the IOIS (Cepolina and Ghiara, 2013; Coronado Mondragon et al., 2017; Panayides et al., 2015).
- **F2: Stakeholder Collaboration**: Effective collaboration among public and private actors involved in foreign trade processes (Bisogno et al., 2015; Boonstra and de Vries, 2008; Carlan et al., 2017; Cepolina and Ghiara, 2013; De Martino et al., 2013; Keceli et al., 2008; Van Baalen et al., 2009).
- **F3: Quality of Information**: Accurate, complete, reliable, relevant, accessible, timely, and easy to use information must be available to the stakeholders involved in the operation of the IOIS (Aydogdu and Aksoy, 2015; Bisogno et al., 2015; Denolf et al., 2015; Harris et al., 2015; Hu et al., 2013; Keceli et al., 2008; Posti et al., 2011; Van Baalen et al., 2009).
- **F4: Regulations**: Regulations and laws that facilitate, stimulate, and mandate the use and implementation of IOISs (Carlan et al., 2017; Cepolina and Ghiara, 2013; Coronado Mondragon et al., 2017; Panayides et al., 2015; Van Baalen et al., 2009).
- **F5: Complementary Technologies**: Availability of technologies (sensors, RFID) that support data collection, transmission and exchange among actors in ports (Heilig and Voß, 2017; Keceli et al., 2008; Coronado Mondragon et al., 2017; Van Baalen et al., 2009).
- **F6: Integration between Systems**: Inter-operability among the systems currently in place with the IOIS (Alkhater et al., 2018; Aydogdu and Aksoy, 2015; Harris et al., 2015; Posti et al., 2011).
- **F7: Management of Expectations**: Clarity in the features that the IOIS provides to users (Bechini et al., 2008; Bisogno et al., 2015; Boonstra and de Vries, 2008; Denolf et al., 2015; Harris et al., 2015; Keceli et al., 2008; Lu et al., 2006).
- **F8: Training**: Personalized training on the use and features of the IOIS (Li and Lin, 2006; Lu et al., 2006; Trkman, 2010).
- **F9: Process Re-engineering**: Modeling and redesign of the business processes associated with foreign trade (Denolf et al., 2015; Lu et al., 2006; Trkman, 2010).

3.2. Step 2. Facilitating conditions validation

The relevance of the facilitating conditions described above was attested with stakeholders of 15 port systems from nine countries,[1] members of the Digital and Collaborative Network of ports (D&C Network) led by the Latin American and Caribbean Economic System (SELA by its acronym in Spanish).[2] Site interviews were conducted in D&C Network activities and events between August 2014 and September 2016. This considers individual interviews with representatives of the Port Authorities and stevedores managers, as well as group sessions with different stakeholders: Transport carriers, National customs, Custom agents and freight forwarders, Stevedores, Maritime Transport operators, and shipping agents, Port Authorities, as well as academics. The total number of participants varied in a range of 10 to 28 participants. Preliminary results of this research have been reported in Schulte et al. (2016), however, reporting specifically sustainability challenges and practices.

Regarding the situation of ports in the region with respect to the development of IOISs and digitalization of foreign trade-related procedures, the following issues can be highlighted:

- **(i)** Several paper-based procedures in port business processes are still prevalent, resulting in delays and inefficiencies.
- **(ii)** Several business processes at the ports do not follow international standards and protocols, such as UN-EDIFACT (United

[1] Ports of Altamira, Veracruz, Manzanillo, Limon-Moin, San Buenaventura, Cartagena, Colon, Balboa, Guayaquil, Montevideo, Valparaiso, San Antonio, Port of Spain, Callao and Paita.

[2] www.sela.org/redpuertos.

Nations/Electronic Data Interchange For Administration, Commerce, and Transport).

- **(iii)** Most of the countries are currently implementing a National Single Window to integrate governmental procedures with a national scope and budget. The countries that have more progress in this aspect are Chile, Peru, Colombia.
- **(iv)** Digitalization of ports has followed a strategy that has evolved over time and depends on who is taking the leadership of the initiative. The main strategies can be classified into three categories: National, Sectorial and Local. Each strategy is described as follows:
  - National Strategy: This implies that the procedures are directly related to the development of the National Single Window. This is a strategy that applies in ports that lack of a Port Authority and are regulated by a National Institution. Countries such as Panama and Colombia have this situation, and this would be a strategy they could follow. Panama has initiated the development of the Maritime Single Windows, but there is still no progress on the development of their PCS or any other IOIS.
  - Sectorial Strategy: This corresponds to the case in which a Maritime Authority or the Ministry of Transport takes the leadership to develop an IOIS with a national approach. Countries under this situation can be considered Jamaica, Peru, and Chile.
  - Local Strategy: This considers that the Port Authority takes the initiative to develop its PCS based on its own logistics model and operations. This is the most common approach in the region and has been followed by the ports of Veracruz (Mexico), Manzanillo (Mexico), Buenos Aires (Argentina) and Valparaiso (Chile). In the case of the Port of Valparaiso, it is important to mention that even though at present, the Ministry of Transport in Chile is following a sectorial strategy, the Port of Valparaiso was the first port that took the initiative to develop their own PCS several years ago. For this reason, it is considered that the initial strategy in this port followed a local approach.
- **(v)** There have been some advancements in the development of IOISs, but their scope and functionalities are still limited. The Port of Valparaiso in Chile and the Port of Buenos Aires in Argentina are the only ports that have implemented a PCS with a functionality for tracking and tracing the cargo, while the Port of Kingston in Jamaica has implemented a PCS only for transshipment cargo (currently working on other business processes).
- **(vi)** Several countries have initiated the development of Maritime Single Windows for vessel entry procedures, such as Panama (as previously indicated), Peru, Mexico, and Chile.

