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PROSPECTS FOR THE DEVELOPMENT OF WATERWAY TRANSPORT ENTERPRISES IN UKRAINE

Abstract

For countries such as Ukraine, one of the decisive factors of their economic development is the state of transport infrastructure. Ukraine has an extensive river network, which determines the availability and the possibility of efficient use of its inland waterways. The article analyzes the state of river transport in Ukraine, assesses the prospects for its development, as well as the problems associated with the existing limitations. It offers instruments for creating effective complexes ensuring the functioning and development of this kind of activity.

Keywords river transport, resource potential, optimization of activities, transport complexes

JEL Classification R41, L91, O18

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INTRODUCTION

To date, the solution of problems related to the functioning of river transport is a priority in the development of the entire transport system of Ukraine. This topic was actively discussed in connection with the signing by the Ukrainian side of the Association Agreement with the EU. This concentration of attention is caused by several factors, namely: creation of optimal conditions for activities carried out directly and exclusively on inland waterways; the use of the potential of inland waterways for multimodal transportations, including the international ones. As E. Yemelyanova (2014) notes, the resource potential of river transport should be considered as a set of such basic elements as: the system of inland waterways, the river fleet, the system of navigation and control over the observation of conditions for the safety of navigation, service infrastructure facilities (river ports, mechanized berths, ship-repairing and ship-building plants); other infrastructure (management bodies, scientific institutions, educational institutions, etc.).

Naturally, the search for the optimal solution of possible problems in the development of this potential should be based on a differentiated approach, taking into account the specific features of each constituent element, with the subsequent finding of the optimum for the functioning of the entire system. This approach makes it possible to assess the potential of river transport as a whole and to determine the prospects for its development.

1. LITERATURE REVIEW

The development of a certain type of transport, as well as economic, technical, environmental and other aspects of these processes is the object of constant attention of specialists and scientists. Examples include the works of Amesho, K., Edoun, E. I. (2016), Gqaji, A., Proches, C. G., Green, P. (2016) and many other authors. It should be noted here that similar studies were conducted in the countries of the former USSR, and in this context it is necessary to mention the works of M. Postaliuk, V. Vagizova, T. Postaliuk (2013), Salih Turan Katircioglu, Ainur Naraliyeva (2006), Jānis Kuškins (2011), P. Pidlisny (2016), Y. Klyuyeva, V. Boyko (2016), I. Sadlovska (2011), S. Golovko (2013) and others. It is also important to study the works of Ukrainian experts in the field of river transport S. Bonyar (2009), V. Vynnikov (2010), which characterize the importance of river transport for the country's economy and the expediency of its effective use. Nevertheless, the number of Ukrainian studies devoted to identification of specific problems of the river transport development with justification of approaches and tools for their solution is critically low. In this case, it makes sense to pay attention to the works, which consider the topic of effective functioning of the river transport and optimal use of inland waterways.

The work of Ekkovan Ierland, Cor Graveland, Robert Huiberts (2000) presents an analysis of the economic and environmental aspects of the use of two modes of cargo transportation – by inland waterways and railways. The authors concluded about the attractiveness of the first one according to all areas of research. The results presented in the article of Vanden Berg, R. and De Langen, P. W. (2011) are focused on the role of ports in the development of inland traffic. They use the example of Barcelona to show the possibility of attracting port authorities to the processes of activation of inland terminals of the state thus increasing the flows of containers from the hinterland to the port, as well as increasing the availability of the port for various types of cargo flows.

V. Koba and E. Goroshko (2004) offer a methodical approach to assessing the investment attractiveness of river transport determining the rating of shipping companies of Ukraine from the point of view of expediency to make investments in their development. This study covers all components of the attractiveness of this type of activity (liquidity and profitability of assets, freight turnover and efficiency of the use of ships, the number of ships and safety of navigation) for all participants of the investment process.

Widely discussed by transportation experts and politicians were the provisions of the draft of the Law of Ukraine "On Inland Waterway Transport" (2017), which has been unsuccessfully considered since 2015. K. M. Mikhailichenko (2015), by criticizing it, assesses public benefits of multimodal transportation, which should use inland waterways as integral infrastructure elements of competitive level.

Therefore, there is an urgent need to resolve all the problems accumulated in the field of development of the river transport taking into account all the advantages of its use and the presence of natural opportunities, the relevance of such studies is obvious.

