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GORZÓW WIELKOPOLSKI AS AN ATTRACTIVE LOCATION FOR AN INNOVATIVE RIVER PORT EQUIPPED WITH A SUSTAINABLE ENERGY SECURITY SYSTEM

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Abstract. The role of inland navigation in the global logistics system is gaining significance. This process is stimulated by policies implemented by major economies and international organizations such as the European Union. The objective is to achieve sustainability in transportation by exploring alternatives to conventional infrastructure. These initiatives also extend to tourism and recreation associated with inland navigation. This article presents the results of an analysis related to the location of a tourist river port, considering optimized benefits and developmental opportunities. An interesting location meeting these criteria, as well as possessing scenic, cultural, ecological, and environmental values, is Gorzów Wielkopolski. In the second part of the article, the authors propose a concept for a sustainable energy system that meets the requirements of port operations and customer demands in an era of rapidly advancing technology and increased emphasis on environmental protection.

Keywords: Inland Navigation; Energy System; Port, Location of Logistical Point Infrastructure; Sustainability

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1. Introduction

Inland navigation holds enormous potential both in terms of transportation and tourism. Unfortunately, over the past few years, this sector has been systematically neglected and undervalued. In the face of current ecological challenges, particularly related to water pollution and freshwater shortages, responsible, innovative, and well-planned inland navigation can provide a real solution to the existing problems.

Investment intentions associated with the construction of point logistics infrastructure, such as ports, must be based on the principles of sustainable development. This involves incorporating modern innovative solutions and engaging interdisciplinary scientific and research entities. This allows for a multi-faceted approach to the encountered issues related to environmental, technical, and social aspects (Andryeyeva et al., 2021; Zumente, Bistrova, 2021; Karpenko et al., 2021; Šulyová, Kubina, 2022; Oliinyk et al., 2023; Hrab, Minculete, 2023; Mutandwa, Vyas-Doorgapersad, 2023).

The Warta River is the third longest river in Poland and a major right tributary of the Oder. The port in Gorzów Wielkopolski, thanks to its location, serves as an excellent point in the European river system, making it an ideal starting point or stopover for inland waterway tourism.

The port should be located very close to the city center, ensuring quick access to hospitality and catering services.

The construction of a river tourist port has ecological, social, and economic dimensions. It will contribute to promoting aquafluvial initiatives in the region, serving as an excellent venue for meetings and outdoor events. It will be another compelling factor for attractive tourism, offering essential services for boat owners, including boat launching, servicing, and mooring facilities. The port will also provide space for use by institutions and rescue services, for example, facilitating the rapid launching of rescue boats by the fire department.

2. The location of the port

In Poland, inland waterways primarily serve as regional routes. In 2021, the total length of the national inland waterway network amounted to 3,768 km. This figure is significant, as evidenced by a comparison with networks in other EU countries. Only Germany, Finland, France, and the Netherlands have a greater network length. In terms of the density indicator, there are 12.1 km of navigable waterways per 1000 km^2 in Poland (the EU-27 average is 10.0 km/1000 km^2). This observation leads to the conclusion that conditions for inland navigation in Poland are favorable (Bilska, Janik, Niewiarowski, 2022; Simionescu et al., 2021a).

Gorzów Wielkopolski stands out as an attractive location for a modern river port. Situated just 53 km from the German border, it is a mere 135 km away from Berlin and the potential customer base. The city's proximity to major Polish urban centers further enhances its appeal, with Poznań at 165 km, Szczecin at 111 km, and Zielona Góra at 113 km. "The city's strategic location near the western border of the country positions it as a crucial hub for communication and transit. Additionally, the favorable conditions for inland navigation contribute to its potential for development in this sector" (Wijura, Lichtarski, Piechówka, 2007).

The agglomeration is situated on seven hills, featuring two levels of Holocene terraces that include numerous preserved oxbow lakes. The part of the city on the right bank is characterized by significant undulations, with elevations ranging from 23.0 to 82.0 meters above sea level. The left-bank, lowland part has an average elevation of 19 meters above sea level and encompasses a flat flood terrace intersected by the Ulga Canal (Rekreacja i zieleń, 2009).

