

The Study on the Prospects for Ship Chartering Market Virtualisation

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Chartering brokers play an important role in the functioning of the maritime industry, providing the role of intermediaries in the search for ships and cargo. However, questions arise in the context of the possibility of virtualising this component of the freight market activity. The purpose of this study is to assess the feasibility of implementing this opportunity, both in the world maritime freight market and in Ukraine. An analysis of trends in freight market virtualisation has been carried out, and the situation in the industry described based on statistical data. Within the framework of the study, the role of modern digital technologies in the freight market has been comprehensively investigated, showing that their use contributes towards the conclusion of contracts, obtaining information about the state of the market, and provides support during the implementation of the transaction, thereby allowing this market to increase its efficiency. It has also been also concluded that the prospect of its further digitalisation plays an important role at this stage of market development. The study has proposed two models: one is linked to a global platform that will include brokerage, logistics, and commercial functions to optimise the entire service lifecycle, while the other consists of many independent platforms that compete with each other, potentially connecting to e-commerce resources. However, it has been concluded that there are problems and difficulties for both models. In addition, it has been shown that modern technologies can provide a certain level of virtualisation of the freight market, but the question arises about the quality of their application. The results obtained in the framework of the study can be used to create effective approaches to virtualisation of the freight market in the future.

KEY WORDS

- ~ Maritime transportation
- ~ International trade
- ~ Digital transformation
- ~ Innovations
- ~ Freight market
- ~ Market development

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1. INTRODUCTION

The freight market plays an important role in the functioning of any country, as it affects one of the main factors in the development of the country's economy, namely trade, through the establishment of transportation prices. However, in the context of the rapid development of technologies observed since the beginning of the 21st century, the question arises about the possibility of introducing innovations in this market. One of these is virtualisation, which represents a significant potential for the transformation of this industry, contributing to increased efficiency, transparency, and flexibility of operations: it allows automating many routine tasks related to monitoring the state of the freight market, analysing information arrays, organising transportation; ensuring transparency of processes by tracking cargo movements in real time, the course of negotiations, thereby increasing mutual trust among market participants; quickly adapting to changes in market conditions and customer requirements in the event of sudden shocks; reducing the need for paper documentation and manual data entry. In other words, the introduction of the latest digital technologies in this component would significantly improve the efficiency of the freight market, which would further improve the quality of trade all around the world. Despite this, it is relevant to explore the possibilities of introducing the latest technologies to the industry, both in Ukraine and in the world.

In the context of the rapid development of digital technologies, virtualisation of the freight market is becoming particularly important. Mutambik (2024) shows that digital transformation not only improves operational efficiency, but also contributes to the achievement of sustainable logistics goals. These trends open up new prospects for innovation and process optimisation in the freight industry. Additionally, the introduction of machine learning algorithms to support operational and real-world planning of tasks in the field of road cargo transportation, as described by Lechtenberg (2023), allows significant improvement of the efficiency and accuracy of logistics operations. This ensures more efficient use of resources, reduces costs, and helps to reduce greenhouse gas emissions, which is an important step towards a sustainable future for the industry.

The question of the possibilities and needs of virtualisation of the freight market, and its research in general, is rarely raised in the current scientific discourse. Nikolayeva and Bereza (2018) investigated the general trends in the development of the global freight market. These include the increasing significance of maritime freight transport in international trade, the gradual integration of local freight markets into a unified global system, the impact on changes in trade volumes and structures on the global fleet. The researchers described how this area is developing, but did not provide any advice for Ukraine. Shramenko et al. (2021) also analysed the freight market in Ukraine. They drew attention to the difficulties caused by insufficient efficiency of the organisation of the transportation process in the country, underdeveloped infrastructure and problems in the context of ensuring the functioning of the transportation process. With this in mind, they developed some recommendations on how to improve the current situation in Ukraine in this area. Kriukova (2022), in turn, paid more attention to how the freight market is developing in Europe, and what experience can be obtained from this for Ukraine as well. The researcher also paid special attention to the impact of the beginning of a full-scale Russian invasion on the development of this industry. This includes the destruction of transport infrastructure, restrictions on cargo movement, and the closure of key trade routes. It led to increased transportation costs, delays in international trade, and forced the Ukrainian logistics sector to adapt by seeking alternative routes and modes of transportation.

