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Digital transformation in the management of Buenos Aires ports

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Abstract

Purpose: Describe the adoption of technologies in port management in the towns of Mar del Plata and Bahía Blanca located in the south-southeast of the province of Buenos Aires (República Argentina) within the framework of the evolution towards smart ports.

Methodology: The research is based on a qualitative case study methodology with the application of interview and direct observation techniques and analysis of secondary sources of information.

Results: A high degree of digitalization is observed in port management through the administrative management and surveillance systems of the vehicular and maritime fleet in the towns of Mar del Plata and Bahía Blanca, with a higher level of maturity in the latter and use of facilitating technologies. Integration is presented in a partial form, requiring strategies for greater interaction between the areas.

Research limitations: The limitation is found in the reduced number of dimensions of analysis, the one corresponding to the so-called technological axis, with respect to digital maturity, since it has been revealed in this first work in the dimension related to advances in digitalization.

Originality: Study of the south-southeast territory of the province of Buenos Aires on the evolution in the adoption of enabling technologies that makes possible the characterization of the advance in digitalization and the detection of technological gaps, a focus of interest for the development of public policies.

Keywords: *Digitalization; Fishing Industry; Naval Industry; Supply Chain; Offshore.*

1. Introduction

In recent years, port management has undergone a significant transformation, shifting focus from traditional physical infrastructure to the optimization of product flows and efficient integration of intermodal logistics chains (Coto Millán et al., 2003). This transition has been fundamental for the evolution of ports, enabling their development from simple trade exchange zones to highly technical logistics centers. This change has required the implementation of business strategies and rigorous quality standards to increase competitiveness and ensure traffic routes in a global market (García et al., 2021).

The first generation of ports, rudimentary and with manual operations, was replaced by so-called industrial ports, limited to products originating from manufacturing. These were succeeded by third-generation ports, focused on transportation and their role as logistical platforms. The latest generation, surpassing the previous ones, is represented by network ports, with internationalization strategies, cooperation, and added logistical services for stowage and storage.

Digitalization in port management, driven by investments in technology and collaboration in information exchange, has facilitated the evolution of ports into integrators and providers of information, expanding their role beyond traditional commerce (Heilig et al., 2017). This change is essential to meet current regulatory and environmental demands, as well as to define effective digital transformation strategies (Venkatraman, 2017; Heilig et al., 2017). Regulatory and sustainability requirements, in addition to the recent offshore hydrocarbon

exploitation in the Buenos Aires ports of Mar del Plata and Bahía Blanca (Argentina), necessitate diagnostics on digitalization levels to define policies and programs that promote their update and improvement; this is the purpose of this work.

2. Literature Review

In recent years, the significant transformation of port management has progressively detached from the traditional focus based on physical infrastructure to concentrate on optimizing product flows and efficiently integrating intermodal logistics chains (Coto Millán et al., 2003). This transition is fundamental for the evolution of ports, from their initial conception as trade exchange zones to becoming logistics centers, with quality requirements and business strategy development to achieve greater competitiveness and retain traffic routes in a global market (García et al., 2021).

The evolution of ports can be distinguished into four generations, with a fourth generation port management incorporated in 1999 by the United Nations Conference on Trade and Development, building upon the three previous generations defined in 1990 by the same entity, with the following characteristics (Coto Millán et al., 2003):

- First generation: Initially designed for cargo transfer between land and sea, with manual operations and basic infrastructure. Small volumes of products were operated for a local or regional area (hinterland), and transactions occurred independently of context, usually on the pier, which was generally rudimentary and predominantly manual.
- Second generation: Recognized as an integral part of the transportation system and a hub for industrial and commercial activity, services were

limited to operating vessels and products in a manufacturing and heavy industry environment. Focused on a specific type of cargo, such as containers, operational improvements were achieved with the incorporation of cranes and other lifting equipment.

