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e-mail: support@smart-scm.org

тел.: (063) 593-30-41
https://smart-scm.org

Contents

GURINA G. S. Doctor of economic sciences, professor, department of management of foreign economic activity of enterprises State University "Kyiv Aviation Institute" (Ukraine), **PODRIEZA S. M.** Doctor of economic sciences, professor, department of management of foreign economic activity of enterprises State University "Kyiv Aviation Institute" (Ukraine), **NOVAK V. O.** PhD in Economics, Professor of Management of Foreign Economic Activity of Enterprises Department State University "Kyiv Aviation Institute" (Ukraine)

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Smerichevska S.V. Doctor of Science (Economics), Professor, Head of Logistics Department, State University "Kyiv Aviation Institute" (Ukraine)

ORCID – 0000-0003-0733-8525
Researcher ID – ABH- 9703-2020
Scopus author id: – 36069708800
E-Mail: smerichevska.s@gmail.com

Bugayko D.D. Student of the Logistics Department State University "Kyiv Aviation Institute" (Ukraine)

ORCID –
Researcher ID –
Scopus author id: –
E-Mail: danilagalicki113@gmail.com

Bugayko D.O. Doctor of Science (Economics), Professor (Full), Academician of the Academy of Economic Sciences of Ukraine, Corresponding Member of the Transport Academy of Ukraine, Vice - Director of ES International Cooperation and Education Institute, Instructor of ICAO Institute, Professor of the Logistics Department State University "Kyiv Aviation Institute" (Ukraine)

ORCID – 0000-0002-3240-2501
Researcher ID – ABF-5564-2021
Scopus author id: – 57216582348
E-Mail: bugaiko@kai.edu.ua

CHALLENGES OF INNOVATIVE DEVELOPMENT OF RIVER TRANSPORT IN THE EU AND UKRAINE

Svitlana Smerichevska, Danylo Bugayko, Dmytro Bugayko. "Challenges of innovative development of river transport in the EU and Ukraine". *The development of the logistics capabilities of Ukrainian river transport enterprises is the main factor ensuring their competitiveness and long-term success. The post-war reconstruction of the national economy of Ukraine will require systematic logistics support, which should be based not only on transportation by classic modes of transport, but will also require the search for new cost-effective transportation. The proposal is to revive Ukrainian river transport by developing the river transportation component on the basis of existing logistics companies. Analysis of global and European domestic transportation confirms the relevance of this direction in Europe and the world, which is of particular importance, taking into account the Euro-Atlantic integration processes of Ukraine.*

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Keywords: river transport, multimodal transportation, innovation, digitalization, strategy

Світлана Смерічевська, Данило Бугайко, Дмитро Бугайко. «Виклики інноваційного розвитку річкового транспорту ЄС та України». *Розвиток логістичних можливостей підприємств річкового транспорту України є головним чинником, що забезпечує їх конкурентоспроможність та довгостроковий успіх. Повоєнна відбудова національної економіки України буде вимагати системного логістичного забезпечення, яке повинне базуватись не тільки на перевезеннях класичними видами транспорту, але й вимагатиме пошуку новітніх економічно ефективних перевезень. Пропозицією є відродження річкового транспорту України, шляхом розвитку складової річкових перевезень на базі існуючих логістичних компаній. Аналіз світових та європейських внутрішніх перевезень,підтверджує актуальність цього напрямку у Європі та світі, що має особливе значення, враховуючи Євроатлантичні інтеграційні процеси України.*

Ключові слова: річковий транспорт, мультимодальні перевезення, інновації, цифровізація, стратегія.

Intraduction. Analysis of world and European inland transportation confirms the relevance of the development of inland waterway transport in Europe and the world. It is also possible to argue that the development of river transport is of particular importance in view of the Euro-Atlantic integration processes of Ukraine and the need for sustainable development of multimodal transportation in the post-war period.

An unresolved part of the problem is the need for research to reach the level of a strategic vision of managing the sustainable development of river transport in Ukraine in the post-war period. Given the above, it is considered relevant to apply a systemic approach in determining ways to improve river transport. This creates conditions for obtaining a positive synergistic effect for sustainable development, both for river transport in particular and for the national economy as a whole.

The purpose of the study. The purpose of the study is to improve the logistical potential of river transport in the national water transport system based on strategic approaches to the sustainable development of EU river transport and the implementation of modern innovative solutions.

The main tasks are:

• Development of innovative logistics products and development of new segments of the multimodal transportation market. The task is to include the river transport segment in the post-war multimodal subsystem of the transport system of Ukraine.

• Interaction with different types of transport in the multimodal supply chain.

• Development of a mechanism for the integration of different types of transport in a single supply chain, taking into account the synergistic effect with the determination of the contribution of river transport.

• Analysis of the main innovative approaches to the sustainable development of river transport.

The object of the study is the strategic management of river transport in the context of sustainable development of the national economy.

The subject of the study is the scientific and theoretical foundations and scientific and methodological provisions that ensure the strategic management of river transport in the context of sustainable development of the national economy.

The main proposal for strategic development is a proposal to form its own river fleet of logistics enterprises, which will allow them to become the flagships of inland water transport in Ukraine.

At the present stage, logistics companies should focus not on the pre-war restoration and reconstruction of the industry, but on

planning the future, using approaches to demand generation and sales stimulation, which will allow Ukraine to integrate into the EU inland waterway transport system and take a worthy place among the inland waterway logistics countries of Europe. At the same time, it is proposed to adjust the strategy of river transport logistics companies in accordance with the main global and regional strategies for the development of inland waterway transport.