Gorzów Wielkopolski is located on the edge of the Vistula Primeval Valley in the South Baltic Lakeland region, a geographic area several times larger than Masuria. The city is situated at the confluence of the Noteć and Warta rivers and can play a role in promoting the South Baltic Lakelands and the MDW W70 waterway. This region is characterized by a specific mild climate of the South Baltic, with an abundance of pristine lakes, rivers, and forests (Kondracki, 2002; Simionescu et al., 2021b).

The primary elements of the logistic hub infrastructure in the immediate vicinity of the agglomeration include the Warta River and the MDW E70 waterway, the national road DK22, the expressway S3, and the railway line 203. Also of significance is the close proximity and access to the MDW E30, which runs through ODW, connecting the Baltic Sea in Świnoujście with the Danube in Bratislava.

3. The conditions for the construction of a port in Gorzów Wielkopolski – a literature review

The implementation of the planned investment in the city will halt the further deterioration of infrastructure and pollution of the area, in line with the goal of"…increased protection and improvement of the aquatic environment. This includes specific measures for the gradual reduction of discharges, emissions, and losses of priority and hazardous substances, as part of the commitment to achieving a higher level of environmental protection"

(2000/60/WE PE i R, 2000).

The development of inland navigation in the current geopolitical realities and the ongoing war in Ukraine is one of the key issues contributing to the improvement of the state's security (Jursza, 2020). Referring to the approved National Security Strategy of the Republic of Poland in 2020, the even saturation of infrastructure and the expansion of inland waterway networks will enhance bilateral, regional, and global transport and logistics capabilities. It will also increase the potential for military mobility (Strategia Bezpieczeństwa Narodowego RP, 2020).

The data from 2018 concerning inland navigation in Poland indicate that a total of 81,683 lockages were performed, including 15,981 for passenger ships and 43,299 for tourist vessels. The following year, this figure decreased to 69,402 lockages (including 19,686 for passenger ships and 42,122 for tourist units). In 2020 and 2021, the number of river tourists experienced a significant increase, with 61,637 and 59,248 lockages for boats and tourist yachts, respectively. This optimistic trend was somewhat disrupted by the fact that the year 2020 brought the COVID-19 pandemic, leading to the implementation of numerous restrictions and limitations. Somewhat unexpectedly, this situation intensified interest in small watercraft, mainly used for recreation, tourism, and sports (Raggad, 2018; Pesaran, 2021, p. 13–50).

The ODW E-30 (Oder Water Route E-30), connected to E-70, features numerous ports and marinas adapted for small watercraft reception. Their concentration occurs in sections that do not align with the state border due to the neutrality of border waters. In recent years, there has been a reversal of this negative trend, largely attributed to effective regional cooperation and cross-border policies. This involves collaboration among Oder river municipalities, as seen in the implementation of projects like "Odra dla turystów 2014" (Oder for Tourists): "its objective was to improve the infrastructure conditions of the Lubusz-Brandenburg support area by eliminating existing barriers in the development of cross-border transport infrastructure and expanding water routes on the Oder by establishing ports for navigation serving cross-border tourism traffic" (Krajowy Program Żeglugowy 2030, 2023, p.37-38).

The National Navigation Program until 2030, developed by the Ministry of Infrastructure in 2023, includes a list of numerous goals and assumptions, most of which are consistent with and align with the outcomes of building a tourist port in Gorzów Wielkopolski. The program mentions the need to create "socially sustainable inland navigation," which entails establishing conditions for building a network of stopping places for waterway users. The density of these stopping places is one of the conditions for more efficient use of waterways as communication routes contributing to economic, social, and environmental goals. The program advocates for equipping stopping places for boats with waste management systems, sewage infrastructure, visual monitoring, appropriate signage, slipways for launching, as well as solutions enabling access to clean water, electricity, and fuel distribution points. Proximity to a public road will also be crucial for the location of stopping places (Jakubowska, Rabe, 2022; Bartley, Sacker, Clarke, 2004, p. 501–506; Vennemo, 2023).