The potential for virtualisation and digital integration in the maritime freight sector has not received much attention, despite the growing interest in digital transformation across a number of industries. Existing research frequently ignores the real-world effects of digitisation in ship chartering procedures in favour of concentrating on the broad trends in the growth of the freight market, efficiency issues, and regulatory considerations. Although several studies examine the function of digital technologies in transportation and logistics, a thorough examination of their use in maritime freight brokerage is lacking. Also, studies that look at how economic and geopolitical upheavals affect the freight business rarely discuss how digital solutions can alleviate these difficulties. This study attempts to close this gap by assessing the feasibility of virtualising the ship chartering industry, while taking the Ukrainian and international settings into account. It offers useful insights for industry stakeholders looking to improve efficiency and competitiveness through technological innovation by evaluating current digital tools, suggesting new models for digital transformation, and identifying potential obstacles.

As can be seen from the above analysis of the papers by Ukrainian researchers, rather little attention has so far been paid to how to ensure the introduction of innovative technologies in the freight market. In view of this, the purpose of the study is to assess the possibility of using the latest technologies in the maritime freight market, both in Ukraine and in the world.

2. MATERIALS AND METHODS

The study of the freight market in Ukraine includes the analysis of qualitative and quantitative data to determine the possibilities of its development in the context of innovation and assess the potential for digital transformation. The statistical

data has been taken from the website of the State Statistics Service of Ukraine (2025) and used to assess passenger and freight turnover in the period from 2014 to 2021 (by mode of transport) and from 2014 to 2023 (total). In the context of a full-scale invasion, statistical information on various aspects of Ukraine's development was limited, which was conditioned both by the complexity of its collection and the fact that the state may decide not to display certain information in wartime. Therefore, the analysis of statistical information was somewhat limited in the context of time frames and the choice of indicators. However, there was information available that allowed investigating the state of the industry as a whole: the trends inherent in it were evaluated, in particular, in combination with an understanding of the impact on the industries of certain world events, namely, the COVID-19 crisis, the outbreak of war with Russia in 2014, and the full-scale invasion of 2022. Thus, the statistical observation method has been used, constructions and calculations being performed using Microsoft Excel.

As part of the study, online tools that can significantly improve the quality and efficiency of the freight market have been considered. Among them are Clean Email, which automates e-mail management processes, in particular, for processing freight requests and communications; Shipindex and VesselFinder, which provide access to information about ships, allowing for a more efficient transportation planning; ZeroNorth, which represents a tool for optimising sea transportation in terms of environmental efficiency; Fleetmon, which offers fleet monitoring and route analysis services; Findaport, which provides information about ports, thereby providing help in logistics planning; OpenseaFreight and Signal Ocean Platform as platforms for sea transportation management, integrating various aspects of logistics; and BTS Coasting, specialising in innovative coaster management techniques.

Within the framework of the study, two models have been developed: one is global, providing a single freight platform, which is a component of the global e-commerce network. It automates brokerage functions, optimising the entire product life cycle from production to delivery; the other one is a model of competing platforms focused on the organisation of the sea transportation stage, potentially integrated with e-commerce resources to increase competition among users and ensure the principles of market competition. The modelling method has been used to build these models, as well as a comparison to evaluate and compare data from the two models, describing the benefits and disadvantages for each of them.

3. RESULTS

The freight market is a complex and multifaceted segment of the global economy, covering various aspects of cargo transportation by sea, air, road, and rail. It plays a key role in securing global trade by facilitating the efficient movement of goods from producers to consumers around the world (Bartle et al., 2021; Wang et al., 2021). The main elements of the maritime freight market include ship-owners and operators who own and operate vehicles; persons who lease these vehicles for the transport of goods; and freight brokers who act as intermediaries between ship-owners and charterers, helping to conclude agreements for the carriage of goods by sea (Bartulovic et al., 2022). The kind of cargo, the distance between the ports of origin and destination, and the shipping mode selected are some of the variables that affect freight costs in the marine industry (Tonguc and Yorulmaz, 2023). Seasonal demand, with higher rates frequently levied during peak shipping seasons, port fees, which vary depending on the port and the services offered, and fuel costs, varying dependent on global oil prices, are additional factors that affect shipping expenses. The vessel's size and capacity also matter since economies of scale allow larger ships to frequently lower shipping costs per unit. Significant price swings can also be brought on by market factors, including the supply and demand for shipping space, the availability of vessels, and geopolitical developments. Lastly, the final shipping cost depends on the degree of service, the type of insurance coverage needed, and whether the shipment is a dedicated cargo or a part of a bigger container.

