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THE ROLE OF INLAND WATERWAY TRANSPORT IN CITY LOGISTICS

Abstract

The urbanization process indicates that today's cities are the main centres where transport demands accumulate. This causes, in effect, an increase in freight and passenger traffic, which in turn contributes to a rise in environmental and noise pollution, accidents, and thus a deterioration of the quality of life in cities. Bearing in mind the numerous advantages of inland waterway transport, it can be assumed that in cities located near inland waterways, this branch can be seen as an important link in the urban logistics chain. Therefore, the aim of this article is to indicate the possibility of using this mode of transport to handle transport needs in cities. The article uses the method of desk research, based on analysing and verifying facts and merging existing statistical data on the urbanization process and experiences related to the use of inland waterway transport to handle various transport needs in selected European cities. The article shows that in cargo transit, the use of inland waters in urban logistics is an attractive branch of transport, not only in such areas as transportation of construction materials or waste collection but also in transport related to the supply of stores. Positive experiences of Western European cities should inspire action to increase the use of this branch in urban logistics in Poland, e.g., in the city of Gdańsk, located above the Motława waterway.

Keywords: transport economics, city logistics, inland water transport

JEL: R41

Introduction

The ever-increasing urban population generates a growing demand for efficient transport of cargo and passengers. This phenomenon de facto increases costs of the removal of municipal and industrial waste along with the cost of supplying cities with raw materials and goods, and it results in an overload of public transportation. Increased cargo and passenger traffic contributes to the deterioration of the quality of life in cities, through the rise of accident rates as well as environmental and noise pollution. Although in many European cities, such as Paris, London, Brussels and Amsterdam, air quality is improving, the problem of pollution in these cities is still serious due to the significant role of vehicle usage in handling transport needs.

The increase in demand for transport in cities also causes an increase in the demand for transport infrastructure, the adaptation of which to current needs is particularly difficult, especially in historic areas of cities. According to the concept of sustainable transport development, there is a need for better integration of various transport branches and use of more environmentally friendly options. It can be assumed that in many cities located near waterways there are right conditions to include inland water transport for servicing the cities, both for passenger and freight transport, and thus to relieve vehicle transport and provide better service to those parts of cities that are not available for car traffic. Assuming that inland water transport can be perceived as a link in the logistics chain in cities, the aim of the article is to indicate the possibility of using this mode of transit to handle transport needs in cities, both in passenger and freight traffic.

1. Methodology and theory

The desk research method was used to analyse the possibilities of using inland water transport in servicing the transport needs of cities, which consisted of analysis and verification of facts and merging existing statistical data from various sources, including scientific articles, analytical reports, the Internet, and the press.

In the first place, the article discusses the main transport problems of contemporary cities linked to urbanization and then analyses the city-river relations as the main factor determining the inclusion of inland waterway transport for servicing of riverside cities. Next, the article presents examples of using inland waterway transport for handling various transport needs in selected European cities.

The issues raised in the article are part of the concept of sustainable transport development policy. According to the definition of the European Federation for Transport and Environment, sustainable transport is a "movement that meets the mobility needs of today's generations at the same time caring for the state of the environment, living conditions and opportunities for the economic development of future generations ..." (Crew, 2013, p. 83). Thus, transport, also in cities, to be considered sustainable, must meet the conditions of environmental, economic,

and social rationality. Therefore, taking into account these main aspects in the sustainable development of city transport should mean more extensive use of public and non-motorized transport, and in the cargo transport – use of low-emission modes of transportation. This postulate is largely met by inland waterway transport.

2. Results

Based on the conducted research, it has been shown that inland waterway network is actively involved in servicing transport needs in many European cities. It is an especially attractive branch of transportation in such areas as:

- deliveries to stores and food outlets in cities, especially in historical areas,
- courier services,
- transportation of construction materials and energy resources for the needs of cities,
- garbage and waste pick up services (e.g. paper for recycling)
- general people transport services,
- tourist transport.

