

The Importance of Digitalisation for Sustainable Development of Maritime Industry

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Maritime transport is the driving force of global trade and is one of the fundamental activities of the blue economy. In the face of changes in globalisation, it must face technological changes. According to the United Nations Conference on Trade and Development, the global commercial shipping fleet grew by three percent, in 2020 up to 99,800 vessels of 100 gross tons or more.

One of the key drivers of technological change in the maritime industry is digitalisation. The digitalisation of shipping is a step towards making it more environmentally friendly and efficient. This will lead to significant cost savings and improve vessel efficiency, transparency, and market access. For the future development of the maritime industry, digitalisation, combined with environmental sustainability, is essential. Experts agree that the COVID -19 pandemic has created certain challenges but also opportunities by creating a great imbalance in the industry and accelerating the progress of digitalisation and innovation. The fourth industrial revolution is expected to have a significant impact on maritime transport.

KEY WORDS

- ~ Sustainable development
- ~ Digitalisation
- ~ Maritime industry
- ~ Technological changes

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The IMO Convention on Facilitation of International Maritime Traffic and the WTO Agreement on Facilitation of International Maritime Traffic have created common standards and regulations that have paved the way for digitalisation. Despite the technological advancements in the maritime industry, there is still much room for further research in developing countries.

Digitalisation in the maritime sector should be promoted as part of global efforts to increase the supply chain resilience. It is the pathway to greener and smarter shipping, and this paper aims at providing an insight into the digitalisation of shipping and highlighting its importance for the future, as well as demonstrating that it contributes towards achieving the sustainable development goals. The level of digitalisation in seaports and maritime transport will also be analysed. The adoption of digitalisation in the maritime industry is essential and will lead to greener maritime transport and a robust economy, as well as increased safety.

The paper includes primary research on the example of shipowners in the coastal liner passenger transport of the Republic of Croatia, and a questionnaire consisting of nineteen questions was used to conduct the research.

1. INTRODUCTION

An efficient transport system is a prerequisite for economic development and plays an active role in shaping space and people's lives (Violić & Debelić, 2013). On the other hand, the development of transport as an economic activity takes place in line with the general development of the economy (Lacković et al., 2016). The importance of maritime trade is unquestionable, and it is the driving force on which most of the world's global trade is based. According to available data, UNCTAD (2022) predicts maritime trade to grow at an average annual rate of 2.1% over the period between 2023 and 2027.

The goal is the long-term sustainable development of the maritime industry as a part of the transport system. The sustainability of the transport system is reflected in its impact on the economy, environment, and society. One of the most important elements of the future development of the transport system is the integration of ecological and environmental goals (Lacković Vinček, Dvorski & Dvorski Lacković, 2016). Achieving the highest possible balance between different modes of transport

will reduce negative impacts caused by the transport system, such as traffic congestion and pollution (Ogorelc, A., 2003). Therefore it is necessary to limit the negative impacts of transport as much as possible by encouraging intermodality, developing intelligent transport systems, and optimising the existing ones. The share of maritime transport in the total pollution caused by the transport sector is shown in Figure 1.

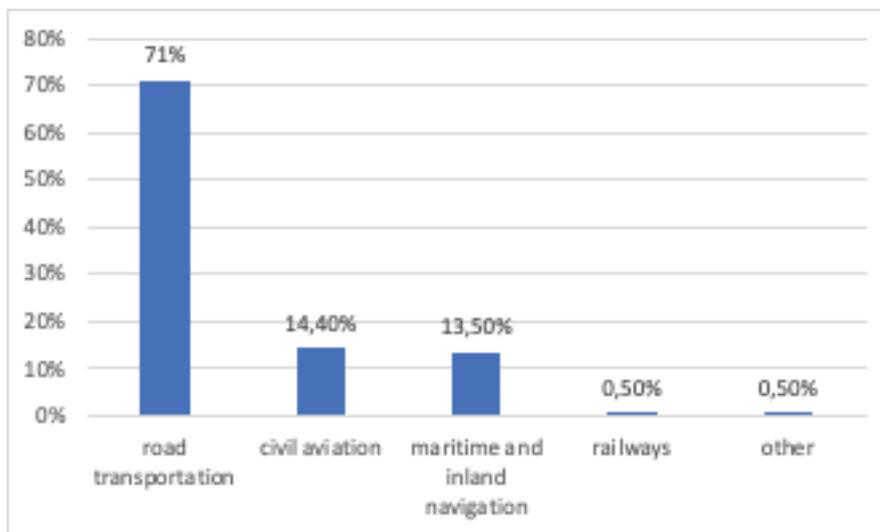


Figure 1.

