

A survey study on seaport modernising in Algeria as a driver for facilitating export and import operations

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Abstract. The modernisation of seaports has emerged as a strategic imperative in the contemporary global economic landscape, driven by the accelerating pace of globalisation and the sustained expansion of international trade volumes. As maritime transport remains the backbone of global commerce, the efficiency and responsiveness of port infrastructure directly influence a nation's trade competitiveness. In light of these developments, this study aimed to investigate the role of seaport modernisation in Algeria as a key driver for facilitating export and import operations. To achieve this objective, a quantitative research methodology was employed, utilising a structured questionnaire administered to a sample of 80 employees at the Skikda Port Enterprise in Algeria. The research specifically examined the contribution of port modernisation to the facilitation of foreign trade operations by focusing on three distinct yet interrelated dimensions: the adoption and integration of information and communication technology, the development and upgrading of physical infrastructure, and the simplification of governance structures and procedural workflows. The study analysed how each of these dimensions individually and collectively influences the efficiency and effectiveness of export and import activities. Respondents expressed generally favourable views across all measured domains, including information and communication technology ($M = 3.8350$, $SD = 0.52171$), governance and procedural simplification ($M = 3.7000$, $SD = 0.60713$), and infrastructure development ($M = 3.5925$, $SD = 0.64234$). The overall mean score for the facilitation of export and import operations was 3.8270. Furthermore, the questionnaire demonstrated sound psychometric properties, with Cronbach's alpha coefficients ranging from 0.769 to 0.879, indicating acceptable to high internal consistency. These improvements have been accompanied by notable reductions in processing times and operational costs. From a practical perspective, this study offers valuable empirical evidence to port authorities, logistics managers, and policymakers regarding the tangible and measurable benefits associated with strategic investments in port modernisation.

Keywords: port modernisation; digital transformation; trade facilitation; port infrastructure; governance

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● INTRODUCTION

With the accelerating pace of globalisation and the exponential growth in global trade volumes, seaports find themselves at a critical juncture. No longer merely passive transit points, they are now pivotal nodes in complex supply chains where even minor inefficiencies can cascade into significant delays, financial losses, and reduced national competitiveness. Consequently, the imperative to modernise infrastructure and implement advanced management systems has shifted from a strategic advantage to an operational necessity, making it essential to examine how effectively ports are responding to these mounting pressures.

In 2024, global maritime trade volumes reached 12,720 million tons, representing a growth rate of 2.2 percent. Meanwhile, global containerised trade volumes experienced robust growth over the same period, with an increase exceeding 6 percent, in accordance with UNCTAD (2024). P. Nguyen & T. Pham (2026) emphasised that digital transformation in the context of port modernisation must be understood as a comprehensive change process that integrates infrastructure, platforms, people, and policies, rather than merely the acquisition of technology. The authors draw on the Smart Port 4.0 model, which emphasises the integration of physical, digital, and organisational elements to build intelligent and adaptive port systems (Clemente *et al.*, 2023). They also relied on the Resource-Based View (RBV) theory, which explains how digital capabilities, as rare and difficult-to-imitate resources, can generate sustainable competitive advantage. The authors also called for enhanced regional cooperation within ASEAN for knowledge sharing and common platforms, as well as for the development of performance assessment frameworks that include digital maturity metrics alongside traditional productivity indicators.

A. Burmambet (2025) noted that Romanian ports stand at a critical crossroads in their evolution from fourth-generation infrastructure to data-driven smart ports. This transformation is not merely a technical necessity but an imperative for economic resilience, environmental responsibility, and geopolitical significance in the Black Sea region. The digital transformation of Romanian seaports from the fourth generation to smart ports has a significant impact on the global logistics ecosystem, particularly in terms of efficiency, sustainability, and resilience in the face of crises. According to O. Melnyk *et al.* (2025), the existence of a dedicated port system within the framework of digital transformation is essential. The authors drew on a wide range of literature relating to energy efficiency and green transformation in ports, the assessment of smart port maturity and performance indicators, challenges of digital transformation in developing countries including Ukraine (Muradian *et al.*, 2023), and applications of artificial intelligence and blockchain in port management (Zhou *et al.*, 2022; Haidine *et al.*, 2024). The integrated autonomous port network is not merely a technical solution but a new management philosophy that alters the traditional approach to port management in an unstable environment.

The studies of B. Belmoukari *et al.* (2023) and G. D'Amico *et al.* (2021) indicated that maritime transport and logistics benefit significantly from big data technologies and digitalisation, specifically technologies for identifying vehicles, individuals, and goods. The authors also noted that

efficiency is strongly affected by operational costs, security, and service availability, and that leading global smart ports share characteristics such as digitalisation, process automation, and the use of smart technologies. According to J. Chen *et al.* (2026), port operational efficiency is primarily linked to economic indicators and the use of alternative energy systems. The authors draw on three main strands of literature. The first concerns traditional port efficiency and focuses on economic indicators such as tariffs, labour, and productivity. The second addresses green port efficiency and incorporates undesirable environmental outputs, including NOx and SOx emissions (Lim *et al.*, 2019). The third examines sustainable port technologies, including alternative fuels and energy carriers such as hydrogen, ammonia, and LNG, as well as shore power, electric equipment, and IoT-based systems for monitoring and optimising fuel consumption (Nguyen & Pham, 2026). The majority of studies on port modernisation and digital transformation have focused on ports in Southeast Asia, Eastern Indonesia, Romania, Ukraine, and global maritime hubs (Pratama, 2025). There is a conspicuous absence of empirical research examining port modernisation processes in North African ports, particularly in Algeria, despite the country's strategic Mediterranean location and its ongoing national port modernisation programme launched in 2025.

