Assessment of Inland Passenger Water Navigation in Bydgoszcz-Torun Functional Area and its Development Concept

Jan Kempa ¹, Damian Iwanowicz ¹

¹ University of Science and Technology in Bydgoszcz, Poland
damian.iwanowicz@utp.edu.pl

Abstract. The article presents a brief analysis of functioning and development of passenger inland navigation in the functional area of Bydgoszcz and Toruń cities, as one of possible forms of urban ecological recreation. These forms are successfully used in some towns of Western Europe and are additional tourist attractions for visitors and also for the city residents. They offer another form of transport to be used by passengers who travel around the city. The functional area of the analyse towns is considered to be a Metropolitan Area of the Kujawsko-Pomorskie Voivodship and is situated in the central part of Poland. The authors have made a profound analysis of strategic and planning documents for the country and for the analyse area in terms of the passenger water transport development directions. Bydgoszcz-Toruń Functional Area (B-TOF) is characterized by a unique, on a global scale, connection of two water trails, that is, E-40 and E-70 making up the so called Bydgoszcz Water Node which increases tourist attractiveness of the area. Toruń also plays a very important role in the region and is its main tourist attraction. Its historical medieval urban area was entered in 1997 into a List of World Cultural Heritage of UNESCO. Having in mind the results of analysis of the current water passenger transport potential within BTOF it has been found to be worth developing. Extension of water connection in Bydgoszcz has been proposed as well as launching a water tram connection in Toruń. Moreover, a concept of water ways development on the remaining territory of the B-TOF has been presented. The planned water connections require determination of localizations for new water marinas. These localizations depend on the plans of local authorities as well as the infrastructure and territorial conditionings. All new localizations have been precisely characterized in terms of their construction, modernization and maintenance. It was also necessary to make appropriate prognoses of potential passenger currents. The prognoses have been performed for three separate social-economic development scenarios: optimistic, stable and regressive within three timescales, that is, 2020, 2025 and 2030. For this purpose, a simulation transport model, developed by the workers of the Department of Road Engineering and Transport, has been used. The article includes yearly costs of functioning and maintenance of Bydgoszcz and Toruń Water Tram and costs of the planned investments. Also the costs of tourist rest areas construction and maintenance have been calculated. Implementation of the proposed solutions will involve significant financial means. However, this kind of investments do not have to be profitable as they are meant to improve the tourist offer of Bydgoszcz-Toruń Metropolitan Area. They are supposed to improve the image of these towns in terms of ecology, sustainable forms of transport and attractive way of spending leisure time by citizens and visitors. It needs to be mentioned that recently the interest in water transport means has been systematically rising which can contribute to promotion of this ecological form of travel and boost its development.
1. Introduction

The number of duties we have to cope with every day, particularly in large urban agglomerations, involves the need to search for new, attractive ways of spending leisure time (recreation, relax, tourism etc.). The quality of leisure time is particularly important in a situation when there are more duties and less free time. Residents of large and medium towns tend to spend leisure time in green areas, far from buildings and streets filled with noise, traffic and fumes. This also applies to groups of tourists who come to big cities and are willing not only to do sightseeing but enjoy their natural values and appreciate ecological transport forms (bicycle, water tram, etc.).

In the Bydgoszcz-Toruń Functional Area (B-TOF) there are two big cities (Bydgoszcz, Toruń) and three medium towns (Nakło on Noteć, Koronowo and Solec Kujawski), which can take advantage of their natural geographic location, particularly the system of inland waterways. Moreover, Bydgoszcz is unusual place due to its geographical location, that is, intersection of two waterways of international range. E-40 and E-70 and Brda (so called Bydgoszcz Water Node). This location offers a significant potential for water related recreational services in the form of special passenger’s transports and ‘small’ individual tourism.

It is worth emphasizing that water transport belongs to the most ecological transport systems. However, now in Poland, it is underestimated, especially as regards passenger water transports, as in 2015 only ~1 mil. passengers used this service, that is, ~0.3% of the total number of passengers in the whole transport system [1]. This is caused by the fact that potential passengers choose to take this transport means almost always for sightseeing and recreational purposes. The article is based on work ‘Study of a sustainable development of transport systems of the Bydgoszcz and Toruń districts, with special emphasis on Bydgoszcz and Toruń’ [2].