3. Contemporary challenges for urban transport

For years, there's been a clear urban living trend that has seen quite a bit of growth (Figure 1). It's expected that in 2050, almost 84% of Europeans will live in cities. In the case of Western Europe, the increase in the population living in cities will be even higher. In that part of Europe, by 2050 people living in cities will amount to 87%, which means that compared to 2010, the number of urban residents will increase by 15%. Together with the increase in the number of city dwellers, their wealth and propensity to mobility also increase. The effect of these changes is the problem with meeting transportation needs in the city, often manifested by congestion and, as a result, longer transport time (Fig. 2), increase in transport costs, and losses incurred by passengers due to the extended transport time.

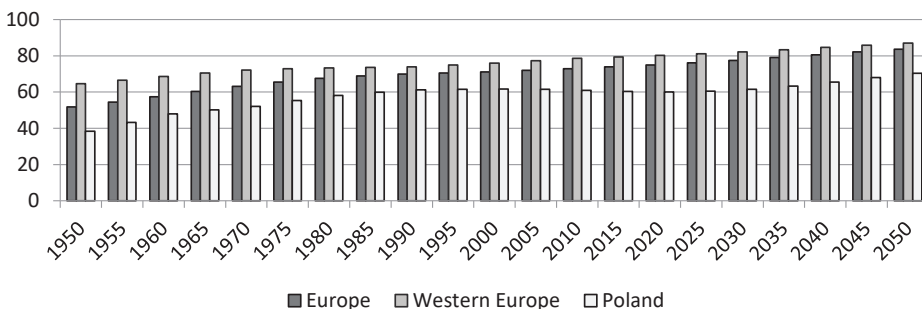


Figure 1. Changes in the proportion of people living in cities in years 1950-2050 (%)
Source: (own elaboration, World Urbanization Prospects, 2018)

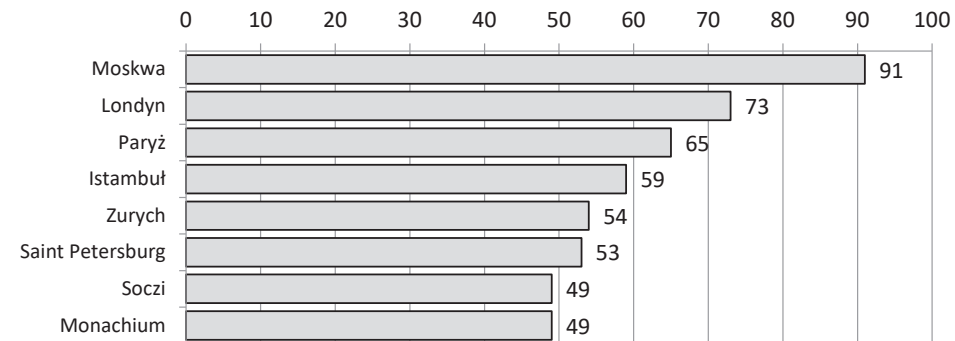


Figure 2. The most congested cities of Europe (number of hours spent waiting in a traffic jam by one person annually)

Source: (own elaboration, Travel News, 2018)

In Poland, in 2017, the cities with the longest traffic jam wait times during peak hours included:

- **Kraków** – 36h,
- **Warsaw** – 35h,
- **Poznań** – 30h,
- Szczecin – 28h,
- Wrocław – 27h,
- Gdańsk – 26h,
- Łódź – 24h,
- Katowice – 17h.

An especially difficult situation occurs in city centres, often with historic buildings, where the transport system is not adjusted to modern standards, while any changes are virtually impossible due to the historical value of the areas. Such regions are often closed to car traffic, which causes a lot of problems when it comes to deliveries, and satisfying passenger transport needs, especially since those are the areas most frequented by tourists.

4. Conditions for the development of inland waterway transport in cities

The primary condition for the inclusion of inland waterway transport in the transport services of cities is the existence of a waterway running through the city or adjacent to it. Many cities meet this condition because, in the earliest times, rivers were an important factor in the location of settlements. Due to the availability of water, the possibility of transport by waterways, and for defence reasons, cities were often located near rivers that were able to meet these diverse needs.

