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Trends in the development of European inland freight transport

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Abstract
The article presents a selection of topics concerning inland freight transport. It is part of the European transport system that holds different places in the transport system of every country. At the same time it is an element of their water management system. Therefore, the development of inland shipping is influenced by two key factors. The first one is the adjusted natural water system, which as a linear system, enables freight transport. The second factor is water management policy, which takes into account inland shipping in the water resources management. In many European countries, especially in the Netherlands, Belgium, Germany and Rumania, barge freight transport is a part of these two systems. Inland shipping in the European overland transport engages in approximately 6.5% of the transport activity by carrying dry, liquid, general and containerized bulk cargo. It is of significant importance to the international cargo transport in many European countries – adjusting techniques and organization of transport to constantly changing requirements of the shippers, which results from the shift in the industry structure in Europe. It is no longer associated with transport of coal and iron are only, although they still make the primary freight in inland shipping. The ro-ro barges carry containerized and palletized cargo and are components of the multimodal transport chains.

Introduction

The main condition for the operation and development of inland shipping is the natural river system upon which an inland network of linear infrastructure can be built. The navigable rivers with buildings and facilities enable fully loaded units to the sail. The accompanying buildings are lock on the rivers which are dammed by transverse and longitudinal dams, groynes and profiled bends of the rivers which slow down the current. What complements this linear infrastructure is the shipping channels combining various rivers into one water system or providing access to the industrial areas. The facilities required to deal with different inland water levels include locks, lift locks and ramps.

Another, equally critical condition for the development of inland shipping is a transport policy with regard to water management. One should bear in mind that inland navigation is at the same time part of the two systems, including transport and water management. This means that it has to be considered a necessary component of both of the systems and not only one of them. In these countries and regions, where, there are natural conditions for the development of inland shipping and where it is regarded as a legitimate component of both of the systems, there is an increase in the use of inland shipping to carry passengers and goods.

Inland freight transport in the countries of European Union

The policy with regard to transport and water management in numerous countries of the EU is focused on adjusting technological and organizational aspects of inland shipping to the new market demand structure. It is in compliance with the EU policy promoting solutions pertaining to intermodality and decrease in emissions and energy consumption of the transport system at the continental level [1].

The European leaders use their water resources, which are suitable for inland shipping, extremely well. As a result, such countries as the Netherlands, Germany, France, Belgium or the countries situated on the Danube river have their transport activity calculated at a rate of billions of kilometre-tonnes

and their inland navigation share in the overall transport exceeds 10%. The list of the above mentioned countries is complemented by Luxemburg, Austria, Hungary and Slovakia with their annual transport activity reaching a level of 10 million tonnes. Inland freight transport has also become of importance to Russia which has been modernizing its waterways for the last several years. Such an extensive use of water resources in these countries results from their relevant application of the orientation principle in transport economics which specifies that a transportation service should be performed along the least expensive route, not the shortest one [2].

According to the Eurostat data in 2011 the share of inland shipping in the transport activity (calculated for road, rail and inland transport) was 6.5% within the whole EU, i. e. 140,707 million kilometre-tonnes with the total cargo volume of 475 million tonnes.

Table 1. Inland freight transport in the selected countries of the European Union in 2010 (own study based on the Eurostat data [3])

Country	Freight volume [thousand tonnes]	Transport activity [million kilometre-tonnes]	Transport activity share [%]
Belgium	142,275	9,251	18.00
Bulgaria	18,372	4,311	21.20
Germany	239,608	55,027	12.90
France	72,747	9,029	4.30
The Netherlands	304,066	46,278	33.00
Rumania	32,088	11,409	27.20

The analysis of periodical trends in inland shipping [3] for 2009 and 2010 shows that in all of the above mentioned countries quarterly transport activity is nearly at the same level and there are no significant, seasonal alterations to it. It means that transport activity by means of inland shipping is scheduled by the TSL sector and shippers for a one-year span.

The Eurostat data also indicates that most of the inland freight transport is performed by international trade. It adds up to 77.6% of the total inland freight transport activity. It shows, how important it is for inland freight transport to create international inland navigation connects and unify technological and legal solutions at the European level.

The structure of European inland freight transport is shown in table 2. This data shows that primary freight transported by means of inland shipping is dry and liquid bulk cargo.