Greenhouse gas emissions by transport sector.

(Source: prepared by the authors according to "EEA greenhouse gas - data viewer", European Environment Agency, available at: www.eea.europa.eu, accessed 15 December 2022).

According to Figure 1, 13.5% of total pollution is caused by shipping and inland navigation. Progress in the sustainability of the maritime sector has been made through increased institutional requirements, more rigorous legal frameworks and regulations. The efforts are also aimed at reducing the emission of harmful gases from maritime transport by increasing the energy efficiency of ships by reducing their sailing speed (European Maritime Transport Environmental Report, 2021) or by determining the most favourable routes based on weather and sea conditions, i.e., by accurately predicting the performance of ship operations under different external conditions (Lu et al., 2015). In this way, fuel consumption and CO₂ emissions can be reduced by about 3% (Yan et al., 2018), which is an environmental and economic benefit for shipowners and other stakeholders in the maritime system. In all these calculations, forecasts, monitoring the movement of a particular segment, inspections, and other maritime activities, digitalisation plays an important role. Digitalisation helps the maritime industry address certain issues, such as increasing administrative and

regulatory requirements (MN Shipping, 2022). All of the above shows that the sustainability of the maritime transport system as part of the transport system also depends on digitalisation within the system, as it influences the reduction of negative impacts of maritime transport in terms of environmental protection and the growth of economic activities.

Digitalisation is one of the main drivers of modern development (Jovanović, Dlačić & Oktanović, 2018). The rapid emergence and development of digital technology have greatly accelerated the transformation of the maritime industry. The industry is expected to be able to achieve zero emissions by 2050. The use of digital solutions and technologies serves to improve operational efficiency and competitiveness. With the help of sensors and other electronic sources, data can be collected and analysed to improve the efficiency of the maritime industry. In this way, informed decisions can be made, and the quality of operations improved. Maritime industry stakeholders need to rethink their strategies and adapt to ensure sustainable and efficient operations. (Det Norske Veritas, 2022) Researchers have

given great importance to this topic as more and more people are interested in the transformation of the maritime industry. At the same time, there is a commendable intention to raise the level of digitalisation of maritime transport to the level of other industries (Sanchez-Gonzalez et al, 2019).

Digitalisation in the maritime sector offers numerous advantages for the management and rapid exchange of information. It also encourages the development of standardisation of existing ports by influencing workflows, reducing transit, and waiting times in a port. Digitalisation also plays an important role in the education and training of seafarers. A major advantage of digitalisation is also evident in various maritime forecasts, such as the number of passengers in a port at a given location at a given time, or predicting breakdowns on a ship or maintenance equipment. Forecasts shape business and management strategies and influence decision-making in the maritime industry. As for the environmental dimension, digitalisation helps to monitor ecological efficiency with the aim of reducing emissions of harmful gasses into the atmosphere, thereby protecting natural marine ecosystems (MN Shipping, 2022).

However, there are also some negative aspects and risks. One of the negative aspects observed is the significant costs caused by the implementation of digitalisation. There is a possibility that smaller companies will be left behind in the implementation of the digitalisation trend, as they will have to finance the infrastructure required to implement digitalisation. One of the biggest risks of digitalisation in shipping is cyberattacks, but also the introduction of systems to neutralise them (MN Shipping, 2022).

2. LITERATURE REVIEW

The rapid emergence and development of digital transformation in the maritime industry have created a great opportunity for companies to transform their operations. It is important to understand what it takes to achieve this and how this can be linked to sustainable goals (Warner, 2022). COVID-19 has become a driver of digital transformation in the maritime industry. The market grew to \$159 billion by 2021, 18% more than the pre-pandemic estimates. In addition, the number of investments in digital technologies increased by 85% in 2021. (Inmarsat, 2021).

The stages of digitalisation in the maritime industry are mentioned throughout the professional literature, and UNCTAD (2019) divides them into three parts: optimisation, expansion, and transformation. The optimisation phase aims at reducing business costs. The expansion phase aims at developing new business models and improve the efficiency of the existing processes. The transformation phase includes the transformation of the business models of traditional and new companies.

