The topical issues, priority areas of the Danube region and prospects of their development are explored. Danube river is the main European inner waterway and the link between a number of European countries. Its role in economic relations, ability to transport big amounts of various cargos, unique infrastructure, and ways of solutions for existing problematic questions are highlighted in the article. Perspective ideas, innovative technologies, and ways to improve the impact of the Danube river on the economic situation of the whole region are presented. All statistical data is based on the Danube Commission's annual reports and development programs. The key role in the improvement of economic efficiency of the Danube region lies in efficient inland navigation which is impossible without the implementation of last achievements in shipping technologies.

Keywords: Danube Region, Danube Commission, inland navigation, economic efficiency, shipping technologies.

ANALYSIS OF THE INFLUENCE OF THE DANUBE RIVER ON THE REGION’S DEVELOPMENT

Summary. The article examines the economic state of the Danube region, its dynamics and prospects for development. The topics addressed include the role of the river and its navigable infrastructure, the impact of the river on the development of the Danube region, and the challenges facing the region. The paper highlights the importance of modernizing the navigable infrastructure of the Danube river and improving the efficiency of navigation in the region. The benefits of using new technologies to improve navigation and reduce environmental impact are also discussed.

Keywords: Danube region, Danube Commission, inland navigation, economic efficiency, shipping technologies.

Formulation of the problem. When we talk about the number of vessels and barges operating in Danube’s water, we should consider that the intensity of traffic may highly vary depending on prevailing navigation circumstances. Summer and autumn months are the most difficult for navigation, the average depth is reducing which causes the restrictions on amounts of cargo possible to transfer and the types of vessels suitable to navigate in shallow waters, as a result, the number of vessels used for navigation is 30% less in overall and 40% less in some areas difficult to navigate (Upper and Mid Danube). In general, average age of inland vessels from any country’s fleet is bigger than age of seagoing vessels, such situation occurs because of more loyal inspecting authorities (which are inspecting vessels of own country). For last 20 years ship owning companies were investing mostly in used vessels built in 1980s–1990s. Now the market condition on the Danube is changing, and the low-value goods (mostly bulk cargo) are being replaced by high-value goods (liquid cargo – raw oil, etc.). This became possible because of the intensive development of the port’s infrastructure, the building of pipelines, and receiving facilities for liquefied cargoes. Another problem of the old fleet is flexibility, modern barges are designed to be able to load 144 TEU in three layers, have a cargo capacity of 1.585 tons, and a draft of 2.25 m. They can be used for dry bulk cargo, containers, or high & heavy transport. Also, some fleet restrictions are caused by the dimension allowance of locks and bridges, the efficiency of river vessels is heavily decreasing due to the inability to proceed with the maximum constructive draft. Another consequence of navigation in so shallow waters is reduced speed because of poor propeller immersion and higher water resistance. These questions may be solved by fleet refreshment, which will be necessary anyway. European Commission and IMO are aiming to reduce the number of emissions from vessels every five years. That means the shipping companies will...
have to comply with new regulations and modify the existing fleet which is not effective and leads to extra expenses because of interference to original vessels and barges constructions or to build new vessels complying with all existing and future regulations in advance. Further modifications will also reduce the number of incidents caused by technical conditions of equipment and delays caused by repairment and so on.

Analysis of recent research and publications. In source [1, p. 501–502] author provides the statistics of the navigable depth changes. As we can see, the average depth decreases every year, especially on critical points. The improvement of navigational conditions is a very long-term strategy that needs huge investments and can not give an immediate result. Meanwhile, the up-gradation of the current fleet or its refreshment can help with the maintenance of the navigational process without long seasonal interruptions. As was mentioned in the source [2, p. 1015], the amount of cargo transferred by the river is increasing every year which is directly connected to the amount of traffic involved and the pressure on the port’s infrastructure and authorities. The article includes the SWOT analysis of inland navigation of the Danube river where we can find the list of opportunities that can positively affect the economic aspects of transferring goods by the Danube. The modern conclusions and efforts made for the further development of the Danube River Basin are presented in the article. Examining the condition of ports and shore maintenance we can see that a lot of areas require the attention of governments. The situation differs from upper to lower Danube regions, so for average data, we can rely on reports from the mid part of the river [3, p. 76–81].

Defining unsolved parts of the problem. The use of Danube river can become much more efficient if governments solve questions regarding river transportation-specific problems:
- the seasonal character of fairways;
- restrictions caused by equipment used;
- efficiency of logistic chains;
- eco-friendliness;
- creation and implementation of intergovernmental law basis for river navigation and transportation of goods.

The purpose of the article is an overview of all efforts paid by European governments in question of Danube infrastructure development. Listing perspective ideas, and promising innovations, some of which are new for industry and other which are successfully implemented in sea-navigation process and shows good results.

Presentation of the main material. Danube Commission is developing a few innovative projects to improve the use of the River’s waters and to establish good environment-saving practices. "GREENDEL – GReen and EfficienNt Danube l'leet" is the 3rd project that addresses the objectives defined in the "Green Deal for Danube River Transport", the policy & business framework to improve efficiency & environmental performance of the Danube waterway transport system elaborated by Pro Danube [4, p. 1–3]. The other two projects funded by the Danube Transnational Programme are:
- DANTE – Improving administrative procedures and processes for Danube IW7: aims at identifying and eliminating administrative barriers for inland waterway transport [5, p. 7–8];
- DAPhNE – Danube Ports Network: aims to facilitate a balanced development of Danube Ports as eco-friendly, well-accessible multimodal hubs for the transport system of the region and to turn them into buzzing economic centers functioning as catalysts for economic growth and creation of high-value jobs [6, p. 12–13].