Finally, two additional conditions were determined as important elements to be considered:

- **F10: Willingness to Change** Willingness of stakeholders to change a process, system, and/or practices.
- **F11: Availability of financing sources** Availability of facilities from which to access financing for the development of technological projects.

3.3. Step 3:Survey Design and Implementation

In addition to the fifteen ports in nine countries considered in the first part of the study, additional six ports were included in the sample,[3] summing up to a total of 21 ports in 13 countries.

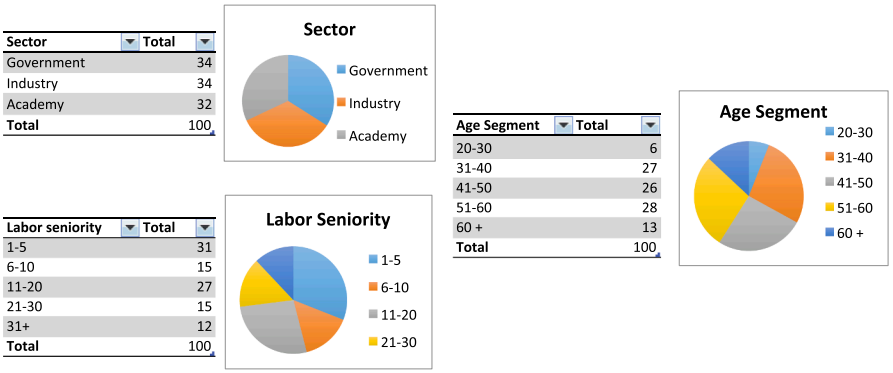
A survey questionnaire was constructed with the aim of ascertaining the relevance of the eleven factors previously identified. The questionnaire was reviewed by ten experts, all of them members of the D&C Network. The experts appraised the structure of the instrument and suggested improvements for item readability and comprehension. The final version of the questionnaire is presented in Appendix A.

The survey questionnaire has three main sections for the assessment of the factors under analysis. The first section of the questionnaire prompts the respondent for an *individual assessment* of each factor based on a four-point Likert scale (1: Strongly agree, 2: Agree, 3: Disagree, 4: Strongly Disagree). The reason to employ this scale is to avoid neutral answers and force the respondent to select one option. The second section, i.e. *self-assessment*, prompts the respondent for reflection on the current situation of the port and/or the country to which he/she belongs. The last section comprises a *relative assessment* of the facilitating conditions, in which the respondent is asked to rank them according to his/her self-perceived relevance. Open-ended questions were included at the end of the questionnaire in order to capture other eventual facilitating conditions not previously considered, and opinions with regard to the potential benefits that can be gained by the implementation of IOISs in ports.

For each subject, the survey instrument was administered either personally in handwritten form, or by means of an online system.[4] During the Second Regional Meeting of Port Logistics Communities organized by SELA in the city of Cartagena de Indias, Colombia (July 2017), 33 complete handwritten surveys were collected from a total of 50 participants, i.e. 66% response rate. Later, a list of community members was obtained from each port in the D&C network. With this information, a total of 524 additional subjects were invited to answer an online survey that was issued over a period of 103 days from the moment that the invitation was sent to the participants until the last answer was received [August-November 2017]. In total, 68 completed online responses to the surveys, thus a total of 101 responses were collected, i.e., 20% combined response rate. All the respondents are either port authority executives, port industry specialists, academics, transport authorities, and related ministers, or technological service operators (The survey is presented in Appendix A).

[3] Port of Buenos Aires, Point Lisas, Kingston, Quetzal, Talcahuano, and the Santa Catarina port complex in Brazil (Sao Francisco do Sul, Itajai and Imbituba).

[4] www.surveymonkey.com.



Sector	Total
Government	34
Industry	34
Academy	32
Total	100

Labor seniority	Total
1-5	31
6-10	15
11-20	27
21-30	15
31+	12
Total	100

Age Segment	Total
20-30	6
31-40	27
41-50	26
51-60	28
60 +	13
Total	100

Fig. 2. Survey Respondents Characteristics.