The consequence of such actions will be an increase in the attractiveness of inland navigation and the achievement of economic and promotional benefits by entities managing the waterway, point infrastructure along this route, and by local government units located within the impact zone of the water route. Support for the expansion of the network of river ports, quays, and marinas is explicitly included as a sub-task among the milestones listed in the National Navigation Program until 2030 (Krajowy Program Żeglugowy 2030, 2023, p.51-52).

The introduction of modern services and digital systems plays a significant role in the development of the broadly defined river sector. "Inland water transport must be 'digitized' to realize its full potential and play a greater role in European transport and logistics chains" (Durajczyk, 2019). To achieve this goal, analog processes carried out by navigation entities should undergo reform. Digitalization should encompass areas such as issuing and transmitting documents, micro-payments, settlements for the use of hydrotechnical devices, and other aspects of service for both businesses and individuals (Krajowy Program Żeglugowy 2030, 2023, p.53-54).

Inland navigation in Poland has enormous development potential, both in terms of transportation and tourism-recreation (Lebiedowska, Lebiedowski, Gąsecka, 2010). For it to develop and play a role, among others, in tourism and as a distinct form of water transport, all conditions for its regular operation must be met (Tołkacz, 2009; Briggs, 2003, p. 1–24), cnd certainly, the location conditions of the planned investment fulfill them. The European Parliament emphasizes, "...that the potential of inland waterways for recreational navigation and other water-based activities should continue to be analyzed. This would stimulate economic growth, provide new employment opportunities, and boost tourism in the respective regions" (EP 2021/2015(INI), P9_TA(2021)0367, 2021). This leads to the conclusion that it is important and necessary to support all initiatives of local administration, local government, social organizations, and private investors that contribute to the development of tourist waters in Poland. This includes, in particular, the construction and renovation of marinas, ports, water fleets, as well as the stimulation of all related services (Czerny, 2013; Nwaogbe, Erhijivwo, Miracle, 2023). One cannot overlook the role and importance of marketing, advertising, informational, and educational activities in this regard (Krajowy Program Żeglugowy 2030, 2023, p.57 – 58).

4. The coherence of building a port in Gorzów Wielkopolski with regional development plans

The construction of a modern, innovative tourist port equipped with a sustainable power system aligns with the goals of the Lubusz Province Development Strategy 2030, particularly with the first goal: an intelligent, green regional economy (operational goal 1.1: strengthening the R&D sector and innovation transfer mechanisms, especially in the areas of regional smart specializations; operational goal 1.2: development of the green economy, including environmentally friendly energy; operational goal 1.6: development of tourism potential), the second goal: a socially strong and citizen-centric region (operational goal 2.5: expansion and modernization of sports and recreational infrastructure), and the fourth goal: an attractive, efficiently managed region open to cooperation (operational goal 4.2: an attractive image and recognizable brand of the region; operational goal 4.5: development of e-services and digital competencies of society) (Strategia Rozwoju Województwa Lubuskiego 2030, 2021),

Smart Specializations in the Lubusz Province include green economy (sustainable product and space design, renewable energy sources), health and quality of life (specialized forms of tourism), and innovative industry (information and communication technologies, innovations, and in the future, during the planned expansion of the port: a hydrogen-based economy) (https://lubuskie.pl/cms/320/inteligentne_specjalizacje, dostęp: październik 2023r.), and the goals presented by the Ministry of Infrastructure in the National Navigation Program 2030: coherence with the main goal of increasing the role of inland navigation in the national and local dimensions, as well as complementary goals: specific goal 2 – development of the market in the inland water transport sector (socially sustainable inland navigation, digitization of services for entities in the navigation market) and specific goal 3 – development of partnerships for the sustainable development of waterways, where a close polarization in as many as 5 out of 8 planned key actions:

- conducting analyses and expertise in the field of sustainable development of waterways and functionally related infrastructure, especially environmental, technical, and economic analyses.
- taking actions to develop a concept for the development of the Polish section of the E70 IWW.
- taking actions to develop the directions for the development of waterways of regional character.
- supporting R&D activities to assist the inland navigation sector through the development of cooperation and platforms connecting academic institutions, business representatives, and the public sector and waterway administration.
- implementing informational, promotional, and educational activities in the field of inland navigation directed to the general public and riverside local communities (including cross-border areas) and promoting education in post-secondary schools providing vocational training in the water transport industry (Krajowy Program Żeglugowy 2030, 2023, p. 41, 51, 52, 54).

5. Identification of benefits from the construction of a port

The benefits arising from the construction of the port should be identified as multi-aspect, including:

- Touristic: Providing access to necessary port infrastructure and navigation on the Warta River (and beyond) and diversifying the region's offerings.
- Showcase: Serving as a complete project in line with the principles of sustainable development; experiences from its construction and applied solutions will serve as a model for similar investments nationwide.
- Research: Tasks planned for implementation are challenging not only technically but also in terms of research and development. The project's realization will be an excellent impulse to utilize regional scientific resources, likely enabling the implementation of proprietary solutions, benefiting both the city, region, and the port itself.
- Activation: Creating infrastructure for social activation, providing access to new and interesting services in the region.
- Promotional: A fully functional tourist port will undoubtedly be a significant asset on the attractiveness map of the region, serving as another argument for the city of Gorzów Wielkopolski to attract tourists and investors.
- Ecological: The construction of the port will incorporate pro-ecological techniques and tools, such as passive lighting.
- Business: It is anticipated that the port will enable self-sufficient economic existence through the provision of port services and other related activities. It's worth noting that there is currently no location in the region equipped with the necessary infrastructure to accommodate floating units. Currently, boats are stationed at the "Winter Port" or marina in Santok, but these places are entirely unsuitable for the requirements of inland waterway tourism.
- Cultural-Social-Educational: The port can be used as a venue for various cultural or sports events.
- Stimulating: The construction of the port will increase the attractiveness of the area, serving as a catalyst for complementary services and activities. It is expected to be an initiator that will focus attention on inland tourism, both from customers and local government administrations.
- Integrative: In the context of cultural exchange, especially with German tourists, the port, located 50 km (in a straight line) from the border and well-connected by river networks, will play a significant role.
- Sports: The port area and its infrastructure can serve as a base for organizing sports events on the Warta River.
- Increased Safety: The construction of the port will enhance safety on multiple fronts: improved river safety through construction, enabling swift deployment of rescue units and other services responsible for safety (e.g., police or firefighting), the port area will be organized and fenced, minimizing access for unauthorized individuals and reducing the risk of accidents, ensuring safety for units stationed in the port and port users through the construction of fencing, interactive monitoring, and a lighting system, the strategic location and well-designed slips of the port's infrastructure will make it a significant focal point in the region, enhancing military mobility (it's worth noting that the port's location holds strategic importance: proximity to the city center, the border, the Odra River, and access to appropriate infrastructure).

6. Innovative sustainable energy system

The port will primarily serve a tourist function. It is envisioned as an initiative with significant development potential. Ultimately, the port will not only cater to boats but will also have facilities to accommodate campers and include an installation for the production, storage, and refueling of hydrogen. Therefore, the energy system must be designed to enable further expansion and the development of infrastructure.

The basic elements of the planned energy system include:

- Photovoltaic cells located on the roofs of buildings,

- Photovoltaic farm mounted on ground racks,
- Transformer station,
- Energy storage,
- Electric distribution cabinets with three-phase sockets,
- Electric distribution poles,
- Electric distribution poles with three-phase sockets,
- Solar electric lighting poles with built-in low-temperature-resistant batteries,
- Solar lighting lamps with built-in low-temperature-resistant batteries,
- Hybrid-powered monitoring (photovoltaic cells and traditional power supply from the grid).

