Safety & Defense 8(2) (2022)
DOI: https://doi.org/10.37105/sd.189

The River Information System (RIS) as an innovation in the transport system

Piotr NIEDZIELSKI

piotr.niedzielski@usz.edu.pl (Corresponding author)
https://orcid.org/0000-0001-5024-4722 (centered, TNR 12 font, single line spacing)
University of Szczecin

Piotr DURAJCZYK

p.durajczyk@am.szczecin.pl
https://orcid.org/0000-0003-1447-973X
Maritime University, Szczecin

Received: 08 August 2022 | Revised: 26 October 2022
Accepted: 26 October 2022 | Available online: 15 December 2022

Abstract

Inland shipping is one of the most neglected transport modes in Eastern Europe. Despite its indisputable advantages, such as the ability to transport goods of high weight and volume at the lowest unit transportation cost, low environmental impact and thus the lowest external costs, inland shipping does not play a significant role as a transport branch in many countries of the European Union. This is primarily due to the poor condition of the waterway infrastructure, the maintenance of which has not been properly financed for decades. In the public's opinion, IWT is often considered an outdated form of transportation that does not meet the current needs of the transportation market.

This article aims to indicate that the RIS system is an important tool for managing inland waterways and inland shipping. Therefore, it is also an important innovation which can redefine the role of IWT in the transport system. RIS can contribute to improving the logistic systems and transport safety. The literature analysis, descriptive statistics and taxonomic analysis were carried out to present the importance of the RIS system and its innovativeness.

The study contributes to the discussion on the impact of modern information services and IT-tools on inland shipping and its role in modern transport systems. Inland waterborne transport is the missing mode, which could supplement the infrastructure deficits, and with the use of the RIS system, interconnect inland shipping into the transportation chains.

Keywords: inland shipping, Innovation, River Information Services, safety, transport system

1. Introduction

Developing techniques and technologies translates into innovation processes implemented at various levels and sectors of the economy and in various entities. Considering the innovation processes in the broadly defined TSL sector, particular attention is paid to the microeconomic level concerning individual enterprises, as well as the level of the sector itself, in this case, the TSL sector. Considering the branch approach, we focus on the external costs of particular transport branches and their negative impact on the environment, indicating the sources of shaping the competitiveness of particular transport branches, including the limitation of the negative impact of transport on the environment. It is also possible to point to the perception of the TSL sector and its individual branches through the prism of modernity, defined as the application of new solutions, of various natures and in various functional areas, in the economic practice, with particular emphasis on suprastructure. The issue of infrastructure development of individual transport branches is not without significance for competitiveness and sustainable development. The development of information technologies has also caused great dynamics of innovation processes in this area. In the literature

Safety & Defense 8(2) (2022)
DOI: https://doi.org/10.37105/sd.189

on the subject, the development of infrastructure and absorption of modern solutions, including IT and telecommunications solutions, is widely studied and noticeable, which is exemplified by air transport, as well as road transport and, more frequently, rail transport. One of the reasons for this public perception may be the fact that these branches have a large share of passenger transport services, which means that the customers of these branches of transport have the opportunity to "touch" new solutions – innovations in the field of transport infrastructure – directly or partially indirectly. Inland waterway transport is perceived as a less innovative branch, a branch where innovation processes are realized more slowly, one can say proportionally to the average speed achieved in the individual branches of transport. The Internet and the development of information and telecommunications technologies as a breakthrough innovation also have an impact on innovation processes in all branches of transport, including solutions in the area of infrastructure operation in all branches of transport. Phenomena such as the Internet of things (IoT), artificial intelligence (AI), mobile – broadband Internet access will have an impact on the development of intelligent transport systems (ITS) in all branches of transport, i.e., air transport, road transport, rail transport, sea transport and inland waterway navigation. The development of intelligent transport systems is aimed at increasing their capacity, operational safety, reducing negative impacts on the environment, including congestion costs, the interaction between the user/entrepreneur and the infrastructure manager, as well as intra- and inter-branch cooperation between carriers or, more broadly, logistics operators. Innovative processes in the development of intelligent transport systems are also part of the phenomenon of the increasing role of knowledge resources in management processes (Niedzielski, 2013) while pointing to the role of the state and supranational organizations in shaping modern transport infrastructure, or more broadly, a modern transport system (Niedzielski, 2003). Contemporary examples include fleet management, intelligent traffic management, V2X communication as part of autonomous vehicles, electric vehicle charging, electronic fee collection and a wide,range,of,other,mobility,solutions (Intel Corporation, 2022).