2. THE MAIN RESULTS OF THE STUDY

The Ukrainian Statistics Service (2015) provides certain information characterizing transport provision (Table 1).

Table 1. Characteristics of the river transport in Ukraine

Indicator	1990	2000	2015
Network length of navigable public waterways, km	4,005.00	2,413.50	1,562.60*
Shipments (transportation) of cargoes, thousand tons:			
by sea transport	53,253.30	6,316.30	3,291.60
by river transport	65,728.10	8,349.80	3,155.50

Note: * with the exception of the temporarily occupied territory of the Autonomous Republic of Crimea, Sevastopol and parts of the zone of the counterterrorist operation.

Ukraine has 18 river ports of various forms of ownership with the total berthage of 11.2 km. At the end of 2015, the density of navigable waterways per 1000 km^2 of the territory of Ukraine was 2.7 km (for comparison, 6.6 km in 1990, 4.0 km in 2000). Table 2 shows the density of internal communication lines in European countries according to the data of *Eurostat* (2016).

Table 2. Density of river shipping routes of European countries, 2015

No.	Country	Density, km/1000 km2
1	Germany	21.5
2	Hungary	20.4
3	Croatia	17.7
4	Poland	11.8
5	Romania	7.6
6	France	7.5
7	Slovakia	4.1
8	Ukraine	2.7

As we see from the data of *Eurostat* (2016) there is a redistribution of the load towards a relative decrease in the level of use of inland waterways and redistribution of cargo flows primarily in favor of railway transport (Table 3). In Ukraine, there is a significant unrealized potential and incentives for the development of river transport.

Table 3. Distribution of freight transport by type in the EU countries, % of the total transport flow in ton-kilometers

Year	Motor transport	Inland waterway transport	Railway transport
2009	77.1	6.1	16.9
2010	75.7	6.9	17.4
2011	75.1	6.3	18.6
2012	74.7	6.8	18.5
2013	74.9	6.9	18.2
2014	74.9	6.7	18.4

Comparative analysis of the cost of transportation by different types of transport confirms the expediency of using river transport; for comparison – the cost of transporting 1 ton of cargo for a distance of 100 km in dollar equivalent is: railway transport – 7.9, motor transport – 11.4, river transport – 4.6. The efficiency of transportation with the use of 1 liter of fuel per 1 km: for railway transport – 97 tons, for motor transport – 50 tons, and for river transport – 127 tons. Without dwelling on the advantages in terms of environmental friendliness, increasing level of multimodality, low external costs and infrastructure costs (in comparison with other types of transportation), in Ukraine, there is an unjustified disregard for this area. Such insignificant use of the possibilities of Ukrainian inland waterways is caused by many reasons, including high or unbalanced tariffs (pilotage, locking, associated payments, etc.), the lack of a legislative and regulatory framework that regulates this type of transportation activity, which should take into account its specific features, obsolete fleet, the lack of sufficient shipbuilding and ship-repairing capacities, the shortage of relevant specialists, the systematic costs of dredging, the morally and physically obsolete infrastructure or its practical absence, insufficiency of investment programs, etc.

The following problems remain complicated: the formation of a portfolio of infrastructure projects considering the degree of depreciation of fixed assets – of the movable and immovable property (635 units of small-capacity vessels of the river fleet suitable for use on inland waterways); regulation of the tariff policy – the procedures and the cost of pilotage, channel charges for bridging, sluicing, etc.

Nevertheless, carriers of various forms of ownership transported through the Ukrainian inland waterways nearly 4 million tons of freights in 2016 (Derzhkomstat, 2016), of which 37% were construction cargos (99.9% of which was internal traffic), ore – 16.3% (of which 41% was internal traffic) and grain – 12% (of which 74.4% was transportation by export-import operations). These statistics show the priority choice of river transport by carriers during the transportation of grain.

The highest amount of income from providing services of the river transport was received in the Poltava region (9.3% of the total volume of transport services provided by the region), Odessa region (3.5%) and Zaporozhye region (1.3%): the main cargo producing these profits was grain.