Relations between the city and the river, depending on the local conditions and needs, are different. When considering the localization of the city in relation to the river, the following types of location, among others, have been distinguished:

- Island-type, defensive (Paris, Wrocław, Kalisz, Opole),
- Bottom of a valley (Duisburg, Leipzig, Poznań, Wrocław, Bydgoszcz, Gdańsk),
- On an edge and on an embankment (Magdeburg, Toulouse, Płock, Grudziądz, Włocławek),
- At forks of rivers (Moscow, Lyon, Berlin, Krosno),
- At a river's mouth near the sea (Lubeck, Hamburg, Gdańsk, Szczecin).

From the city-river relation's point of view, the spatial structure of cities is also important. It is possible to distinguish several types of spatial systems of riverside cities which define the layout of streets and squares: longitudinal, comb, axial, and landscape (Fig. 3).

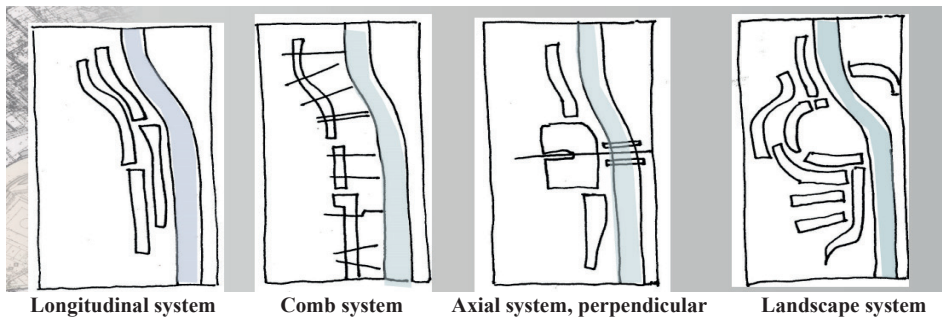


Figure 3. Urban structure of a riverside city
Source: (Kafka, 2018)

Each of the layouts allows for a slightly different relationship between the city and the river. In each case, however, there is a possibility of the most beneficial transport use of the river for a given system.

5. Inland water transport in passenger transport in cities

An important area of application of inland waterway transport in the areas of seaports and shipyards may be commuting to work. Shipping often provides the best connections in these areas. The use of passenger ships for this type of transport would significantly reduce traffic peaks and their consequences. Transport of this type is relatively easy to plan because the demand for it is predictable and may be implemented in cooperation with interested business entities.

Inland waterway transport can play an important role as a public transport link. The rationale for the development of this type of transport is primarily based on:

- location of most large cities near waterways,

- very few requirements for passenger ships in relation to waterways (good possibility of adapting the fleet to local conditions),
- relatively few requirements for passenger harbours,
- problems with parking in city centres,
- high parking fees,
- congestion on roads,
- significant threat to road safety,
- many closures of city centers to passenger car traffic (Wojewódzka-Król, Rolbiecki, 2014, s. 266).

Waterways, as previously mentioned, run through the most crowded areas of cities – their centres, which creates opportunities for their use for transport in selected relations. A requirement for success, however, is the treatment of inland waterway transport analogously to other modes of transportation, both in terms of price that must be attractive and comparable with the cost of other public transport modes, as well as in terms of coordinating timetables with transport needs. Transport of this type is not usually large in volume; however, it can play an important role in peak rush hours. Together with the growing attention to the development of riverside areas in the cities, the demand for tourism travel by water is growing. For tourists, an attractive offer in terms of touring a city may be the use of ships adapted for this purpose, which, at the same time, provide many additional services e.g., culinary. Such cruises have been very popular in Paris for years now, and they are increasingly organized in other European cities, including Poland. In Bydgoszcz, for example, cruises in a solar powered boat serve as a water tram and an element of public transport, but they are also a tourist draw.