Chartering brokers themselves play an important role in the freight market (Oleksy-Gebczyk, 2023). Their main function is to facilitate the conclusion of contracts for the carriage of goods by sea, which includes the search for suitable vessels for cargo and cargo for ships. They act as intermediaries, helping both parties to find the best commercial conditions for making a deal. One of the key roles of brokers is to provide information about the market. They have data on current market conditions, freight rates, and supply and demand for specific types of ships and cargo. This allows them to provide clients with valuable advice on the optimal time for concluding contracts and the most favourable conditions, that is, to ensure maximum efficiency of the market. Brokers also monitor changes in legislation, international regulations, and economic trends that may affect the market (Oleksy-Gebczyk, 2024).

The brokers' ability to efficiently coordinate between ship owners and charterers may be impacted by a variety of issues. Market volatility is one of the main challenges, since shifts in supply and demand can result in erratic freight prices, which makes it challenging for brokers to provide their clients with competitive and consistent terms. External factors, like natural catastrophes or geopolitical conflicts, frequently make this volatility worse by further upsetting international shipping and commerce schedules (Kriukova, 2022). Brokers also have to deal with complicated regulatory compliance requirements because international shipping is governed by a wide range of laws differing from one nation or another. These laws include safety regulations, environmental standards, and customs processes. Ensuring adherence to these standards increases the administrative burden and complicates the negotiating process. Lastly, contract negotiations pose a challenge since brokers

have to strike a balance between the frequently conflicting interests of charterers and ship owners [13]. It takes skilful negotiating and a thorough awareness of market conditions, regulatory frameworks, and the technical limitations associated with sea shipping to reach advantageous agreements for both parties, while preserving legal and financial protections. These challenges require brokers to stay agile, well-informed, and proactive in addressing the evolving needs of the freight market.

Brokers perform a significant part of the preparation and negotiation work, represent clients' interests by discussing the terms of the contract, including freight rates, charter party duration, loading and unloading conditions, insurance and other details (Ma et al., 2022). Their goal is to achieve the best possible conditions for clients: after reaching an agreement, brokers help with the processing of all necessary documents, providing legal and administrative support (Pietrzak et al., 2021; Jain et al., 2020). In addition to the main negotiation functions, brokers are often engaged in post-contract support, helping to resolve possible disputes that may arise during the execution of the contract. They also assist in solving problems related to the operational activities of ships, such as delays in port, route changes, or in the event of *force majeure*. It is advisable to divide the responsibilities of a freight broker or brokerage company into basic steps according to the tasks that are being solved, as shown in Table 1.

Step	Tasks
1	Analysis of the principal's task, preparation of a market offer
2	Entry into the freight market Analysis of offers, selection of the best offer according to the principal's criteria
3	Negotiation with the selected partner, the charter party editing in accordance with the positions agreed by the parties
4	Advisory support during delivery of goods (cargo) to the port of destination
5	Development of the final package of documents – drawing up a timesheet, conducting final calculations. Protection of the principal's interests in the event of disputes
6	Monitoring trends in the global freight market, participation in international conferences, search for potential customers

Table 1. Responsibilities (tasks) of a broker in the freight market (Source: compiled by the authors.)

The last, 6th step does not depend on interaction with a certain principal or principle?, but is a necessary condition for the successful functioning and development of a brokerage company. A freight broker expands its capabilities at each of the above steps. As of today, a number of digital resources have been developed to help a freight broker at every stage of their professional activity. Among them are services that automate the processing of correspondence, provide access to databases of ships and ship-owners, inform about the open tonnage and offers of cargo for transportation by sea, track the positions of ships in real time, contain information about ports of the world with monitoring of capacity utilisation, and help to make appropriate calculations of planned and performed flights, as shown in Table 2.

As can be seen from Table 2, the number of such resources is very significant: however, their use is not widespread or widely accepted. There are two models of digital transformation of the chartering market. The first is the complete absorption of all brokerage functions by a single global platform that will be able to automatically determine the most profitable modes of production, storage, transportation of products, transportation routes from the standpoint of the global economy, and select certain sea and land carriers. Such a model should provide maximum total profit over the entire product life cycle (Borca et al., 2021). At the same time, some stages of the product life cycle, including transportation by sea, may be less profitable at the expense of others. Another option is to develop platforms focused solely on freight activities, followed by the ability to connect to e-commerce resources. This solution allows users (charterers and ship-owners) to compete with each other.