It is estimated that the global digital technology industry will be worth around \$345 billion by 2030. It is expected to grow for three more years, faster than previously estimated. The pandemic also caused online retail sales to increase by \$675 billion in 2020 alone, and one of the world's twenty ports saw digital investment accelerate due to the pandemic. Daily data consumption by ships increased from 3.4 to 9.8 gigabytes during the pandemic and in less than a year (Inmarsat, 2021). Various organisations, including international shipping agencies and governments, have already begun to address the challenges of digitising the maritime industry. A number of private companies have also begun to promote the use of digital technologies in the maritime sector.

In recent years, several studies have been conducted on the importance of digital technology in the maritime industry. These studies have been conducted using different approaches and methodologies (Gavalas, Syriopoulos & Roumpis, 2022). The aforementioned authors examine various factors that influence the development and implementation of digital technologies in the maritime industry. The results of the study show that working in a digital ecosystem can help to promote the adoption of digital solutions, although not at the same rate in different departments and shipping facilities. Jović et al. (2022) investigated the topic through a comprehensive analysis of various factors that influence the development and implementation of maritime transport and the digitalisation of seaports. They used the method of reviewing publications related to the digitalisation of seaports and maritime transport. On the other hand, the research by Babič et al. (2020) provides an overview of the different steps in the implementation of digital technologies in the maritime sector. In the article the authors discuss the challenges faced and classify the factors that characterise the digitalisation process of maritime transport.

Accordingly, the World Bank (2020) published the Accelerating Digitalisation report, which aims at providing a comprehensive overview of the different measures to strengthen the resilience of the logistics and maritime sectors for each country. It also aims at ensuring that they are able to realise the full potential of digitalisation.

3. READINESS OF EUROPEAN SHIPPING INDUSTRY FOR THE DIGITAL AGE

The European Commission has recognised the importance of the development and implementation of advanced technologies in the maritime industry. To address this issue, it has developed a number of strategies and programmes (European Commission). Accordingly, the European Maritime Safety Agency (EMSA) has published a five-year strategy that is an important part of the European Union's efforts to address the various challenges and opportunities facing the maritime sector. The goal of the EMSA

strategy is to provide a strong support mechanism for European member states and commissions. The procedures that are part of the EMSA framework contribute towards the development of a barrier-free European maritime transport system. They are also useful for the implementation of a single market in the maritime transport sector. EMSA has a broad portfolio of digital tools to help countries to manage their maritime activities. These tools are designed to support the various activities of flag states, coastal states, and ports. The agency's activities are in line with the increasing attention the industry is paying to the development of new technologies, such as artificial intelligence. To ensure that the digital services offered by the organisation meet the needs of its users, the agency is also strengthening its security measures. The agency is also working to better meet the expectations of its clients by improving its security measures and digital capabilities. This will enable it to move from the concept of "must know" to "must share" (EMSA, 2019).

European experts believe that the topics such as decarbonisation, digitalisation, sustainability, data sharing, and zero pollution need to be seriously discussed in the coming years. The right knowledge support is also important to ensure that the sector can effectively address these challenges. Technology and digitalisation are issues that shape the maritime sector and are aspects with far-reaching consequences. Many official EU documents in the maritime sector emphasise the free movement of people, services, and goods and, on the other hand, the responsibility of the transport sector to exploit the potential of this environment and digital transformation and to work towards sustainable and smart mobility.

Understanding the different success factors and challenges in the industry is very important for developing a successful digital transformation strategy (Raza et al., 2023). Although the literature on the digitalisation of maritime transport provides valuable information on the various challenges and opportunities that can be expected in the industry, it is still unclear how many shipping companies are adapting their strategies towards this new technology (Ichimura et al., 2022).

With the aim of developing concrete measures to identify shortcomings and best practices and to monitor the development of digitalisation, the European Commission developed the DESI (Digital Economy and Society Index) to measure and monitor the digital performance of EU member states (Jovanović, Dlačić & Okanović, 2018). As any development, the development of digitalisation brings certain negative side effects. In this sense, it is a misuse of digitalisation, which points to the importance of cybersecurity development (Pavlinović, Račić & Karin, 2021). For this reason, the European Union Agency for Cybersecurity was established in 2004 as a key factor in the implementation of digitalisation itself. By sharing knowledge, building capacities, and providing information, the Agency works to strengthen

the digital security of European society and citizens, which is also applied to the maritime industry (European Union Agency for Cybersecurity). Cybersecurity is the backbone of digital transformation. The need for it permeates all sectors and must therefore be addressed across a wide range of areas and policies (European Union Agency for Cybersecurity).

