Koncepcje innowacyjne rozwoju systemów transportowych z wykorzystaniem wodnych dróg śródlądowych.

Słowa kluczowe: sieci transportu śródlądowego, koncepcja innowacyjna, żegluga regularna, żegluga trampowa, port rzeczny, intermodalność.

Streszczenie
Żegluga śródlądowa jest najstarszym rodzajem przewozów towarowych i pasażerskich i liczy około 5000 lat. W obecnych czasach ta gałąź transportu ponownie nabiera znaczenia, co wymaga zmian organizacyjnych oraz podwyższenia skuteczności systemów obsługiwanego. Wygania te związane są z pewnymi zmianami koncepcyjnymi. Wynika to z faktu, że transport kombinowany kolejowo-drogowy szeroko stosowany w XX wieku coraz częściej zmaga się z wysokimi kosztami zewnętrznymi obejmującymi koszty odnowiania środowiska, koszty kongestii oraz koszty związane z poważnymi skutkami wypadków samochodowych. Doświadczenie krajów UE pokazuje, że innowacyjne podejście do organizacji transportu śródlądowego jako podstawowego ogniwa zintegrowanych systemów transportowych może pomóc rozwiązać te problemy.

Innovative Conceptions Impacts on Development System of Inland Navigation Network

Key words: inland navigation networks, innovative conception, linear shipping, tramp shipping, river port, intermodal, multi-trailer system, “multi-points” mode

Summary
Inland navigation is the oldest mode of the cargoes and the passengers’ traffics, counting near 5000 years. Now this transport mode gets main importance again, that requires innovative changes in the inland waterway networks, vessels and its service systems. It is connected by that combined rail/road transport widely used in XX century is currently struggling with high external costs along the main traffic corridors of the Trans-European Transport Network, including costs of environment renewal, congestion consequences and refund of traffic accidents charges. Experience of some EU countries has shown, that innovative approaches to the organization of inland navigation as element of integrated transport systems could help to solve these problems.
1. Introduction

The basic purposes of Poland transport development are creation of favorable conditions for fuller and effective satisfaction of region’s economy needs and the country as a whole in sustainable transport services, expansions intra-EU transportations, competitiveness increase of Polish commodity producers and carriers in the world transport markets, and also of population mobility, at simultaneous reduction traffic congestion on roads, railways etc. and decrease environmental impacts. One of directions for achievement of these purposes is development inland shipping networks on the basis of innovative traffics technologies that answer the directions of EU transport policy:

- to make better integration of Poland’s inland shipping into the common European transport system;
- to create favourable conditions for the development of the inland shipping;
- to encourage business to widen use of the inland navigation;
- to format conditions for quality services of the passengers with disabilities;
- to coordinate development of Poland’s transport infrastructure with the purpose of fuller integration with EU logistical systems for wide unobstructed transportation;
- to optimum of transport process with the purpose of transportations quality improvement and decrease the transport expenses in final cost of the goods;
- to create of conditions for tariffs decrease by means of the transportation capacity increase of Poland’s transport;
- to effective localization of the intermodal logistical terminals;
- to increase of investment projects funds for quickly development of a transport infrastructure network and the best use of available resources;
- to reduction of a trucks traffic which is meeting the requirements EU to increase waterways transportation (towing) and providing convenient connections into landside/waterside networks intra- EU and outside- EU;
- to create conditions for promoting increase of a service quality (information, safety, accesses)

If problems of a congestion and pollution are obvious it is necessary to search for other ways of the freight/passengers transportation guaranteeing higher carrying capacity and environment friendly, namely, a railway, short-sea shipping, inland navigation. The European Union has for some time recognized the great potential that Europe's inland waterway network has for freight and passenger transport. Inland waterway transport is considered rather cheap and efficient, reliable, safe and environmental friendly particularly compared with road transport.
2. Basics tasks and trends

Limitation of resources on development of inland waterway transport demands their concentration on the major directions according the Poland’s national interests. In this connection on the analysis basis of modern experience, dominant importances for inland navigation development are:

– R&D on the segment market of inland navigation, with the purpose: preservation of traditional waterways cargo-carrying and development of new inland waterways routes;
– construction of the innovative vessels for short-route consignment delivery for freight/passengers service on the small rivers, e.g. small-draft vessels;
– modernization of passenger vessels according a comfort conditions;
– development of a coastal and riverside infrastructure for service passengers;
– widening of material base of waterborne transport education;
– modernization of shipbuilding and repair yards,
– enlargement, reconstruction and modernization of inland ports (see Table 1).