6. Transport of cargo by water in cities

One of the main consequences of the urbanization process is the concentration of cargo flows in cities. As a result, cities are included among the unique places where problems related to the transport of cargo accumulate. Freight transportation in cities is carried out primarily by means of vehicle transport. Research shows that from all vehicle transport of cargo, about 10-15% takes place in urban areas. However, the share of these areas in the total consumption of energy and pollutant emissions by vehicle transport is much higher; the share in energy consumption is 19%, in CO₂ emissions – around 25%, NOX – 30%, and particulate matter – 50% (Janjevic, Ndiaye, 2014, p. 280). Transport carried out by vehicles is ever more often taken over by other branches of transportation, to reduce congestion on roads, air pollution in city centres, increase safety on motorways, or reach areas closed to car traffic. In terms of the location of cities on waterways, inland waterway transport, as the most environmentally friendly branch of land transport, can help reduce transport problems in cities, as well as external transport costs, by taking over some of those transit responsibilities. These types of outcomes can be observed in such European cities as Lille, London, Brussels and Paris. In London, inland waterway transport accounts for over 6% of cargo transport – that's about 9 million tonnes per year (Transport for London, 2013), and in Brussels, the share of inland

waterway transport in urban areas is estimated at 20% (Central Commission for the Navigation of the Rhine, 2018).

The effects of this type of use of inland waterway networks can be obtained by including this branch of transport in traditional modes of transit as well as in new areas of application (Table 1). Most of all, traditional transport spheres include the transportation of building materials and energy resources. According to the experiences of Western European cities, inland waterway transport can also play an essential role in new areas such as:

- daily transport of goods to cities,
- transport of rubbish and recyclable materials,
- transport of courier parcels.

The processes of urban expansion and modernization generate significant demand for building materials. In cities located near waterways, this demand can, to a certain extent, be satisfied by the aggregate extracted from rivers as part of their maintenance and deepening.

Table 1. Review of city logistics solutions using inland navigation

Initiative	Stakeholders involved	Estimated environmental impact												
Beer Boat (Utrecht): deliveries to local shops, hotels and restaurants	<ul style="list-style-type: none"> • City of Utrecht (Department of PublicWorks), Four breweries, • One catering industry wholesaler, • 65-70 final customers 	Reduction of emissions:												
		<table border="1"> <thead> <tr> <th>Beer Boat</th> <th>Particales</th> <th>CO₂</th> <th>NOx</th> </tr> </thead> <tbody> <tr> <td>Diesel</td> <td>74%</td> <td>27%</td> <td>85%</td> </tr> <tr> <td>Electric</td> <td>98%</td> <td>94%</td> <td>100%</td> </tr> </tbody> </table>	Beer Boat	Particales	CO ₂	NOx	Diesel	74%	27%	85%	Electric	98%	94%	100%
		Beer Boat	Particales	CO ₂	NOx									
Diesel	74%	27%	85%											
Electric	98%	94%	100%											
Mokum Maritiem (Amsterdam): deliveries to local shops and waste transport	<ul style="list-style-type: none"> • Icova (waste transportation), • Koninklijke Saan (transport operator) and • 3 tour boat companies (Rederij ,t Smidtj'e, Rederij de Nederlanden and Canal Company) 	Information not available												
Vert Chez Vous, Paris (France): parcel deliveries	<ul style="list-style-type: none"> • Vert chez Vous (city logistics operator), • Port of Paris, • Navigable Waterways of France, • Euroflots (river transport) 	Allows avoiding :												
		<table border="1"> <thead> <tr> <th></th> <th>heavy-duty vehicles</th> <th>kg CO₂ / day</th> <th>kg CO₂ /year</th> </tr> </thead> <tbody> <tr> <td>Now</td> <td>15</td> <td>207,9</td> <td>51,975</td> </tr> <tr> <td>A goal</td> <td>30</td> <td></td> <td>103,950</td> </tr> </tbody> </table>		heavy-duty vehicles	kg CO ₂ / day	kg CO ₂ /year	Now	15	207,9	51,975	A goal	30		103,950
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Now	15	207,9	51,975											
A goal	30		103,950											
DHL floating distribution centre, Amsterdam: parcel deliveries	<ul style="list-style-type: none"> • DHL (transport operator), • City of Amsterdam 	Allows avoiding:												
		<table border="1"> <tbody> <tr> <td>Cars</td> <td>10/ day</td> </tr> <tr> <td>car-kilometers</td> <td>150,000/ year</td> </tr> <tr> <td>liters of diesel</td> <td>12,000 liters/year</td> </tr> </tbody> </table>	Cars	10/ day	car-kilometers	150,000/ year	liters of diesel	12,000 liters/year						
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liters of diesel	12,000 liters/year													