No.	Resource specialisation	Resource name	Chartering step	Stage where it is used
1	Message processing	Clean Email, SaneBox, ActiveInbox, Sortd, Reply, Shortwave, Hey Imbox	1, 6	Prefixing, Fixing, Postfixing
2	Ship databases	ShipIndex.org, Lloyd's Register of Ships online, ABS, Shipping Intelligence Network, Ships in Class, Clip, Marine Log	1, 2	Prefixing, Fixing
3	Open tonnage	Shipping online CN, Bulk Vessel, SHIPBROKER.gr, SEA PROJECTS, Toantang Shipping, ZeroNorth	1, 2	Prefixing
4	Tracking ship positions	Marine traffic, FleetMon, Shipfinder, VesselFinder, Vesseltracker, VT Explorer, myshiptracking	1, 2	Prefixing, Fixing
5	World port databases	World Port Source, Findaport.com, SEARATES, Lloyd's List, World Ports Tracker, Inchcape World of Ports	1	Prefixing, Fixing
6	Cargo offers	SHIPBROKER.gr, Shipping online CN, OPENCARGOES, openseafright.com, Ala Shipping CHARTERING, Industrial Marine Power, SMTC Open Cargo	1, 2, 6	Prefixing
7	Calculations	Voyage Management System Dataloy, Searouts, StormGeo Voyage Calculator, SEAMETRIX, ELOQUENCE, SHIPINTEL, The Voyage Estimator, AXSMarine Smart Calculator	2	Prefixing
9	Comprehensive information processing	ShipNext, OrbitMI, SEA, eShip, Shipfix, AXSDry/AXSTanker, Signal Ocean Platform, Shipbroking SDSD, BTS Coasting, smartPAL	1, 2, 5, 6	Prefixing, Fixing, Postfixing

Table 2. Services that facilitate the work of freight brokers (Source: compiled by the authors.)

Full automation of chartering brokerage activities, complete replacement of the broker with a digital resource, for example, artificial intelligence, in addition to technical capabilities and the corresponding software solutions, require meeting a number of important conditions. One of them is to solve the problem of formalising all factors at each stage of chartering, developing a number of criteria for evaluating the results of each stage, and a general criterion that will help to obtain the best result by choosing the best offer. In addition, the result must meet certain requirements. For the first model, this is the search and selection of a vessel for sea transportation, provided that the total costs are minimised throughout the product life cycle, the functioning of the entire link: production – storage – delivery – distribution – use. For the second model, it is the search for and selection of a vessel that meets the requirements of two counterparties, the charterer and the ship-owner, that is, the final decision must be a compromise (Heinbach et al., 2022). Another condition is that, in order to function adequately, a digital resource must be tested, “trained”, having access to as much data as possible, and being able to take into account the reaction of users.

The development of data collection technologies combined with an increase in computing power helps to analyse large amounts of data, improving operations and increasing the degree of reliability of forecasting (Maulenov et al., 2024; Maulenov et al., 2021). Large amounts of analysed data create better and more complete analytical results. And if most projects based on the use of artificial intelligence, neural networks, can rely on huge amounts of data from open sources, customer base, comments and user reviews, then information about the course of freight negotiations is a commercial secret and access to it is restricted by or to? employees of companies (Kichkina and Kichkin, 2023). Even at the stage of entering the freight market, users want to control the circle of people who can view the offer, expanding it if necessary (Chen et al., 2023). The shipping industry has traditionally been slower than others to adapt to modern technologies, including digitalisation. Such slow implementation of the latest technologies is associated with a long life cycle of assets (sea vessels have been in operation for more than 30 years), a slow rate of investment, and strict maritime regulations. However, such an area of the industry as chartering brokerage activities has much shorter innovation cycles, which allows quick

implementation of advanced technologies, including digital ones. In addition, brokerage activities are not subject to strict international regulation.

The COVID-19 epidemic significantly affected the maritime freight business by accelerating digitalisation, changing supply and demand dynamics, and upsetting international trade flows (Aifen et al., 2025). Due to lockdowns, travel restrictions, and manufacturing shutdowns, the initial outbreak resulted in a significant drop in the demand for goods. However, demand unexpectedly recovered as economies adjusted and e-commerce grew. This resulted in major port congestion, container shortages, and unstable freight rates, causing major supply chain inefficiencies and underscoring the necessity of adaptive logistics strategies (Cedillo-Campos et al., 2024). Shipping firms had to deal with labour shortages, erratic freight quantities, and unclear vessel schedules. As a result, the Baltic Dry Index (BDI), a crucial measure of shipping costs, saw significant fluctuations (Wang et al., 2024).