Existing studies have predominantly employed quantitative methodologies, such as the Digital Transformation Index or technical design assessments, with limited attention to perceptual and experiential data from port employees and commercial operators who directly interact with modernisation initiatives. While several authors have acknowledged the importance of digital tools and automated gates, few studies have explicitly investigated the direct relationship between port modernisation and the facilitation of export and import operations. Most research on port modernisation and digital transformation has focused on Southeast Asia, Eastern Indonesia, Romania, Ukraine, and global maritime hubs, with little empirical work on North African ports, particularly Algeria, despite its strategic Mediterranean location and 2025 national modernisation programme. Existing studies are largely quantitative, paying limited attention to the experiences of port employees and commercial operators. Moreover, few studies explicitly examine how port modernisation affects export and import operations. The aim of present study was to investigate the role of seaport modernisation in Algeria as a driver for facilitating export and import operations, through a survey-based study conducted at the Skikda Port Authority, focusing on the perceptions of commercial department employees regarding the impact of modernisation initiatives on operational efficiency, customs procedures, and trade facilitation. Based on the theoretical framework and the empirical context of Skikda Port Enterprise, the following research hypotheses were formulated:

H₁: The adoption and integration of Information and Communication Technology (ICT) – particularly through interconnected systems such as SARPORT, the Port Community System (PCS), SIEL, and ALCES-positively contributes to enhancing export and import activities by improving cargo tracking, reducing processing times, and accelerating customs and administrative procedures.

H₂: The modernisation of physical infrastructure-including the expansion and deepening of berths, the acquisition of advanced handling equipment, and the intelligent reorganisation of storage areas-positively influences the volume of export and import operations by increasing reception capacity, reducing vessel turnaround time, and improving cargo flow efficiency.

H₃: The implementation of governance reforms and the simplification of port procedures-through digital coordination platforms, standardised operational protocols, and enhanced transparency mechanisms-positively stimulate export and import activities by reducing administrative bottlenecks, improving real-time data exchange, and increasing stakeholder trust.

MATERIALS AND METHODS

The questionnaire was distributed to employees of the Skikda Port Authority. The sample included staff members from the institution's commercial department, employees of the commercial department were purposively selected as the primary respondents because they are directly responsible for the daytoday execution of export and import operations. A total of 85 questionnaires were distributed in person among employees representing the study population, and 80 completed questionnaires were returned fully completed, with no missing responses on key variables and deemed valid for analysis. The study was conducted during May 2025, a period coinciding with the launch of the port

modernisation programme in Algeria. The study was conducted in accordance with the ethical principles of the ICC/ESOMAR international code on market, opinion and social research and data analytics (2025).

The questionnaire was constructed around the central theme of seaport modernisation as a driver of trade facilitation, using Skikda Port Enterprise as a case study. The final instrument contained 25 items measured on a five-point Likert scale (1 = Strongly disagree; 2 = disagree; 3 = neither agree nor disagree; 4 = agree; 5 = strongly agree). To categorise respondent perceptions, the equal-interval method was adopted. The scale range (5 – 1 = 4) was divided by three to produce three equal categories, each with a width of 1.33. It consisted of two parts. The first part covered the respondents' personal and professional characteristics, including gender, age, work experience, educational level, and job position. The second part focused on port modernisation and the promotion of the foreign trade sector. This part was divided into two main variables (Fig. 1). The first variable is port modernisation, which consists of fifteen statements distributed across three distinct dimensions. The first dimension concerns information and communication technology and comprises five statements. The second dimension addresses port infrastructure development and also consists of five statements. The third dimension focuses on governance and port operations management and includes five statements as well. The second variable is facilitating export and import operations, which comprises ten statements.

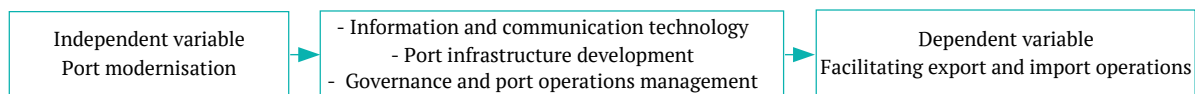


Figure 1. Variables of the study

Source: prepared by the authors

To ensure the reliability and validity of the questionnaire, Cronbach's alpha coefficients and Pearson correlation coefficients were calculated. Cronbach's alpha was used to assess the internal consistency of the items within each dimension, with higher values indicating greater reliability. Pearson correlation coefficients were used to assess internal construct validity by examining the relationships between each item and the total score of its respective dimension, as well as the correlations among the questionnaire dimensions. Statistical analysis was performed using SPSS. Descriptive statistics included the arithmetic mean to determine the average response score for each item and dimension and the standard deviation to assess the variability of responses around the mean.