Initiative	Stakeholders involved	Estimated environmental impact				
Franprix, Paris: supermarket deliveries	<ul style="list-style-type: none"> • Franprix (supermarket retailer), • Norbert Dentressangle (logistics service provider), • Navigable Waterways of France, • Port of Paris, Terminal de Seine and • Paris Terminal (dock work), SCAT (river transport) 	At full volume, the will allow Avoiding: <table border="1" style="margin-left: 20px;"> <tr> <td>Road transport</td> <td>450,000 km</td> </tr> <tr> <td>CO₂ emissions in the entire supply chain</td> <td>37%</td> </tr> </table>	Road transport	450,000 km	CO ₂ emissions in the entire supply chain	37%
Road transport	450,000 km					
CO ₂ emissions in the entire supply chain	37%					
Sainsbury's, London: transport of food to supermarkets	<ul style="list-style-type: none"> • Sainsbury's (supermarket chain), • Port of London 	If extended to all stores in the same area, the system could avoid some 350,000 road km every year				
POINT-P, Paris: transportation of palletized construction material	<ul style="list-style-type: none"> • Point-P (construction material distributor), • Le Freedom (river transport), • Navigable Waterways of France, • Paris Port Authority 	Allows avoiding per year: <table border="1" style="margin-left: 20px;"> <tr> <td>Trucks</td> <td>2000</td> </tr> <tr> <td>CO₂</td> <td>220 t</td> </tr> </table>	Trucks	2000	CO ₂	220 t
Trucks	2000					
CO ₂	220 t					
Velib (Paris)	<ul style="list-style-type: none"> • JC Decaux, • Mairie de Paris 	Information not available				
Lille: river transportation of domestic waste	<ul style="list-style-type: none"> • Port of Lille, • Lille urban community 	Information not available				
Paris (France) Paper recycling by barge,	<ul style="list-style-type: none"> • SITA and Sycotm for the transports, • UPM Kymmene, • Paris Port Authority, • Rouen Port Authority, • NavigableWaterways of France, French • Environment and Energy Management Agency 	Allows avoiding per year around : <table border="1" style="margin-left: 20px;"> <tr> <td>Truck movements</td> <td>4,500</td> </tr> <tr> <td>Forssil energy consumption and CO₂ emmission</td> <td>40%</td> </tr> </table>	Truck movements	4,500	Forssil energy consumption and CO ₂ emmission	40%
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Source: (Janjevic, Ndiaye, 2014, p. 282).

In Western European cities, inland navigation is commonly used to transport this type of cargo. In Brussels, inland waterway transit mainly meets the needs related to the transport of construction materials, serving 57% of that demand. Also, in the Paris area, inland water transport mainly carries building materials. The share of this branch in the transportation of construction materials is 75% and in the transport of agricultural products (9%) (Janjevic, Ndiaye, 2014, p. 280). Transportation of building materials by inland waterways shows high development dynamics in handling the transport needs of cities. It is estimated that this type of transport in Paris (Figure 4) increased between 2015 and 2017 by almost 20%.

