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River Information Services (RIS) as a Tool to Improve Poland's Position in the European Logistic System

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Abstract:

Purpose: *The aim of the article is to indicate that modern inland navigation using the RIS system can contribute to the improvement of Poland's logistic attractiveness measured on the basis of the LPI logistics performance index. LPI index was created by the World Bank, and is a synthetic measure of the logistic efficiency of economies, how the TSL (transport-freight forwarding-logistics) industry influences the economy of individual regions.*
Design/Methodology/Approach: *The following methods were used in the study: literature analysis, descriptive statistics and taxonomic analysis.*
Findings: *Investments in inland waterways and river information systems RIS can further improve this assessment. IWT is the missing mode, which would supplement the infrastructure deficits, especially in metropolitan areas where no further expansion of roads or railways is possible due to the lack of land (e.g. in the Tricity agglomeration).*
Practical Implications: *The use of inland shipping for the transport of goods between the main industrial centres of the country would reduce transport costs, including external costs, and would contribute to the achievement of the transport objectives of the European Union.*
Originality/Value: *The study contributes to the discussion on the role of inland shipping in Poland and European Union. The article dicusses the potential of inland shipping for transport system measured with the use of the LPI logistics performance index created by the World Bank.*

Keywords: *Inland navigation, RIS system, management, LPI index.*

JEL Classification: *R1, R4.*

Paper type: *Research article.*

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1. Introduction

In 2004, Poland became a member of the European Union. Since then- thanks to the access to European funds- the transport infrastructure has changed significantly. In January 2004 Poland used 486 km of motorways and 156 km of dual carriageways (altogether 642 km of dual carriageways of the highest category), whereas in September 2021 there were already 1711 km of motorways and 2353 km of dual carriageways (altogether 4067 km). This means that in less than 18 years Poland has gained 1225 km of motorways and 2197 km of dual carriageways (3422 km in total).

Part of the investment funds were allocated to repair and modernisation of the railway network in Poland, which, on the one hand, improved the technical parameters of the main railway lines and the operating speeds of freight and passenger trains, but, on the other hand, did not lead to restoring the network from 1990 and, at present, it is 3733 km shorter and the effects of some of the works, In spite of this, the overall assessment of the condition of the transport infrastructure and thus the transport system in Poland has improved in recent years, which is reflected in numerous reports and gauges.

One of such measures is the Logistics Performance Index (LPI) developed in 2007 by the World Bank, which describes the logistics performance of more than 150 economies worldwide. The position taken by particular economies indicates both their weaknesses and strengths, being a kind of measure of competitiveness and achieving advantage in the global logistics market.

The aim of the paper is to show that investments in the development of inland waterways and telematic management systems can contribute to increase Poland's logistic efficiency and thus improve its position in the LPI ranking. Inland navigation is one of the most neglected transport branches in Poland. Despite its indisputable advantages, such as the possibility of transporting goods of high weight and volume at the lowest unit transport cost, low environmental impact and thus the lowest external costs, inland navigation does not play a significant role as a transport mode in Poland.

The considerations are accompanied by a research thesis that the development of inland navigation, including further extension of the system of harmonised river information services RIS will contribute to the improvement of Poland's position in the LPI ranking, which is the basis for determining the competitive position of the economy on the global logistics market.

The article is structured as follows: In the following part of the article, theoretical aspects of inland waterway transport and RIS supporting this transport in various contexts are presented in a synthetic way. Then the LPI is discussed and in the last part the influence of the inland waterway transport development supported by the river information system on the improvement of Poland's position in this ranking is

presented. The discussion ends with a summary and recommendations for further research process related to the role of the indicator in determining the competitiveness of the country.

2. Literature Review

The available literature presents various aspects of inland shipping. Numerous studies deal with the development of inland shipping as a transport branch that can participate in transport chains (Żylicz 1979; Kulczyk *et al.,* 2003; Woś 2005). The need and possibilities to include inland shipping in Poland in the intermodal transport chain are the subject of many publications (Rosa 2013; Wojewódzka- Król and Rolbiecki 2013; Jacyna (ed.) 2012), in which the authors present the advantages of inland waterway transport and its potential role in the transport system of Poland.