RESULTS

Results of the assessment of port modernisation and its impact on export and import operations

All Pearson correlation coefficients for the statements ranged between 0.647 and 0.833. These values are positive

and statistically significant at the significance level ($\alpha = 0.001$). Therefore, the statements are considered valid. Cronbach's alpha coefficient reflects the reliability of the instrument used in the study, namely the questionnaire. The closer Cronbach's alpha coefficient is to 1, the greater the reliability of the instrument. As shown in Table 1, the overall Cronbach's alpha value is above 0.90, reaching 0.908, which is close to 1 and considered high. Furthermore, the Cronbach's alpha values for the various dimensions ranged between 0.769 and 0.879, which are also high values, indicating the reliability and validity of the study instrument. Table 2 presents the analysis of the first dimension of the independent variable, namely information and communication technology, by showing the responses of the sample members to the statements related to ICT at Skikda Port. The overall arithmetic mean for the statements reached 3.8350 with a standard deviation of 0.52171, indicating a high level of agreement among respondents.

Table 1. Cronbach's alpha coefficient

Axis	Cronbach's alpha coefficient
First Axis – Independent Variable: Port Modernisation	0.769
First: Information and Communication Technology	0.781
Second: Port Infrastructure Development	0.809
Third: Governance and Simplification of Administrative Procedures	0.879

Table 1, Continued

Axis	Cronbach's alpha coefficient
Second Axis – Dependent Variable: Facilitating Export and Import Operations	0.838
All Items	0.908

Source: prepared by the authors based on on SPSS outputs

Table 2. Means and standard deviations of information and communication technology

No.	Statements	Arithmetic mean	Standard deviation	Agree level
01	Integrated information systems are used for managing port operations at Skikda Port	4.0000	0.59534	High
02	Port management relies on electronic programs to track and monitor the flow of goods and containers	4.0125	0.58448	High
03	Modern electronic gates are available to accelerate customs and administrative procedures	3.6750	0.85351	High
04	Economic operators can use digital platforms to declare and submit documents remotely	3.7250	0.82638	High
05	The use of smart technology has led to a reduction in operational costs at the port	3.7625	0.71589	High
Total		3.8350	0.52171	High

Source: prepared by the authors based on on SPSS outputs

Statement (2) recorded the highest arithmetic mean ($M = 4.0125$, $SD = 0.59534$), ranking first and reflecting strong agreement among respondents that electronic tracking is essential for improving port performance. Statement (1) ranked second ($M = 4.0000$, $SD = 0.58448$), indicating clear awareness of the importance of integrating modern systems into port management. Statement (5) ranked third ($M = 3.7625$, $SD = 0.71589$), showing a considerable level of satisfaction regarding technology's contribution to reducing financial burdens. Statement (4) ranked fourth ($M = 3.7250$, $SD = 0.82638$), reflecting a positive assessment of the use of digital platforms in facilitating procedures. Statement (3) ranked last ($M = 3.6750$, $SD = 0.85351$), suggesting

moderate to high agreement, which may indicate limited or varying user experience with these gateway. The high ratings for technology-related statements at Skikda Port are significant for improving port efficiency, real-time tracking reduces cargo dwell time, prevents loss, enables better planning, and accelerates cargo release. This is a direct, measurable contribution to port efficiency, and lower operational costs per container or per shipment directly improve the port's cost efficiency, making it more competitive and attractive to economic operators. Table 3 presents the analysis of the second dimension of the independent variable, namely port infrastructure development, by showing the means and standard deviations for the related statements.

Table 3. Means and standard deviations of port infrastructure development

No.	Statements	Arithmetic mean	Standard deviation	Agree level
06	The port's berths have been developed and equipped with advanced facilities to accommodate modern ships	3.6875	0.82052	High
07	Advanced handling and unloading equipment that complies with international standards is available	3.6125	0.86410	High
08	Storage areas have been expanded and organised in intelligent ways that ensure rapid access to goods	3.6750	0.93829	High
09	The port is equipped with smart devices for monitoring temperature, humidity, and secure shipping	3.4875	0.96776	High
10	The port's current infrastructure capacity is proportionate to the growing volume of maritime trade	3.5000	0.79556	High
Total		3.5925	0.64234	High

Source: prepared by the authors based on on SPSS outputs

The results indicate that statement (6) ranked first, with an arithmetic mean of 3.6875 and a standard deviation of 0.82052. This reflects strong agreement among sample members that the berths are effectively equipped to receive heavy goods. The results indicate that statement (7) ranked third, with an arithmetic mean of 3.6125 and a standard deviation of 0.86410. This suggests a considerable level of satisfaction regarding the efforts made to improve storage and handling speed. The results indicate that statement (8) ranked second, with an arithmetic mean of 3.6750 and a standard deviation of 0.93829. This indicates a considerable level of agreement concerning the modernisation of

equipment in line with international standards. The results indicate that statement (9) ranked fourth, with an arithmetic mean of 3.4875 and a standard deviation of 0.96776. This shows moderate agreement regarding the port's capacity to keep pace with increasing demand. The results indicate that statement (10) ranked fifth and last, with an arithmetic mean of 3.5000 and a standard deviation of 0.79556. This suggests moderate to high agreement, with the possibility of variation in experiences or deficiencies in certain safety or regulatory aspects. Table 4 presents the analysis of the third dimension of the independent variable, namely governance and simplification of port procedures.