Results of the research.

Experience in developing logistics solutions in river transport in the EU. European countries, having developed river transport, can radically differ in the level of intensity of its use. Realizing two important advantages of river transport, such as economy and environmental friendliness, many researchers focus only on individual aspects related to the formation of demand and supply of river transport services, less often - from the standpoint of a systemic approach, considering river transport as a subsystem of the country's logistics system. This initiates the need to analyze the experience of forming river transport systems based on their coordinated functioning with other modes of transport in the process of implementing the logistics concept for the development of port regions [1].

Freight transport by inland waterways, EU, 2013-2023. Unfortunately, the activity of river transport in the European Union has a tendency to decrease (Fig. 1).

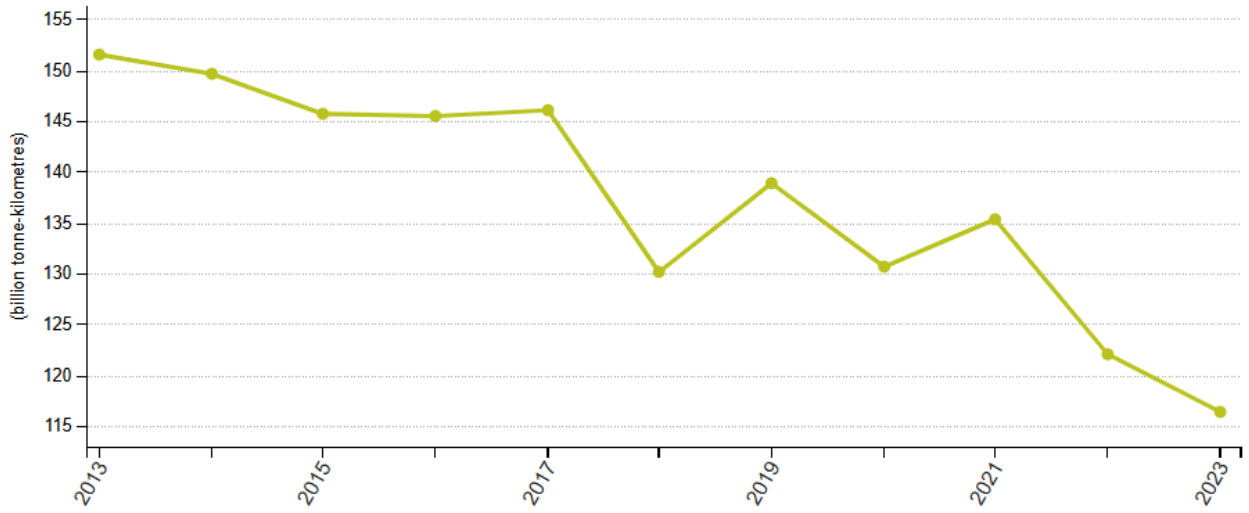

Figure – 2. Inland waterway freight transport, EU, 2013-2023.
Source: [2].

Inland waterway transport activity was volatile over the period 2013-2023. Measured in tonne-kilometres, activity decreased every year over the period 2014-2016. A slight increase was observed in 2017 (+0.5%), followed by a sharp drop in 2018 (-10.9%) and an immediate recovery in 2019 (+6.6%). A decline was observed in 2020 (-5.9%), while a new recovery was recorded in 2021 with an increase of 3.6% compared to 2020. A sharp decrease of 9.8% was recorded in 2022. In 2023, freight transport by inland waterways decreased by 4.6% (or 6 million tonne-kilometres), reaching its lowest point since data for the EU began to be available (i.e. 2005). A similar trend can be observed in 2023 in tonnes, with a decrease of 4.0% (or 20 million tonnes).

Freight transport by inland waterways, EU, 2013-2023 (billion tonne-kilometres) is shown in Figure 3 [2].