Inland waterway transport also implements such innovation processes with regard to intelligent transport systems of inland waterway transport in Poland, an example of which is the river information system RIS, which has been implemented on a part of the Oder Waterway.

2. The creative destruction of innovation processes in transport

A. Schumpeter, in his research on business cycles, stated that the driving force behind economic development is key innovations that occur cyclically. In this way, he opposed the theory that bases economic development on the economy's pursuit of equilibrium. He believed that a strong and healthy economy is not based on equilibrium but one that is constantly disrupted by technological innovation. The differences between his views and those of the representatives of classical economics at the time are presented in the table below.

Table 1. Economic equilibrium in economic concepts

Authors	Economic equilibrium	Economic disequilibrium
Classicists and neo-classicists	typical	Incidental
J.A. Schumpeter	incidental	Typical

Source: Kozioł-Nadolna, 2013, p. 30.

It should also be emphasized that J.A. Schumpeter pointed to the uniqueness of business cycles, by which he meant that subsequent changes (cycles) are caused by other branches or industries of the economy (industry). He believed that economic revival – the recovery phase of the business cycle – begins at the moment of the widespread use (diffusion) of new innovations. As examples, he cited hydropower, textiles and iron in the 18th century; steam power, railways and steel in the 19th century; and electricity, the internal combustion engine and chemicals in the 20th century. These revivals eventually fade when technology reaches maturity, and its benefits begin to diminish (the inevitable depression phase). As a result, another wave of new innovations emerges in another branch of the economy (industry), whereby market and institutional structures are eroded (destroyed). These are replaced by new, more efficient economic conditions in the coming recovery cycle. Schumpeter called this phenomenon creative destruction while pointing out the role played in this phenomenon by entrepreneur-imitators. "Entrepreneurship is a self-destructive process. New ideas attract a huge flock of imitators who saturate the market, eliminating any short-term gain. A new wave of entrepreneurial genius removes old products and technologies, destroying old markets and the companies that provided them. It is this process of creative destruction that lies at the heart of economic progress" (Kamerchen et al, 1991) In the practice of economic life, the notion of "creative destruction" means that the collapse of enterprises or entire industries does not have to entail only negative consequences for the economy and society, because in the place of inefficient, failing enterprises or industries new,

Safety & Defense 8(2) (2022)
DOI: https://doi.org/10.37105/sd.189

more efficient, more effective ones can be created. Many researchers stress that the crisis is a kind of catharsis for the economy, from which a new economic order emerges. It should also be noted that today there is a tendency to shorten individual business cycles. The frequency of the appearance of key innovations is increasingly higher due to faster – exponential, not linear – growth of knowledge resources and accumulation accelerating innovation processes due to shortening of the implementation times of innovation processes within individual innovations.

J.A. Schumpeter based his considerations on the theory of the evolution of species, and he was also one of the precursors of the so-called evolutionary trend in economics. This evolutionary approach created a framework for analyzing phenomena that could not be analyzed within the classical current. Based on the ideas of Charles Darwin, Jean Lamarck and Herbert Spencer, evolutionary economics perceived the economy as an ecosystem of entities that interact with each other, shaping the processes of change. The consequence of this perception was a change in the focus of analyses related to economic growth and development from the macro to the micro level.

Schumpeter's ideas allowed for the flourishing of theories that put creativity, knowledge, innovation and entrepreneurship at the center of the determinants of economic growth. In particular, this applies to theories related to the recognition of entrepreneurs as carriers and initiators of change, innovation as a mechanism of economic development and progress, and creativity and knowledge in terms of the causal element of socio-economic development.