Table 4. Means and standard deviations of governance and simplification of port procedures

No.	Statements	Arithmetic mean	Standard deviation	Agree level
11	The port relies on digital management that ensures rapid coordination among economic actors	3.6750	0.92470	High
12	Port management follows a clear policy for quality control and occupational safety	3.7875	0.75797	High
13	Operations are carried out according to standardised protocols to avoid delays and human errors	3.8000	0.78595	High
14	Real-time data exchange is enabled among various authorities (customs, police, handling operators)	3.5625	0.77694	High
15	Modern governance contributes to enhancing transparency and combating bureaucracy within the port	3.6750	0.77582	High
Total		3.7000	0.60713	High

Source: prepared by the authors based on on SPSS outputs

The results indicate that statement (13) ranked first, with an arithmetic mean of 3.8000 and a standard deviation of 0.78595. This suggests a strong level of agreement among sample members that working according to clear protocols has contributed to reducing errors and improving professional discipline. The results indicate that statement (12) ranked second, with an arithmetic mean of 3.7875 and a standard deviation of 0.75797. This denotes considerable satisfaction regarding the administration's commitment to applying quality standards and enforcing safety conditions. The results indicate that statement (11) ranked third, with an arithmetic mean of 3.6750 and a standard deviation of 0.92470. This justifies a positive perception regarding the effectiveness of digital management in facilitating coordination among stakeholders involved in port activity. The results indicate that statement (15) ranked fourth, with an arithmetic mean of 3.6750 and a standard deviation of 0.77582. This reflects a good level of agreement concerning the role of technology in improving the administrative climate. The results indicate that statement (14) ranked fifth, with an arithmetic mean of 3.5625 and a standard deviation of 0.77694. This denotes moderate agreement regarding the effectiveness of information exchange between departments.

Effective institutional cooperation breaks down traditional administrative barriers among the various

authorities operating within a port. When joint coordination mechanisms are established, such as unified electronic data exchange platforms and single-window systems, these authorities are enabled to function as an integrated system rather than operating in isolation from one another. This coordination reduces the duplication of procedures, eliminates inconsistencies in requirements, and limits delays caused by unclear responsibilities, thereby improving risk management without disrupting the flow of goods. Furthermore, coordinated and electronic customs procedures contribute to reducing cargo dwell time and inspection processes. The integration between port authority systems and customs enables the advance planning of loading and unloading operations, as well as the more efficient allocation of resources. Moreover, effective coordination reduces waiting time between unloading, inspection, and final release, thereby accelerating the movement of goods from the maritime gateway to warehouses or land transport modes. This acceleration lowers logistical costs, improves supply chain reliability, and enhances the port's reputation as a preferred destination for economic actors. Table 5 presents the analysis of the dependent variable, namely facilitating export and import operations, by showing the responses of the sample members to the statements related to the promotion of the foreign trade sector.

Table 5. Means and standard deviations of facilitating export and import operations

No.	Statements	Arithmetic mean	Standard deviation	Agree level
16	The development of seaports has contributed to reducing export lead times to foreign markets	3.8875	0.65591	High
17	Improving port services is considered an important factor in enhancing the competitiveness of Algerian products in the international market	3.8500	0.81287	High
18	The availability of modern port infrastructure has contributed to attracting foreign investors for export and import	3.8500	0.76473	High
19	The effectiveness of customs operations at ports has affected the quality of foreign trade	3.8000	0.66371	High
20	Digitisation in ports has facilitated the tracking of goods at the international level	3.9125	0.67868	High
21	The presence of modern equipment in ports enhances the smooth flow of exports and imports	3.9000	0.72216	High
22	The availability of real-time trade information helps in making quick decisions regarding export and import	3.8500	0.67698	High
23	The level of coordination among port stakeholders enhances the efficiency of the international supply chain	3.7875	0.72880	High
24	Fast port procedures facilitate the needs of foreign operators efficiently and flexibly	3.8125	0.74789	High

Table 5, Continued

No.	Statements	Arithmetic mean	Standard deviation	Agree level
25	Improved performance of Algerian ports encourages the entry of new products into foreign markets	3.8625	0.72468	High
Total		3.8270	0.43042	High

Source: prepared by the authors based on on SPSS outputs

The results indicate that statement (20) ranked first, with an arithmetic mean of 3.9125 and a standard deviation of 0.67868. This denotes strong agreement regarding the importance of digitisation in facilitating the control and monitoring of the global flow of goods. The results indicate that statement (21) ranked second, with an arithmetic mean of 3.9000 and a standard deviation of 0.72216. This suggests a high degree of satisfaction concerning the direct temporal impact of port modernisation. The results indicate that statement (16) ranked third, with an arithmetic mean of 3.8875 and a standard deviation of 0.65591. This shows a considerable level of satisfaction regarding the contribution of technology to reducing financial burdens. The results indicate that statement (25) ranked fourth, with an arithmetic mean of 3.8625 and a standard deviation of 0.72468. This indicates that improved port performance is considered a contributing factor to the diversification of Algerian exports. The results indicate that statement (18) ranked fifth, with an arithmetic mean of 3.8500 and a standard deviation of 0.76473. This reflects a high degree of agreement among sample members and confirms the importance of digitisation in facilitating the tracking of goods movement and improving port operational efficiency.