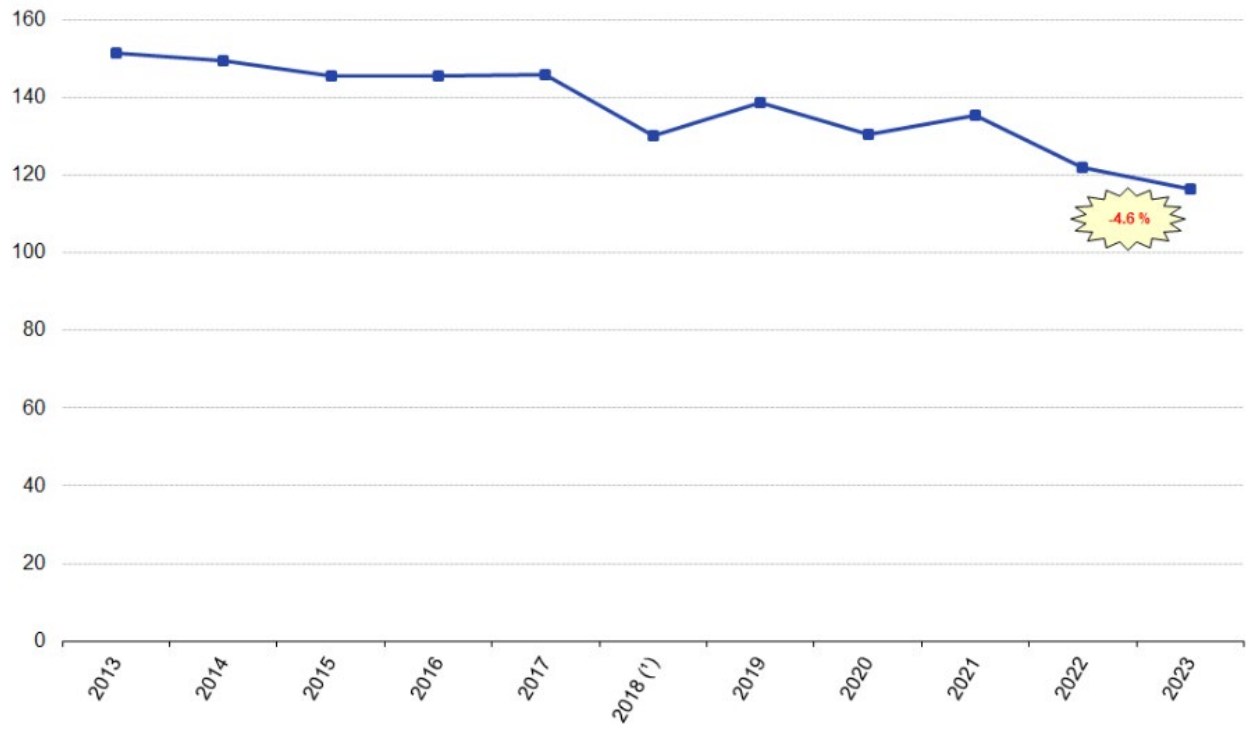

Figure 3 – Inland waterway freight transport, EU, 2013-2023 (billion tonne-kilometres)
Source: [2].

Freight transport by inland waterways, 2013, 2022 and 2023 (million tons) is shown in Fig. 4.

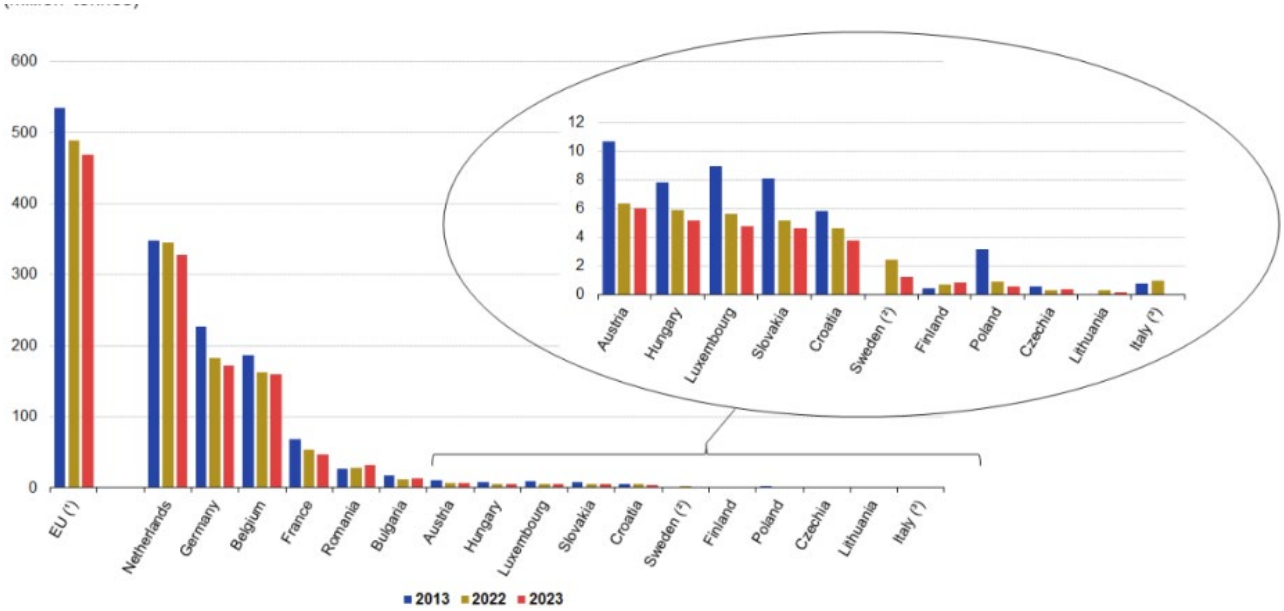

Figure 4 – Inland waterway freight transport, 2013, 2022 and 2023 (million tonnes).
Source: [2].

When looking at freight transport in tonnes, the picture is quite similar to that for tonne-kilometres, with some notable differences (Figure 4). All countries experienced a decrease in 2022 compared to 2021, with the exception of the Czech

Republic (+19.3%), Finland (+14.5%), Romania (+12.2%) and Bulgaria (+7.0%). However, the significant percentage changes for the Czech Republic and Finland should be viewed in light of the low starting values. It should be noted that while the Czech Republic experienced a significant increase in freight transport measured in tonnes, it experienced a decrease in freight transport measured in tonne-kilometres (-10.9%). The largest relative declines were recorded in Sweden and Lithuania, with -48.6% and -46.4% respectively. However, these significant percentage changes should be seen in light of the low starting values, with absolute values decreasing from 2.5 million tonnes to 1.3 million tonnes in Sweden and from 303 thousand tonnes to 162 thousand tonnes in Lithuania. Other countries with significant declines were Poland (-36.1%), Croatia (-18.6%), Luxembourg (-16.0%), Hungary (-12.2%), France (-11.0%) and Slovakia (-9.8%). It should be noted that while Lithuania experienced a significant decrease in freight transport measured in tonnes, it experienced an increase in freight transport measured in tonne-kilometres (+24.6%).

