

# DIGITAL TECHNOLOGIES – A CHALLENGE FOR MARITIME INDUSTRY IN ROMANIA

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**Abstract:** Insufficient, at the national level, studies in the Romanian maritime port field, regarding the benefits of the implementation of digital technologies, which would provide answers on issues such as security systems for navigation, data security, and confidentiality, improvement of the operations and port infrastructure, reduction of the logistics costs, reduction of the dangerous shipping events, improvement of the traffic conditions and the handling of goods in ports, led to the present research. Based on the study of the scientific literature on the benefits of the digital technologies in the maritime industry, the author resorted to this research based on a methodological mix that includes data from several sources: interviews with members of port communities, direct observations in seaports, and a survey of port authorities. Based on the answers and qualitative interpretations resulting from the data collection period, relevant information was obtained, which allow the creation of an image of the benefits of implementing digital technologies in Romanian seaports.

**Keywords:** marine industry, digital technology, port operations, seaport.

## 1 INTRODUCTION

The maritime industry facilitates global trade and is considered a critical factor from a social and economic point of view, representing 90% of the EU's foreign trade (Sullivan et al., 2019). In response to economic, political, and technological trends, the maritime sector continues to grow, from ship design and construction to the optimization of cargo routes. While new emerging technologies are emerging that are changing the way ships are designed and developed, the efforts of European builders are focused on building specialized ships of high complexity and high technological content (Sullivan et al., 2021).

The dynamics of the European maritime industry bring into question the need to rethink the way in which the next stage of ship development can be facilitated by capitalizing on digital technologies, which for this industry means an opportunity in the development of next-generation ships.

To increase the competitiveness of the European maritime sector, a new approach is needed to incorporate new digital technologies (Internet of Things (IoT), big data analytics (BDA) into engineering and design practices, but also into all that means port and transport operations, robotics and intelligent automation, and intelligent simulation which incorporates

artificial intelligence (AI), additive manufacturing (AM), cloud computing, etc.), material, but also optimization processes (Thanopoulou and Strandenes, 2017).

Digitization thus becomes the best solution for optimizing port operations, and the use of new technologies is the first step in accessing digitization. In this way, all data is provided in real-time to stakeholders, which leads to increased efficiency in design, production, and operation, and ships better meet customer and market requirements. Digitization in maritime transport can achieve real-time tracking and positioning of ships, avoid collisions, satellite communications, intelligent traffic management, optimization of costs, capacity, and operations but also the management of navigation performance with implications for the efficient use of the transport infrastructure and new remote operation models, transport route planning, equipment monitoring (Sullivan et al., 2020).

Although resistant to change, ports are gradually changing their perception due to the emergence of new technologies that offer solutions to the problems they face, with the port sector moving towards a more connected future.

Due to the fact that in recent decades maritime transport has undergone a profound process of technological transformation, automation and digitization have increased the number of ships that can perform docking maneuvers in ports with high accuracy, without being assisted by tugs, has increased. Thus appeared the first autonomous ships operated by remote satellite and without crews (Paulauskas et al., 2021; Paulauskas, Dawidowicz and Paulauskas, 2021). Also, due to the new technologies, the ship's operating activities have undergone transformations, and the transport of goods in the large logistics terminals has been digitized. Added to this is the fact that in 2020 the European Commission has decided to stimulate investment in 5G technology with transport

applications. The aim of these investments is to create transport ecosystems that include 5G roads, railways, and sea routes, in which mobility is autonomous and connected, ecosystems that contribute to the construction of European strategic value chains (Sustainable and Smart Mobility Strategy - European transport on track for the future, 2020).