Table 4. The balance of grain in 2015–2016, thousand tons

Indicator	Grain, total	including					
		wheat	barley	corn	rye	buckwheat	other
Grain supply	71122	30430	8798	28677	458	197	2562
Production	60464	25839	8201	24490	355	135	1444
Internal consumption	24041	10031	4264	7815	444	171	1316
Export	36832	15899	3734	16862	0	1	336
Ending inventory	10249	4500	800	4000	14	25	910

Every third dollar imported to Ukraine is obtained from the export of agricultural products. According to the forecasts of agricultural experts, gross exports can reach 50 million tons, which, given the resource potential of the country's river transport and its development, seems to be an important instrument.

Ukraine retains the status of importer of grain crops and oilseeds (Table 4), and according to the Ministry of Agrarian Policy and Food of Ukraine, 5% of them are transported by river transport (the share of railway transport – 61% and of motor transport – 34%).

For comparison, the share of river transport in the transportation of grain in the United States is 55%, and in France – 25% (UNCTAD). At the same time, the cost of transportation in Ukraine is 6-8 $/t for the river transport, 12-15 $/t for the railway transport and 25-26 $/t for the motor transport.

One of the key problems, among others, remains the lack of the necessary technical basis for the development of this type of transportation despite the fact that there is a potential opportunity to ensure the flows of goods. For example, in the general structure of the railway transport, domestic transportation accounts for 85% (in most cases, the products of Ukrainian companies), which could help successfully redistribute these volumes. In fact, in 2014, the river transport transported 3 million tons of cargo in Ukraine, which accounted for 0.19% of its total amount (0.17% – for sea transport, 70% – for motor transport and 24% – for railway transport).

To modernize the river transport, we need: the material and technical basis (long-term resources conditioned by the essence of the technological process); current assets (the assets that ensure realization of the technological process) and labor resources. In this regard, it is important to focus on the problems associated with the state of the infrastructure and the fleet. Their presence and unsatisfactory condition, as evidenced by Ukraine's position in the competitive rating, reduces the possibility of development of the river transport (Table 5 – World Economic Forum).

Table 5. Positions of Ukraine in the rating of competitiveness of the world's countries

Option/year	2014–2015	2015–2016	2016–2017
All infrastructure	68	69	75
Quality of roads	139	139	134
Railway infrastructure	25	28	34
Port infrastructure	107	108	96

The state of the entire ship-building industry, not only as an auxiliary one in the development of the river and sea transport sector, but as a defining and forming one of the main resource potential of the river transport sector in Ukraine, minimizes the possibilities of its use. At the same time, repair works should be considered as a source of reproduction of the fleet (in equal measure and as an active part of the basic productive assets) along with ship-building. However, the presence of only the repairing base cannot fully replace ship-building. In 2014, the Ukrainian river fleet had 1261 vessels including those unfit for operation (State Statistics Service). Its optimal reproduction should consist of the optimal ratio between ship repairing and ship-building, and their optimal proportion should be determined by minimizing the costs in these types of activity. The conditions for effective reproduction of the river fleet can be expressed by the following formula, which is a modified approach to the traditionally used tools of quantifying the optimum of the given costs:

$$K_{yp} \cdot N + \frac{C_{pi} + S_i}{P_i} < K_{yc} \cdot N + \frac{C_c + S_I}{P_I}, \quad (1)$$

where K_{yp} are specific investments into repairs to restore the i-th age group of the fleet's ships;

- N – coefficient of comparative efficiency of capital investments;
- C_{pi} – the cost of repair of ships forming the i-th age group;
- S_i – the cost of operation of ships in the i-th age group;
- P_i – the total capacity of ships in the i-th age group;
- K_{yc} – specific investments into shipbuilding;
- C_c – the cost of construction of ships forming the I-th age group;
- S_I – the costs of operation of ships in the I-th age group;
- P_I – the total capacity of ships in the I-th age group.

For correct and objective assessment of the necessary capacity of technical facilities (fleet's vessels, equipment, provision, etc.) and in order to ensure the transportation of goods, it should be carried out on a step by step basis. During the first stage, the volume of resources is determined for each type of cargos, based on the specific weight of costs in the total value of freight flows for a particular direction in general or for a region being serviced. Based on the preliminary assessment of costs of technical facilities and general costs on the maintenance of a certain area, a decision is made on the appropriate choice of the type of activity. This is followed by the second stage of determining the volumes of technical support for a particular area. The analysis of costs for individual regions gives a more accurate result, since the conditions in different regions are different, which inevitably leads to the redistribution of capital investments.