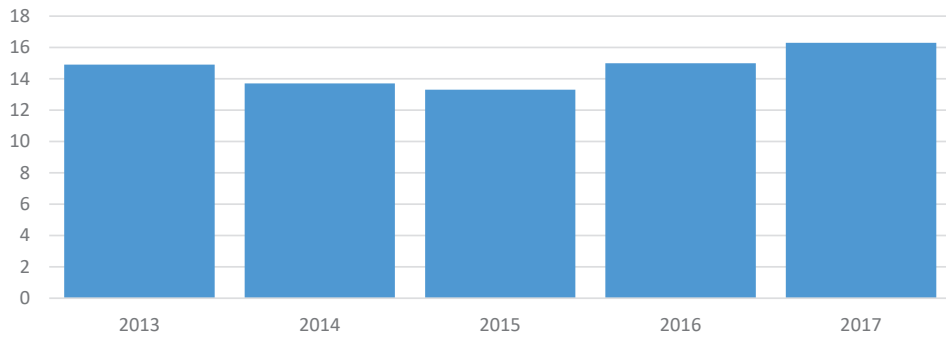


Figure 4. Reloading of building materials in a river port Paris (mln tonnes)
Source: (Central Commission for the Navigation of the Rhine, 2018)

Each agglomeration also reports the need for various types of energy resources, which can also be transported by water, thus reducing road congestion and accidents. In Brussels, for example, inland waterway transport accounts for 26% of the needs related to the transit of petroleum products (Janjevic, Ndiaye, 2014, p. 280).

The new field of using inland water transport in cities is the daily supply of stores. For example, the container shipping traffic between the ports of Bonneuil-sur-Marne and Paris la Bourdonnais, delivering supplies to 300 supermarkets, increased from 25,000 TEU to 34,000 TEU from 2014 to 2017 (Figure 5). The research shows that the dynamic growth of container transport via inland waterways will be primarily shaped by container traffic carried out as part of urban logistics. Another example of the use of inland waterway transport in urban logistics is the use of inland vessels in supplying gastronomic establishments located near waterways.

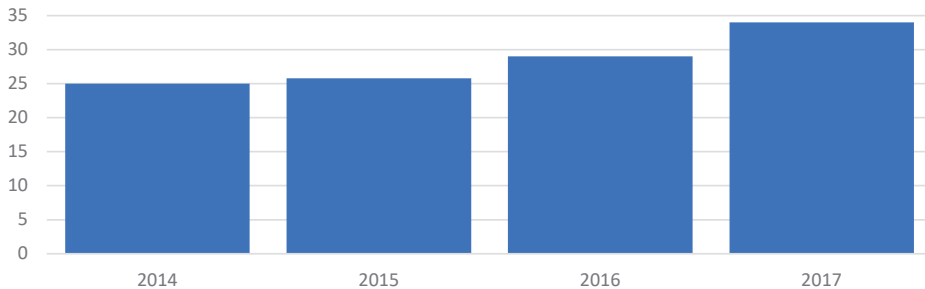


Figure 5. Container traffic between the ports of Bonneuil-sur-Marne and Paris la Bourdonnais in servicing supermarket chains (thous. TEU)
Source: (Central Commission for the Navigation of the Rhine, 2018)

In the process of supplying cities, another novelty is a floating warehouse – a self-unloading ship that functions as a storehouse of parcels (INE, 2019). An innovative aspect of this project is that to compensate for the loss of time associated with shipping, barges are used as warehouses in which during the travel employees sort goods and prepare parcels containing various products for final recipients.

The waterways are also used by courier companies to deliver parcels. Such experiments were carried out, for example, in Paris, where one of the courier companies delivered parcels using ships and bicycles (Central Commission for the Navigation of the Rhine, 2018). In Amsterdam, DHF provides courier services as part of the Floating Distribution Centre. To this end, the company uses a ship specially adapted for this type of shipments on the network of river channels, and the last stage of delivery is carried out by bicycle couriers. This solution is a source of numerous benefits, as this delivery system is not dependent on the road or traffic situation (Janjevic, Ndiaye, 2014, p. 283).

An additional new area of inland water transport in urban services is the transport of rubbish. The European Union generates 2.3 billion tons of garbage annually, of which 60% is currently transported by vehicles. Thinking in terms of a prospective solution to this problem, cities such as Brussels, Lille, Liege, London, Paris, The Hague, and others try to increase the transport of this cargo by water, thereby reducing congestion in cities, as well as transport costs and CO₂ emissions. The port of Lille has been taking care of waste transport by inland waterway since 1999 (Figure 6).