In order to help maritime companies to reduce their administrative burden and improve operational efficiency, there is a need to simplify and standardise the information systems for reporting. EU member states have developed a European single window digital interface that allows ship operators and agents to electronically submit reports related to their activities in ports. As a result of all of the above, it can be concluded that with the introduction of the European single window digital interface, which would significantly shorten administrative procedures, e-certificates, and e-bills of lading, Europe is ready for digitalisation of the maritime industry.

4. SHIPPERS AND DIGITALISATION IN MARITIME INDUSTRY

Digitalisation in the shipping industry is manifested at all levels, from navigation aids to algorithms used for various predictions and business decisions, through the prevention of maritime accidents, reduction of business costs, fleet monitoring, etc (Sanchez-Gonzalez et al., 2019). Digitalisation in the maritime industry has a significant impact on all stakeholders. The research shows that digitalisation in the maritime industry has brought the most benefits to its stakeholders in the areas of sales, accounting, finance, procurement, analytics and reporting, bureaucratic and administrative formalities, and human resource management (Jović et al., 2022). Shippers, as key stakeholders in the maritime system, are highly dependent on the development and implementation of digitalisation, but at the same time they have to accept it due to market requirements, legal rules and regulations, and the success of their own businesses. At the same time, all stakeholders involved in maritime transport chains are increasingly dependent on information and communication technologies. As a result, digital transformation can have a positive impact on all segments of a shipping company business by optimising and improving business processes and reducing the negative impact on the environment (Jović et al., 2022). Shipping companies also need to adapt to the demands of service users by providing high-quality, efficient, and appropriate service in the long term (Tijan et al., 2021), and service users have an increasing level of knowledge and expectations in the field of digitalisation. Passengers today want accurate and up-to-date information at all times, easy online purchase of tickets, the ability to express their opinions on the services provided, and fast and efficient communication, and all of this is closely related

to digitalisation in shipping. One of the biggest challenges for shipping companies today is the integration and use of new digital technologies, which influence the formation of some new business models, necessary to meet market needs and achieve competitive advantages (Tijan et al., 2021).

An important part of the maritime industry is public maritime transport, which ensures regular and safe connections of islands with the mainland and between islands. Public coastal maritime transport includes the transport of passengers, cargo, and vehicles in the internal sea waters and territorial sea of a given state, carried out on predetermined lines according to the publicly available conditions of the published timetable and price list for services (Act on Liner Shipping and Seasonal Coastal Maritime Transport). Such a system falls under the jurisdiction of the state, as it takes into account the importance of the traffic connection of all parts of the state territory. The higher the coastal indentation index, the more pronounced the problem of traffic connecting the islands with the mainland and the islands with each other within a given maritime state. The island population has the right to the same standard of living and quality of life as other citizens. Considering the importance of coastal liner maritime passenger transport, this paper examines the relationship between digitalisation and maritime public transport within a particular maritime state.

5. DIGITALISATION IN THE SYSTEM OF PUBLIC TRANSPORT CONNECTING ISLANDS WITH LAND AND BETWEEN THE ISLANDS

For the purpose of this scientific paper, a research has been conducted on the example of the Republic of Croatia, as the coastal indentation index is 11.1. (Riđanović & Bićanić, 1993). The Republic of Croatia has 49 permanently inhabited islands. The transport connection between the islands with the mainland and between the islands in the Republic of Croatia is regulated by the system of coastal linear shipping. The system of coastal linear shipping ensures regular transport connection between 73 islands and 22 land ports (Maritime Development and Integrated Maritime Policy Strategy of The Republic of Croatia for the Period from 2014 to 2020, 2014.). Regular public transport in coastal linear seafarer traffic in the Republic of Croatia is valid by the Decision on the determination of state lines in public transport in coastal linear transport of 2016, and amendment and supplement resolutions of 2020 include 51 state lines, which are maintained by 13 shippers with a total with a fleet of 82 vessels (Coastal Liner Services Agency).