The seaports of Constanța, Mangalia, and Midia are part of the Romanian seaport complex, being coordinated by the National Company Maritime Ports Administration SA Constanta (APM), which in 2021 reported that the sea traffic in these ports increased by approx. 15.01%, ie 48.06 million tons compared to 41.8 million tons at the end of 2020, which is the highest traffic in the history of Romanian seaports. To these is added the fact that this company is involved in attracting European funds totaling 400 million euros aimed at streamlining Romanian seaports in terms of energy. This refers to the Onshore Power Supply (OPS) when ships are stationed in ports, a solution to reduce pollution from ships arriving in EU ports (<https://www.portofconstantza.com/pn/ro/home>). Also, the advantageous geographical positioning of the port of Constanța, on the pan-European transport corridor Rhine-Danube, determines that it has a major role in the European intermodal transport network. It is located at the intersection of trade routes connecting the Transcaucasus, Central Asia, and the Far East with the markets of landlocked countries in Central and Eastern Europe. The other two ports, Mangalia and Midia, play a key role in increasing the efficiency of port facilities in the port of Constanta.

The implementation of digital technologies in the three ports is particularly important, as a result of the requirements of global trade, which refers to operational congestion, high volume of goods, safety and security, but also geopolitical issues.

The study carried out in the paper refers to the three Romanian seaports, the results being

able to be applied to ports with similar characteristics. Starting from the fact that there are already ports in the world where the implementation of digital technologies has been a success and that until now the digitization of Romanian seaports has not been considered a priority, the research conducted in this paper aims to present the first time such study focused on the need to implement digital technologies in these ports. The following research questions (RQ) were asked:

RQ1: To what extent are digital technologies part of the strategies of Romanian seaports?

RQ2: What are the expectations following the implementation of digital technologies in the ports studied based on qualitative data?

In order to carry out the research, the author contacted experts from the port authorities from the three Romanian seaports and from the APM to carry out a complex analysis of them in terms of the need to implement digital technologies.

The aim of this research is, based on an analysis of the necessary digital solutions, identified by the communities of the three ports, to obtain a perception of the benefits that would be obtained from the implementation of new digital technologies in the activity of seaports.

The paper is divided into the following sections, as follows: literature review in section 2; research methodology in section 3; results and discussions in section 4 and conclusions in section 5.

## 2 LITERATURE REVIEW

Intelligent technologies and the digitization of information are commonplace in many areas of business today, including the maritime industry. Equipping ports with tracking technologies, sensors, and advanced monitoring systems, allow them to provide faster and more efficient services. Use of technologies such as automation, AI, ICT (Information and Communication Technology), Mobile services,

Cloud technologies, IoT, Robotics and automated machinery, Cybersecurity solutions; BDA, is the first step towards the transition to smart ports (Aslam, Michaelides et al., 2020; Kapkaevaa et al., 2021; Michaelides et al. 2021; Paulauskas et al., 2021a; Paulauskas et al., 2021b; Sullivan et al., 2019; Sullivan et al., 2020).

In the opinion of Heilig et al. (2017a), modern information technologies allow better planning and management within and between ports, considering that "digital technology is a means, not just a goal." The authors demonstrated how, based on the theoretical framework of the conceptual game presented, tools and methods can be developed for strategic decision-making leading to digital transformation in seaports.

The adoption of information technology and information systems is essential for the competitiveness of ports, as stated by Heilig et al. (2017b), with positive effects on the productivity, efficiency, and safety of the port procedures. The authors state that while current initiatives focus on the adoption and integration of information technology and information systems, exploiting new capabilities and related (real-time) data capabilities requires models and methods capable of doing so. Moreover, the authors believe that digital innovation contributes to the modernization of the port.

De la Peña Zarzuelo et al. (2020) show that cooperation between port authorities, terminals, port users, port service providers, and the port hinterland is a key element for development, stating that ports are considered to be in the fifth stage of evolution due to digital transformations and alignment to the practices of Industry 4.0.

Sullivan et al. (2020) have introduced a descriptive approach to understanding the notion of maritime industry M4.0 presenting an organized set of characteristics related to industrial transformation I4.0. The authors consider the M4.0 concept as an integrated system that requires the use of innovative

technologies for the development of sustainable, secure, and connected ships.

Aslam et al. (2020) have conducted a study of the Internet-of-Ships (IoS) paradigm, a new field of IoT applications, to demonstrate how these applications can stimulate improved maritime safety, energy-efficient operations, route planning, and optimization, automatic fault detection, environmental monitoring, automatic berthing of ships.