Inland navigation has, for centuries, been used mostly for bulk cargo transport. With the industrial development, it has also been used in the transport of technologically processed and large-scale goods, and containerized loads (Caris *et al.,* 2011; Konings, 2007).

The possibility of cargo transport in inland navigation is largely determined by the technical parameters of the waterways, which depend primarily on the class of the river. The required parameters for each class are described in detail in the Ordinance of the Council of Ministers of 7 May 2002 on the classification of inland waterways. It should be emphasized that these parameters are purely theoretical, and in many places they are not fulfilled, as proven by numerous analyses (Report of the Supreme Chamber of Control, 2014).

In recent years new studies were carried out to redesign the inland vessels for improvement of transport efficiency, especially to facilitate the use of vessel in shallow waters (Watertruck+, Inbat—Innovative barge trains for effective transport on shallow waters). Another line of enquiry concerns the reduction of pollution from inland vessels (Semenov et al 2018) and cargo handling processes (Douma, 2012). Some works focused on ways how to include inland shipping into intermodal transport chains (Konings, 2013; Bergqvist, 2015). There are also examples of such studies in Poland (Jacyna *et al.,* 2012; Rosa, 2013; Wojewódzka-Król and Rolbiecki, 2012).

Also, analyses of cargo transported in Poland indicate that its structure differs significantly from other EU countries. In contrast to EU countries, container transport by inland waterway is practically non-existent in Poland (CSO, 2015; Kulczyk and Skupień, 2010; Woś, 2005; Hann and Woś, 2016). Although the first practical research on the possibility of transporting containers along the Oder Waterway took place in the late 1970s, in the publication (Krautwald, 1981), where the author describes the results of practical research on the transport of containerised cargo along the Oder Waterway using ships.

3. Inland Shipping in Poland

The layout and length of inland waterways in Poland has remained at a similar level for years.

The length of the inland waterways network in Poland in 2020 was 3768 km (46 km more than in the previous year), of which 2524 km were regulated navigable rivers, 655 km - channelised river sections, 335 km - canals, and 255 km - navigable lakes. 3549 km (94.2%) of navigable roads were operated by shipping. The requirements for roads of international importance (classes IV and V) in 2020 were met in Poland by 5.5% of the length of waterways (206 km). The remaining waterway network consists of roads of regional importance (classes I, II and III), whose total length in 2020 was 3562 km (Główny Urząd Statystyczny 2021, p. 1).

The reactivation of inland shipping in Poland is gaining in importance; this is due to the pursuit of sustainable development of the country and the development of ecological forms of transport.

One factor that has a direct influence on the volume of freight transport and transport work in inland shipping is the condition of the waterways. Unfavourable navigation conditions determine basic parameters of rolling stock, i.e. the relatively low loading capacity of barges (Główny Urząd Statystyczny 2021, p. 1).

In 2016, the Polish government adopted assumptions to the strategy for the development of inland waterways in Poland, which assumes a gradual improvement of navigation conditions on the Oder River, among others, and an increase in the share of inland navigation in cargo transport. In 2017, Poland ratified the European Agreement on Main Inland Waterways of International Importance (AGN) and thus committed to upgrade the ODW to at least Class IV. The new approach to inland waterway transport in Poland is in line with the long-term strategies of the European Union, where the share of inland waterway transport in freight transport in Europe is expected to increase significantly by 2030.

In 2020, 3990.9 thousand tonnes of freight were transported by inland navigation and 516.3 million t·km were performed in terms of transport work. These values were lower than the year before by 14.7% and 21.3% respectively. The largest annual decrease in freight transport and transport work was recorded in the 3rd quarter (by 25.6% and 31.7% respectively) (Główny Urząd Statystyczny 2021, p. 2)

At present, it is not possible to precisely estimate future traffic flows on the Oder Waterway.