Iron ore, coal, coke, oil and petroleum products add up to 55% of the total amount of freight transport. In "agricultural products" and "other" there are also other various, dry and liquid bulk loads included. Nevertheless, over the years there has been an increase in freight transport by means of intermodal cargo units, especially large containers included in the specification as "unclassified". The "other" group primarily includes general cargo such as steel products, sacked artificial fertilizers, cement, vehicles and palletized cargo. A special group of cargo listed in the specification as "other" includes sizable heavy and bulky loads. Inland shipping is especially suitable for transporting this kind of cargo.

Table 2. The structure of inland freight transport in the European Union in 2010 (own study based on the Eurostat data [3])

Freight	Total transport activity share [%]	Primary freight
iron ore	24.50	iron ore and other metal ores
coal and oil	10.10	power coal, coke coal, crude oil
coke and petroleum products	11.20	coke, diesel oil, burning oil, petrol, gas
agricultural products	12.70	corn, feeds, rape, vegetable oils, wine, processed foods, meat, livestock
unclassified freight	14.50	various general cargo, dry and liquid bulk cargo transported in large containers
other	27.00	scrap metal, aggregates, other general cargo such as palletized cargo, steel products, vehicles, heavy and bulky loads, waste

Forms of inland freight transport

The crucial technological and utility factors of inland navigation include:

- capability for transporting of up to several thousand tonnes of freight at a time;
- option for combining single vessels into formations, which increases one single freight transport capability;
- vessels of various sizes constructed for inland navigation on the particular bodies of water with their capacity limited by the parameters of the transport infrastructure;
- diversity in the types of vessels with regard to transported freight.

Historically, the applied principles of classification with regard to the inland vessels, as well as the operated types are closely related to technological development. The following factors had their impact on the development of the vessel fleet and

Fig. 1. Self-propelled barges – motor barges [5, 6]

various kinds of vessels, as well as transport organization [4]:

- applicable types of propulsion including rowing and sailing drives, the steam engine and electric engine which has been in use to date;
- methods used for handling and holding including lo-lo and ro-ro systems;
- construction materials (wood in the past, and then steel which has been in use to date);
- vessel construction technologies;
- condition of the waterways and their improvement for bigger and bigger vessels;
- demand for transport services;
- approach to water management.

Inland freight transport evolved into two primary means of transport including *self-propelled barges* (B) and pushed formations combining *towboats* (T) and non self-propelled barges) (PB).

The 250 to 3,000 DWT self-propelled barges operate in Europe. Their capacity depends on the parameters of waterways they are constructed for. For example, in the post-war Poland[1] the 500 tonne BM-500 barge became standard. Its versatile use suited the waterways within the Oder, Warta along with the Noteć river, as well as the Vistula (class 2 in the Polish categorization system for waterways). The higher tonnage motor barges are used in inland shipping on the Elbe, Rhine and Danube and other waterways of Western Europe. Their capacity is of course limited by the parameters of the waterways, they are constructed for. For example, the 1,000 to 1,500 tonne vessels operate on the waterways categorized as class 4, 5, 6 or higher. The 1,500 to 3,000 tonne barges operate on the class 6b waterways.[2]

Self-propelled barges can be divided into versatile and specialized barges (see Fig. 1). The versatile barges are suitable for transporting dry bulk cargo (coal, iron ore, aggregates, corn), as well as standard general cargo (steel products, fertilizers in sacks or big bags), vehicles, as well as heavy and bulky loads. The specialized vessels include:

- tankers for transporting various liquid bulk cargo such as fuels, chemicals and vegetable oils;
- barges for transporting containerized cargo (container ships), cooled cargo or palletized cargo;
- ro-ro barges for transporting vehicles and heavy and bulky loads.

The European fleet structure of self-propelled barges is fragmented. It is owned by several thousand shipowners, who have very often one vessel only. In particular it relates to the owners of versatile barges. It is a bit different, when it comes to specialized vessels, because permanent freight transport contracts force shipowners to create vessels, which meet the demand for particular freight transport on the permanently operated routes. The shipowners of inland versatile barges carry cargo within different routes which are of inconstant nature. The fragmented ownership infrastructure is one of the main reasons for big share of self-propelled barges in inland freight transport in Europe. The second reason is a comfortable formula for forwarding agents and operators pertaining to organization of inland navigation by means of such vessels.

The reason for the existence of numerous small shipowners, who are very often vessel leaseholders,

[1] It is difficult to write in the present tense as in practice the BM 500 barges use only waterway in Poland which is the Oder river tributary ports waterway called the Oder-Havel Canal. However, this waterway is suitable for much larger vessels of up to 1,000 tonne DWT.