Chen (2020) has shown how cutting-edge technologies such as IoT, cloud computing, big data processing and AI have changed the world. The author refers to how devices connect the physical world to the virtual world via IoT, how cloud computing environments allow smart decisions based on big data analytics and machine learning, and how data security is ensured.

Starting with the demand for increasingly complex ships, Sullivan et al., (2021), have shown the need to incorporate intelligent simulations into the construction process by using IoT and Big Data to support decision making. The authors point out that the combination of digital technologies leads to a harmonious synchronization of efforts to improve the maritime industry.

Kapkaeva et al. (2021) have described port IT systems for the port of Hamburg using DAKOSY system solutions. The authors have concluded that port information systems and technologies have a significant role to play in collecting, exchanging, and distributing important information to all stakeholders.

In their work Michaelides et al., (2021) provide an overview of the value chain of maritime data. The authors have discussed state-of-the-art technological solutions for managing and processing maritime data as efficiently as possible, creating a holistic framework for performing spatio-temporal analyzes during a ship's voyage. It refers to a number of practical applications, which aim at long-term route planning, collision avoidance, cargo tracking, and

port stop optimization. This provides improved tools and solutions to support maritime stakeholder decision-making.

Gavalas et al. (2022) have assessed the possibility of adopting digitalization in the maritime field, in order to highlight how industry stakeholders can make superior operational and strategic decisions. The data used in the study have been collected from different countries and they have as resulted in evidence that working in a digitized ecosystem is a way to promote efficiency.

Jovic et al. (2022) have conducted a bibliometric analysis to define key points in the current process of digitization in maritime transport and seaports. The authors point out the importance of new digital technologies, highlighting the fact that there are a number of specific risks, including data falsification/manipulation.

Ichimura et al. (2022) have analyzed the significance of digitization strategies developed by a number of maritime trade actors. They detailed the term "digitization" and investigated its impact on the shipping industry, focusing on the reason for digitization and the associated measures.

The digitization of the maritime sector means the integrated implementation of digital processes and technologies for the development of innovative digitally connected ships, solving the problems of the traffic congestion in ports, ensuring a sustainable environment, and especially increasing the efficiency of the port operations.

### 3 RESEARCH METHODOLOGY

The study presented in this paper is a perspective on the views of maritime stakeholders on the implementation of digital technologies in the ports studied. The study was based on data from three main sources: (1) interviews; (2) field observations made at the three Romanian seaports and (3) an online

survey of the authorities of the three ports and of the members of the APM.

A significant number of papers discuss the use of digital technologies in ports (Aslam, Michaelides, and Herodotou, 2020; Kapkaeva et al., 2021; Michaelides et al. 2021; Paulauskas et al., 2021a; Paulauskas et al., 2021b; Sullivan et al., 2019; Sullivan et al., 2020). Taking into account these studies, in order to identify the needs of the Romanian seaports regarding digital technologies, the data used in the research have been collected from interviews with members of port communities completed with visits to the three seaports and an online survey, which have allowed a ranking of the importance of the nine digital technologies presented by the analysis tool (Digital Transformation Scoreboard, 2018) of the European Commission. These digital technologies are (1) Social media; (2) Mobile services; (3) Cloud technologies; (4) IoT; (5) Robotics and automated machinery; (6) Cybersecurity solutions; (7) BDA; (8) 3D printing; (9) AI, and they also have served as a basis for the survey questions, in order to identify to what extent they are part of the Romanian seaports strategies. The interviews were conducted in March 2021 in the three Romanian seaports. Respondents expressed their own opinions, ideas, and comments on the need to implement digital technologies in these ports. The interviews also focused on the flexibility and reliability of port operations, the efficiency of the port operations, port safety and security, the way information is distributed and interoperability, as well as port infrastructure (port basins, operating berths, dikes, loading and unloading areas, land areas, terminal).

Twelve people from the port authorities (7) and the APM (5) took part in these interviews. The seven members of the three seaports were: a coordinating director of the maritime pilotage compartment in the port of Constanta, a head of the security office at the Midia shipyard, chief of the maritime traffic monitoring office in the port

of Mangalia, and two other members from this office, a head of the port operation and safety service from the port of Constanța and a member of this service. Of the five respondents to the APM, they are in the category of those who deal with reporting on the behavior of port infrastructure and port facilities over time. All respondents to the interview have extensive experience in maritime navigation.