The decision of the indicated problems will allow using effectively inland waterway transport, to lower transport expenses, to improve an ecological situation, to provide safety of traffics, to increase number of workplaces. Inland navigation using super-size tugboat/barges systems, also as novel self-propelled vessels can have the great future. Depending on freight traffics capacity, tugboat/barges systems can be using “point-to-point” (linear shipping) or “multi-points” (tramp shipping) schemes that are defined by transportation profitability.

In the rivers with the limited fairways sizes, expedient tugboat/barges systems equip an articulate architecture, more effective in comparison with self-propelled ships. The role of inland waterway transport in the common EU transport system will be defined by competitiveness and innovative forms of servicing. In this situation the main goals of EU transport politics are: organization stable and quality service of cargo flows; improvement of interoperability intra multimodal systems; free consignors from superfluous transport risk; preparation of conditions for an innovative conceptions implantation e.g. intermodal cargo-carrying according “Trunk &feeder” scheme.

Inference 1. The transport potential of the inland navigation are:
– the develop of inland waterway systems for safe navigation;
– the accessibility of inland port’s infrastructure for cargo/passengers flows;
– the levels of the transport services (must be satisfactory for passengers);
– the transportation time and tariffs (must be satisfactory for consignors);
– the compatibility in the worldwide logistic chains.

In future transport development is possible 30-40% of cargo’s volume will be transmitting from road to inland waterways.
<table>
<thead>
<tr>
<th>Ports classes</th>
<th>Ports zones</th>
<th>Wharfs</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inland ports</td>
<td>Passenger’s departure /arrival area</td>
<td>4 – 6 wharfs for passenger vessels, 2 – 4 wharfs for recreation boats, <strong>ΣL</strong>: 800-1000 m</td>
<td>A modern terminal building with: services facilities, e.g. restaurants, hotel, ticket office, etc. port facility security, e.g. personal protection system, policies, surveillance</td>
</tr>
<tr>
<td></td>
<td>Container’s dispatching area</td>
<td>3 – 5 container wharfs, 2 – 4 wharfs for RO-RO freight, 1 – 2 wharfs for heavy weights, <strong>ΣL</strong>: 800-1200 m</td>
<td>Open warehouses: <strong>S</strong>: 5000-15000 sq. m, with 500-1500 sockets for refrigerated containers Cranes: portal 5-12; floating 3-5; others 5-15 units Straddle carriers, platform scales etc.</td>
</tr>
<tr>
<td></td>
<td>Dry-bulk dispatching area</td>
<td>10 – 30 wharfs, Trans-shipment of coal, grain, gravel etc., 2 – 4 wharfs for reloading grain, <strong>ΣL</strong>: 1000-3000 m</td>
<td>Warehouses: open <strong>S</strong>: 150 000 – 800 000 sq. m, closed <strong>S</strong>: 20000-100000 sq. m Cranes: portal 8-30; floating 5-25; others 10-40 units Straddle carriers, forklifts, platform scales, suppressor-pilars, clam-type suppressors, piping, platform scales</td>
</tr>
<tr>
<td></td>
<td>Liquid bulk dispatching area</td>
<td>3-10 wharf, Trans-shipment of crude oil and oil products, <strong>ΣL</strong>: 500 – 1700 m</td>
<td>Inflammable stores: closed <strong>V</strong>: 250000-500000 t Pipelines, oil-line pumps, field pumps Safety system, incl. monitoring system, electronic surveillance, fire fighting equipment etc.</td>
</tr>
<tr>
<td></td>
<td>Passenger’s departure /arrival area</td>
<td>1-2 wharfs for passenger ferry, 1-2 wharfs for recreation boats, <strong>ΣL</strong>: 150 – 300 m</td>
<td>A terminal building with: services facilities, e.g. waiting room, ticket office and café port facility security, e.g. personal protection system, fences, electronic surveillance, policies, etc.</td>
</tr>
<tr>
<td></td>
<td>Container’s dispatching area</td>
<td>1-2 container wharfs, 1-2 RO-RO wharfs, <strong>ΣL</strong>: 250 – 450 m</td>
<td>Open warehouses: <strong>S</strong>: 20000-300000 sq. m with 200-400 sockets, platform scales, Cranes: portal 2-4; others 2-4 units</td>
</tr>
<tr>
<td></td>
<td>Dry-bulk dispatching area</td>
<td>3-7 wharfs, Trans-shipment of coal, grain, gravel etc., <strong>ΣL</strong>: 600-1400 m</td>
<td>Warehouses: open <strong>S</strong>: 100000 – 600000 sq. m, closed <strong>S</strong>: 10000-70000 sq. m Cranes: portal 3-10; others 5-7 units</td>
</tr>
<tr>
<td></td>
<td>Local ports</td>
<td>1-2 wharfs for passenger vessels, L: 50 - 100 meters</td>
<td>Wharf-boat, mooring equipment, ticket office, monitoring system café</td>
</tr>
</tbody>
</table>