The number of passengers in maritime transport (excluding passengers on round trips) of the Republic of Croatia in the period from 2016 to 2020 is illustrated in Figure 2, which shows the importance of the system of coastal linear maritime transport on the territory of the Republic of Croatia in terms of the number of passengers transported.

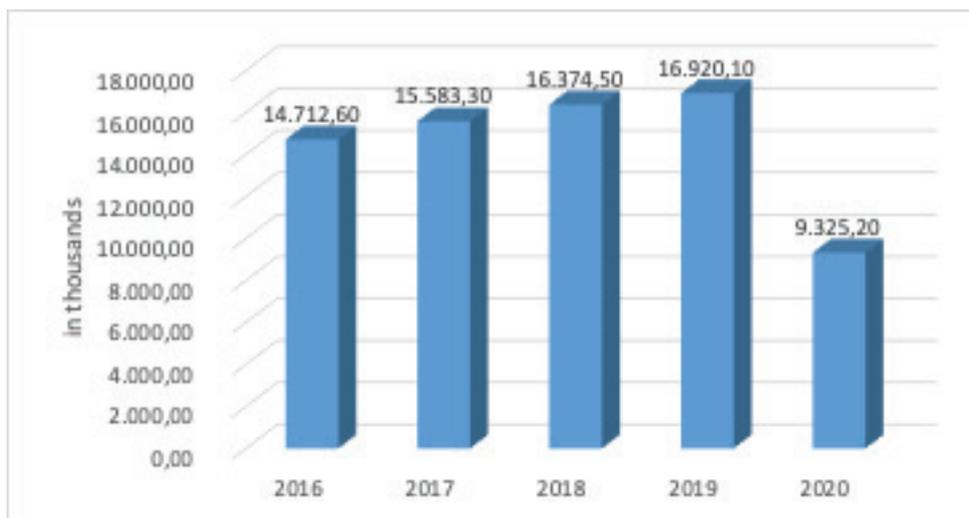


Figure 2.

Number of passengers in maritime transport (excluding passengers on round trips) of the Republic of Croatia in the period from 2016 to 2020.

(Source: Prepared by the authors according to the data from Eurostat, Available at: www.ec.europa.eu, accessed on: 21st December 2022).

The above data confirm that a representative sample was taken to investigate the impact of digitalisation on the sustainability of public maritime transport. The research includes shippers within the system of coastal linear maritime transport of the Republic of Croatia, and a questionnaire has been used to conduct the research. The questionnaire, consisting of nineteen questions, was sent to the shippers by e-mail.

The questionnaire was filled out by 10 shippers, out of which 70% are women. 33% of the respondents belong to the age group between 45 and 54, followed by the group between 35 and 44. 67% of the respondents are not involved in making management business decisions in the company.

The shippers are aware of the importance of digitalisation for business and the realisation of a long-term and sustainable

system of coastal linear maritime transport on the territory of the Republic of Croatia. They also believe that a successfully implemented process of digitalisation ensures a better positioning in the market. Only 22.2% of the respondents believe that the state actively supports shippers in achieving an appropriate level of digitalisation in the system of public maritime transport on the territory of the Republic of Croatia. However, 100% of respondents believe that digitalisation has an impact on the sustainability of the system of public maritime transport in the Republic of Croatia. The research shows that shippers are well familiar with the concept of digitalisation in the system, and Figure 3 shows shipowners' attitudes towards the concept of digitalisation in their companies.

An important factor in the successful operation of a shipping company is the level of digitization.
10 odgovora

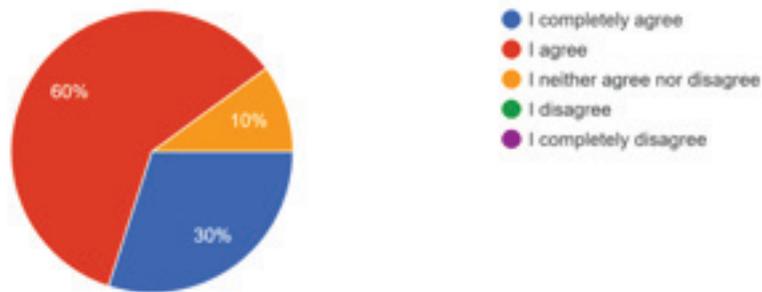


Figure 3.