4. Discussion and results

In this section, we present a discussion of the results obtained (Step 4 of the proposed methodology). Firstly, we present an assessment of facilitating conditions in Section 4.1. Then we present the results of a PCA to explore the dimensions underpinning facilitating conditions in Section 4.2. Finally, recommendations and managerial insights are presented in Section 4.3 (Step 5 of the propoed methodology).

4.1. Assessment of facilitating conditions: results and discussion

First, we provide the characteristics of the respondents of the survey in Fig. 2. We can see how the respondents are proportionally distributed among industry, government and academia. On the other hand we can see that the surveys are divided into five levels of seniority work, being more common those people who are in the first years (1–5). Finally we can observe the age separation of the surveys, well balanced in people over 30 years and less than 60 years.

Table 3 presents the results obtained from processing the survey, considering the three sections of the instrument, namely, individual, self, and relative assessments. For the first two sections, the table presents the average value and standard deviation of the responses for each condition, considering the complete sample. We also present the average values and standard deviations (last rows) of the average values for each factor. In the last column, the relative assessment of the factors as a ranking is shown, and the average values obtained are presented. In this case, the lowest value indicates that the factor has greater importance. In the self-assessment section, the existence of formal agreements in the port community for the adoption of IOISs is also indicated. For each section, the three factors considered the most relevant are highlighted in bold type and filled in with grey. Recall that the scale of the survey for the individual and self-assessment, a value of 1 represents the best performance whilst a value of 4 the worst one. For the relative assessment, the scale of the survey (ranking) also considers a value of 1 as the best performance. For the cases in which the factor is significant according to the t-student test, the values are underlined (only in the first two sections). The details of the Factor Assessment table, separated by each sector: industry, academic, and government is presented in Appendix B. Even though results vary per type of respondent, we can observe that in the individual assessment, all the different types of respondents selected F2 with the lowest grade, which is consistent with the overall average evaluation in Table 3. In the relative assessment section, all the respondents selected F9 with the lowest grade, which indicates is the one best implemented. But, in the self-assessment section, the

Table 3
Factors assessment.

Factors	Individual assessment Average	Std Dev.	Self-assessment Average	Std Dev.	Relative assessment Average
F1	**1.39**	0.57	**2.22**	0.74	**2.93**
F2	**1.17**	0.38	**2.38**	0.74	**3.18**
F3	**1.20**	0.40	**2.41**	0.69	5.74
F4	1.43	0.52	**2.52**	0.82	**5.31**
F5	**1.36**	0.48	**2.22**	0.70	7.54
F6	**1.30**	0.50	**2.46**	0.74	6.03
F7	1.46	0.61	2.39	0.75	8.32
F8	1.34	0.50	2.28	0.68	7.61
F9	**1.66**	0.60	**2.17**	0.72	7.07
F10	1.35	0.56	2.35	0.68	5.61
F11	1.54	0.59	2.42	0.64	6.66
F12*	N/A	N/A	**2.66**	0.68	N/A
Average	1.38		2.37		N/A
Std Dev.	0.14		0.14		N/A

Industry and Government respondents selected F1 as the most important on average, while the academic respondents selected F2.

It can be noted that the most relevant facilitating conditions differ among sections. When comparing the individual and relative assessment sections (the first and third), only F2 appears in both sections with the lowest values (that indicates the best performance) even though both measure the relevance of the same facilitating conditions. The participants providing, on average, very close values to the facilitating conditions when evaluated one at a time, can explain this. Actually, they have an average value of 1.38 with a very low standard deviation (0.14). In all cases, the participants recognized the importance of all the facilitating conditions. F2 is considered relevant when the participant is required to provide an individual assessment but it does not have the best grade when a self-assessment is performed which indicates that it is an important element but has not been implemented in the port and country as required. F1 and F4 appear more relevant than F3 and F6.

For the evaluation of the current situation of each condition at their corresponding port and/or country, the values obtained for the self-assessment fell within a range from 2.17 to 2.66, which means that ports and countries in the region have an intermediate performance. Out of the three conditions that were evaluated as the most relevant, only F1 ('Political Willingness') corresponds to a facilitating condition that was valued among the most relevant in the relative assessment. This is consistent with the current situation of ports in the LAC countries since the governments have shown interest during the last decade in promoting the development of information systems and technologies to facilitate trade and transport.

Contrary to the strategies followed by ports in other regions, where the private sector had significant participation and leadership in the development of port technologies and information systems, in the LAC region initial efforts have been pursued by public institutions. This has happened either following a national strategy (National Single Windows system, NSW), sectorial or local strategy, such as the PCSs developments led by the port authorities as in the case of SILOGPORT in Valparaiso; e-PuertoBue in Buenos Aires). In Chile, for example, the Ministry of Transport established a commission to address the development of a PCS following a sectorial strategy, considering the design of base modules for tracking and tracing, as well as truck appointments. Survey respondents acknowledged these efforts, as they indicated that F1 has been the best achieved in their countries and ports, compared to the rest of the factors.