In order to estimate the total costs of ensuring the freight traffic during the first stage, it is proposed to use the following expressions:

$$S = \frac{S_t}{1-k}, \quad (2)$$

where k is a normalized coefficient of operating costs to ensure the flow of freights in general in all directions;

- S_t – the costs for technical facilities in all directions, where

$$S_t = \sum_{j=1}^{n} S_{tj}, \text{ where } j = 1, 2, \ldots n \quad (3)$$

where

- S_{tj} – the costs of technical facilities for the j-th direction of cargo transportation;
- j – the number of directions of the planned cargo flows.

During the second stage, it is advisable to conduct a more detailed assessment of the required capacities of technical facilities. However, it becomes possible to choose the options for developing a particular cargo flow (direction, type of cargo, etc.), including determination of both the total cost of these facilities and the costs of each separate type of equipment on all levels – from their use on a particular direction to the aggregate demand for them.

Within the proposed designations,

- the necessary amount of costs of technical facilities of the i-th type to ensure the flow of the y-th type of cargo:

$$S_{iy} = \sum_{g=1}^{n} V_{ig}, \quad (4)$$

the total cost of technical facilities of the i-th type to ensure the flow of goods for the j-th direction:

$$S_{ij} = \sum_{y=1}^{m} S_{iy} = \sum_{y=1}^{m}\sum_{g=1}^{n} V_{ig} \times y, \quad (5)$$

the necessary volume of technical facilities of the i-th type for all directions of cargo flows:

$$S_i = \sum_{j=1}^{p} S_{ij} = \sum_{j=1}^{p} \sum_{y=q}^{m} \sum_{g=1}^{n} V_{igy}. \quad (6)$$

Then, the formula for determining the cost of technical facilities necessary to ensure the coverage with freight traffic for all directions in a certain region will take the form:

$$S_t = \sum_{j=1}^{p} \sum_{y=1}^{m} \sum_{g=1}^{n} \sum_{i=1}^{r} V_{igyj}, \quad (7)$$

where V_{igyj}, – the cost of the i-th type of technical facilities in the g-th region for the y-th type of cargo for the j-th direction.

Reproduction of the entire complex of technical facilities necessary to ensure the flow of freights (actual and potentially possible) is a process combining the results of activities, ship-building and ship repairing. Proceeding from this, it is advisable to organize a complex, which includes companies carrying out such activities, as well as all the necessary accompanying subsystems. A formalized expression of the total production capacity of such a complex will be determined as the sum of capacities for the reproduction of technical facilities for all directions of freight flows:

$$P = \sum_{q=1}^{l} \left(P_{bi} + P_{ri} \right), \quad (8)$$

where P – production capacity of the whole complex;

- P_{bi} – shipbuilding capacities for the construction of technical facilities of the i-th type;
- P_{ri} – repair capacities for technical facilities of the i-th type;
- q – the number of units assigned to technical facilities.

Units can also be systematized according to the type of technical facilities (ships, barges, tugs, equipment of terminals, etc.). In this case, it is necessary to establish dimensions of specialized production not only for each type of vessels, but also for each of their elements.

The main criterion for the optimal functioning of such production complexes is minimization of production facilities. Unknown values express the intensity of functioning of the object for each of the development's options. Their determination is connected with the objects of forecasting (shipbuilding and ship repairing enterprises, external suppliers).

The structure of this model is proposed in the form of integer linear programming problem that is reduced to finding values that show the intensity of the ways enterprises operate under the conditions when:

- l – the volume of consumption of products;
- i – the number of an enterprise, unit $(i = 1, 2, \ldots, m)$;
- r – the number of the development project of the i-th enterprise (unit);
- R_i – the total number of development projects for the i-th enterprise (unit);
- V_i^r – the volume of production at the i-th enterprise $(r = 1, 2, ..., R_i)$;
- C_i^r – production cost at the i-th enterprise of the r-th development project;
- K_i^r – capital investments at the i-th enterprise of the r-th development project;
- $l_{(n1+1)}$ – the cap on investments;
- V_{ni}^r – the volume of products provided by external supplies at the i-th enterprise of the r-th development project;
- C_{nj}^r – the cost of products supplied by the j-th enterprise of the r-th development project;
- K_{nj}^r – capital investments for the development of external supplies under the r-th project;
- j – the supplier of products.