Shipowners' attitudes towards the relationship between digitalisation and the success of a shipping company. (Source: Prepared by the authors).

The analysis of Figure 3 shows that the majority of shipowners agree with the statement that digitalisation is an important factor for the success of shipping companies, although 66.7% of shipowners do not have a person or a department responsible for implementing digitalisation in their companies. 55.6% of them do not plan any financial resources for digitalisation on an annual level. The research shows that most of them, therefore, do not neglect the digitalisation process and that the topic of digitalisation is significantly present in their business meetings.

Digitalisation process requires significant financial resources from shipowners. From Figure 4, it is clear that mostly only what is an obligation is introduced, even though shipowners

perceive that this process has a positive effect on business. From the results of this research, it can be concluded that the process of digitalisation is closely related to the sustainability of public transport connection of the islands with the mainland and between the islands. The shippers are well acquainted with the process of digitalisation, but they lack more active support from the state, as the process requires certain financial investments. Also, the research shows that shipowners, pressed by financial burdens, introduce only mandatory parts of digitalisation, even though they are aware that a higher degree of digitalisation would ensure more efficient operations and a better positioning on the market.

Only mandatory and prescribed novelties are introduced into the company's operations in the digitization process.

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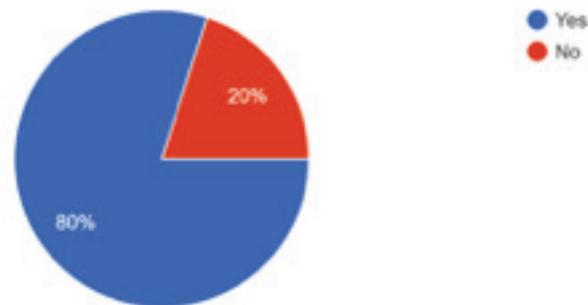


Figure 4.

Shipowners' attitude about the process of digitalisation in business.

(Source: Prepared by the authors).

6. CONCLUSION

Digital transformation is a hot topic in the maritime industry. The increased level of digitalisation, automation, and the availability of highly reliable computer-controlled systems are enabling advances in environmental preservation, economic development, higher levels of safety, automation, and reductions in costs and time. In this way, new business logic and models for the creation of additional social and economic values are emerging, i.e., the entire strategy for the development and operation of the maritime industry is being transformed. With advanced analytical methods, ship crews and companies can take more constructive actions when looking at the large amounts of data generated by today's vessels. Digitalisation will undoubtedly increase vessel efficiency and reduce costs, but will also impact various other functions related to shipping and the maritime industry.

As the port industry continues to face increasing pressure, smart technologies, such as artificial intelligence, are becoming more important. Digitalisation affects the entire supply chain. Despite seaports' investments in smart technologies, the issue of digitalisation remains particularly important.

Smaller terminals are still lagging behind in digital transformation. To improve the supply chain, experts believe the industry should focus on the seaports' hinterland and the terminals and hubs in the transport chain. The lack of such hubs has a negative impact on the entire maritime chain. In its official documents, the European Maritime Safety Agency mentions artificial intelligence as one of the main ways to be

used in the future to strengthen safety, protect maritime areas, and administratively simplify EU maritime transport with a view to greater efficiency. Digitalisation in shipping is inevitable, and it seems to be of paramount importance to find more effective digital solutions to the various administrative burdens in cargo transport.

The conducted research indicates the importance of the impact of digitalisation on the sustainable development of the maritime industry. The segment that has been observed in this research is the relationship between digitalisation and public maritime passenger transport. The research has been conducted on the example of the Republic of Croatia as a representative sample, taking into account the coastal indentation index and the number of inhabited islands connected to the mainland and among each other through a system of coastal liner passenger transport. It may be concluded that digitalisation is an important factor for the long-term sustainability of the system of public transport connections between the islands and the mainland and among the islands. Shipping companies are well acquainted with the process of digitalisation, but they lack a more active support from the state in terms of the necessary financial investments for its realisation. State aid would encourage the adoption of digitalisation in the maritime industry in general, and not only the fulfilment of mandatory and legal requirements. Achieving a higher level of digitalisation would result in more efficient business and better positioning in the market. For the Republic of Croatia, this would also mean strengthening of the economy and greater resilience in times of crisis, as emphasised in the Digital Croatia Strategy for the period up to 2032.

CONFLICT OF INTEREST:

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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