The F9 factor ('Redesign of Processes') had the best self-assessment. Note that this factor was posed both in the individual and relative assessments, too. The respondents identified that process redesign is an aspect on which ports have been working, and their perception is that it has been highly achieved.

According to ESCAP (ESCAP, 2009), business process redesign is one of the first steps to take for developing a technical system such as a NSW. Hence, although this factor did not result as significant as F1, it is of fundamental concern to port stakeholders in the LAC region. The 'Complementary Technologies' facilitating condition ranked in the third position in the relative assessment.

In contrast to other regions that have had a long history of PCS implementation and operations based on monolithic system architectures that have evolved over decades, ports in the LAC region at present integrate a variety of complementary technologies available in the market (Heilig et al., 2017b). Survey responses seemed to acknowledge this fact.

In terms of regulations, LAC countries present the worst performance. Respondents also indicated the lack of formal agreements for developing and implementing collaborative solutions in the port communities. This result is consistent with the state of legislation, as most of the ports are still operating under legislation dating back to the late 1990's and few amendments have been carried out (Sánchez and Pinto, 2015).

Finally, the responses to the open-ended question that asked for additional facilitating conditions not considered in the survey were inductively coded into categories. The most recurring categories were considered to derive recommendations (see Section 4.3).

4.2. Exploring dimensions underpinning facilitating conditions

A PCA was conducted with survey responses in order to devise dimensions underpinning the facilitating conditions that were considered theoretically. Also, perceptual maps were constructed considering the respondents' countries of origin. The following procedure was used (see Gorsuch, 1983 to conduct PCA). Firstly, the adequacy of the sample was analyzed by applying Bartlett's test. The null hypothesis of the test states that the correlation matrix is equal to the identity matrix, i.e. the bivariate correlations between the various factors are all close to zero. For this, a Chi-square statistic is constructed. The result for this statistic is 510.06 with 66 degrees of freedom, which rejects the null hypothesis with $p < 0.001$. This informs that there are strong bivariate correlations that justify the use of PCA.

Next, PCA was applied with varimax, i.e., orthogonal rotation. The eigenvalues are studied to determine the number of components to be selected for constructing perceptual maps. The first three eigenvalues are 5.69, 1.09, and 0.93. Two components are then selected by applying the rule of eigenvalues greater than 1, which represents 56% of the total variance of the sample.

The factor loadings (FL) are studied to provide an interpretation for the two components considered. Each of the eleven factors surveyed was assigned to one of the two components based on the highest factor loading. The factors that have the highest correlations with the first component are 'Stakeholder Collaboration' (F2, FL = 0.85), 'Political Willingness' (F1, FL = 0.78), 'Regulations' (F4, FL = 0.76), 'Formal Agreements' (AG*, FL = 0.61), and 'Integration Between Systems' (F6, FL = 0.54). On the other hand, the factors that have the highest correlations with the second component are 'Training' (F8, FL = 0.84), 'Process Re-engineering' (F9, FL = 0.72), 'Management of Expectations' (F7, FL = 0.68), 'Complementary Technologies' (F5, FL = 0.65), and 'Quality of Information' (F3, FL = 0.56). The remaining factor loadings are close to 0.5 for both components. According to this analysis, we refer to the two identified components, or dimensions underpinning the facilitating conditions, as 'IT Governance and Institutionality', and 'IT Infrastructure and Business Processes'.

Finally, the various countries are plotted on the two-dimensional perceptual map. The factor scores are used for this purpose. We

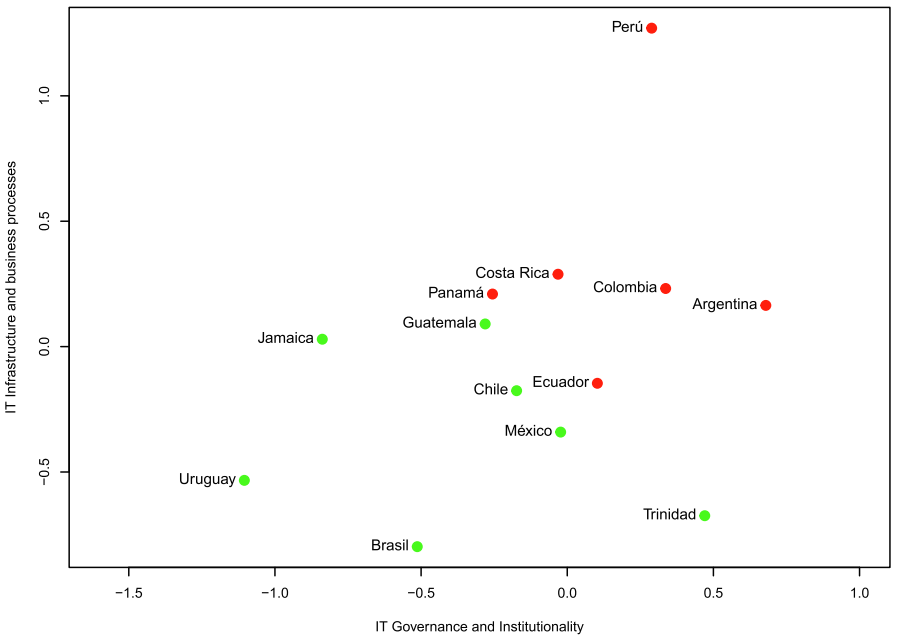


Fig. 3. Perceptual map aggregated by country.