- Third generation: Advanced logistics functions were incorporated, including efficient product distribution using information and communication technologies to add value to port management operations and storage. They transformed into logistic and intermodal centers for handling large cargo volumes through automated systems.
- Fourth generation: Characterized by the incorporation of telematics networks between port areas and the diversification of operations, integrating global logistics chains to reach the end user; using logistics platforms, Industry 4.0 technologies, information flows, and human interaction networks providing additional services that generate greater added value.

Creating an agile, customer-centric, and innovation-oriented business culture is the main characteristic of digital transformation (Venkatraman, 2017). In the case of ports, digitalization is strongly facilitated by investments in technology and cooperation to promote information exchange (Heilig et al., 2017). The adoption of digital technologies and information systems reveals that ports increasingly become integrators and providers of port information, expanding their traditional commercial reach (Heilig et al., 2017).

Given the inherent complexity of hydrocarbon exploitation, the supply of materials and equipment to floating platforms, efficient transportation of people, and flow of personnel must be ensured. Ports play a significant role in the offshore industry value chain as command and control centers, in the reception, storage, and

distribution of materials and equipment, facilitating exports, and providing repair, maintenance, and specialized equipment services. The challenge for port administrations is transforming current ports into smart ports by implementing advanced technologies such as Artificial Intelligence, the Industrial Internet of Things, and Blockchain.

In this context, the question arises: how is the digitalization process in port administrations meeting current regulatory and environmental demands? Analyzing the phenomenon of digital transformation is essential to gain knowledge on the use of management technologies in the sector, providing useful input for defining roadmaps that promote digital transformation.

3. Methodology

This work is based on qualitative, exploratory research to characterize the adoption of technologies for port management. A case study analysis was conducted, selecting the ports of the cities of Mar del Plata and Bahía Blanca (Yin, 2018). The importance of evaluating the level of digitalization in these ports is founded on the growing demands for supplies, services, and permits generated by the recent start of offshore exploration off their coasts in March 2024. A methodological design with triangulation of methods was defined, consisting of in-depth interviews, secondary source information collection, and participant observation in port management settings.

A theoretical sample of businesspeople and public sector officials from the analyzed cities was defined to investigate the implementation of enabling technologies in systems, devices, and management processes. An interview guide, validated by experts in logistics and port management, was developed.

Subsequently, a pilot test was conducted to verify the scope of the proposed topics, and the interviews were carried out for subsequent analysis into relevant citations and codes in the study.

Participant observation was conducted during visits to the Port Consortiums to understand the context in which management processes are carried out and the personnel involved, in accordance with the case study application (Yin, 2018). Secondary source information was collected from official databases to obtain characteristics of the ports in connectivity attributes and certifications to ensure the quality and traceability of port processes as key variables to consider.

The conceptual framework for analyzing the interviews was based on an analysis of the digital maturity dimensions from scientific literature, choosing those defined by INDTEch 4.0 for their greater scope and update (Ministry of Productive Development, 2022). These dimensions fall into the following thematic lines: strategy and business model, structure, human resources and culture, value chains, information systems and technological resources, products and services, and processes. This study addresses the dimension of information systems and technological resources.

4. Results

The analysis provides evidence of different degrees of technology appropriation in the port managements of Mar del Plata and Bahía Blanca. Although this is an exploratory study of one of the traditional dimensions of digital maturity analysis in organizations, the interpretation of the information remains preliminary, offering significant signals about progress in digitalization, particularly with system integration and the use of enabling technologies.

The Regional Port Consortium of Mar del Plata, a non-state public entity created by Decree 3572/2000 of the Provincial Executive Power (Buenos Aires), is the entity to which the port's operation and administration was delegated, which was enabled in 1922 (Gualdoni and Errazti, 2006, p. 68). Connectivity is mainly by 4G coverage (nPerf, 2024), and since 2005, it has held the Safe Port certification for terminals 2 and 3, granted by the Argentine Naval Prefecture (International Ship and Port Facility Security Code - ISPS Code) (Mar del Plata Port Consortium, 2024).