The field observations, following the visits in this port area also made in March 2021, completed the data necessary to carry out this study. Following this visit, a series of informal discussions were held on the availability of the introduction of digital technologies in port operations.

As for the survey, it was conducted electronically in April 2021, using the Microsoft Teams platform. This research method was chosen to benefit from the expertise of the people involved in maritime transport. Twenty-five people answered. Open-ended questions have been included so that respondents can develop answers where they have not found an appropriate answer for fixed-answer alternatives. One-third of them were directors of the analyzed seaports (nine directors from the three ports-operating directors, technical directors, and commercial directors), and the rest (sixteen people) were members of the APM and they dealt with port strategies and policies, with the events observed during the activities of surveillance and safety during the operation of ships, and with reporting on the transit of the dangerous goods through Romanian seaports. Their experience in the port field is between 5-10 years (seven people), 11-20 years (ten people), and > 20 years (eight people). The data collected are representative, providing a perspective based on the benefits of digital technologies, being representative.

The questionnaire used in the survey includes the following questions: What is your specialization?; Which company do you belong to?; How many years of experience do you have

in the company?; Is your port interested in digitizing?; How would you classify digital technologies: (1) Social media; (2) Mobile services; (3) cloud technologies; (4) Internet of Things (IoT); (5) Robotics and automatic machines; (6) Cyber security solutions; (7) Big data and data analysis; (8) 3D printing; (9) Artificial intelligence (AI), using the Likert scale from 1 to 5, where 5: extremely important; 1: extremely unimportant?; Which of the following digital technologies are used by your port? To what extent are digital technologies part of the strategies of the Romanian seaports ?; What is the level of implementation of digital technologies in your port?; In your opinion, how would you classify the port areas with the greatest influence on performance growth, using the Likert scale from 1 to 5, where 5: is extremely important; 1: is extremely unimportant?; In your opinion, what are the port areas that need to be considered given the large share of the port operations?; In terms of security and safety, which would, in your opinion, be the main benefits of implementing digital technologies?; In your opinion, in terms of the port operations and infrastructure, what would be the main benefits of implementing digital technologies?; Regarding the traffic in the vicinity of the port, which would be, in your opinion, the main benefits resulting from the implementation of digital technologies?; In terms of the environment, which would, in your opinion, be the main benefits of implementing digital technologies?

The port areas analyzed are port operations and infrastructure, safety and security, environment, port management, traffic in the vicinity of the port, data exchange within the port community, and traffic on railways, roads, and water.

All three research methods used by the author have aimed to identify aspects that highlight the need to implement digital technologies in Romanian seaports. Therefore, the selected respondents are experts (port

workers, ship operators, shipbuilders, APM employees) who are directly related to the port operations.

#### 4 RESULTS AND DISCUSSIONS

This section has been divided into two parts. In the first part are the results obtained based on the survey, shown in Table 1 and Figure 1, and in the second part are the results obtained on the basis of qualitative materials (interviews and field observations), shown in Table 2. Table 3 shows the benefits that could be obtained from the implementation of digital technologies and which responds to RQ2. To get answers easier and faster the five-step Likert scale has been used, where 1 being the weakest option and 5 being the best option.

The answers from the survey reflect a correct representation of the seaports in our country (Constanta port (60%); Mangalia port (30%); Midia port (10%)).

Table 1. Distributions of the survey responses

Question (1-The lowest; 5-The best)	1	2	3	4	5
Is your port interested in digitizing?	0%	10%	25%	25%	40%
To what extent are digital technologies part of the strategies of the Romanian seaports?	10%	20%	25%	30%	15%
What is the level of implementation of digital technologies in your port?	15%	25%	30%	25%	5%

The answers provided, as shown in Table 1, demonstrate that the seaports are interested in

the implementation of digital technologies, and also represent the answer to RQ1. At the question about the level of implementation of digital technologies, only the ports of Constanta and Mangalia answered. To the open question "which of the mentioned digital technologies are used by your port", most of the respondents from the three ports stated that a situation of the technologies used was not realized. Most respondents focused on traffic monitoring and the digitization of port operations.