The industry responded by depending more and more on digital solutions to control risks, minimising inefficiencies, and optimising operations. In order to navigate volatile market conditions, automated freight management systems, predictive analytics, and AI-driven logistics platforms became crucial. These tools allowed businesses to monitor cargo movements, modify routes, and optimise freight pricing in real time. Digital freight platforms reduced reliance on in-person contacts and paperwork by enabling automated documentation, real-time cargo tracking, and remote contract negotiations (Bronin et al., 2021; Nurbatyrova et al., 2024). The crisis hastened the adoption of integrated logistics solutions, such as cloud-based management systems and forecasting models driven by AI, enhancing supply chain resilience and visibility (Wu et al., 2024). In addition to addressing immediate disruptions, this greater dependence on digital tools set the stage for long-term efficiency gains in the maritime freight industry.

Notwithstanding these developments, there are still obstacles in the way of completely integrating digital solutions into the global goods market. The pandemic exposed differences in shipping businesses' digital readiness, with smaller operators finding it difficult to adopt cutting-edge technologies because of high prices and inadequate infrastructure. However, the trend towards digital freight management is increasing and becoming unstoppable, as industry participants acknowledge its potential to improve market stability, lower prices, and increase operational efficiency in the event of future crises (Molchanova et al., 2021). Thus, the COVID-19 epidemic served as a driving force behind digital transformation, highlighting the importance of automation and data-driven decision-making in maritime freight operations.

Considering the situation with the shipping industry of Ukraine, its condition is characterised by significant complexity and instability, the reason for which is, first of all, the war in Ukraine, since military operations, mine threats, shelling and bombing create a high level of danger to navigation, which leads to a significant increase in insurance premiums for ships entering the ports of Ukraine, and an increase in security costs (Law of Ukraine..., 2013). Due to the military conflict, some key ports in Ukraine were blocked or significantly damaged, thereby limiting opportunities for export and import, especially grain, metals, and other important cargo. Port blockages force shippers to look for alternative routes, often through ports in neighbouring countries, which increases costs and extends delivery times. The economic situation in Ukraine also affects the freight market: currency fluctuations, inflation, and general economic uncertainty force market participants to be careful in planning transportation and financial transactions, which can lead to a decrease in chartering volumes and an increase in the cost of loans to finance transportation (Kadlubek, 2022).

It is critical for the freight market of Ukraine to conclude and extend a grain agreement that allows the export of Ukrainian grain through the Black Sea. This agreement partially restores Ukraine's export opportunities, stabilising the market situation and helping to reduce the food crisis in the world. In response to the blockade of ports, Ukraine is actively developing alternative routes for export, including the use of river ports on the Danube, road and rail transport to neighbouring countries of the European Union, which contributes to a certain relief of the situation, but such routes are less efficient and more expensive compared to sea transport (Law of Ukraine..., 1996). Considering all these factors, the cost of freight in the Ukrainian market has increased, which is conditioned by both an increase in security and insurance costs, and limited capacity of ports and routes (Shandrivska and Kizlyak, 2023). The existence of such problems reduces the attractiveness of the Black Sea-Azov section and prevents any measures aimed at virtualising this segment of the freight market.

While there are many advantages of the digitalisation of the maritime freight sector, including increased efficiency and transparency, there are also some possible drawbacks (Haikova et al., 2023). Cybersecurity is one of the main issues since the market is more susceptible to cyberattacks due to its growing reliance on digital platforms and online technologies (Danieliene et al., 2024). Hackers may target freight businesses and brokers that handle sensitive financial and operational data in an attempt to steal confidential information or interfere with business operations (Hryshchuk and Molodetska, 2017; Kullolli, 2024). The extensive use of digital tools necessitates the gathering, storing, and sharing of enormous volumes of sensitive data, making data privacy and security major issues as well (Chen et al., 2022). The more stakeholders that join the digital ecosystem, the more complicated it is to ensure compliance with data protection laws. Furthermore, the workforce

may be disrupted by the quick transition to digital platforms since traditional roles in freight management and chartering may become less necessary as a result of automation and artificial intelligence. Digital technologies improve operational efficiency, but they can also cause job displacement and require workers to learn new skills to keep up with the changing industry (Miethlich and Slahor, 2018). Therefore, even while digitisation has long-term advantages, these concerns must be carefully considered to make sure the shift is safe, just, and sustainable for all parties.