Projects support fleet operators in fleet modernization in different areas:
- use of low carbon/alternative fuels;
- reduction of air emissions;
- overall energy efficiency;
- improvement of logistics.

The project improved the logistics chain between different stakeholders, one documental base was created to regulate the fleet number and capacity of goods in transit. Modern eco-friendly solutions are presented to fleet operators, their implementation is highly appreciated by governments of member countries by the easier certification process for vessels and ease of tariffs for modern vessels. The project named DAVID (Danube Navigation Standard Forms) was successfully implemented in 2022 and already has Hungary, Croatia, Serbia, Bulgaria, Ukraine, Romania, and Moldova as participants. The project establishes the standard forms for passing the Customs formalities and obtaining the Customs and Port Clearances.

Temporary but effective for some time decision was to upgrade waterways by dredging operations. This allows for improved port size and capacity but has to be repeated periodically. Another problem is hardly predictable circumstances for river bed conditions and totally unpredictable circumstances for ecology. Nowadays dredging operations on the Danube are done only in critical situations.

Conclusions. The effective use of vessels especially in confined waters highly depends on the proper work of traffic control services. Because of Danube specifics, there are some “bottlenecks” along the river – the areas with heavily confined waters and one fairway for both traffic directions. Such places require additional control measures from shore stations to reduce any delays and establish a safe navigational process. In addition to modernization of propulsion systems which necessarily is obvious to shipping companies, deep modernization is required for bridge equipment. Still, lots of vessels are not equipped with type-approved ECDIS. The use of unapproved software leads to a big variety of charts used for navigation and unstable application of updates leads to imperfect situational awareness. To prevent lots of groundings, collisions, and other incidents list of compulsory shipboard equipment must be created and maintained on board all vessels operating in Danube waters. The use of approved ECDIS and official charts which may be easily accessed by official ENC providers will make all the necessary information available to ship operators. In addition to mentioned above, certified ECDIS can be connected with critical ship equipment such as Gyro Compass, Speed Log, Echo Sounder, Anemometer, and NAVTEX receiver. One display for all data will highly improve situational awareness and safety of navigation. Moreover, connected NAVTEX will
display all safety-related messages directly in navigational mode on ECDIS, this guarantees that urgent information provided to ship operators by shore stations will be timely received and noted. Some vessels are still using paper charts which are hardly possible to maintain updated because of intensive navigation and usually very short stoppages in ports. It’s much easier to have a laptop continuously connected to the network via modems (the satellite coverage of the Danube area allows to maintain a stable connection all the time) and to get the latest weekly updates and chart corrections directly from the Internet using licensed software from chart providers (Voyager World Wide, Navionics, TimeZero, KnowWake, Navtor, etc.). The update process takes 10-15 minutes against hours as it was before. Investing in digital solutions will reduce risks during navigation, which reduces insurance costs.

The present hydrographic warning system is well developed, but there are not so many aids to navigation and ways to reach vital information. Create a separate NAVTEX service for the Danubean area will allow delivering the latest notices, warnings, and forecasts to keep ship operators well-informed about the situation on the river. Such development will increase the efficiency of traffic, logistics, and communication between vessels and shore facilities. Another point is the use of virtual AtoNs (Aids to Navigation) and AIS buoys.

The use of virtual buoys system gives an opportunity to provide fast and easy updates of the buoy’s position without any physical interaction. This will highly reduce the costs for maintenance of the river infrastructure (in perspective the only physical interaction with the river will be dredging on critical areas and maintenance of port areas). The characteristics of river fairways are not constant, every month navigational conditions are changing, and weather impact also cannot be predicted, that is why timely provided information is highly important to maintain safe navigation. It may be not obvious how modern nav equipment will make noticeable changes in the economic situation. But such inventions as GPS, AIS, and so on allowed ship operators to operate at high speeds, and shore operators – to improve effective and really required only in critical locations. All these small changes changed the industry and now it’s the right time to implement some solutions tested by use and time to river navigation.

Another solution lies in the use of AR (Advanced Reality). Some ship equipment providers already implement AR solutions in bridge navigational equipment. Multipurpose displays can provide all valuable navigational information in one place providing safe water routes, fairways, and traffic displaying in any condition of visibility which is vital for overloaded by intense river navigation mates. Such an improvement will reduce the number of incidents, and delays and increase the average speed of vessels, especially in severe weather conditions. Furthermore, such systems will allow navigators to “see” the incoming traffic even covered by the landscape (such situations are quite often during inland navigation). An example of such a system is ENVISION created by FURUNO.

The area which is not well developed yet but has a good perspective is the transportation of goods requiring the temperature and humidity control by waterways. Transportation of such goods by vessels is possible in special refrigerator containers which will require continuous electrical power supply on board. The use of vessels for this purpose is much more efficient because of the bigger quality of units transferred by vessel and much safer for cargo (there is always an opportunity to keep required spare parts for repairment of such containers onboard the vessel or to provide the technical support without stopping the transportation and causing delays in delivery of goods.

Danube river can give numerous benefits to all countries which are ready to cooperate in the creation of modern vessels for this purpose. This will require continuous electrical power supply on board the vessel or to provide the technical support without stopping the transportation and causing delays in delivery of goods.

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