aggregate all the respondents by country by computing the mean of the corresponding factor scores for each of the two components. This perceptual map is presented in Fig. 3. In the figure, given that the answers obtained on the survey indicate a positive value when they are close to 1, the countries that have better performance are those located in the left-inferior quadrant; i.e., countries such as Uruguay, Brazil, Jamaica, and Chile. On the other hand, those countries located in the right-superior quadrant have the worst performance for both components (such as Peru).

As stated above, countries such as Jamaica, Uruguay, Brazil, and Chile showed the best performance for both dimensions. In the case of Jamaica, respondents indicate that the implementation of a PCS brought significant benefits to their community. Another country that has made important efforts is Chile. The port of Valparaiso has already implemented a PCS with a module for traceability of cargo. Furthermore, the Ministry of Transport created a PCS Commission that has conducted several activities with the stakeholders of the main port communities in the country for the development of national strategies to foster port and logistics efficiency through the digitalization of the related procedures.

The cases of Uruguay and Brazil are relatively similar in practice. They are striving to promote digitalization of ports, and both have an important maturity level that was perceived by the survey respondents. On the other hand, the worst performance, according to the PCA, was observed in Peru. It is important to highlight that several ports and countries have been developing their NSW and the maritime single windows, the reason for which some procedures such as vessel entry have been automated, reducing related paper-based procedures. This is the case in the port of Buenos Aires, Argentina, and Panama. However, in all of these countries, there are still inefficiencies in the landside interface of ports.

4.3. Recommendations

In light of the results of the survey, the facilitating conditions and their relative importance are summarized in Fig. 4. This includes four additional conditions suggested by the participants in the open-ended questions: (1) National Logistics Development, (2) Technical capabilities of the development team and partners, (3) Efficiency of port processes and (4) Analytical methods to support decision making.

All the facilitating conditions were grouped into the two dimensions derived from the PCA procedure: ‘IT Governance and Institutionality’, and ‘IT Infrastructure and Business Processes’. The relative importance of each condition (with the exception of the new ones) is indicated in the left-hand side corner, according to the results in the relative-assessment section of the survey.

The three most relevant facilitating conditions are related to IT Governance and Institutionality: (1) Political willingness, Leadership and Institutionality; (2) Stakeholder collaboration and governance of the port logistics community; and (3) Regulations. These three conditions are thus the base elements of the framework. As indicated by the respondents, it is not enough to have the political willingness to foster the technological development of ports. Rather, leadership from the institutions is necessary to foster commitment and enhance the management change process. The strategy employed for the implementation of an IOIS in seaports is influenced by the leadership from the institutions, as leadership and strategy go hand in hand. Another important element revealed by the respondents relates to the governance and the need for co-operation of all the public–private stakeholders of the port community.

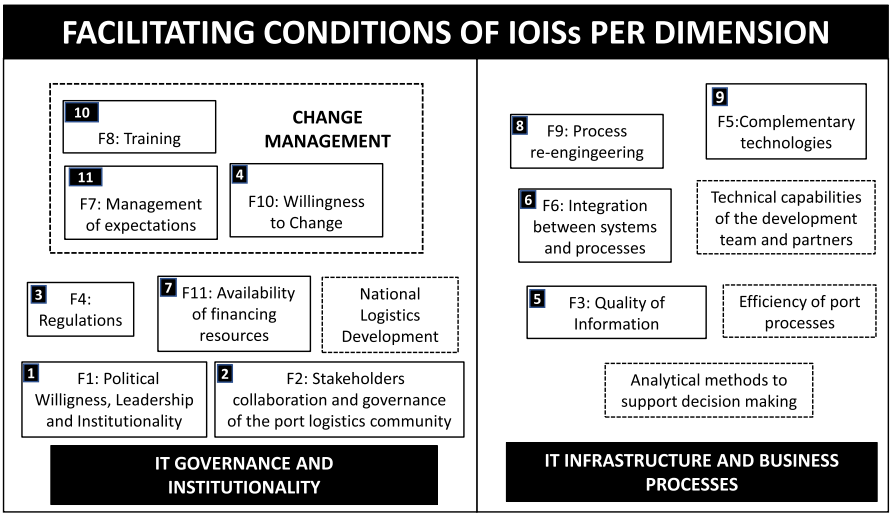


Fig. 4. Facilitating Conditions for IOIS adoption at seaports by dimension.