2. Water transport development directions in the light of urban planning

Serious negligence in management and maintenance of Polish water ways has adversely affected inland water transport. It caused and still does, a marginal role of water transport in the Polish transport system. It should be stressed that though the role of water transport is insignificant it constantly decreasing which is reflected by the fact that in Poland, in 2000-2016, the share of inland water transport decreased from ~0.8% to ~0.4% [1].

The major problem of the Polish inland water transport, which is stressed in many studies (e.g. [3]), in the period to 2030 involves answering a question, „whether the standard of the Polish inland waterway navigation is to be raised to match the European level or the level from before their degradation”. The Polish government has given priority to revitalize the inland waterways and include them into the European system. Recently President of the Republic of Poland ratified the Convention AGN. One of the latest state documents [4] provides that the government commits to take actions to revitalize International Water Ways on the territory of the country (sectors E-30, E-40 and E-70). Moreover, the Ministry of Maritime Economy and Inland Water Ways has included the assumed the scope of revitalization and its estimated costs.

The general vision of inland water transport has been set out in ‘Transport development strategy until 2020’ [5] and applies mainly to freight transport on the Odra Water Way. It is also assumed that the lower part of the Vistula can be used for transport of cargo from the Baltic Sea ports.

Other actions include creation of water ways on a stable basis to comply with local and regional transport forms, among others, passenger transport. Investment within B-TOF (specified in the Implementation Document” [6] for the above strategies), are connected mainly with revitalization of the Brda and Bydgoski Channel and the Lower Noteć as well as modernization of hydrotechnical structures of these water ways. In Voivodeship documents [7, 8, 9] there are also records concerning reactivation of water trails E-40 and E-70. Undertaking a construction of a multi-modal platform in the area of Solec Kujawski – Bydgoszcz Łęgnowo is also an important investment.
The above mentioned documents include prospects of only freight water transport. The authors of this article are very sceptical about being able to recover navigability of the Polish water ways to reach class V and higher. It is caused by the fact that implementation of new investments would need huge financial means. Initially estimated costs are included in document [4], and indicate a sum of ~31.5 bln PLN – in relation to merely the middle and the lower part of the Vistula from Warszawa to Gdańsk. None of the cited documents takes into consideration the aspect of ‘small tourism’.

3. Potential of inland passenger water transport in B-TOF

After having performed some research the authors came to the conclusion that Polish towns do not have regular water passenger connections such as water tram, as one of the forms of public transport. This form functions only in few European cities such as: Goeteborg, Oslo, Hamburg, or London – though mainly for tourist purposes. There are regular passenger connections in Europe but usually in island countries. There is, for instance, a line connecting: Helgoland with Hamburg and Cuxhaven, Great Britain with the isle of Man, or Greece with archipelago of the Aegean Sea.

In some towns of our country there are water trams carrying passengers for tourist purposes, e.g. Bydgoszcz, Toruń, Kraków, Warszawa or Gdańsk. Recently in Paris, an attempt was taken to use ships for providing passenger services. Paris water fleet consists of four catamarans which travel in the east part of the town between railway station Austerlitz and the suburbs of Paris. Each ship (covered with a roof and equipped with heating) can transport 70 passengers at a time. Frequency of cruises is 20 minutes in rush hours, whereas in the remaining time and on the weekend it is 30 minutes. Transport is free of charge for holders of seasonal public transport tickets. In 2008-2011 as many as nearly half a million people used this transport and, therefore, the city authorities decided to extend this experiment for the entire city. It needs to be mentioned though that the main users of this transport means are numerous tourists who come to visit Paris. It results from the fact that this solution is for people who are not in a hurry as the speed of a water tram is only 12 km/h downtown Paris and 18 km/h uptown. This is not very competitive for other public transport means in this city (e.g. conventional tram, subway).