The results indicate that statement (19) ranked sixth, with an arithmetic mean of 3.8000 and a standard deviation of 0.66371. This reflects considerable agreement among sample members and indicates that the overall performance development of ports is considered a stimulating factor for increasing the diversity and expansion of Algerian products in international markets. The results indicate that statement (17) ranked seventh, with an arithmetic mean of 3.8500 and a standard deviation of 0.81287. This indicates that the availability of real-time data enables effective and rapid decision-making. The results indicate that statement (24) ranked eighth, with an arithmetic mean of 3.8125 and a standard deviation of 0.74789. This denotes a good awareness of the importance of accelerating procedures in improving the experience of port users. The results indicate that statement (22) ranked ninth, with an arithmetic mean of 3.8500 and a standard deviation of 0.66371. This reflects an awareness of the role of customs in either improving or hindering the commercial process. The results indicate that statement (23) ranked tenth, with an arithmetic mean of 3.7875 and a standard deviation of 0.72880. This points to the impact of institutional cooperation in strengthening the global supply chain.

This institutional integration creates an integrated working environment that enhances port efficiency and development. Through information sharing and joint coordination, vessel waiting times can be reduced, the flow of goods through ports can be improved, and customs and administrative procedures can be standardised. This integration encourages ports to adopt international standards, invest in digital and physical infrastructure, and transform themselves into multimodal logistics hubs. Furthermore,

institutional cooperation drives ports to develop their competitive capabilities by offering value-added services such as smart warehousing, redistribution, and pre-clearance customs services. Consequently, logistical and administrative barriers are lowered, and the volume of trade exchange between countries is stimulated to increase.

Assessment of the research hypotheses

The first hypothesis. The adoption of information and communication technology (ICT) contributes to enhancing export and import activities at Skikda Port Enterprise through the implementation of integrated information systems for port operations management. The port relies on four interconnected systems and provides electronic tracking and monitoring programs for the flow of goods and containers. These systems improve cargo tracking and reduce processing time. Furthermore, the availability of modern electronic gates designed to accelerate customs and administrative procedures contributes to improving the fluidity of the services provided. Based on the extent to which the sample agreed with the statements in the “Information and Communication Technology” section, it became evident that digitisation and information systems play a significant role in improving the effectiveness of port operations at Skikda Port Enterprise. The sample expressed considerable agreement with the statement: “Integrated information systems are used to manage port operations”, indicating that respondents recognise the pivotal role digitisation plays in organising work and reducing administrative inefficiencies. This positive assessment also suggests that digital transformation has contributed to enhancing coordination among various stakeholders, facilitating real-time tracking of containers and goods, accelerating procedures, and reducing document processing time—all of which positively affect the port’s overall performance. A number of digital systems and modern software have been adopted, including: The SARPORT system for managing port operations; The Port Community System (PCS) to facilitate interaction among various operators; The Economic and Logistics Information System (SIEL); The Algerian Customs Digitisation System – Algerian Customs System (G-Serport, n.d.)

Furthermore, the statement “Management relies on electronic programs to track and monitor the flow of goods and containers” received a high level of agreement. This reflects a collective awareness among respondents regarding the importance of such systems in enhancing control over the movement of goods within the port. These programs enable precise tracking of container locations at every stage of processing, thereby reducing loss and delays. They also contribute to expediting customs and logistical procedures while providing real-time data that supports fast and effective decision-making. This underscores the success of digital transformation in improving transparency and reducing the time required for the export-import cycle. Modernisation has helped reduce processing time through: integrating

digital systems into document processing; improving the internal organisation of loading and unloading operations; minimising time lost due to administrative delays.

Approximately 75 percent of the study respondents agreed with the statement: “The availability of modern electronic gates accelerates customs and administrative procedures”, which points to improved service fluidity. This reflects a clear recognition of the impact of digitisation in reducing the time and costs associated with port transactions, thereby contributing to smoother cargo flow and faster commercial operations. Such improvements support the port’s effectiveness in serving foreign trade. Technical upgrades and new equipment have increased the speed of handling operations and reduced waiting times, thereby strengthening the efficiency of the supply chain. Moreover, the adoption of “digital platforms and smart technologies” in ports represents a qualitative advancement in operations management. It has enabled economic operators to complete declarations remotely, accelerating procedures while reducing operational costs. This demonstrates a direct effect of port modernisation on improving logistical performance and supporting foreign trade.