Inland waterway transport activity was volatile over the period 2013-2023. Measured in tonne-kilometres, activity declined every year during the period 2014-2016. A slight increase was observed in 2017 (+0.5%), followed by a sharp drop in 2018 (-10.9%) and an immediate recovery in 2019 (+6.6%) (Figure 1.5). A decline was observed in 2020 (-5.9%), while a new recovery was recorded in 2021 with an increase of 3.6% compared to 2020. A sharp decrease of 9.8% was recorded in 2022. In 2023, freight transport by inland waterways fell by 4.6% (or 6 million tonne-kilometres), reaching its lowest point since data for the EU began to be available (i.e. 2005). A similar trend can be observed in 2023 in tons with a decrease of 4.0% (or 20 million tons) [3].

Currently, "Metal ores and other mining products" and "coke and petroleum products" are the two main categories of goods transported [4].

'Metal ores and other mining and quarrying products; peat; uranium and thorium' (NST2007, section '03') was the main category of goods transported by inland waterways in the EU in 2023, both in terms of tonne-kilometres and tonnes. This category of goods accounted for almost a quarter (23.7%) of the total tonnes transported for all goods and over a quarter (27.9%) of the total tonnes transported. However, in 2023, a decrease in the transport performance of 'metal ores and other mining and quarrying products' in tonne-kilometres was recorded compared to 2022 (-2.1%). There was also a drop in tonnes transported (-2.6%). When analysing this category of goods from the perspective of different modes of transport, national transport showed the largest decrease in tonne-kilometres (-9.1%), followed by transit transport (-5.8%). International transport, on the other hand, registered a growth of 3.1%. Analyzing the volume of transported tons in 2023, national transport decreased by 4.7%, while international transport increased by 0.3% compared to 2022. [4]. Transport indicators of inland waterway transport on the national territory of each European country - comparison between 2022 and 2023 (in million tkm) are shown in Fig. 5 [5].

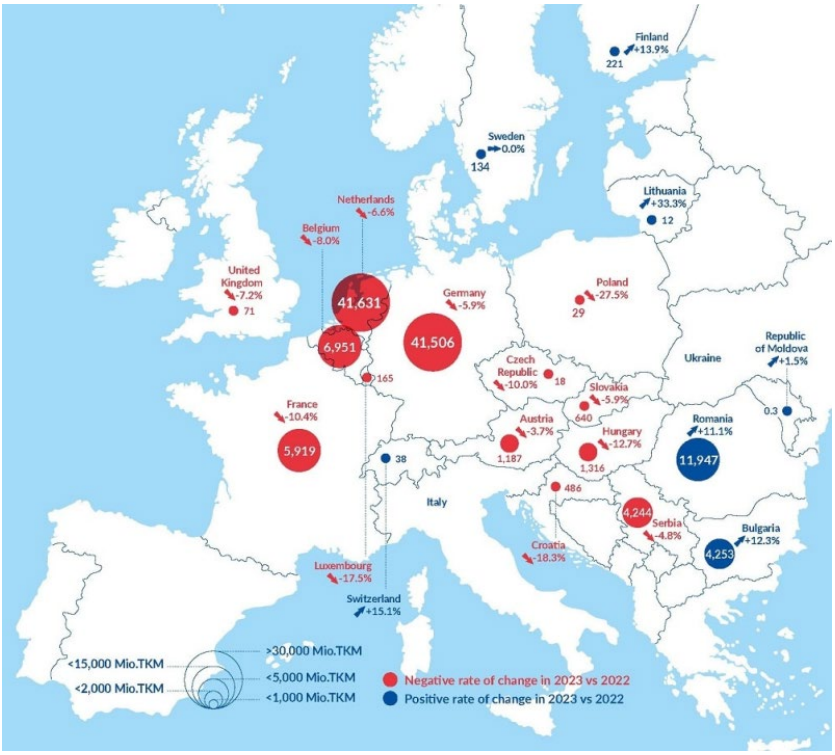

Figure 5 – Inland waterway transport indicators on the national territory of each European country – comparison between 2022 and 2023 (in million tkm)

Source: [5].

Inland waterway transport indicators in European countries in 2023 (in billion tkm) are shown in Fig. 6 [5].

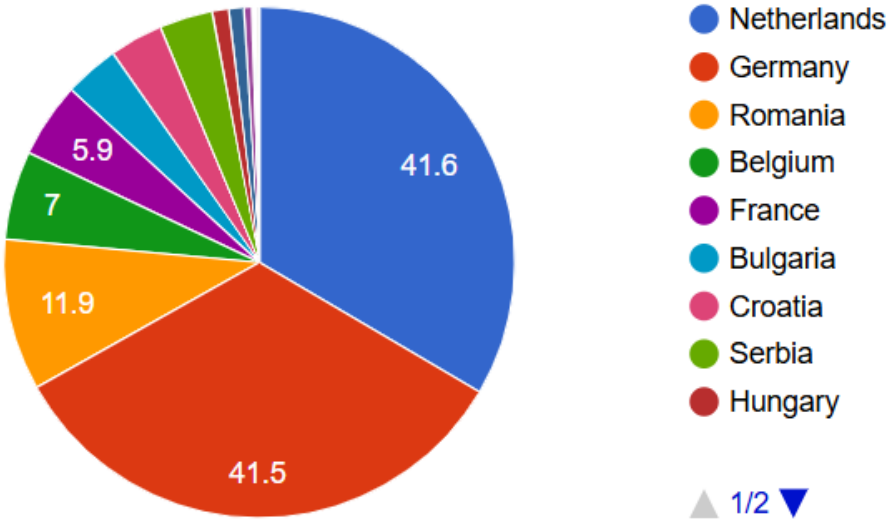

Figure 6 – Inland waterway transport performance in European countries in 2023 (in billion tkm)

Source [5].