The main obstacles limiting the possibilities of using inland passenger boats in a regular public transport systems are: low speed, high costs of marina construction, short navigation period, inconvenient passenger exchange on marinas. Moreover, travel by water ways would, for the majority of city dwellers especially larger areas, make up a short fragment of the whole trip, so there would be more transport means changes as compared to conventional tram or bus transport. The above factors make passenger water transport relatively unattractive public transport means.

Having this in mind, it is proposed to maintain water tram in Bydgoszcz and Toruń for recreational purposes but extend its offer. However, construction of several service points for canoeists, sailors and cyclists has been proposed for the remaining areas of B-TOF, adjacent to the Bydgoszcz Channel, the Brda and the Vistula rivers. One of the factors supportive of this concept are positive experiences connected with functioning of the water tram in Bydgoszcz (recently the number of passengers has risen from 32 thousand to 34 thousand annually). The areas of B-TOF, especially those located in the vicinity of water ways E-40 and E-70, which are very attractive in terms of tourism and recreation speak in favour of such points. The proposed concept assumes the best possible integration of the water transport with current and planned systems of city transport, especially bicycles.

The authors of this study have made an attempt to develop such a concept for B-TOF and the possibilities of its implementation according to three scenarios of the country social-economic development that is [2]:

- optimistic – dynamic economic development of the country, noticeable increase in motorization and mobility rate, development of domestic and provincial road network, development of the domestic and railway infrastructure;
• stabilization – maintenance of current economic, mobility trends, slower rate of transport investment implementation in Poland and in the Kujawsko-Pomorskie Province in relation to the optimistic scenario;
• regression – possibility of economic regression occurrence and the slowest rate of transport investment development in Poland and stabilization of the motorization index.

4. Passenger water transport in Bydgoszcz

Having in mind an increasing demand for recreational water transport services in Bydgoszcz, a target system of transport connections to be provided by the Bydgoszcz Water Tram (BWT), has been proposed, see fig 1. with stops existing in the period 2014-2015, as well as an extension of the existing water tram route to a marina in Stary Fordon (A. Frycza-Modrzewskiego st.) construction of which is planned by the authorities). Extension of the water tram line to the new marina to be built in Stary Fordon is an extension of recreational offer for the citizens of Bydgoszcz (especially Fordon) and tourists. The marina is supposed to be finished by 2020, along with modernization of boulevards as part of Bydgoszcz Water Node Project.

Increasing attractiveness of BWT requires ‘opening’ the city to the Brda and the Vistula rivers through appropriate development of boulevards along those rivers. Pedestrian and bicycle paths should be incorporated in the system. Marinas should be equipped with stations for city bikes, thus making these two transport forms more attractive. The embankments should also include places for active recreation, for example: play grounds for children, fitness equipment (with rehabilitation functions) etc. They should also perform a social functions involving social integration and become like ‘Wyspa Młyńska’ (currently one of the most attractive places in Bydgoszcz), popular recreation space for Bydgoszcz city residents.

On the basis of changes in the number of passengers reported in 2007-2015, a predicted number of water tram passengers was determined by 2030, for the stable economic development scenario. Moreover, it was assumed that according to the regressive scenario the number of passengers will remain unchanged in relation to the current state, whereas in the optimistic scenario the predicted number of passengers will be reached 5 years earlier than in the stable scenario – Figure 2. The costs of inland water way transport in Bydgoszcz are as follows. In 2013 the city paid the operator - Żegluga Bydgoska,
the sum ~540.0 thousand PLN, and in 2014 ~525.0 thousand PLN. For this amount the operator committed to use solar powered boats (‘Słonecznik’ and ‘Słonecznik II’ for 28 passengers) of their own production, and a historical ship (motor powered, M/S Bydgoszcz” for 24 passengers). For each hour of a solar powered ship travel the city paid ~250.0 PLN, whereas by motor powered ship ~227.0 PLN. The time of transport services and hour rates were established on the basis of a bidding, which was won by Żegluga Bydgoska. However, incomings from the tickets which were ~115.0 thousand PLN in 2013 and ~100.0 thousand PLN went to the city coffers. The above data shows that profitability of the water tram in Bydgoszcz is insignificant app. ~20%. However, according to the authors, due to its attractiveness for the Bydgoszcz city residents and visitors the water tram needs to be maintained ad developed.