Alongside work to improve the technical parameters of the waterway, measures are being carried out to improve the efficiency and safety of inland waterway transport. In 2013, the system of harmonised river information services RIS was piloted on the

lower Oder River, which allows for better organisation and management of transport on inland waterways and for optimising the use of existing rolling stock and infrastructure. However, there is no comprehensive research on the possibility of using the already implemented system to improve the reliability of container transport on the Oder Waterway due to the passage of inland vessels under bridges.

In contrast to the EU countries in Poland, the transport of containerised cargo by inland navigation does not exist despite the fact that the first attempts to transport containers (standard, type 1C) from Polish inland ports took place as early as 1979 (Krautwald, 1981). This is influenced by the widely held opinion that due to low bridges, transporting cargo in two layers (which determines the profitability of transport) is not possible (Pluciński, 2016).

This is mainly due to the poor state of the waterway infrastructure, the maintenance of which has not been properly funded for decades.

4. RIS System

There is no single accepted definition of RIS in Europe. It is up to each country to decide to which extent RIS will be implemented. In general terms, River Information Services (RIS) means harmonised information services to support traffic and transport management in inland navigation, including wherever technically feasible interfaces with other transport modes. RIS comprise services such as fairway information, traffic information, traffic management, calamity abatement support, information for transport management, statistics and customs services and waterway charges and port dues.

RIS is an information system based on the compatible interaction of three elements: equipment, software and operators. The link between all these elements is the communication system, both wired and wireless. RIS consists of four main segments:

- Sensor segment - information source,
- data transmission segment,
- RIS centre - information processing location,
- RIS user segment - addressee of the information.

The RIS user segment includes:

- Pilots,
- Transportation companies,
- Lock, port and terminal operators,
- RIS operators,
- Waterway Supervision Authorities (in Poland the Inland Waterway

- Authority in Szczecin and the Regional Water Management Board in Szczecin),
- Emergency Services.

Information is provided to RIS users in the form of different services, available both on the Internet on dedicated information portals, in dedicated devices and applications, and traditionally e.g., via VHF.

Four main technologies are used to provide RIS river information services:

- Vessel traffic control system (VTT),
- Notices to Skippers (NtS),
- Electronic Ship Reporting (ERI),
- Inland Electronic Chart Display and Information Systems (Inland ECDIS).

RIS on Polish waterways was implemented in 2013. It currently covers a total of 97.3 km of waterways lying on the lower section of the Oder River from Ognica to Szczecin, viz:

- Lake Dabie to the border with internal sea waters (9.5 km),
- the Oder River from Ognica to the Klucz-Ustowo Piercing and further as the Regalica River to the mouth of Lake Dabie (44.6 km),
- the Western Oder River from the weir in Widuchowa to the border with internal sea waters, together with side branches (33.6 km),
- Klucz-Ustowo ditch, which connects the East Oder River with the West Oder River (2.7 km),
- Parnica River and Parnicki Crossing from the West Oder River to the border with internal sea waters (6.9 km).

Within the framework of the implemented project "Full implementation of the Lower Oder River RIS", by the end of 2021 works on the extension of the RIS system coverage in Poland will be completed. After the implementation of the aforementioned project the following waterways will be covered by the RIS system:

- River Odra from the motorway bridge in Świecko (km 580 of the Odra River) to Ognica (km 697 of the Odra River) - 117 km;
- the Warta River section from the water control point in Świerkocin to the mouth of the Warta River - 28.5 km.

The total length of the waterways covered by the RIS system in Poland after the implementation of the project "Full implementation of the RIS of the Lower Oder River" will amount to 242.8 km.

The main objective of the implementation of the RIS system in Poland is to improve the organisation and management of the inland waterway transport system along the

border and lower section of the Oder River. The implementation and expansion of the infrastructure for management of the international section of the Oder River will create opportunities for an increase in national transport and a chance for an increase in international freight transport. It will also enable effective use of the connection of Polish waterways with the western European system of waterways.

The improvement of shipping conditions resulting from the RIS implementation will allow shifting part of the cargo carried by other means of transport, mainly road transport, to the waterways. The RIS system will prevent a further weakening of the competitiveness of inland waterway shipping. Measurable indicators for the objectives will be:

- an increase in transport volumes,
- extension of the distance over which goods will be transported.