Annual inland waterway transport performance in the EU-27 (in billion tkm) is shown in Figure 7[5].

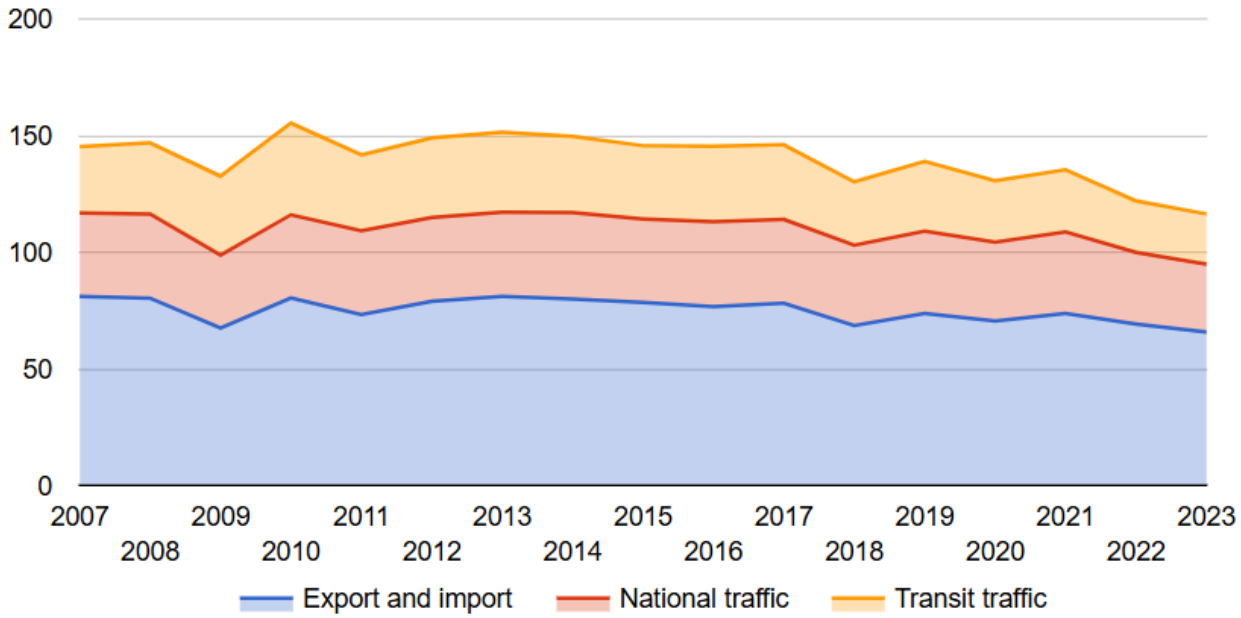

Figure 7 – Annual inland waterway transport figures in the EU-27 (in billion tkm)
Source [5].

Features of the functioning of river transport in the logistics system of Ukraine. Ukraine has a huge potential for increasing the volume of freight transportation by inland waterways. Compared to other modes of transport, which are limited by a deficit in capacity, inland waterways has an undoubted advantage - the possibility of a significant increase in freight transportation volumes [6].

Inland waterways are a type of transport that includes vessels and business entities that carry out and provide transportation mainly by river waterways of cargo, passengers, luggage and mail, provide other services using inland waterways, provide navigation on river waterways, maintain infrastructure facilities of inland waterways, and provide navigation and hydrographic support for navigation.

Inland waterways of Ukraine include rivers defined by the European Agreement on the Most Important Inland Waterways of International Importance, in particular, the Danube, Dnieper, Dniester, etc. [6].

At the time of the full-scale invasion of river transport in Ukraine, the following problems were inherent:

- lack of an improved regulatory and legal base for river transport;
- outdated port infrastructure;
- lack of specialized terminals;
- lack of a modern fleet;
- insufficient funding for the infrastructure of the Navy, etc. [6].

Martial law and bombing were added to the above problems, which significantly complicated navigation on Ukrainian rivers.

Let us conduct a study of the potential of river transport in Ukraine based on the concept of sustainable development. Ukraine, which is the largest country in Europe by territory, has significant potential for river transport. Taking into account the significant distances of potential river transport and the structure of freight transport in domestic and export-import logistics processes, which are dominated by raw material flows of dry and liquid cargo, large-sized goods, etc., river transport should occupy a significant share in

total freight transport and in the structure of GDP. However, the river freight transport industry has been stagnating over the past 20 years despite its objective advantages in terms of low costs, reliability and environmental friendliness. River transport in Europe consumes 1.5 times and 3.5 times less energy, respectively, than rail and road transport. On the other hand, the lack of consideration of external negative effects in costs in Ukraine makes this transport uncompetitive compared to rail or road transport, despite the fact that in Europe there are reverse relations [1].

There are three major navigable rivers in Ukraine: the Danube, the Dnieper, and the Southern Bug. All of them have access to the Black Sea, and the Danube and the Dnieper are among the five largest rivers in Europe. However, despite the existing potential for the development of transport connections using river transport in Ukraine, only 0.5% of goods are transported by it before full-scale invasion. Among the EU countries, this figure reaches 16.3% in Bulgaria, 12.3% in Germany. In general, in the EU countries this figure is 6.7% [7].