Predicted costs involved in transport work time BTW for particular scenarios of economic development and prognosis years are presented in Figure 3, and current costs of this time provided the basis for their determination. These costs include the proposed extension of the tram route from the marina in Brdyujście to Stary Fordon. It was assumed that it will be launched no later than in 2020 by the optimistic scenario, in 2025 by a sustainable scenario and in 2030 by a passive scenario. The cost of launching this additional connection would be ~65.0 thousand PLN annually, whereas cruises would take place in July and August only on Fridays, Saturdays and Sundays (8 cruises every day in both directions).

Functioning of an additional connection requires construction of a new marina in Stary Fordon. The authors know that the cost of its construction is ~330.0 thousand PLN. It was estimated on the basis of 10 marinas on the Odra river specified in the project ‘Regional Operational Program of Lubuskie Province’. It needs to be emphasized that the cost can significantly grow as it is necessary to be familiar with local hydrogeological conditions which are crucial for construction of one of the most expensive elements of the investment, that is, reinforcement of the embankment. Construction of Hala Łuczniczka Bydgoszcz marina can be an example of such a situation. The cost of hydrotechnical works connected with deepening the Brda river and reinforcement of embankment was ~0.4 thousand PLN. However, the cost of all construction works N, that is, a platform for pedestrians, stairs, sheds elements of small architecture etc. ~0.5 mln PLN. In turn, the cost of electric works (installation of electric, optical fibres of a dynamic information board, lighting, other systems) and other works is ~0.5 thousand PLN.

According to the authors it is necessary to modernize all the existing so called floating marinas. Now they are poorly equipped and therefore it is necessary to modernize passenger platforms and equip them with shelters, improve the technical state of approach paths and add a few elements of small architecture, that is, benches, tables, decorative flowers etc. Total cost of modernization of these 8 floating passenger platforms is estimated to be ~240.0 thousand PLN. Moreover, the total cost of the water tram
maintenance includes maintenance costs of all platforms which are estimated to be ~30 thousand PLN, yearly (keeping clean, small repairs etc.).

5. Passenger water transport in Toruń

Currently, in Toruń it is possible to sail across the Vistula by a motor boat ‘Katarzynka’ or go on a longer boat trip by ship named ‘Wanda’ along the river, which turns around a road and railway bridge. Toruń, due to its outstanding historical, natural and tourist values should be interested in providing seasonal water transport services for recreational purposes. Hence, the authors suggest launching a recreational-tourist passenger water connection that would connect the outstanding central area of Toruń (in the proximity of Philadelphia Boulevard) with west districts of the town. This connection would enable service of passenger between the city center and the recently constructed church of St Mary Star of New Evangelization and Saint John Paul the Second. Because of the range and significance of this place, first of all from the point of view of religious cult, an increased passenger traffic (pilgrims and visitors) is predicted to use the route, especially on religious holidays, on Sundays and religious celebrations.

The proposed route of the discussed Toruń Water Tram connection (TWT), 7 km long in one direction, is illustrated in fig 4. The route would start in ‘Toruń Miasto” marina situated in the vicinity of railway station Toruń Miasto, within an integration node (passenger tram connections with regional and inter-regional connections of railway transport). Moreover, a station of regional bus transport is located at a small distance, which provides a possibility to service additional passengers from other places. Another marina to be named ‘Dworzec Główny’ (Main Railway Station) would be located in ‘Toruńskie Majdany’ (left bank of the Vistula, so called ‘Panorama Torunia’). At the distance of merely 650 m from the proposed location there is a train station ‘Toruń Główny’ – which also, due to lots of passengers is very useful. Majdany street connecting the planned marina with PKP railway station has already been modernized as well as the bridge on Mała Wiselka. In this street a residential zone was established and in its vicinity, parking lots were built. According to the authors, it would be convenient to construct a station of Toruń City Bike in this area which, with a bike station located near Toruń Główny Train Station would significantly improve and facilitate the journey of passengers getting on and off at the railway station. It is proposed to provide all the marinas with city bike stations.