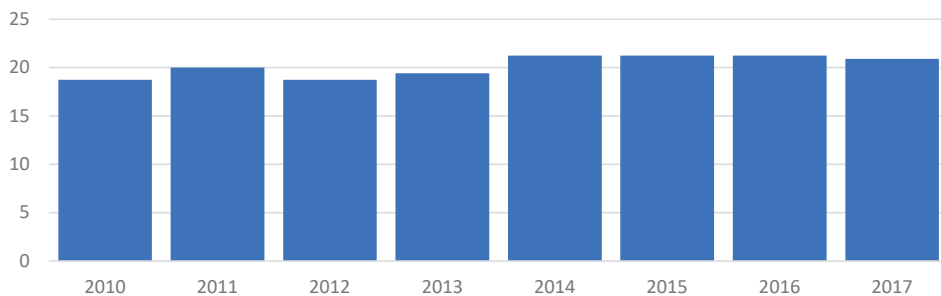


Figure 6. Transshipment of waste in the port of Lille (thous. TEU)

Source: (Central Commission for the Navigation of the Rhine, 2018)

Household waste and renewable waste are transported in containers to an energy waste treatment plant located in the northern part of the city and a recycling centre in the south of the city. It is estimated that the wastewater transport in Lille over the year replaces almost 12,000 trucks and reduces CO₂ emissions by 1500 tons. In the Netherlands, in the Amsterdam area, the transport of 140,000 tonnes of rubbish to the landfill site in Alkmaar via waterways removes 5,500 trucks from the roads each year. In Great Britain, rubbish-carrying barges replace 100,000 trucks annually (INE, 2008). Another niche, which is already used in some countries by inland waterway transport, is the transport of paper for the supply of municipalities and on the way back – recycled waste paper.

The development of inland waterway transport in the presented areas brings a reduction in external transport costs, which obviously has a positive effect on the quality of life in communities as well as the value of socio-economic development, in addition to alleviating transport problems that are particularly severe in these regions. The daily transport costs for a 25-ton truck and a 300-ton barge are

the same, so savings on transport costs can also be significant (Central Commission for the Navigation of the Rhine, 2018). Infrastructure requirements for this type of transport are insubstantial – waterways running through city centres generally have sufficient parameters for movement of these small delivery vessels. However, it is crucial to position the urban distribution centres very near the waterway while waste collection points, e.g., landfills, garbage, or incineration plants need to be located at least a short distance from the waterway.

7. Transport by inland waterways in Gdańsk

Gdańsk is an excellent example of a city predestined to include inland waterway transport in its urban logistics:

- The Main Town, with historical buildings, mostly closed to car traffic, is located along the Motława River (Figure 7),
- most grocery stores and restaurants in the area are located along the Motława River,
- urban structure – the comb arrangement is very beneficial for the river-city relations, as it provides convenient access to cargo collection points,
- Motława is a navigable shipping route, used for years for transport by inland waterway vessels, primarily by Żegluga Gdańska Sp. z o.o.,
- in the area of the main city, there are marinas where ships can be serviced.



Figure 7. Location of the Main Town in Gdańsk on the Motława River
Source:(Główne Miasto, 2019).

Unfortunately, so far the waterway in this area is mainly used for passenger transport, both for commuting and tourist needs. The inclusion of inland waterway transport for freight transport in this region is a significant challenge that would soften the increasing transport problems in Gdansk.

Conclusions

In summary, it can be concluded that inland waterway transport can play an essential role in the development of sustainable transport in cities. Thus far, these possibilities are used only on a small scale and mainly in passenger transport. However, innovative ship constructions, allowing for the expansion of this mode of transport, create a possibility that with the increase of population in cities located near waterways and resulting transport problems, the use of this mode of transit will gradually increase.

The presented experiences of cities in Western Europe may form the foundation for practical engagement and action, leading to broader use of inland waterway networks, especially in freight transport, in cities located near waterways in Poland, including, among others, in Gdańsk, which is located near the Motława waterway.

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