Thus, Ukraine potentially has the resource to increase river freight transportation by more than 12 times. The total length of navigable rivers in Ukraine is 4,400 km. The traditional waterways in use are the Dnieper - 1,205 thousand. km and its straits (Desna – 520 km and Pripyat – 60 km), as well as the Danube – 160 km, the Bug – 155 km and other so-called small rivers [7].

The technical condition of the river fleet is constantly deteriorating. The number of technically and morally obsolete vessels is 81.9%. The largest share of old vessels is cargo-passenger vessels – 97.1%. As a result, over the past 5 years, taking into account the global financial crisis, the total volume of cargo transportation has decreased by 3.5 times [7].

The length of inland waterways in Ukraine is the smallest among the analyzed countries – 2129.4 km compared to 3572 km (RP) and 7600 km (FRG), despite the largest area of its territory – 603.6 thousand km2 compared to 312.7 thousand km2 and 357.1 thousand km2 in the RP and FRG, respectively. The density of river waterways in FRG is 21.28 km/1000 km2 and significantly exceeds the similar indicator in the RP (11.42 km/1000 km2) and 3.52 km/1000 km2 in Ukraine. The GDP of Germany significantly exceeds the GDP of the Republic of Poland or the GDP of Ukraine (3865 billion USD compared to 509.955 billion USD and 112.154 billion USD, respectively). Germany is the leader in the intensity of foreign economic exchanges (exports – 1279 billion EUR; imports – 1035 billion EUR), in which river transport occupies an active place. The volume of cargo transportation by this transport in Germany is 221.349 million tons compared to 3.821 million tons in the Republic of Poland and 3.642 million tons in Ukraine. Taking into account the average distance of cargo transportation (Germany – 296.3 km, the Republic of Poland – 24.8 km (domestic transportation), Ukraine – 391 km), the cargo turnover of river transport in Germany was 54.347 billion t·km; in the Republic of Poland – 0.105 billion t·km, in Ukraine – 1.465 billion t·km, which indicates the strategic role of river transport in Germany. Thus, taking into account the low density of river roads in Ukraine (extensive factor), the short average distance of cargo transportation and the meager ratio of GDP to a unit of roads (intensive factors) compared to similar indicators in Germany, we note a low level of use of the potential of river transport in natural, temporal and spatial dimensions. At the same time, due to short transportation distances, which leads to a significant increase in the share of fixed costs (loading and unloading operations) per unit of distance, river transport becomes uncompetitive from a cost perspective. Separate factors have a source of formation from both the supply and demand sides.

The prospects for the formation of demand for river transport services are quite optimistic for three reasons:

a) the history of the development of river transport during the Soviet Union, the weight and volumes of transportation were at least an order of magnitude higher then;

b) the density of river roads and the scale of freight transportation of bulk cargo, in particular through seaports, are comparable to the prerequisites of river transportation in Germany;

c) the presence of significant transit potential due to the geographical location of the territory of Ukraine.

The prospects for river transport in Ukraine, in the near future, may be quite optimistic due to the acquisition of complementary relations between it and sea transport. In fact, sea transport may be one of the drivers of the development of river transport, given the positive dynamics of the former. In 2018, cargo turnover in 13 seaports of Ukraine reached 135 million tons, having processed 11,654 vessels. The ports of "Pivdennyi" handled the most cargo – 42.7 million tons, Mykolaiv – 29.2 million tons, Odesa – 21.7 million tons and Chornomorsk – 21.5 million tons. These ports are dominated by cargo (80%) of agricultural products, ores, metal products and container transportation. In 2018, the first place was taken by agricultural products (52 million tons of grain and other agricultural products), ores (28 million tons) and metal products (18 million tons). Container transportation takes fourth place and amounts to only 846 thousand TEN. Then the volume of cargo exports amounted to 100 million tons, imports – about 25 million tons and transit – only a little more than 10 million tons. It should be noted that a significant share of cargo is generated by territories close to the Dnieper River [1].

Introducing digital technologies and innovations into EU river transport logistics. The digitalisation of inland waterway transport (IWT) and, consequently, the digital transformation of business processes for all stakeholders, is an essential part of measures to ensure the sustainable development of the transport and logistics system in order to ensure safe, efficient and environmentally friendly navigation.

An important prerequisite for this is digital transformation, which consists in ensuring the availability of digitised information about waterways. Digitalisation can improve the safety of IWT operations by monitoring vessels in a "digital twin" of the waterway in real time, allowing shippers and authorities to identify unsafe practices and take appropriate preventive measures.

Finally, digitalisation can also help to improve the efficiency of IWT operations. Digital solutions can enable the tracking of vessels and cargo, allowing for route optimisation and reduced waiting times. This can reduce the amount of time, energy and resources used in transporting goods, leading to lower emissions and supporting climate change measures. Through digitalisation, inland navigation can be seamlessly integrated into multimodal transport chains.

Figure 7 shows the main IWT digitalisation measures proposed by the sector in the EU Masterplan Digitalisation of Inland Waterways (DIWA) [8].