Restrictions include:

- the volume of consumption at which the total volume of production for a certain period of time will satisfy general economic needs of the whole region:

$$\sum_{i-1}^{m} \sum_{r=1}^{R_i} V_i^r X_i^r + \sum_{i=1}^{m} \sum_{r=1}^{R_i} V_{ni}^r X_i^r \le l, \quad (9)$$

- condition of integrity of the proposed projects:

$$\sum_{r=1}^{R_i} X_i^r \le 1, \quad X = \begin{cases} 1 \\ 0 \ (i = 1, 2, \ldots, m) \end{cases}, \tag{10}$$

- restrictions on capital investments:

$$\sum_{i=1}^{m}\sum_{r=1}^{R_i} K_i^r X_i^r + \sum_{j=1}^{n}\sum_{r=1}^{R_i} K_{nj}^r X_i^r \le l_{(n_r+1)}, \tag{11}$$

- conditions for minimization of production costs:

$$\sum_{i=1}^{m}\sum_{r=1}^{R_i} C_i^r X_i^r + \sum_{j=1}^{n}\sum_{r=1}^{R_i} C_{nj}^r X_i^r = \min. \tag{12}$$

The problem consists in finding such value X_i^r, at which the conditions (9), (10), (11) will be satisfied and the minimum value of the target function (12) will be achieved.

It is offered to solve the problem of concentration of the production base by using the following expression for the given costs:

$$C_i + N_k K_i \frac{1}{P_i} + S_i \to \min, \tag{13}$$

where:

C_i – the cost of the i-th type of technical facilities on the terms "free port – manufacturing works";

N_k – the coefficient of comparative efficiency of capital investments;

K_i – capital investments into the development/formation of production capacities for the production of the i-th type of technical facilities;

P_i – the production program for the i-th type of technical facilities;

S_i – the costs of transportation of the i-th type of technical facilities from the manufacturer to the place of operation.

All values (with the exception of N_k) depend on certain factors for each of the variants of the development projects. Hence, it is important to determine all factors determining their values and establishing their boundary conditions.

With the help of expression (13), and thanks to it, we can make an analysis of the economic efficiency of the functioning/repairing of technical facilities as key elements of the resource potential of inland waterway transport, and the formation of programs for the acquisition of these technical facilities.

However, the economic efficiency of interregional distribution of such enterprises is not limited to the formula of reduced costs. An enterprise continues to function even at the end of the payback period of capital investments and to be a source of income. In this case, the economic efficiency of the complex can be expressed by the sum of the results of activity of individual enterprises of this complex:

$$E = \sum_{i=1}^{n} E_i \ge 0, \tag{14}$$

where:

n – a number of enterprises of the complex;

E_i – the economic effect obtained by the whole complex from the activity of the i-th enterprise after the payback period.

The presented methodical approach is a basis for carrying out a survey of the level of the region's transport infrastructure. The Southern parts of the Black Sea regions of Ukraine, including the Odessa, the Mykolaiv and the Kherson oblasts were analyzed. The choice in favor of these regions was made based on the concentration of the most important river routes there, as well as the largest sea port complexes, ship-repairing and shipbuilding plants. As an illustrative example of the use of the methodology in practice, we will present the purchase of a floating dock for the functioning of the shipbuilding and ship-repairing plants of ASK "Ukrrichflot". The results are shown in Table 6.

Table 6. The reduced costs on acquisition of the floating docks "Pallada", mln. UAH

Index	Ship-building and ship-repairing plant, Zaporozhye	Ship-building and ship-repairing plant, Kherson
Cost of the floating dock	200.00	200.00
Capital investments (total)	89.80	89.40
Costs of transportation of the floating dock	prices	prices
Reduced costs	289.80	289.40
Relative costs	1.0	0.99

CONCLUSION

The results of the study showed certain patterns and trends. Based on the proposed approach, it is expedient to formulate integrated measures for the development of the river transport. With the practical equality of the reduced costs for the acquisition of an object (cargo), the economic efficiency of its purchase and delivery will be determined based on the presented approach, the influence of the type, volume and direction of freight flows.

The results of the studies were taken into account during the formulation of the transport infrastructure development programs in the southern regions of Ukraine, primarily the development of potential of the national inland waterways.

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