The third stop of the water tram would be ‘Rybaki’ marina on the right riverbank, in Rybaki District in the area of ks. Jerzy Popiełuszko street. Recently construction works connected with the Toruń marina have been finished. First of all, so called ‘harbor’ part with a transport platform, points for canoe mooring and wooden piers. Renovation of the main building and the hangar was carried out as part of the investment. The area was structured and developed. The marina will be used by water lovers canoeists and students of Sports School. Attractiveness of the water tram marina ‘Rybaki’ is highlighted by the area designed for active recreation and a Zoobotanical garden located near this place.

In 2007-2013 a project "Revitalization of Zoobotanical Garden Elements on Bydgoskie downtown in Toruń", which was co-financed from the European Regional Development Fund of the Regional Operational Program of Kujawsko-Pomorskie Voivodeship and from the funds of Toruń City Council budget. After revitalization, this is one of the most attractive places in the city, especially for children. It would be good though, to build a water tram stop directly at the reinforced Vistula riverbank as construction of such a stop near the Vistula basin embankment would not be advisable due to the possibility of low water level occurrence in the period of drought (which happened in 2015) which would prevent a water tram from entering the basin.

The last marina of ‘Toruń Zachód” would be a destination of the proposed water transport line, to be located in Starotoruński district, near Starotoruńska street, that is, in the proximity of the above mentioned church and the objects of College of Social and Media Culture. Two localizations were considered: the first one was the Vistula basin and the second the right bank of the Vistula river. Small distance from the above mentioned objects would be an advantage of the marina location in the Vistula
basin ~100.0 m as well as insignificant costs involved in construction of an approach road. (pedestrian-road). However, in the periods of drought the level of water in this basin is so low that even a small passenger boat would have problems to enter it. Having the above in mind, it is proposed to locate the marina ‘Toruń Zachód’ (Toruń West) directly at the right bank of the Vistula river which would require construction of an access road with ~0.8 km. length.

**Figure 4.** Scheme of target water transport passenger connections in Toruń (Toruń Water Tram)

The predicted number of passengers for TWT for particular economic development scenarios and years is presented in Figure 5. It was assumed that three passenger boats of ‘Słonecznik’ type (with 28 seats) will be used in the proposed water tram connection.

The predicted costs of Toruń Water Tram operation for particular economic growth scenarios and prognosis years are shown in Figure 6. It was assumed that 1 hour of travel on the Vistula river will cost (like in Bydgoszcz) 250 PLN and the speed of travel will be 6.5 km/h. According to performed calculations, average occupancy by passengers will be ~65%, for all scenarios and predicted years. With such occupancy, profitability of TWT can be estimated, like in Bydgoszcz, to be at the level of 20%.

Now in Toruń there is ashore tourist information point Kaszczorek I. The Town Space Planning Office considers building a marina in Rubinkowo near Fort I (right bank of Vistula – phot. 2). A recreation area for the inhabitants of Toruń, mostly Rubinkowo, is supposed to be constructed there. This marina would be distant (to the east), from Toruń Miasto marina by about 3.0 km. The authors, having in mind financial aspects, suggest that it should be constructed no sooner than after building the recreational area, and finding out whether there is a demand for extension of the TWT route. Similarly, the investment -Kaczorek II marina (city investment) is under preparation and is to be implemented in near future.

TWT requires construction of ‘Toruń Zachód (Toruń West)’ marina whose cost is estimated to be 330.0 thousand PLN (like in the case of a marina in Lubuskie Province). The marinas: „Toruń Miasto” and „Dworzec Główny” (approach roads and platforms for passengers, elements of small architecture etc.), and total estimated cost of these works would be 50 thousand PLN. However, the cost of „Rybaki” marina construction, is estimated to be 50 thousand PLN as the embankment is already reinforced. Moreover, an approach road needs to be built (pedestrian-road) from „Toruń Zachód (Toruń West)”
marina to the church of Mary the Star of New Evangelization and Saint John Paul II, whose cost is estimated to be ~1.0 mln PLN.