The introduction of RIS along the whole length of both cross-border routes is one of the most important elements for increasing the competitiveness and attractiveness of transport and inland waterway transport. The following effects are expected to be achieved as a result of the project:

- improving the conditions and safety of navigation,
- improving ship handling conditions,
- improving multimodal links,
- strengthening environmental protection.

5. Logistics Performance Index -LPI

The Logistics Performance Index (LPI) is an interactive benchmarking tool designed to help countries and groups of countries identify the challenges and opportunities they face in implementing logistics processes, presented in the form of a report (pdf and excel) and a web-based tool for quick data analysis. It also indicates what should and can be done to improve their performance in each category indicated in the synthetic logistics performance measure. The development of the indicator took place in 2007 and periodically until 2018 it is presented in the form of data in individual categories and their aggregation system. To date, the index has been published in 2007, 2010, 2012, 2014, 2018 (www.lpi.worldbank.org, 02.21).

The index is a multidimensional assessment of logistics performance (rated on a scale from 1 to 5). For its interpretation are used the results of surveys, performed periodically on more than 5000 unit assessments, made by more than 1000 logistics stakeholders from 160 countries. The survey is carried out by means of an online questionnaire. The results of particular rankings are presented and interpreted using statistical methods in order to make the presented research results more credible and enable their aggregation and comparison, which allows wider use of the index for scientific analyses.

The research sample consists of entities from the TSL sector (mainly logistics and forwarding companies and logistics operators) operating both in the local and, or maybe first of all, international markets.

The aim of the LPI is to show how the TSL industry (transport-forwarding-logistics) has a real impact on the economy of individual regions, how it is related to the development of trade and the expansion of exports to various directions, and a kind of indirection related to showing how internationalised logistics processes affect regional development. A high level of logistics performance index can contribute directly to economic growth through the factor of attracting foreign investment into the country.

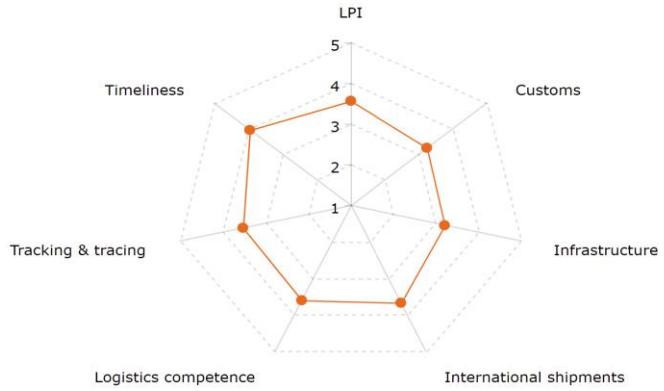
To lend credibility to the survey results, the methodology focused on a high number of respondents representing the industry. A five-point rating, based on the Likert scale, of the cooperating countries lends ease and lightness to the answers, and at the same time is an accurate measure of it (Tundys, 2011). The questions were formulated in a clear and simple way so as not to raise doubts about the answers. To analyze the results, statistical methods were used to compensate for irregularities resulting from incomplete answers received in the questionnaires.

The Logistics Performance Index (LPI) therefore consists of both qualitative and quantitative measures and helps build logistics friendliness profiles for the countries assessed. It is a measure of performance in a country's logistics supply chain that offers two different perspectives: international and domestic. The LPI can be divided into international and domestic.

- The International Logistics Performance Index (International LPI) uses six key aspects to compare country performance and also displays the overall LPI. The scorecard enables comparisons with the world and with a region or income group on the six indicators and the overall LPI index. The International LPI provides qualitative assessments of a country based on the ratings of its trading partners, logisticians doing business outside the rated country.
- The National Logistics Performance Index, provides both a qualitative and quantitative assessment of a country, based on the responses of logisticians working there. It includes detailed information on the logistics environment, basic logistics processes, institutions, and time and cost data. The national LPI analyses the logistics environment of 100 countries in detail. In this case, logistics professionals are surveyed and evaluate the logistics environment of their country. This approach takes into account the logistical constraints within whole countries, not only at points where freight is exchanged between carriers or transport modes, such as ports or national borders. This assessment is based on four main determinants of overall logistics performance: (1) infrastructure; (2) services; (3) border procedures and time; (4) supply chain reliability.