As for the development of the legislative framework, it is worth considering the possibility of creating unified standards in the context of simplifying and harmonising the rules of chartering tonnage and transportation for various types of transport (Law of Ukraine..., 2001). The legislative environment should support the introduction and scaling of innovative technologies, including the revision and potential relaxation of regulations that prevent the introduction of technologies in the freight transport market. Another way to improve the situation is to introduce financial incentives or subsidies for companies that invest in digital transformation and the introduction of new technologies: this may include tax incentives or grants for research and development in logistics and transport technologies. In addition, given the high risks due to current geopolitical tensions, especially in regions such as Ukraine, the government may consider measures to compensate for the increased insurance and security costs incurred by transport companies. It is also effective to invest in port and other transport infrastructure to increase the overall capacity and efficiency of railway and road networks. Although the use of all the above-mentioned approaches can achieve significantly better results, their mass implementation is possible only after the end of the war in Ukraine; nevertheless, the state should seriously consider implementing such initiatives in the future.

Given the existing situation, Ukraine's maritime freight business presents both significant prospects and difficulties for the use of digital technologies. The ongoing war has seriously hampered the nation's infrastructure and market stability, notwithstanding the possible advantages of more efficiency, transparency, and operational optimisation. The immediate feasibility of extensive digital integration in the industry is constrained by the loss of important ports, increased navigational hazards, and rising security expenses. Furthermore, despite the fact that digital solutions, like AI-driven logistics platforms and automated goods management systems, are essential for increasing operational efficiency, their broad adoption in Ukraine is now hindered by a lack of funding and regional instability. However, the prospect of implementing digital technology remains feasible, especially in the long run, as the market adjusts to alternate export routes and recovery initiatives continue.

4. DISCUSSION

Given the complexity and critical role of the freight transport market, governments can take a number of measures to improve its efficiency, sustainability, and modernisation. Thus, it is effective to promote the development and integration of digital platforms that optimise cargo brokerage activities, including assistive technologies that automate correspondence, provide access to ship databases, track ship positions in real time, and manage the process of contract formation. It is also effective to implement artificial intelligence technologies in such a context to improve market forecasting, operational efficiency, and decision-making processes. It is important that these technologies should have access to large data sets, while maintaining commercial privacy.

As a part of an up-to-date study, it has been noted that the introduction of the latest technologies in the freight market can significantly improve the efficiency of the industry. This is conditioned by the fact that the use of such technologies allows qualitatively improving the quality of functioning of this area, reduces costs, and allows the processing of the selected information to be quicker. These aspects have been explored in other studies: the use of the latest system for tracking vehicles from sea cargo, which can effectively identify multimodal routes to and from objects, was analysed by Asborn et al. (2021). They noted that the analysed methodology helped to identify the coverage areas of multimodal transport by mapping unique roads and waterways, thereby improving the assessment of the area of impact of the object. The researchers have reached a conclusion about the effectiveness of using this technology to improve the quality of transportation, and the introduction of any other innovations. The need for the use of innovative technologies by freight companies was considered by Williamsson and Moen (2022). They concluded that with the development of globalisation, the demand for freight transport is growing, with logistics companies striving to meet customer needs by expanding their customer base and optimising costs. In view of this, researchers recommend introducing innovative technologies in this territory to further improve the functioning systems at their enterprises. As can be seen from the above analysis, different approaches to the introduction of innovative technologies in the industry can influence the efficiency of its functioning in their own way: however, in any case, this impact is more positive than negative.

The introduction of the latest technologies in the logistics sector has also been confirmed by other studies. The introduction of innovative technologies in cities was investigated by Engholm et al. (2020). The researchers examined the use of the Delphi method to assess the impact of 14 technologies and obstacles to implementation and their impact on three main sustainability indicators. The researchers noted that most innovations in the field of road freight transport would reach mass adoption slowly. They pointed out that this was due to the significant cost orientation of the sector; at the same time,

high investment costs and long depreciation times of logistics infrastructure have prevented rapid implementation. Government incentives from the state are needed to accelerate the introduction of technologies (Zahid et al., 2025). As part of the current study, attention is also drawn to the fact that it is quite difficult to introduce the latest technologies in logistics, especially if there is no significant amount of funding. This remains relevant for Ukraine, which, in the conditions of war, may not be able to find additional funding for the development of the latest technologies due to the fact that it requires funds for the needs of the front and ensuring a better standard of living for the population. In addition, despite the fact that the current study has not directly paid attention to this type of technology introduction in the industry, it can be concluded that this will bring positive consequences for the development of the industry in the country.