According to G-Serport (n.d.), the presence of actual digital platforms used by employees of the port enterprise was confirmed, demonstrating that digital transformation is not merely a procedural formality but rather a practical application that contributes to enhancing performance efficiency and achieving flexibility in service delivery. Digital transformation improves interaction between Skikda Port and importers, freight forwarders, transport companies, and customs authorities. When customs procedures are digitised, unified digital windows are established, and electronic cargo tracking systems are implemented, transactions become faster and more transparent. This reduces the need for paper-based intermediation, thereby building trust and encouraging economic stakeholders to engage with the port on a more frequent basis. The adoption of digital transformation may render Algerian ports more attractive to global shipping lines that prioritise speed and transparency. Consequently, these ports would become the preferred choice for international companies, particularly given Algeria’s ambition to position its ports as alternative maritime logistics hubs.

The second hypothesis. The modernisation of infrastructure contributes to increasing the volume of export and import operations at Skikda Port Enterprise. This is achieved through the expansion of berths and the enhancement of reception capacities. The port enterprise has witnessed a series of expansion and modernisation projects, along with the provision of modern equipment for loading and unloading operations, which has improved the port’s carrying capacity and accelerated the turnover of goods. These upgrades have also helped reduce the turnaround time of ships and cargo, thereby encouraging economic operators to expand their export and import activities through the port. Based on the extent to which the sample agreed with the statements in the “Infrastructure Modernisation” section, plainly, the structural development of facilities and equipment has played a decisive role in improving the performance of Skikda Port. The sample expressed considerable agreement with the statement: “The port’s berths have been developed and equipped with advanced facilities to

accommodate modern ships”. This reflects respondents’ recognition of the importance of these works in increasing the port’s carrying capacity and improving the quality of services provided to vessels. In other words, the berths have been renewed in terms of structure and depth to accommodate large and modern ships. Technical upgrades and new equipment have increased the speed of handling operations and reduced waiting times, thereby strengthening the efficiency of the supply chain. The statement “There are advanced handling and unloading facilities that comply with international standards” also received a high level of agreement, indicating that the port is equipped with advanced facilities such as cranes and intelligent mooring systems. These enable the efficient and safe reception of modern vessels and accelerate loading and unloading operations. These works were part of a broader port modernisation project.

Regarding the statement “Storage areas have been expanded and organised in intelligent ways that ensure rapid access to goods”, this indicates that warehouse spaces and storage yards have been increased, and modern systems such as electronic coding and classification have been adopted. These facilitate the rapid location of goods and accelerate loading and delivery operations without delay or disorder. A relative improvement has been recorded in terms of reducing the time required for unloading and loading goods, and performance has become more competitive compared to the past. Furthermore, the presence of modern equipment on the berths and in cargo handling areas—such as new cranes and modern loading equipment—confirms that infrastructure modernisation is a tangible operational reality rather than a mere administrative declaration. It has clearly contributed to improving the productivity of operational processes and enhancing the port’s readiness to accommodate growing trade volumes. Accordingly, the survey results showed that the development and equipping of berths with modern handling equipment, together with the expansion of carrying capacity, have contributed to reducing vessel turnaround time and improving cargo flow. This substantiates the relationship between infrastructure modernisation and the stimulation of foreign trade. The modernisation of physical infrastructure—such as expanding and deepening berths and equipping them with modern handling equipment—enables the reception of larger vessels with reduced waiting times. This enhances port reliability and encourages economic actors to choose it over competing ports, while also reducing excess shipping costs.

The third hypothesis. Governance and the simplification of port procedures contribute to stimulating export and import operations at Skikda Port Enterprise. This is achieved through the administration’s adoption of a digital system that enables rapid coordination among various economic actors, the application of standardised protocols that ensure smooth operational execution and reduce errors and delays, the implementation of a strict policy for quality control and occupational safety, and real-time data exchange between authorities. Governance thus helps enhance transparency and reduce bureaucracy, thereby activating the flow of goods. Based on the extent to which the sample agreed with the statements in the “Governance and Simplification of Port Procedures” section, it was unmistakable that the majority of respondents believe that

improving management methods and work organisation within the port enterprise plays a significant role in enhancing its performance.

The statement “The port relies on digital management that ensures rapid coordination among economic actors” received a considerable level of agreement. This indicates that respondents are aware of the importance of coordination among various authorities—customs, police, and handling operators—in accelerating transactions and reducing administrative complexities. Digitisation has helped integrate systems and facilitate interaction among different stakeholders through the Port Community System (PCS), thereby supporting the principle of participatory governance based on real-time data and information sharing among actors (G-Serport, n.d.). Responses also showed a positive assessment of the statement “Modern governance contributes to enhancing transparency and combating bureaucracy within the port”. This suggests that the adoption of governance principles such as transparency, effectiveness, and accountability has positively affected the relationship between management and economic operators while reducing administrative obstacles. However, some reservations were expressed by operators, particularly regarding transparency and operational efficiency, indicating that the modernisation process has not yet fully translated into service quality.

Clearly, the adaptation process is still in its early stages. The absence of a smart inspection system represents a weakness in the technical governance framework, which hinders the smooth flow of exports and imports and delays operations despite efforts made in digitisation. Notwithstanding these challenges, the adoption of digital governance principles and the application of modern management tools have helped, to a certain extent, reduce administrative lead times, clarify responsibilities, and improve information tracking of files. This constitutes a step toward strengthening the port’s position within the foreign trade system. The survey results showed that the port enterprise relies on a digital administrative organisation and employs mechanisms to simplify procedures and accelerate services, which has led to a reduction in administrative obstacles and the enhancement of transparency.