In the overall ranking of 2018, the position of Poland is high (28th place), the point value of each of the examined areas ranges from 3, 25 to 3.95. (Figure 1), comparing these values to the best rated country on the basis of the LPI, i.e. Germany, the differences in the values achieved in individual categories of the indicator are not large (Germany to 3.86 to 4.39 - Figure 2). This means that a slight improvement in one of the components of the index is enough and the position in the ranking can change dramatically.

Figure 1. *LPI for Poland - Ranking 2018*



Source: *https://lpi.worldbank.org/.*

Analysing particular elements evaluated within the framework of the indicator it should be indicated that (figure 3) the situation related to construction, possession, development of logistic infrastructure is gradually improving, by 2007 Poland's position improved by 17 positions (from 51 to 35), and the value of the indicator rose from 2.69 to 3.21).

6. Synthetic Indicator of Socio-Economic Development Impact of Harmonised River Information Services RIS on LPI

The implementation of RIS and the services it provides have a direct impact on all the above defined determinants of national logistics, i.e.: infrastructure, services, border procedures and time and supply chain reliability, as synthetic yet aggregated information is a management tool.

As regards the use of technical infrastructure, RIS can contribute to efficiency gains:

- The use of waterways, especially in the so-called bottlenecks, i.e., locations that hinder the efficient functioning of inland navigation. Such locations include:

- locks and elevators, which are built to overcome water level differences by water craft. Due to the limited technical parameters of a lock chamber (length, width, depth) and the locking process itself lasting several tens of minutes, locks represent a major constraint on waterway capacity. RIS can be used in this case to improve lock efficiency, e.g., by grouping vessels (according to vessel size and/or cargo) to fully utilise the lock potential. This may mean locking a big ship and a group of small ships together. Or ships that do not carry dangerous cargo and that can be simultaneously cleared. A major limitation for the full use of RIS is that the first come-first serve principle has to be abandoned in favour of the lock operator or the RIS centre operator determining the so-called RTA. In this case, skippers or logistics service providers enter the technical characteristics of the vessel, cargo and port of destination in the ERI electronic ship reporting service. Based on the data from the RIS system, in particular from the AIS equipment on the basis of the declaration of all vessels, the RIS operator could estimate the future traffic flows and send the individual skippers the required arrival time at the lock in order to perform clearance without delay. On the other hand, the energy efficiency of the vessel would be improved, as after being informed that the vessel will be served at a certain time the skipper could decide to reduce speed in order to arrive on time, thus reducing fuel consumption and emissions to the environment and increasing the average speed of transport. From the point of view of lock operation this would prevent situations where there are long waiting times at certain times or days and a lack of lock applicants at others.
- Drawbridges - which constitute a major constraint for inland navigation. The application of RIS in this case is the same as for locks and hoists.
- Terminals and quays - timely notification of the desire to use the coastal infrastructure can contribute to faster ship handling and streamline the process of loading and unloading the vessel.

Additionally:

- Streamline the clearance and customs process - RIS can be used to improve the quality and efficiency of processes and procedures during customs clearance. A dedicated service for this purpose is ERI, which makes it possible to automatically send information on a planned or ongoing journey in good time. This gives the relevant services - border guards, national tax administration, phytosanitary services - time to prepare for possible checks or clearance. This is particularly important at the external borders of the Schengen countries, where regular passport and customs clearance takes place.