### Figure 5
The number of passengers predicted to use TWT, for particular the country economic growth scenarios and predicted years

### Figure 6
Annual transport costs predicted for TWT for particular scenarios of economic growth (acc. to prices in 2015)

### 6. Passenger water transport on the remaining area of BTOF

It is planned to build 16 tourists rest areas for canoeists, bikers and water users in the remaining area of BTOF. They will be equipped with the following infrastructure:

- reinforced embankment,
- canoe service point (places for keeping and drying canoes),
- a few places for relaxing (wood, roofed sheds, tables, benches) with adequate infrastructure (WC, waste container etc.),
- racks for bicycles and parking places for cars,
- bollards or mooring rings for sailing boats and yachts,
- barbecue equipment and fireplaces.

The cost of construction of one tourist rest area is estimated to be ~50.0 thousand PLN, hence the total cost of construction of 16 facilities of this type would be 0.8 mln PLN. It does not include the cost of land purchase by a given commune, works connected with preparation of the terrain and connection of the site with pedestrian -vehicle routes as evaluation of these elements requires a good knowledge of many local conditionings. Moreover, it is estimated that a yearly maintenance cost of such places would be 24.0 thousand PLN.

The proposed localizations of such places on the territory of BTOF are illustrated in Figure 7. They are supposed to be built by: 2020 – in the optimistic scenario, 2025 – in the stabilization scenario, 2030 – in the regression scenario. All tourist rest areas are located so as (according to the directives of Study [2]) to be connected with the existing and planned road and bicycle routes and stops of public transport means.

Water trails available for small passenger transport means are marked apart from the locations of tourist rest stations. In the future the offer should also include the possibility of ordering special, occasional water tram cruises to Bydgoszcz or/and Toruń. Such a solution would have a positive influence on the development of small water tourism in the region of BTOF, both individual and for groups.

It needs to be emphasized that a marina was built in Nakło on Noteć, whose construction was co-financed from the funds of the European Regional Development Fund as part of Operational Program for the Kujawsko-Pomorskie Voivodship for years 2007-2013. The cost of the entire investment (harbor administration, conference hall, shipbuilding workshop, hangar for water equipment) was app.10 mln PLN.
Figure 7. Proposal of localization of tourist service points for canoeists, sailors and bikers as part of extended offer of the small water tourism of B-TOF

Authors emphasize that the water trails marked in Figure 7 are supposed to depict the potential possibilities of water travel between the proposed tourist rest areas. No research was done to explore technical possibilities of covering these distances by small vessels.

7. Conclusion
Despite many advantages (ecological) of the inland water transport it accounts for a small share of both passenger and freight transports. It results from negligence of inland water ways navigability and, in the case of passenger transport, from very low speed offered by the vessels. However, the authors would like to focus attention to the new trend connected with interest in inland water transport – which as it seems– is related to its attractiveness in terms of tourism and recreation.

As regards Bydgoszcz it is proposed to extend the existing water tram route to Fordon. It will certainly increase recreational possibilities of the largest housing estate of Bydgoszcz. It can also contribute to promoting the region by providing the possibility of watching beautiful areas spreading along the Brda and Vistula rivers.

In Toruń, due to outstanding tourist attractiveness of the old town boulevard and the new architectural object - the church of the Virgin Mary Star of New Evangelization and St. John Paul II, and a very vast number of visitors, it is proposed to launch regular, tourist lines of Toruń Water Tram. It should be stressed that launching this sector of transport will extend the recreational and tourist offer of the city and will contribute to its ecological image. As for the remaining part of Bydgoszcz-Toruń Functional Area it is proposed to build a few tourist rest sites for water transport users.

They are elements which add color and diversity to the landscape. They will provide the possibility of undertaking further actions aiming at integration of Bydgoszcz and Toruń, this time, by means of a system of inland water ways.
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