Accordingly, we provide the following recommendations and managerial insights toward the successful adoption of IOISs for seaports that have been divided per type of stakeholder: policy maker and private companies: From the policy makers' perspective, we can provide the following recommendations:

- Countries need to be aware of the importance that the public sector has in the digitalization of ports. The institutionality of the public sector must involve an agency that governs the different aspects of ports and their logistics. Leadership from the authorities must be proactive in convincing and involving the different stakeholders, and gaining their enthusiasm and commitment.
- IT Governance and Institutionality have been confirmed to be a critical condition. As indicated in the literature review, the difficulty of having different interests and benefits among the stakeholders and the required negotiations can significantly impact on the timing and successful implementation of IOISs (Van Baalen et al., 2009).
- The government agencies and the port logistics communities need to clearly define the leadership who will foster an understanding of such technologies, the benefits to be obtained, and the requirements for each stakeholder. Leaders should manage the expectations of the stakeholders, so that there may be a clear understanding, for instance, of the features a system will provide.
- Governments need to establish regulations to facilitate the development of IOISs following consistent standards and protocols. In addition, clear definitions of information access and ownership policies are needed given the variety of stakeholders that interact with IOISs. Special efforts by public agencies are required to promote public policies and regulations that facilitate the digitalization of port operations. For instance, amendments to certain regulations might be necessary prior to the introduction of any IOISs at the port.
- Ports and governments need to constitute formal logistic communities as a public–private partnership and foster their governance, with a permanent structure that allows the different stakeholders to gather and discuss the different issues of port digitalization plans. This initiative requires the support and leadership of Port Authorities, but is very relevant to incorporate Customs Authorities and Maritime Authorities in the process.
- Countries need to define a digitalization strategy for their ports and transport systems. For countries such as Jamaica, envisioning a single PCS on a national scope with a sectorial strategy resulted as being very positive. There are, however, other countries that are following a local strategy for the development of such systems. Planning and designing the strategy and roadmap of technological developments result very importantly.
- In the component analysis described above, high variability in the responses of various countries for each component was observed. From the case study region, the countries that had better performance resulted in Jamaica, Uruguay, Brazil, and Chile, followed by Mexico. The rest of the countries showed a relatively lower performance since the current efforts to implement IT and other technologies in those countries have been focused only on the maritime interface. In the case of Peru, the country has a clear vision of the need to implement technology and IT systems at the ports and are currently developing a technological roadmap with a list of specific actions to be developed.

From the private stakeholders of the port logistics community we can provide the following recommendations as well:

- The technical capabilities of the team in charge of developing and implementing the IOIS at the seaport is an important element to take into consideration. It is required to have a team with the capabilities to define the appropriated terms of reference for tendering the IOISs implementation project. The team should be able to also evaluate the proposals for the tendering, as well as conducting due diligence, among other tasks. The selected consultant team should also have the required technical capabilities

and experience to lead the project.

- An important step that some ports have already taken is the modeling and redesign of their business processes, with a clear understanding of the interactions among the different stakeholders, current mechanisms for information exchange, key performance indicators, associated documentation, and requirements. It is also important to specify what the available complementary technologies and technological projects being developed are and how to integrate and inter-operate the different systems. In order to undertake this step, the involvement and willingness of the different stakeholders of the port community to provide the necessary information to the team in charge of the business process modeling is required.
- As it was pointed out as a recommendation for public agencies, it is necessary that all the stakeholders may be clear about the benefits obtained as well as the responsibilities in terms of sharing data and its confidentiality. Negotiations on this matter are pretty important on the well-implementation of IOISs.

5. Conclusions and future research

In this research, an empirical study following a grounded theory approach was conducted, with the aim to determine the most relevant facilitating conditions for fostering the implementation of IOISs, such as Tracking and Tracing systems, in seaports in the region of Latin America and the Caribbean. As a result, a total of fifteen facilitating conditions were identified: nine from a literature review, two from expert opinions and four from the open-ended questions of a survey instrument.

Two dimensions were found to underpin eleven facilitating conditions, according to the PCA procedure conducted. These are namely 'IT Governance and Institutionality', and 'IT Infrastructure and Business Processes'. We could observe that performance in these constructs varied significantly across countries in the LAC region. Both constructs can be regarded as facilitators of successful adoption of IOISs for port communities and could be considered as external variables for future studies based on technology adoption theories, such as UTAUT. In addition, several recommendations have been derived in order to facilitate the adoption of IOISs in seaport communities.

The governance of port logistics communities or port clusters has received little attention in the literature, as often governance has been associated with the port authority model. However, the results of this work highlight that ports need to foster governance issues prior to initiating a digitalization project. This is one of the current efforts undertaken by the Ministry of Transport in Chile, which has derived guidelines for the development of port logistics communities in the country. The governance of port logistics communities or port clusters has received little attention in the literature, as often governance has been associated with the port authority model. However, the results of this work highlight that ports need to foster governance issues prior to initiating a digitalization project. This is one of the current efforts undertaken by the Ministry of Transport in Chile, which has derived guidelines for the development of port logistics communities in the country. To summarize, while we have indicated recommendations for policy makers as well as private stakeholders, at the end of the day it must be a joint effort, even if policy makers might have to go first.