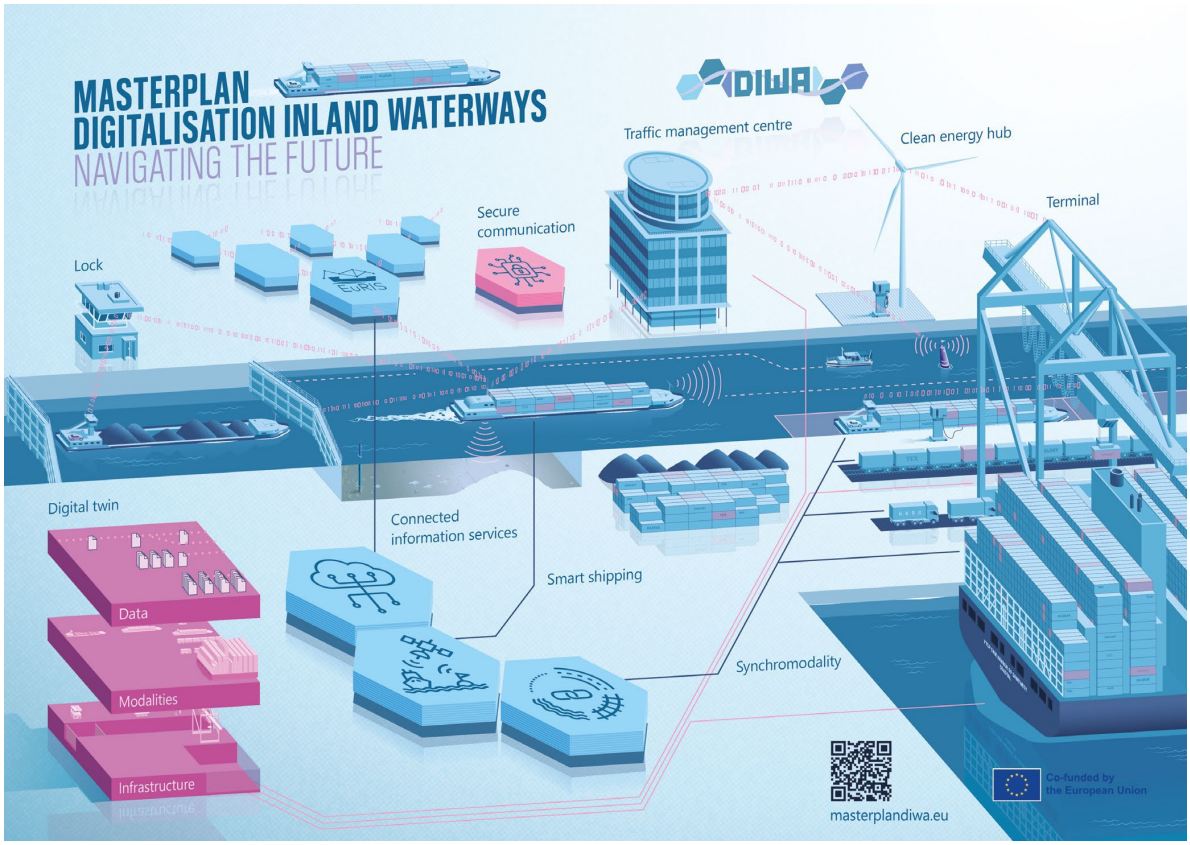

Figure 7 – Key digitalisation measures for IWT
Source: [8].

The DIWA Masterplan roadmap aims to achieve the overall digital transformation objectives set out in European strategies.

These objectives include:

- "safe and efficient navigation",
- "digital by default",
- "synchronous transport",
- as well as "reliable supply chains",
- creating a sustainable, environmentally friendly IWT sector,
- combating climate change
- adapting to the shortage of skilled workers [8].

These objectives outline the strategic horizons for the development of European IWT for the period up to 2032 and are supported by three main areas of practical measures:

- Synchronous modal shift,
- Connected information services,
- Smart delivery [8].

These measures are supported by requirements for standardization processes, cybersecurity, technology, data quality, legal and regulatory components. The success of digitalization and digital transformation also depends on stakeholder engagement and social acceptance.

Digitalization is rapidly transforming the global economy and society. Digitalization is an important source of innovation and new business development. Digitalization has the potential to transform IWT into a smart, efficient, sustainable, safe and multimodally integrated mode of transport.

In transport and logistics, the use of digital technologies is important for optimizing business processes between shippers and logistics market participants, as well as for exploring the possibility of semi-autonomous use of vehicles. The EU is actively improving the regulatory framework for the digitalization of transport and supporting new developments in this innovative direction. This is an important aspect of the future competitiveness of both the EU as a whole and all its member countries. Therefore, in view of European integration

trends, it is also very important for Ukraine to develop the state regulatory framework in this area, integrating it as much as possible with EU requirements.

True sustainability and efficiency can only be achieved if the entire supply chain is involved in digitalization processes. IWT, as part of a larger multimodal chain, requires seamless cooperation with other modes of transport and logistics companies [8].

Digitalization will contribute to:

1) optimized route planning in real-time conditions and using forecasts of expected water levels, weather conditions and traffic density to reduce fuel costs and negative environmental impact;

2) optimized traffic management and infrastructure operation with reduced waiting times and real-time tracking of cargo shipments;

3) increased traffic safety through a higher level of automation, supporting technologies such as modules for situational awareness (exchange of intentions, incident, warning) and improved communication protocols for ship-to-ship and ship-to-shore communications;

4) higher levels of automation to address common shortages of qualified personnel;

5) integration and interconnection with other modes of transport at multimodal hubs as a prerequisite for synchronous transport operations to support the sustainable development of the transport and logistics industry;

6) reducing the administrative burden by sharing digital data with the consent of the owner and reducing bureaucratic reporting;

7) developing new services for stakeholders based on existing and accessible data [8].

One of the main EU initiatives is to use the core network of multimodal corridors across Europe. The challenge for IWT includes establishing and adopting the institutional and regulatory framework for inland navigation in Europe. This is necessary for the development of a pan-European network of inland waterways and waterways of international importance with sustainable infrastructure as an integrated part of multimodal networks and markets. Ukrainian river transport logistics companies can also be involved in the development of such transport.