J.A. Schumpeter linked the regularity of changes in the economy with the emergence of radical innovations, i.e., such products, services or technologies that completely replace existing solutions. Some authors refer to this heuristic concept of Schumpeter's waves of innovation when talking about the factors that led to the creation of a knowledge-based economy. In his work *Business cycles: a theoretical, historical, and statistical analysis of the capitalist process* from 1939, Schumpeter wrote about the existence of three types of cycles: Kondratiev's (long), Juglar's (medium) and Kitchin's (short), which remain in specific relationships to each other. It was Kondratiev's concept of long waves, lasting from 50 to 60 years each, that gave rise to the concept of waves of innovation. Schumpeter noted that the starting point of each long cycle is the emergence of innovations that become the engine that drives the economy in the following decades.

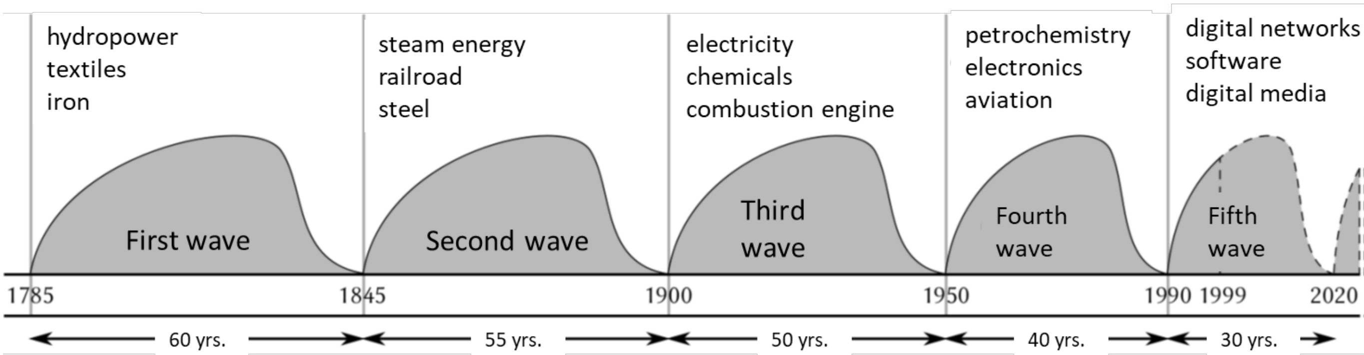

Figure 1. Schumpeter waves

Adopted from: Gust-Bardon, 2012, p. 6, after R. Solow, Notes on social capital and economic performance, in Social capital. A multifaceted perspective, edited by P. Dasgupta, I. Serageldin, The World Bank, Washington 1999.

Nowadays, with reference to Schumpeter's theory of waves of innovation (long waves of economic prosperity), attempts are being made to identify the main innovations that are the "engines" of change in particular periods. These can be referred to as "general purpose technologies" (general purpose technology). Certainly, these innovations include the Internet and information and communication technologies, which enable the development of intelligent transport systems in all sectors, including inland waterway transport.

3. River Information System RIS and its functionalities as an example of Intelligent Transport System (ITS) in inland waterway transport

ITS – Intelligent Transport Systems, according to the definition presented at the 1st World Congress on Transport Systems in Paris in 1994, are systems constituting a comprehensive set of various technologies (telecommunication, information, automatic and measurement), which provide innovative services related to various modes of transport and traffic management in order to protect safety and mobility of passengers and goods and to improve the standard of transport services (Grant-Muller et al., 2014). These

Safety & Defense 8(2) (2022)
DOI: https://doi.org/10.37105/sd.189

solutions allow more efficient, safer use of transport infrastructure, and support traffic management supported by technological solutions from the IT area. Thus, they allow infrastructure managers to provide infrastructure access services to transport companies more efficiently, effectively, and safely, realizing the objectives of sustainable transport (Nowicka, 2014).

The River Information System (RIS) provides information and enables data exchange between the widely understood users of inland waterway navigation, including river pilots, shipping companies, lock, port and terminal operators, RIS operators and waterway authorities and emergency services. It is based on the concerted interaction of three elements: equipment, software and operators. The link between all these elements is the communication system, both wired and wireless.

According to the Act of 10 June 2011 amending the Act on Inland Waterway Transport (Journal of Laws of 2011, No. 168, item 1003), the entity responsible for the implementation of the river information services RIS in Poland is the Inland Waterway Shipping Office in Szczecin, which is a central public administration unit, subordinate to the minister in charge of maritime economy and inland navigation.