3. Management of the inland waterway transportation

Any enterprise including enterprise-carriers has three interconnected purposes of management:
1. provide qualitative a service for passengers and consignors;
2. implement effectively financial policy;
3. increase competitive using the marketing methods.

Rys.1. Składowe zarządzania transportem śródlądowym

Achievement of these purposes is possibly thanks to rational planning, the organization and the transportation control (Shown in Fig.1).

4. The characteristic of inland transport process

General purpose Inland Shipping Networks are cargoes and passengers transportation, and its elements:
- Rivers and coastal ports (logistical centers) are intended for a cargo receipt from consignors (including - wharfs, cranes, warehouses).
- Inshore terminals are intended for a cargo receipt from any vessels.
- Entrance locks are intended for lockage a vessels on canals.
- Sluices are intended for sluicing a vessel on the rivers.
Iouri Semenov

– Fairways are intended for freight/passengers service under hauling from a PoO (Port of Origin) to a PoD (Port of Destination). For estimation requirement of vessels cargo-carrying capacity (NT-netto tonnage & DWT-deadweight tonnage) can be recommended the graphic procedure. Let’s investigate two tasks.

**Task A.** Vessel using under “point-to-point” mode i.e. linear shipping. At that this vessel is loading by one type of a cargo (Illustration in Table 2).

**Table 2**

<table>
<thead>
<tr>
<th>Task A. Graphic interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>

**Task A:** River-tanker loading by one type of a cargo

<table>
<thead>
<tr>
<th>NT changes vs. changes of the river-tanker’s draught</th>
<th>The river-tanker tonnage</th>
</tr>
</thead>
<tbody>
<tr>
<td>NT</td>
<td>The river-tanker tonnage</td>
</tr>
<tr>
<td>NT_max</td>
<td>The river-tanker tonnage</td>
</tr>
<tr>
<td>Light cargo</td>
<td>Designed</td>
</tr>
<tr>
<td>Designed</td>
<td></td>
</tr>
<tr>
<td>Heavy cargo</td>
<td>V_min</td>
</tr>
<tr>
<td>T_min(DW_min)</td>
<td>V_max</td>
</tr>
<tr>
<td>T_max(DW_max)</td>
<td>Hull</td>
</tr>
</tbody>
</table>

*Source: Author’s research*

The analysis allows suggesting next opinion; that the vessel’s rational use probably only in case of the designed cargo’s transportation. From the practice, such situations don't exceed 0.3 – 0.4 likelihood in the traffics using inland waterways navigation. In this case condition of river vessels profitability requires stable freight flows, and can be used under the shuttle-type transportation scheme.
**Task B.** Vessel using under “multi-points” mode i.e. tramp shipping. At that this vessel is loading by two types of a cargo. Suppose we have demands to loading, namely light freight and heavy freight. (Illustration in Table 3).

*Table 3*

<table>
<thead>
<tr>
<th>NT changes vs. changes of the river vessel’s draught</th>
<th>The river vessel tonnage</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image.png" alt="Diagram" /></td>
<td><img src="image.png" alt="Diagram" /></td>
</tr>
</tbody>
</table>

Source: Author’s research

The analysis allows suggesting next opinion; the linear shipping has the lower functional efficiency, than tramp shipping under next conditions, namely small partial shipments or short consignment delivery. Thus there is a basis to assert, that inclusion of inland navigation in intermodal networks will allow raising its functional efficiency, especially in conditions of unstable cargo flows. Therefore river-vessels have profitableness if they are included into transport networks according “Trunk & feeder” scheme. The further increase of river navigation’s efficiency depends from feeder transport throughput which requires wide implantation of new solutions, e.g.:

- MTS (Multi-Trailer System) as Long Train, Short Train;
- Conveyor-belt system that can eliminate up to 120,000 truck trips per year.