[2] The waterway classes specified in this publication are in compliance with the European Agreement on Main Inland Waterways of International Importance (AGN).

results from the system which organizes inland freight transport in Europe. A large forwarding enterprise or logistic operator enters into long-term commercial contracts with shipowners of the barge (and frequently prior to that they provide funds for building a vessel or give a loan or hold it on a lease) on freight transport with a stipulation that they have exclusivity for orders or availability in terms of transport order priority relating to a several-year long period of cooperation. A forwarding agent, who has several dozen vessels at their disposal can provide freight transport services related to numerous loads from a various location and in many relations. Due to this organization they can receive orders for carrying a large portions of load of about several to several dozen thousand tonnes.

It was in the 60's of the twentieth century that the push system in Europe was applied. It is based on separating a propelled vessel from a vessel that carries freight. As a result a fleet was formed, including towboats (T) and non self-propelled barges (PB). The primary types of pushed barges are versatile vessels, including upper and bottom deck vessels. The second type also includes roofed barges, adapted for carrying various loads which are sensitive to precipitation. Their tonnage depends on the waterway parameters they are constructed for, and is 200 up to 3,000 tonnes. Combining barges to make formations means that it is possible to carry several thousand tonnes of freight at the time. Using pushed formations makes it possible to increase freight transport capacity and leads to reduction in transport costs per unit related to specific loads. In Europe, the push system is used now widely, especially for carrying dry bulk cargo. It brings high transport efficiency and is used for carrying large quantities of cargo on the permanent freight transport routes, which frequently occurs on a regular basis (see Fig. 2). The largest formations used in Europe carry 12,000 tonnes of load at a time (4×3,000 tonne barges)

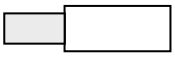
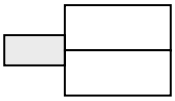
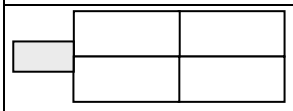
Formation configuration	Symbol	Name
	T+PB	single, one-row
	T+2PB	double, one-row
	T+2×PB	single, two-row
	T+2×(2PB)	double, two-row

Fig. 2. The pushed formations used in Europe [4, p.112]

The size of pushed formations depends on the waterway class and therefore it is at the stage of constructing a vessel that it is taken into account on what bodies of water it will operate. For example, for the Polish waterways 500-tonne barges were constructed and it was possible to combine them maximally in such formations as T+2PB, whereas for the 800-tonne barges it was T+PB. On the international class 5b waterways formations of up to 6,000 DWT combined as T+2×(2PB) are used including 1,500 tonne barges. Whereas on the class 6b waterways which make approximately 21% [7] of the waterways belonging to the E network (the network of main inland waterways of international importance included in the AGN), formations of up to 12,000 DWT combined as T+2x(2PB) including 3,000 tonne barges are allowed to operate. Figure 3 presents examples of pushed formations on the Rhine and Danube.

In inland shipping we also use mixed configurations which make a formation including a self-propelled barge and a pushed non self-propelled barge. This solution is very often used for carrying containers, transport of which has been on a steady increase.

It is also various general cargo, that is carried by pushed formations including versatile upper and bottom deck barges, independently of a bulk cargo

Fig. 3. The pushed formations carrying coal and aggregates on the Gliwicki Canal and the Rhine respectively [5, 8]

transport performed. On the other hand, similarly to the self-propelled barges, specialized pushed barges are used for carrying various freight. The group includes tankers for carrying various liquid loads (fuels, chemicals), cement carriers, container barges, as well as single and multiple deck ro-ro barges with their own entrance ramps and a ballast system for carrying passenger cars, as well as heavy load vehicles transporting sizable loads. Single deck, pushed barges of this kind are very often adjusted to transport long, heavy or bulky loads[3].