Various information systems are found for administrative-accounting management with modules for purchases, invoicing, revenues, payments, payroll settlement, and management of files to control requests made to the Consortium and their follow-up in the established administrative circuit. The maritime and vehicular fleet surveillance is carried out through stowage area control and truck and vessel traffic (entry and exit) to the port; for vessels, it manages movements, repairs, and provisioning. Access control is carried out over visitors entering port terminals through plastic cards and a closed-circuit TV system for access monitoring and video surveillance systems.

In Mar del Plata port administration, both management systems and control of vehicular and maritime fleets, stowage, and energy consumption are observed, while the use of enabling technologies in systems is incipient. There is a diversity of areas that are computerized with a high level of digitalization; however, these areas do not present an integrated perspective, and the possession of access devices does not respond to current trends to offer security guarantees.

The port of the city of Bahía Blanca, in the south of the Buenos Aires province, is managed by a non-state public entity, created in 1993 by Law No. 11,414 of the Buenos Aires Provincial Legislature. Connectivity is mainly by 4G coverage

(nPerf, 2024) and holds ISO 9001, ISO 14001, and ISO 45001 certifications (Bahía Blanca Port, 2024).

Information systems and technologies are observed to fulfill different functions, for administrative management: contractor personnel control for those entering the port area and supplier management, contracting, budget control, and internal areas through an integrated system (ERP). Data entry into the system is carried out by each port licensee and Consortium areas, such as grain operators in the logistics area. Once the cargo is registered, prior to port entry, its journey is monitored until its unloading, with reports from each licensee from their interface to the Consortium system. In this category of systems are both proprietary developments and one of the most widely used worldwide. The licensees have control systems for production, loads, dispatches, and warehouses, among others, showing the level of digitalization of upstream links in the port management supply chain.

Another functionality covered by systems is maritime fleet surveillance, through navigation control using a two-layer information system: one public, online, allowing identification of the vessels' characteristics and position, and another private, describing the economic operations of each vessel. The system, called Vehicle Tracking System (VTS), was implemented more than 20 years ago.

Among the enabling technologies used, the automation of video surveillance in 2022 stands out, through expanding the camera network and incorporating artificial intelligence to detect intruders and perimeter protection in sensitive and strategic port sectors, identifying people or object absence. This solution integrates with a module for reading vehicle licenses operating within the facilities.

In summary, Bahía Blanca port administration offers a certain level of digital maturity in the information systems and technological resources dimension: information is recorded in modular systems by function, and advanced technological resources, such as automation and artificial intelligence, are used, with partial integration between areas.

5. Discussion

In the cases under study, incipient levels of adoption of enabled technologies were observed, varying according to the functions and their degree of integration with other systems of the organization, offering evidence of a transition from third to fourth generation port management, with concrete initiatives to optimize product flows, but with weaknesses in the integration of information from the intermodal logistics chain.

The port management systems of the cities of Bahía Blanca and Mar del Plata follow the digitalization trends of other locations, prioritizing the monitoring of the flow of products between computer applications due to the precision and speed with which the information is evaluated for greater efficiency in the transactions. According to the evidence of the contribution of digitalization to digital transformation, as a factor of change, and its improvement in organizational performance, the observed transition of port management systems forces us to redouble efforts in favor of integration.

6. Conclusions

The analysis of technology adoption in port management in southern and southeastern Buenos Aires provides a key element for port management.

Understanding the characteristics, environment, and impact of technological innovation adoption, particularly the application of enabling technologies in the growing digital transformation of organizations, is a vector to facilitate the identification of technological development gaps and thus improve the efficiency, security, sustainability, and connectivity of operations.

The challenge of port management lies in the efficient use of data generated in the administration of goods flows, security, coordination of logistics operations and infrastructure maintenance. It is vital to convert this data into strategic information for the design of public policies on the effective and sustainable use of facilities and the development of environmentally friendly practices. Future studies will expand the analysis to other dimensions of digital maturity, since the current limitation is the approach to a single dimension.

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