**Inference 2.** The competitiveness, vessels tonnage, terminals productivity and waterways throughput, possible environmental impacts, traffic safety and external costs have to be taken into account to compare transport schemes used.
The decisive criteria for the selection of the effectiveness means of transportation are minimal transportation risk, maximal operating speed, maximal carrying ability under minimal services price.

5. Routing for inland navigation's tasks

The inland navigation schemes can be defined as combination the direct and return traffic’s routes of freight/passengers flows. The greatest inland navigation effectiveness can be achieved if empty trips will be minimizing and the mutual combination of different type’s vehicles using under feeder’s schemes will provide for fully use of their carrying capacity, speeds, etc. As an illustration of effectiveness criteria can be offered several functions, namely “A minimum of the operating expense (OPEX) at the time of the circular routes”; “A minimum of the empty trips inside the intermodal chains”; ”A maximum of the vehicles carrying capacity”.

Multi-ways inland navigation

Throughput of the inland navigation can be estimated by two methods, namely graphically and analytically. The graphic approach to base on next technique:
– to each route must be forming the parallel route;
– throughput estimation can be put in the practice according parameters ”the circle’s shipping route period” and “the time-table period”

The circle’s shipping route period is dependent from operational speed of the vessel (tugboat/barges system), distances between ports and loading/unloading time at the each port. Traffic simulation allows asserting that use multi-ways regime in inland navigation have great throughput and can be used as solution in transport networks differing high level of congestions, traffic jams etc.

One-way inland navigation

For estimation of the time-table period under condition of a one-way traffics define time when this route will be occupied servicing other vessels or tug/barges systems.

As regards one-ways regime this has lower throughputs than multi-ways regime. It’s evidential statement. There are the some recommendations on its increase. For example, is possible the throughput increase owing to the fact that the vessels or tug/barges systems will be to move according serial operation mode. The unilateral passing of the vessels (tugboat/barges systems) in comparison with bilateral passing of the vessels (tugboat/barges systems) essentially reduces throughput of the inland waterway system. In this connection it is recommended to use bilateral regime for the vessels (tugboat/barges systems) passing.
Organization rules of the inland navigation

Dispatches interval usually is not measured by the days as whole items. Fractional value of the dispatches interval complicates a problem of the vessels movement coordination on the one hand; on the other hand, takes place the compatibility violation of the vehicles and the ports, tug and tonnage etc. For eliminating these negative phenomena, the numerical assessment of the dispatches interval usually approximate to the nearest integer. It enables, coordinate a dispatches time and arrival time of the vessels (tugboat / barges systems) into destination river ports. Let’s introduce several rules in purposes successfully organization of the inland navigation.

Rule 1. In situation when the dispatches interval less than day for fruitful organization of the inland navigation formation two and more freight traffic lines is necessary under the condition that between everyone departure will be appropriate interval.

Rule 2. In situation when the dispatches interval is equal to fractional number exceeding one day:

- first of all, evaluate interval duration afterward equate interval to the nearest smaller number of the days as whole items;
- secondly, assess an interval between vessel’s departure afterward increase an interval to the nearest integer;
- thirdly, pick out one form of the movement organization out of two possible i.e. linear shipping (“point-to-point”) or tramp shipping (“multi-point”).

6. Conclusion

1. At present, the implantation of intermodal transport conception is the most important goal of EU on the transport services market. Nevertheless, not more than 10% of all exchanged cargo flows in European regions are practically transported by intermodal scheme.
2. Management and transportation organization must be improved (e.g. new approaches to consignors satisfaction, network quality management and introduction risk-managing methods).
3. In a world of linear transport innovation, future transport demand can be forecast in terms of structurally stable relationships between factors like growth rates, elasticity and subsequently market shares of transport technologies based on expert assessment of their potential relative to competitors, suppliers, etc.
4. The economic efficiency, capacity reserves of the ships, terminals and waterways, environmental impacts, traffic safety and external costs have to be taken into account to compare transport schemes used. The decisive parameters for the selection of the means of transportation are competitiveness, availability, safety, reliability, speed and price.
Reference

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