The survey has found that the most important areas of development are Cybersecurity solutions; BDA and Mobile services, the social networks having the least importance, according to the respondents. The two main seaports, Constanta and Mangalia, have stated that digital technologies are part of their development strategies, while the port of Midia is progressing towards digitalization. Each of the three ports concerns the implementation of these technologies differently, depending on their internal needs. Thus, the digital technologies (Figure 1) are implemented in a proportion of 5% in the ports of Constanța and Mangalia within the port operations.

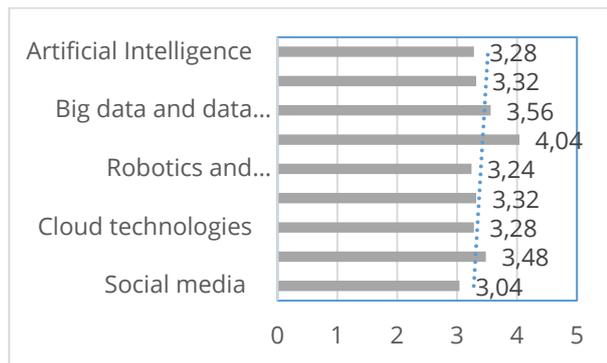


Figure 1. Classification of digital technologies in the vision of Romanian seaports

Table 2 presents the necessary digital solutions, as identified by the three ports studied. These are presented exactly as they

have been received from respondents during the data collection period.

Table 2. Necessary digital solutions identified by Romanian seaports

Area	Digital solutions obtained from interviews and observations in the field
Port Management	Mobile applications for reporting problems
	Improving the interaction between members of the port community
	Dissemination of information to all stakeholders
	Informing port community employees about dangerous situations
	The port manual is required in digitized form
	Lack of real-time data
	Lack of guidance on movement in port areas
Port infrastructure	Responsibilities for operating docks, floating pontoons, and berths are unclear
	Lack of load capacity specifications
	Lack of update on deviation reporting
	Unnecessary consumption of resources due to lack of inventory on port infrastructure
	Poor port space planning
Data exchange within the port community	Lack of desire to exchange data
	Lack of information to establish responsibilities
	Many information systems are not interoperable
	Too many technologies are used in data sharing
	Long waiting times
	Lack of information leads to unsafe programs
	Data transfer interoperability is often non-existent
	Limited level of data sharing due to technical difficulties

Area	Digital solutions obtained from interviews and observations in the field
Rail, road and water traffic	Use of sensors for railway monitoring
	Smart traffic guidance
	Presence of security devices in water areas
	Automatic mooring of ships
	Vehicle scaling by automatic systems
	Lighting traffic with smart guides
	Image recognition systems with the help of smart cameras
	Traffic management is uncontrollable in the vicinity of ports
Environment	Careless handling of hazardous substances
	Too few waste handling points
	Waste status data is limited
	Environmental pollution caused by ships
	The need to locate hazardous materials

As for the expectations/benefits that would result from the implementation of digital technologies, they are presented in Table 3, as identified by survey respondents, and interviews, and based on observations outlined during visits to the three seaports analyzed, but also on the basis of the studied literature.

Table 3. Expectations/benefits resulting from the implementation of digital technologies

Area	Expectations/benefits
Port operations and infrastructure	<ul style="list-style-type: none"> <li>• increasing the efficiency of port operations, solving environmental problems and traffic congestion by introducing technologies such as AI, IoT, 5G, etc.;</li> <li>• informing port actors about port operations, as well as reporting deviations through the</li> </ul>