The structure of freight carried by means of inland shipping has its impact on the structure of fleets operated by the shipowners, who sail under different European flags. The analysis in relation to the Eurostat data, resources published by the shipowners and the European countries, performed by the author for the purposes of this publication makes it possible to draw conclusions, which indicate certain regularities showing how the fleet structure is connected with the types of transported freight:

- transport of dry bulk cargo on the permanent routes is frequently performed by means of pushed formations, which in particular pertains to transportation conducted from seaports to their hinterland; this kind of freight transport is primarily performed on the Rhine, Danube and on a smaller scale on the Elbe;
- the main cargo carried by the Belgian, Dutch (self-propelled barges) and Slovakian (pushed formations) fleets includes oil and petroleum products such as liquid fuels;
- the Bulgarian, Czech, Hungarian, Polish and Croatian fleets are mainly non self-propelled barges carrying dry bulk cargo by means of pushed formations;
- containerized freight transport is performed by means of self-propelled barges and formations including a self-propelled barge and a pushed barge; this kind of transportation is mainly conducted from the ports of Rotterdam, Amsterdam and Antwerp by the Dutch, Belgian and German fleets;
- "other" loads are mainly operated by self-propelled barges; the transport directions cover all water bodies with great diversity of quantity and types of freight;
- heavy and bulky loads are carried by both versatile and specialized barges with a ballast system; the market demand for this kind of freight transport is on the increase.

[3] called "ponton" in Poland.

Inland shipping conforms to the rule of optimal selection of an operated fleet with regard to the anticipated needs, which means that in this respect the market of inland freight transport reacts appropriately to the change in demand by the European industry.

Development prospects for inland freight transport in the European Union

Inland freight transport is at the same time one of the cheapest and the most environmentally friendly branch due to its [9]:

- relatively low energy consumption which is necessary for carrying cargo;
- low atmospheric emissions from burning fuel;
- relatively small contamination of the waters it uses;
- lower indirect costs compared to road and rail transport.

"Although traditionally inland shipping is thought to be suitable for carrying big quantities of bulk cargo and cover long distances, it has met the new challenges and since the 90's it has been competing successfully on the new markets, especially in the field of containerized freight operations which are primarily in the domain of inland shipping at the hinterland of seaports of North-West Europe." [9] Maintaining the position of inland shipping in the transport systems was possible because of a number of changes which adjusted it to the new conditions. These changes included mainly implementation of new methods of transportation and organization related to handling of new loads, as well as transport relations by means of [9]:

- joining the European, intermodal transport system operating large containers;
- introducing seagoing river vessels into operation;
- servicing logistic centres with their river ports, as well as river ports with container terminals;
- handling new loads such as waste or transported in a new form (palletized cargo), heavy and bulky loads.

Further development of inland shipping in Europe will be connected with:

- maintaining its strong position in dry and liquid bulk cargo transportation on the permanent freight transport routes;
- an increase in containerized freight transport from the seaports;
- further development of seagoing river transport by way of increasing the fleet of vessels, which

have a small draught and are suitable for sea shipping and river shipping at the same time;
- development of logistic centres in the seaports, the sea-river ports, as well as the river ports, which use their access to the inland shipping waterways;
- involving inland shipping in the delivery logistics by the way of using the existing vessels and constructing specialized vessels such as pallet vessels or ro-ro vessels in order to arrange deliveries of consumption goods to the shopping centres situated in the cities by means of water transport;
- the increasing demand for transport of heavy and bulky loads, which substantially exceed rail and road gauges with their unit weight of up to several hundred tonnes.

The EU policy with regard to the European transport system, presented in the latest White Book aims at transforming it into a cost-effective and low emission system. Inland shipping and sea shipping match these provisions ideally, which will be an impulse for performing activities in many of the EU countries for the development of water transport. It is especially true in the occurrence of the congestion phenomenon, which is increasing, in the European road transport.

Conclusions

Inland shipping is an essential component of the European transport system. The superb example of its matching the integrated overland and sea transportation chains is the development of the port of Duisburg, which is the largest inland port in the world. It handles several dozen vessels a year. The port is also called in by the seagoing river vessels shipping regularly to the selected North Sea ports. In 2012 at the port of Duisburg 63.3 million tonnes of cargo in the relations water-road, water-rail and rail-road was handled. The containers are handled at a level of 2.6 million TEU.

The next example of inland shipping matching the integrated transport chains includes inland ports on the Rhine-Main-Danube waterway along with the port of Nuremberg, which belongs to the second biggest logistic centre in Europe. The other inland ports in Europe are being transformed into logistic centres treating inland shipping as a necessary component of the transport chains.

The above mentioned issues with regard to inland navigation, as well as actions taken by the shipowners, shippers, forwarding agents, logistic operators related to creating integrated freight transport systems, let us state, that the importance of inland shipping in the European transport system will not be diminished, and in fact it should to increase, which will be supported by the EU policy related to the development of transport in Europe.

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