It is assumed that the required connection power for the port from the operator's side should be 50 kW. Photovoltaic cells will be installed on the roof of the multifunctional building and the technical building. The total surface area for the cells (considering only those oriented in the most efficient southern direction) will be approximately 100 m2. The overall estimated electricity demand for the building throughout the year is in the range of 8,000 kWh to 10,000 kWh. Due to the fact that the obtained energy can be partially used to operate the port and its services, it is planned to build a photovoltaic installation with a capacity of 30 kWp (which will allow reaching 30,000 kWh; when transferring energy to the power plant, the received energy will be about 0.7 of this value, i.e., 21,000 kWh) (https://jbenergia.pl/blog/ile-paneli-fotowoltaicznych-dla-domu/, https://www.otovo.pl/blog/magazyn-energii/, dostęp: październik 2023r.).

The planned ground photovoltaic installation will cover an area of approximately 140 square meters. It will be equipped with a grid inverter. Sixty photovoltaic panels with a power of 500W each will be placed on it, totaling 30 kW. In addition, there will be around 30 photovoltaic installations on the roof of the building, with similar parameters, bringing the total power output to around 45 kW. Assuming proper installation of the equipment and their orientation to the south, it can be assumed that during a full day, direct sunlight will occur for about 2 hours and 45 minutes - this value represents the time when sunlight falls directly on the panels (average sunlight in Poland is around 1600 hours per year). The actual daily energy production for the entire installation will therefore be 110.25 kWh (and slightly over 40,000 kWh annually).

The building planned in the project will be energy-efficient and will have the characteristics of passive construction, meaning lower energy and water consumption and heat loss. It is planned to use a heat pump and, if possible, install a system for recovering rainwater. All peripheral devices, such as lighting or monitoring, will, if possible, also have their own photovoltaic cells, with security monitoring in strategic locations having hybrid power.

The distribution of electrical energy in the port will be carried out using distribution cabinets and distribution poles. Where there is a potential demand for the use of "heavy equipment and devices," distribution points will be additionally equipped with three-phase sockets.

The construction of a compact transformer station is planned, housed in a concrete enclosure with external service and a transformer with a maximum power of 630 kVA. The energy storage will have a power of 500 kW, equipped with NMC batteries and AC/DC converters, allowing the conversion of DC from PV to AC.

The devices designed in the port will be characterized by increased resistance to weather conditions. Those requiring a power source will be selected for durability at low and high temperatures and high humidity. The batteries will be protected to ensure temperature fluctuations do not limit their lifespan. The enclosures of these devices will be made of stainless steel or suitable plastics. Special heating cables will be used in the distribution poles to protect the water installation. In the process of designing devices and infrastructure, emphasis should be placed on multifunctionality, easy reconfigurability, mobility, and the ability to expand facilities.

7. Conclusions

Inland tourism, especially river tourism, is currently experiencing an existential renaissance. At the macroeconomic level, three main factors contribute to this: sustainable transport policies encouraging alternative freight transport, the recent lockdown due to the global COVID-19 pandemic, and the dynamically developing waterfront infrastructure. The latter seems to be crucial, as the attractiveness of a water route depends not only on the beauty of nature and location but also on the network of tourist embankments and marinas.

In Gorzów Wielkopolski, there is a lack of professional services for river tourism. Potential boat mooring places are not equipped with modern infrastructure, lack sufficient security systems, and are also distant from the city center, significantly complicating access to cultural, entertainment, gastronomic, and accommodation attractions.

The construction of a tourist port in this location not only addresses these market shortages but also provides a much broader range of services in response to the requirements of modern tourists. The investment should be multi-aspect and have high development potential. Location in the city center, quality (modern infrastructure), autonomy (digitally supported autonomous services), safety, scale (ability to serve current customers and future increased tourist traffic), development potential (areas for future expansion) are just a few important aspects to consider when designing the port.

Moreover, the construction of a port in the city can tangibly contribute to meeting social needs related to rescue services (river safety, rapid interventions), the military (possibility of launching and handling military units), or cultural development (resources enabling the organization of cultural events).

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