● DISCUSSION

Skikda to manage port operations with a high degree of efficiency. The management of the facility relies on advanced electronic programs to monitor and track the flow of goods and containers in real time. According to A. Tei & C. Ferrari (2026), the use of advanced technologies such as artificial intelligence can enhance the capacity to improve systems and serve as an effective tool for monitoring and intervention when necessary, thereby producing a tangible impact on the port sector. Modern electronic gates are also available, which serve to accelerate the completion of customs and administrative procedures for importers and exporters. Economic operators are now able to use specialised digital platforms to declare goods and submit documents remotely. These technologies have enhanced transparency and reduced customs clearance times, eliminating the need for physical travel to the port. The adoption of smart technology has further contributed to a notable reduction in operational costs. This aligns with F. Russo & G. Musolino (2022)

conclusion, namely that the availability of emerging information and communication technologies in transport enables ports to reduce costs.

Expenditures on manual labor, paper-based processes, and human errors have decreased as a result of automation and digitalisation. In addition, fuel consumption and truck waiting times have been lowered through electronic system integration. And this is what O. Belcore & A. Polimeni (205) addressed, through an examination of the use of technology in port terminals, by applying it across all the stages that characterise a port call and the calculation of ship turnaround time. These gains have rendered the port more competitive and have attracted increased trade flows through it. Thus, digital systems emerge as a fundamental pillar for achieving a more efficient and sustainable port economy at Skikda port. The port’s berths have been developed and equipped with advanced facilities to accommodate modern ships. Advanced handling and unloading equipment that complies with international standards is available. Storage areas have been expanded and organised in intelligent ways that ensure rapid access to goods. The port is equipped with smart devices for monitoring temperature, humidity, and secure shipping. The port’s current infrastructure capacity is proportionate to the growing volume of maritime trade. Taken together, these features indicate that the port has undergone a comprehensive infrastructural upgrade, aligning its physical and technological assets with both international benchmarks and the demands of expanding trade flows. The integration of smart monitoring systems alongside expanded, intelligently organised storage zones further enhances operational efficiency and cargo security. Consequently, the port appears well-positioned to sustain its responsiveness to increasing maritime traffic without immediate capacity constraints. H. Akyıldız *et al.* (2026) contended that the development of seaports enhances competitiveness in the global maritime sector by promoting efficient, sustainable, and strategically managed port operations.

The port relies on digital management that ensures rapid coordination among economic actors. Port management follows a clear policy for quality control and occupational safety. Operations are carried out according to standardised protocols to avoid delays and human errors. Real-time data exchange is enabled among various authorities (customs, police, handling operators). Modern governance contributes to enhancing transparency and combating bureaucracy within the port. D. Sumarno *et al.* (2026) contended that the relationship between governance arrangements can be understood as part of a port development system, specifically through the application of a collaborative governance framework. Furthermore, governance can facilitate the development of logistics and transport services more broadly, particularly in developing countries and in Africa. This has the potential to bring about a paradigmatic shift toward participatory and inclusive governance of institutions (Daudet, 2025). Development projects should not be limited to technology or infrastructure alone, but must also encompass individuals by way of institutional relationships and mechanisms for workforce participation in port development. The sustainability of ports should form part of port performance evaluation, as the management of Environmental, Social, and Governance (ESG) criteria in ports can enhance sustainable development (Makkawan *et al.*, 2025).

The development of seaports has contributed to reducing export lead times to foreign markets, as improving port services is considered an important factor in enhancing the competitiveness of Algerian products internationally. The availability of modern port infrastructure has attracted foreign investors for both export and import activities. This is what M. Karthik & O. Dubey (2024) addressed, namely that the development of competitiveness depends on infrastructure. The author found that the added value within India's logistics system plays a dominant role in enhancing and diversifying the export structure of a developing country such as India, while the effectiveness of customs operations has directly influenced the quality of foreign trade. Digitisation in ports has facilitated the tracking of goods at the international level, and the presence of modern equipment enhances the smooth flow of exports and imports. Furthermore, the availability of real-time trade information supports rapid decision-making regarding cross-border transactions. The level of coordination among port stakeholders improves the efficiency of the international supply chain, and fast, flexible port procedures effectively accommodate the needs of foreign operators. Ultimately, the improved performance of Algerian ports encourages the entry of new products into foreign markets. The studies of B. Sun & R. Kauzen (2023) and A. Sahoo *et al.* (2025) have demonstrated a direct relationship between seaport infrastructure and the economy, as improving seaport infrastructure can maximise its potential for international trade and economic growth.