Area	Expectations/benefits
	development of mobile applications; <ul style="list-style-type: none"> <li>• better use of available resources based on more precise coordination by port actors as a result of the introduction of intelligent port procedures, which would reduce logistics costs;</li> <li>• ensuring the automatic berthing of ships, but also directing traffic by remote control of the digital infrastructure;</li> <li>• improving port operations, better handling of goods, providing accurate and timely information, making decisions based on traffic conditions can be achieved by implementing Big Data Analytics</li> <li>• providing large amounts of data for better predictability can be achieved by implementing intelligent production technologies;</li> <li>• testing and optimizing systems before any physical changes that reduce machine downtime can be accomplished by intelligent simulation that uses real-time IoT data in a virtual model.</li> </ul>
Safety and security	<ul style="list-style-type: none"> <li>• Improving safety conditions for port workers can be achieved by implementing IoT and intelligent robots;</li> <li>• Port authorities and operators can improve and secure their IT networks by implementing cyber security systems, which must become an integral part of the port security;</li> <li>• collision avoidance, satellite communications, and ship position management, useful for port operators to operate the ship safely, can be achieved through AIS systems, installed onboard the ship, as tracking systems;</li> </ul>

Area	Expectations/benefits
	<ul style="list-style-type: none"> <li>• data protection and transparency can be achieved by using blockchain technology, which eliminates the possibility of copying data;</li> <li>• avoidance of unauthorized access to sensitive port data (security-related), data theft, deletion, or corruption of the port data, but also infection with malware can be achieved with the help of cyber security systems;</li> <li>• the transmission of data from the ship's sensors to the navigation center could be done via wireless protocols via a private 5G network. These sensors would provide information such as the speed and direction of the ship, water and wind speed, etc., towards the ship's monitoring equipment, which would allow the crew to make appropriate decisions and support the diagnosis on board the ship;</li> <li>• implementation of data-assisted navigation applications that use IoT detection systems and video cameras installed both in ports and ships. These would allow safer port operation, but also increased security of the navigation, even in severe weather conditions;</li> <li>• Global Positioning System (GPS) will improve safety and waterway management;</li> <li>• the establishment of the security operations centers would allow the understanding of the potential and real threats to port facilities, as well as the detection of the unauthorized changes to port systems.</li> </ul>
Environment	<ul style="list-style-type: none"> <li>• creation of the management centers for coordination in the region and implementation of the environmental management systems;</li> </ul>

Area	Expectations/benefits
	<ul style="list-style-type: none"> <li>• use of the emission control systems with a role in reducing emissions from port traffic;</li> <li>• use of the sensors to check the air quality before opening cargo containers;</li> <li>• ensuring the integrity of the ship's cargo, so that the goods remain intact throughout, can be achieved by using sensors and analyzing the corresponding data flows based on the Artificial Intelligence mechanisms.</li> </ul>
Traffic in the vicinity of the port	<ul style="list-style-type: none"> <li>• use of the 5G communications technology that allows connection to multiple data sources to indicate the optimal speed of the ship which allows for lower fuel consumption;</li> <li>• retrieving real-time data on navigation parameters requires inputs from applications using 5G network capabilities, improving the quality of the ship position data and remote control of ships;</li> <li>• the provision of data on the type, position, and speed of the ship, but also the estimated travel time of the ship can be achieved by implementing the automatic identification system (AIS), which would permit standardizing and bring telematics technologies to assist the navigation at a higher level;</li> <li>• use of the AIS system to detect objects in the vicinity, but also in areas further away from the ship, to create a map of obstacles in front of ships;</li> <li>• the creation of the cloud computing centers for the processing and merging of data in order to facilitate the exchange of ship data with the maritime port authorities or teleoperators in order to inspect the situation in</li> </ul>

Area	Expectations/benefits
	real-time and take appropriate action; <ul style="list-style-type: none"> <li>avoiding stationary downtime due to navigation errors, but also reducing the transport of empty units can be achieved by implementing the communication and travel monitoring technologies, which would allow better communication between ships and ports of operation, through real-time connectivity of radio and video navigation equipment.</li> </ul>

The immediate priority solutions, as it results from the research carried out on the three Romanian seaports would be mobile applications for reporting problems; sharing information with all stakeholders; informing port community employees about dangerous situations; data transfer interoperability; data sharing using dedicated software; automatic berthing of ships; intelligent traffic guidance; use of smart cameras and local sensors; remote control of ships using 5G technology capabilities; intelligent handling of hazardous substances. The real benefits that could be obtained starting from the identified solutions refer to the optimization of the performances in the maritime transport sector. Among the most important benefits identified by the author are:

- introduction of modern 5G communications technology that allows automation of the logistics transport on ships. This technology paves the way for faster connections and better response times. Ships equipped with additional 5G connectivity would allow the remote control of ships, reduce the number of personnel required on board the ship, and minimize berthing times. Real-time route planning can also be done, which would lead to optimizing the port operations, thus avoiding unnecessary waiting times in the port area. The 5G network combines IT,

cloud, and telecommunications technologies;

- introduction of the autonomous ship control systems, which include monitoring data from sensors, detecting and tracking obstacles, but also predicting the ship's route for which the local cameras and sensors can be used. These systems allow the aggregation of real-time data needed for navigation planning;
- use of the Navigation Speed Optimizer which helps ship operators to optimize their navigation speed. This instrument can be connected to multiple data sources indicating the optimal speed of the ship so that it can reach its destination on time (with lower fuel consumption), without waiting times before loading/unloading goods. Basically, this tool allows users to work more efficiently by bringing real-time data from different systems, which are then processed on 5G networks, resulting in superior data on ship position, speed, etc.;
- using local sensors and smart cameras is another benefit of shipping. The collection of data from these sensors and cameras on board the ship allows to know at any time the speed of the water, the depth, the temperature inside and outside the ship, the functional parameters of the engine, the oil level, etc., these being made available to a local server 5G, which has specific interfaces for various surveillance modules, but also for devices installed on board the ship;
- the introduction of the Digital Twin systems is another benefit, which uses the data available from local sensors and video cameras to increase their visual field of perception, but it can also be used as a backup plan in case of failures caused to the sensors and video cameras.

According to Directive 2010/65 / EU, adopted on 20 October 2010 by the European Parliament and the Council on the reporting formalities for ships, both on arrival and

departure from Member States' ports, the use of digital information leads to improved efficiency, the attractiveness and ecological sustainability of maritime transport, contributing to the integration of the sector in the digital multimodal logistics chain.

## 5 CONCLUSIONS

The conditions necessary for the development of seaports envisage good cooperation between all members of the port community, consisting of administrations, authorities, customs commissioners, transport operators, terminal operators, logistics service providers, quality control companies, and ship agencies companies. etc., which ensures the proper functioning of the ports.

This study is useful for the port communities, but also for the academic environment because it brings to attention a first perception of the benefits that the implementation of digital technologies in Romanian seaports would have. Research demonstrates a good understanding by port authorities of the need to implement digital technologies in the day-to-day operation of seaports.

Respondents have considered that the implementation of digital technologies in these three seaports would be extremely beneficial for coordinating port operations, avoiding unexpected events, safer port operations, increased shipping security, avoiding delays in the transport chain, understanding potential threats and realities on port facilities, and their adoption in Romanian seaports prepares the transition to the smart port.

In terms of the managerial contributions, the research offers an interesting and promising field for the Romanian port authorities, which have shown a general interest in the implementation of digital technologies, which represent both opportunities and challenges for the maritime industry. According to the survey,

the most important areas of future development are considered Cybersecurity solutions, Big data and data analytics and Mobile services. This demonstrates that seaports are increasingly focusing on increasing the efficiency of the port operations, providing accurate and timely information, better integration of data to their connections and managing from multiple sources, making informed strategic decisions, avoiding unauthorized access to the sensitive port data, avoid malware infection, real-time connectivity of the navigation equipment, increased security in navigation, solving environmental problems and traffic congestion, a safer port operation.

Both the survey and the interviews aimed to identify the perspectives on the implementation of digital technologies in Romanian seaports, depending on the internal needs of each port.

Future research considers comparisons between the benefits of each seaport following the implementation of digital technologies.

The limitation of this research refers to the fact that the implementation of digital technologies at the level of the Romanian seaports is still in an incipient stage, and the perception and experience of the respondents are relatively subjective. The results of this study can be used successfully by seaports despite this limitation.

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