Digitalization is considered a favourable factor for the modernization of IWT by using core multimodal networks. Thus, it stimulates the improvement of the efficiency, reliability, safety and sustainability of the IWT system. As a result, waterways will be more attractive to new users and the use of waterways can be intensified.

Another challenge is the greening of river transport. According to the EU Green Deal, transport in Europe is expected to become carbon neutral by 2050. In addition, IWT must adapt to the effects of climate change. Already, low and high water periods are becoming longer and more frequent. In addition to these challenges, there are several major challenges that will be crucial for the role and position of IWT in the coming years [8].

European Commission strategies that lay the foundations for the digitalization of IWT.

Digital Inland Waterway Area DINA. The DINA study set out the first strategy for the development of a digital inland waterway area and digital multimodal hubs. The first roadmap for the digitalisation of IWT was developed, presenting short-term and long-term measures to stimulate the use of digital IWT technologies [9].

EU Digital Single Market Strategy. The strategy aims to create a single digital market for goods and services across the EU. The strategy also includes the development of the necessary infrastructure. Due to existing barriers, consumers limit access to goods and services, from which businesses cannot fully benefit from digitalisation, and governments and citizens cannot fully benefit from this digital transformation. The Digital Single Market aims to open up new opportunities, eliminate key differences between the online

and offline worlds, breaking down barriers to cross-border online activity [10].

European Green Deal. The main objective of the EU Green Deal is for the European Union to become carbon neutral by 2050. The Green Deal promotes sustainable transport, in particular the development of zero-emission vehicles and alternative fuels. Digitalisation is seen as an important catalyst for this process. Digital platforms help to promote the concept of sustainable mobility and the use of intelligent transport, and allow for systematic optimisation of energy efficiency. The Green Deal strategy envisages the development of smart mobility, with freight transport becoming paperless by 2030 and automated mobility being deployed on a large scale. In addition, the Green Deal aims to increase the modal market segment of IWT and short sea shipping by 25% by 2030. It is expected that a multimodal trans-European transport network for sustainable and smart transport will be fully operational by 2050 [11].

European (Open) Data Strategy. The EU (Open) Data Strategy aims to promote data sharing in the European Union through measures to support the development of relevant infrastructure, such as data sharing platforms. Open public data is an integral part of the EU data strategy. The Directive on Open Data and Re-use of Public Sector promotes the sharing of high-value data [12].

EU Mobility Data Spaces. The EU Mobility Data Space (MDS) is an initiative of the European Commission that aims to ensure the safe and interoperable sharing of mobility data across transport modes [13].

EU Mobility Data Space (MDS). The EU Mobility Data Space (MDS) is an initiative of the European Commission that aims to ensure the safe and interoperable sharing of mobility data across transport modes. The EU Mobility Strategy paves the way for a fundamental transformation of transport, including the concepts of green, smart transport, and affordable mobility. The EU Mobility Strategy focuses on several key areas of action in the domains of sustainable, smart and sustainable mobility and transport. The EU Mobility Strategy aims to enhance sustainability by providing sustainable alternatives and setting the right incentives. The EU Mobility Strategy aims to establish a concept of smart mobility, taking full advantage of smart digital solutions and intelligent transport systems, as well as the use of Connected, Cooperative and Automated Mobility (CCAM). The concept of smart mobility also includes the development of paperless transport, multimodal journey planning, the construction of a common European mobile data space and the use of AI ecosystems. The EU Smart Mobility Strategy identifies the need to increase sustainability in transport [14].

NAIADES III – PLATINA 3. The NAIADES III Action Plan focuses on transforming the EU transport systems towards zero emissions and developing multimodal transport. These goals are planned to be achieved by digitalising freight transport and logistics, developing inland waterway transport infrastructure for better navigability, including inland ports as multimodal hubs and suppliers of alternative fuels. The PLATINA3 project acts as a policy platform for the implementation of the future of inland navigation. The Action Programme has the main objective of providing a knowledge base for the implementation of the EU Green Deal and the NAIADES III programme. The platform is considered a catalyst for awareness, stakeholder engagement and the use of results from related European projects and initiatives [15].

The article is a logical continuation of a series of publications by the authors dedicated to the sustainable development of multimodal transport and logistics [16 - 18].

Conclusions. The development of the logistics capabilities of Ukrainian river transport enterprises is the main factor ensuring their competitiveness and long-term success. Strategic approaches that can be used are participation in the post-war reconstruction of the Ukrainian economy. The post-war reconstruction of the national economy of Ukraine will require systematic

logistics support, which should be based not only on transportation by classic modes of transport, but will also require the search for new cost-effective transportation. The proposal of the publication is the revival of Ukrainian river transport by developing the river transportation component on the basis of existing logistics companies. The analysis of global and European domestic transportation confirms the relevance of this direction in Europe and the world, which is of particular importance, taking into account the Euro-Atlantic integration processes of Ukraine.

The main proposal for strategic development is the proposal to form its own river fleet, which will allow logistics companies to become the flagships of inland waterway transportation in Ukraine, which have undeniable potential. At the same time, it is proposed to adjust the strategy of logistics companies in river transport in accordance with the main global and regional strategies for the development of inland waterway transport. In fact, the task is not to rebuild the pre-war system of river transport in Ukraine, but to build a fundamentally new, innovative system of river transport. This system will be based on the basis of modern innovative solutions and on systemic integration with the provisions of European concepts of a sustainable EU transport system in general and sustainable development of inland waterway transport, as its integral component, in particular.

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