The maritime freight industry's digital transition has given rise to creative models that try to improve decision-making, streamline operations, and maximise efficiency (Kerimkulov et al., 2015; Nitsenko et al., 2017). The potential of a multi-agent framework for container booking and slot allocation is highlighted by Mandal et al. (2024). This framework allows autonomous agents, including shippers, freight forwarders, and shipping lines, to communicate in real-time, addressing issues like port congestion and market segmentation. Particularly in crowded ports, this technology improves booking management and operational efficiency by resolving discrepancies and optimising container slot utilisation. Additionally, a mathematical programming method for evaluating shipbrokers is proposed by Koronakos et al. (2024). This method combines performance factors including terms and conditions, broking fee, and reputation, offering a more strategic and objective method of evaluating and choosing shipbrokers. These technological developments help improve decision-making and raise the competitiveness of the maritime goods sector by integrating optimisation models.

In turn, innovations in the context of transport chartering were considered by Kiani Mavi et al. (2022). They noted that in certain areas, such as transport operations, technological innovation, transport economics, transport policy, and sustainability and disaster management, some of the latest technologies were introduced, namely artificial intelligence and machine learning. The researchers have shown that their use leads to significantly greater efficiency of these operations, indicating the effectiveness of using and implementing such technologies. In general, similar conclusions have been drawn in the framework of an up-to-date study, which noted the importance and usefulness of developing innovative technologies in the freight market to ensure the efficiency of its functioning. Within the framework of the current study, it has also been concluded that ensuring innovative development in the industry allows achieving significantly better results in the context of its functioning, which is also relevant for the logistics industry and the freight market in particular (2022). In view of this, it can be concluded that the evaluation of the above paper confirms this thesis. This indicates the need to ensure more active actions on the part of the state to provide this area with innovative technologies: although it is currently problematic in Ukraine due to the consequences associated with the war, this should nevertheless become one of the components of the country's development in the future.

5. CONCLUSIONS

The study has shown that digitalisation of the freight market, both in the world and in Ukraine, has significant prospects for improving the efficiency and transparency of cargo transportation. The global trend towards digitalisation encourages the introduction of cutting-edge technologies, such as blockchain, IoT, and AI, which should revolutionise the freight market by automating processes, reducing costs, and improving data accuracy. The study has shown that digital platforms can optimise the entire life cycle of cargo operations, from comparing cargo with relevant vessels to tracking shipments in real time and ensuring compliance with international standards. However, it is essential to remain mindful of the associated risks. Cybersecurity is a big issue since the industry is more susceptible to cyberattacks due to its greater reliance on digital platforms. Furthermore, workers may need to acquire new skills as a result of job displacement brought on by the automation trend. Digital transformation requires a balanced strategy to make sure that efficiency advantages do not come at the expense of social stability and security.

The paper also shows that there are currently two main models of digital transformation of the freight market: one based on the creation of a global platform with brokerage, logistics, and commercial functions, and one that functions due to the competition of a large number of independent platforms specialising in the provision of freight services. However, the application of each model requires significant resources to collect data, process and formalise evaluation criteria to ensure optimal decision-making. In the future, the use of artificial intelligence is also relevant on such platforms.

The situation on the Ukrainian cargo transportation market is an example of the market's vulnerability to external shocks. The conflict has seriously affected the transport industry, and therefore, the use of adaptive strategies and the development of alternative transportation routes has become more relevant. Long-term, the digitisation of the goods market in Ukraine and around the world is probably going to help create transport networks that are more flexible and resilient. However, the government must strongly support this shift by enacting new laws, offering financial incentives, and making investments in digital infrastructure. The safe, effective, and equitable growth of the maritime freight sector will depend on

the ongoing development of these technologies, as well as initiatives to address cybersecurity threats and workforce transformation.

Further assessment of the possibility of introducing the latest technologies on the freight market, both in Ukraine and in the world, is indubitably relevant for further research. Cybersecurity issues and state support for the development of this area also remain important for any future studies.

CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and publication of this article.

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