In light of the findings obtained from the study, it is recommended to establish partnerships with advanced foreign institutions in order to benefit from their expertise in port management and modernisation. Skikda Port Enterprise should demonstrate a stronger commitment to education and continuous training by developing periodic training and capacity-building programs for employees in the fields of logistics and information technology, the port infrastructure must be improved to align with the requirements of modern vessels and the prevailing volume of commercial activity. Digitisation should be generalised across various port activities in order to accelerate administrative procedures and enhance transparency in port operations, fees related to port services should be reduced in a manner consistent with their quality and efficiency, thereby enabling the port to compete effectively with foreign ports and attract international vessels. And efforts should be made to develop ports so that they can accommodate the growing commercial traffic between Algeria and other countries. This can be achieved through the construction of specialised ports equipped with all necessary facilities, machinery, and storage areas to serve shipping, unloading, and warehousing operations.

● CONCLUSIONS

The modernisation of seaports in Algeria contributes to stimulating the foreign trade sector by improving the competitiveness of Algerian products in the international market and facilitating export and import operations. It also leads to a reduction in both the costs and the duration of commercial procedures, while enhancing the attractiveness of Algerian ports in drawing foreign economic partners. Based on the extent to which the sample agreed with

the statements in the "Promotion of the Foreign Trade Sector" section, it became evident that port modernisation at Skikda Port Enterprise has effectively contributed to improving the quality of external commercial performance. The results showed considerable agreement with the statement "The development of seaports has contributed to reducing export lead times to foreign markets", (mean = 3.8875, standard deviation = 0.65591). reflecting a clear awareness of the role of upgrades in accelerating operations and facilitating access to international markets. This means that improving and equipping ports with modern facilities and technologies has helped speed up cargo shipping procedures and complete formalities, thereby reducing the time goods take to reach foreign markets.

The port is considered relatively advanced compared to some other national ports, yet it still requires additional developments to meet international standards. The survey results also indicated that improving port services represents an important factor in enhancing the competitiveness of Algerian products in the international market, particularly with the introduction of advanced handling equipment and the presence of effective digital platforms. This contributes to cost reduction, faster processing, and increased satisfaction among foreign operators. In other words, it directly helps accelerate operations and reduce both the costs and time required to export products, making them more attractive and their prices more competitive in global markets. The more efficient and reliable port services become, the greater the ability of Algerian products to compete effectively against those of other countries, thereby strengthening their presence in international markets. However, there are currently no active partnerships with foreign ports, which represents one of the weaknesses that could be addressed in the future.

The results have demonstrated that modernisation projects at Skikda Port Enterprise, particularly in terms of digitisation and infrastructure improvement, have positively impacted the effectiveness of export and import operations while reducing time and costs. This, in turn, enhances the competitiveness of Algerian products in the international market. Future research could extend the present survey study by adopting a longitudinal approach to examine how the ongoing modernisation of Algerian seaports dynamically influences export and import facilitation over time. Comparative studies across multiple Algerian ports would help identify which modernisation dimensions (e.g., digital governance, infrastructure upgrading, or customs automation) yield the most significant reductions in lead times and transaction costs.

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● CONFLICT OF INTEREST

None.

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Дослідження модернізації морських портів Алжиру як чинника сприяння експортно-імпортним операціям

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Анотація. Модернізація морських портів стала стратегічною необхідністю в сучасній глобальній економіці, що зумовлено прискоренням процесів глобалізації та сталим зростанням обсягів міжнародної торгівлі. Оскільки морський транспорт залишається основою світової торгівлі, ефективність і здатність портової інфраструктури оперативно реагувати на зміни безпосередньо впливають на торговельну конкурентоспроможність країни. З огляду на ці тенденції метою дослідження було визначити роль модернізації морських портів Алжиру як ключового чинника сприяння експортно-імпортним операціям. Для досягнення поставленої мети застосовано кількісну методологію дослідження з використанням структурованої анкети, яку було запропоновано вибірці з 80 працівників портового підприємства Скікди в Алжирі. У дослідженні проаналізовано внесок модернізації портів у спрощення зовнішньоторговельних операцій за трьома окремими, але взаємопов'язаними напрямками: упровадження та інтеграція інформаційно-комунікаційних технологій, розвиток і модернізація фізичної інфраструктури, а також спрощення структур управління та процедурних процесів. Проаналізовано, як кожен із цих напрямів окремо та в сукупності впливає на ефективність і результативність експортних та імпортних операцій. Респонденти загалом позитивно оцінили всі досліджувані напрями, зокрема інформаційно-комунікаційні технології ($M = 3,8350$; $SD = 0,52171$), управління та спрощення процедур ($M = 3,7000$; $SD = 0,60713$), а також розвиток інфраструктури ($M = 3,5925$; $SD = 0,64234$). Загальне середнє значення показника сприяння експортно-імпортним операціям становило 3,8270. Крім того, анкета продемонструвала належні психометричні характеристики: коефіцієнти альфа Кронбаха варіювалися від 0,769 до 0,879, що свідчить про прийнятну та високу внутрішню узгодженість. Зазначені вдосконалення супроводжувалися помітним скороченням тривалості оброблення операцій та операційних витрат. З практичного погляду дослідження надає портовим адміністраціям, менеджерам у сфері логістики та представникам органів державної політики емпіричні докази відчутних і вимірюваних переваг, пов'язаних зі стратегічними інвестиціями в модернізацію портів

Ключові слова: модернізація портів; цифрова трансформація; спрощення процедур торгівлі; портова інфраструктура; управління