- The area of consignment monitoring and tracking - the use of RIS makes it possible to precisely track the location of the vessel, and thus the cargo that is being transported. The use of AIS (Automatic Identification of Ships) devices with DGPS corrections allows to determine the location of vessels with an accuracy of several dozen centimetres. In addition, with low implementation costs, it is possible to create a dedicated service that would allow the estimation of time of arrival of the ship to the destination, taking into account the traffic density, the use of point infrastructure of the waterway (locks, drawbridges) navigational conditions and weather forecasts.
- Timeliness of logistic processes - this is where the most interesting results can be achieved as RIS can be used to estimate the probability of transport task execution. An obstacle limiting the development of river transport in Poland is its susceptibility to external factors that hinder or even prevent transport and thus negatively affect transport reliability. Available transit depth of the waterway and clearances under bridges depend on weather conditions. These are the factors that determine the possibility of transportation as the lack of sufficient transit depth or clearance means the impossibility to pass the given section of the waterway. What values of the above mentioned parameters are necessary depends on the construction of a vessel or a convoy. For example the most often used set for inland waterways cargo transportation in Poland consisting of Bizon III pusher and BP-500 type pusher barge needs min. 1.20 m transit depth (this results from the draught of the pusher alone of 1.10 m plus 0.1 m safety reserve).

  However, depending on the weight of the cargo, the draught of the BP-500 barges can reach a maximum of 1.70 m in the case of heavy cargo. This means that beyond a certain weight, the draught of the barge will be limiting. When transporting containers in two layers, a draught of 1.10 m is achieved with an average container weight of 21 t. At higher weights, the draught becomes limiting. It should be remembered, however, that the smaller the average weight of containers, the smaller the draught of the vessels and thus the greater the clearance under bridges necessary for the vessel to pass. The Oder Waterway from Kędzierzyn Koźle to Szczecin is crossed by 69 bridges, some of which have a clearance of less than 4.00 at High Navigation Water (WWŻ). For passage of a barge with two layers of containers the minimum clearance under the bridge is 442 cm. Thus it is necessary to use RIS to determine whether a transport task can be carried out at a given time, and more generally to determine the probability of carrying out a transport task for particular weeks/months of the year (depending on the season of the year, the amount of water in particular months varies). Studies have shown [Durajczyk 2020] that the use of RIS for load planning and/or vessel ballast system utilisation can contribute to increased reliability of waterway freight transport. In an analysis for the Oder Waterway, it was

shown that RIS can reduce the risk of not fulfilling a transport task in a short season from 11% to 5%, i.e., by 6 points.

7. Discussion and Conclusion

The development of logistic systems and the importance of logistics in economic processes has significantly increased in recent years, causing that even the previously widely defined transport system and its efficiency is considered as an element of the logistic system, based on which logistic chains or logistic networks are implemented. With the help of the objective indicator it is also possible to determine the logistic potential of a region and the factors influencing the lack of obstacles to logistic activity.

The position of Poland in the ranking reflects the infrastructural resources as well as procedures in the TSL and warehouse management market. The interpretation of the individual elements of the index indicates that the situation of Poland is improving (there are exceptions that confirm the rule), but still, for the most part, we are at the level that can be described as "average". It seems that an excellent geographical situation and political-economic connections should motivate to take strategic decisions in the scope of investments in TSL infrastructure, in order to get closer to the top of the world ranking, i.e., among others, to our western neighbours. This work confirms the results of other work indicating the importance of technical infrastructure (Niedzielski *et al.*, 2021; Kotowska *et al.*, 2018; Pluciński, 2018).

At the same time it can be seen that investments in infrastructure, especially from the European Union funds (changes in position and place in the ranking, related to the allocation of EU funds in the TSL market in Poland) contribute to the positive assessment of the Polish logistics market. Investments in inland waterways and river information systems RIS can further improve this assessment. IWT is the missing mode, which would supplement the infrastructure deficits, especially in metropolitan areas where no further expansion of roads or railways is possible due to the lack of land (e.g., in the Tricity agglomeration) (Caris, 2011).

Additionally, the use of inland shipping for the transport of goods between the main industrial centres of the country would reduce transport costs, including external costs, and would contribute to the achievement of the transport objectives of the European Union, which is in line with outcomes of other studies (Durajczyk and Drop, 2021; Konings, 2007; The World Bank, 2018).

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