Future research will aim at conducting comparative analyses considering other regions, to determine the impact of geographical conditions and differences that may influence on the facilitation of IOIS adoption at seaports. In addition, further research will focus on port governance structures and strategy, in order to provide guidelines and recommendations that may support the digitalization process of ports. Other intermodal terminals such as airports can be also studied, in this case, with the aim to understand the facilitating conditions for the adoption of systems such as the aircargo community systems. Another research avenue considers assessing the impact and benefits of disruptive technologies such as blockchain and IoT, and how these technologies can support the inter-relation processes and exchange of information at ports. With these novel technologies in consideration, our future research will investigate their related adoption processes in seaport communities, based on a technology adoption theory such as UTAUT, considering the facilitating conditions elicited in the present research.

Finally, an alternative approach for understanding the appraisal of different ports via surveys is conjoint analysis. This strategy has been widely used in marketing and transportation sciences (see, e.g., Wooliscroft and Ganglmair-Wooliscroft, 2014; Maldonado et al., 2015; Böse et al., 2001), and is a powerful tool for eliciting respondent preferences. Conjoint analysis, however, requires a completely different survey design, and therefore it is suggested as future work.

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Appendix A. Survey Questionnaire

Through international experience, critical factors have been recognized in the successful implementation of Information Systems and Technology. This survey aims to validate the influence of a set of critical factors on the implementation of Inter-Organizational Information Systems (IOISs) and the current conditions in the ports that are participating in the Network of Digital and Collaborative Ports of Latin America and the Caribbean. This survey is structured in three sections. Section I requests general information of the participant. Section II asks about your perception of the influence of eleven factors on the successful implementation of IOISs in seaports. Section III asks about your perception of these eleven factors on your country and related ports.

Your comments are very important for our team, so in advance we thank you for participating in this study. The information will be treated with academic objectives and we will provide a report with the results to those that answer the survey.

I **Personal Information**

I Personal Information

Name:
Institution:
Current Position:
Number of years in position:
Age Range: ☐ 20-30 ☐31-40 ☐ 41-50 ☐ 51-60 ☐ 61 and more

II **Individual Assessment of Conditioning Factors**

II Individual Assessment of Conditioning Factors

N	Item
1	**Political Willingness**: Cooperation among governmental agencies and institutions in the implementation process of IOIS. The political willingness influences the successful implementation of an IOIS in a seaport. ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree
2	**Stakeholder collaboration**: Effective collaboration among public and private actors involved in foreign trade processes. The collaboration of stakeholders influences the successful implementation of an IOIS in a seaport. ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree
3	**Quality of information**: Accurate, complete, reliable, relevant, accessible, timely, and easy to use information must be available to the stakeholders involved in the operation of the IOIS. Having quality information influences the successful implementation of an IOIS in a seaport. ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree
4	**Regulations**: Regulations and laws that facilitate, stimulate, and mandate the use and implementation of IOISs. The existence of regulations has a positive influence on the implementation of an IOIS in a seaport. ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree
5	**Complementary Technologies**: Availability of technologies (sensors, RFID) that support data collection, transmission and exchange among actors in ports. The availability of complementary technologies facilitates the implementation of an IOIS in a seaport. ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree

6	**Integration between systems**: Inter-operability among the systems currently in place with the IOIS. The integration between systems influences the successful implementation of an IOIS in a seaport. ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree
7	**Management of expectations**: Clarity in the features that the IOIS provides to users. The clear management of expectations to the users facilitates change management for the successful implementation of an IOIS in a seaport. ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree
8	**Training**: Personalized training on the use and features of the IOIS. Proper training for users influences the successful implementation of an IOIS in a seaport. ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree
9	**Process re-engineering**: Modeling and redesign of the business processes associated with foreign trade. The redesign of business processes in ports is necessary for a successful implementation of an IOIS in a seaport. ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree
10	**Willingness to Change**: Willingness of stakeholders to change a process, system, and/or practices. Willingness to change is an element that positively influences the implementation of an IOIS in a seaport. ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree
11	**Availability of financing sources**: Availability of facilities from which to access financing for the development of technological projects. The availability of funding sources in a port significantly influences the implementation of an IOIS in a seaport. ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree

III **Self-Assessment of Conditioning Factors**

III Self-Assessment of Conditioning Factors

N	Item
12	**Political Willingness**: In my country there exists the political willingness that facilitates the successful implementation of an IOIS in a port. ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree
13	**Stakeholder collaboration**: In my country there exists collaboration between public and private actors in different areas such as the provision of timely information and coordination of the operations in which they participate. ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree
14	**Quality of information**: In my country and the port where I participate, the actors have mechanisms that facilitate the exchange of information between them. ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree
15	**Regulations**: In my country there are the regulations needed for a successful implementation of IOISs in seaports. ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree
16	**Complementary Technologies**: In my country and the port that I participate, the different stakeholders have implemented the required Information and Communication Technologies (ICTs) to support, for instance, data collection, reporting and decision planning. ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree
17	**Integration between systems**: In my country and the port where I participate there exist the required inter-operability protocols between different technological systems. ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree
18	**Management of expectations**: In my country and the port where I participate, there is an appropriate management of change and expectations that promotes a successful implementation of IOISs. ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree

19	**Training**: In my country and in the port where I participate, an adequate training is performed when an IOIS or any other technological project is carried-out. ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree
20	**Process re-engineering**: In my country and the port that I participate, when carrying out a technological project, the associated business processes are analyzed and redesigned prior to its implementation. ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree
21	**Willingness to Change**: In my country and the port that I participate, the actors and users are committed and open to changes in the systems and processes in which they operate. ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree
22	**Availability of financing sources**: In my country and the port that I participate, there is access to different financing sources for the implementation of technological systems. ☐ Strongly Agree ☐ Agree ☐ Disagree ☐ Strongly Disagree

IV Relative Assessment of Conditioning Factors

IV Relative Assessment of Conditioning Factors

N	Item
23	**Facilitating Conditions Ranking**: Considering the eleven conditions previously analyzed, please rank them in terms of their importance in the list below. Assign the first position to the most relevant condition, and position number 11 to the least important: ☐ Political Willingness ☐ Collaboration of Actors ☐ Quality of Information ☐ Regulations ☐ Complementary Technologies ☐ Integration between systems ☐ Management of expectations ☐ Training ☐ Process re-engineering ☐ Willingness to change ☐ Availability of financing sources

V Open-ended Question

V Open-ended Question

24	Indicate if there is another facilitating condition that has not been considered and is relevant to be included.
25	Please indicate if there exist formal agreements for the adoption of IOISs in the port community where you participate.

Appendix B. Appendix B. Factor Assessment for Industry, Government and Academy

(See Tables)9–11.

Table 9
Industry factors assessment.

Factor	Individual assessment		Self-assessment		Relative assessment
	Average	Std Dev.	Average	Std Dev.	Average
F1	1.47	0.66	2.12	0.74	3.50
F2	1.15	0.36	2.39	0.70	3.69
F3	1.15	0.36	2.33	0.74	5.44
F4	1.35	0.49	2.67	0.89	4.94
F5	1.29	0.46	2.03	0.73	7.44
F6	1.24	0.50	2.52	0.80	5.63
F7	1.47	0.66	2.36	0.82	8.44
F8	1.32	0.47	2.18	0.64	7.88
F9	1.68	0.64	2.12	0.74	7.00
F10	1.47	0.71	2.45	0.67	6.22
F11	1.56	0.56	2.42	0.66	5.84
F12*	N/A	N/A	2.55	0.71	N/A
Average	1.38		2.35		N/A
Std Dev.	0.17		0.20		N/A

Table 10
Government factors assessment.

Factors	Individual assessment		Self-assessment		Relative assessment
	Average	Std Dev.	Average	Std Dev.	Average
F1	1.35	0.54	2.00	0.76	2.13
F2	1.21	0.41	2.16	0.72	3.25
F3	1.24	0.43	2.25	0.67	5.94
F4	1.38	0.49	2.31	0.82	4.41
F5	1.29	0.46	2.19	0.69	7.28
F6	1.41	0.56	2.16	0.72	6.59
F7	1.47	0.61	2.22	0.71	8.25
F8	1.38	0.55	2.28	0.77	8.03
F9	1.71	0.63	1.94	0.76	7.94
F10	1.35	0.49	2.13	0.66	5.47
F11	1.53	0.61	2.31	0.69	6.72
F12*	N/A	N/A	2.56	0.76	N/A
Average	1.39		2.21		N/A
Std Dev.	0.14		0.16		N/A

Table 11
Academics factors assessment.

Factors	Individual assessment		Self-assessment		Relative assessment
	Average	Std Dev.	Average	Std Dev.	Average
F1	1.34	0.48	2.55	0.62	3.17
F2	1.16	0.37	2.58	0.76	2.57
F3	1.22	0.42	2.65	0.61	5.87
F4	1.56	0.56	2.58	0.72	6.67
F5	1.50	0.51	2.45	0.62	7.93
F6	1.25	0.44	2.71	0.59	5.87
F7	1.44	0.56	2.58	0.67	8.27
F8	1.31	0.47	2.39	0.62	6.87
F9	1.63	0.55	2.45	0.57	6.23
F10	1.22	0.42	2.48	0.68	5.10
F11	1.56	0.62	2.52	0.57	7.47
F12*	N/A	N/A	2.87	0.50	N/A
Average	1.38		2.57		N/A
Std Dev.	0.16		0.13		N/A

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