The RIS system has been implemented in Poland so far on a short, estuarial section of the Oder River. The necessity of implementing a harmonized river information system RIS on the Lower Oder River by the end of 2013 resulted from the provisions of Directive 2005/44/EC of the European Parliament of 7 September 2005. In accordance with the aforementioned Directive, Member States of the European Union were obliged to implement RIS on all international waterways, i.e., waterways classified as Class IV and above if they are linked to other waterways of the same standard (PIANC, 2003; PIANC, 2004). In Poland, only the lower section of the Oder River fulfils all these conditions, hence the obligation to implement the system.

The system has been implemented from Ognica in the south to the borders with marine waterways in Szczecin Waterway Node in the north. The RIS area includes the following waterways (Durajczyk 2016):

1. Lake Dabie to the frontier with internal sea waters – a length of 9.5 km
2. River Odra from Ognica to the Klucz-Ustowo Piercing and further as River Regalica to Lake Dąbie – a stretch of 44.6 km
3. River Western Oder:
    a. From the weir in Widuchowa (704.1 km of the Oder River) to the border with internal sea waters, together with side branches – a section of length 33.6 km
    b. The Klucz-Ustowo Piercing linking the East Oder River with the West Oder River – a section of a length of 2.7 km
    c. River Parnica and the Parnicki Crossing from the West Oder River to the border with internal sea waters – a section with a length of 6.9 km.

As a result of detailed analyses of system extension options, it was decided that the full implementation of RIS Lower Oder (including the area already included in the pilot implementation) would cover waterways with a total length of 242.9 kilometers from the borders with the internal seaways in the port of Szczecin /north/ to the motorway bridge over the Oder in Świecko /south/. This means the RIS area will be extended to include part of the border section of the Oder Waterway. The figure below shows the area of the individual system implementation stages.

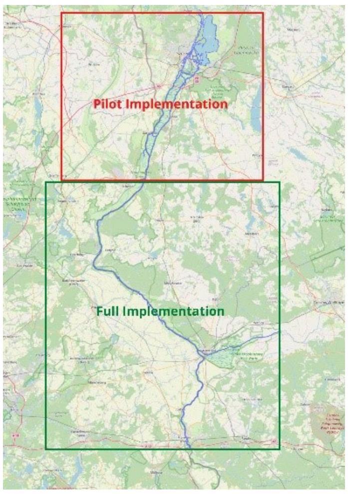

Figure 2. Area of RIS implementation
Adopted from: Durajczyk, 2020a, p. 120

Safety & Defense 8(2) (2022)
DOI: https://doi.org/10.37105/sd.189

The River Information System (RIS), through the use of technology, offers a number of services as shown in the figure below.

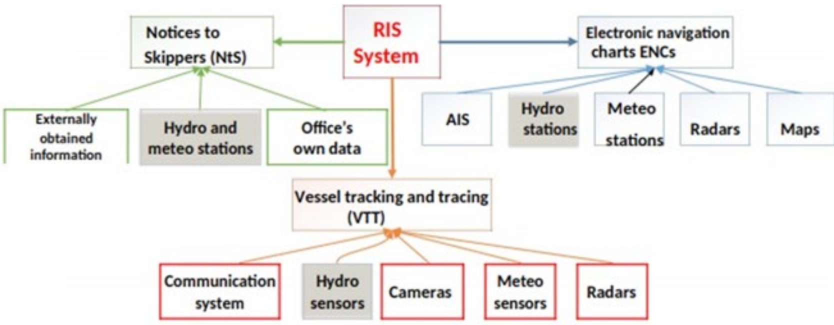

Figure 3. RIS system diagram
Adopted from: Durajczyk, 2020b, p. 203

The RIS system in Poland comprises the following services:
- Vessel Traffic Control System VTT [Vessel Tracking and Tracing],
- Notices to Skippers (NtS),
- Electronic Reporting International (ERI),
- Inland Electronic Navigation Charts (IENC).

a. VTT – Vessel traffic services

Vessel Tracking and Tracing (VTT) is a system for supervising the safety of inland navigation, monitoring waterway traffic and cooperating and transmitting information to the relevant authorities. VTT can be realized on three technological levels (Kozłowski, 2014):
- presenting the current traffic image on the basis of AIS data combined with an electronic navigational chart and/or satellite images,
- enrichment of the current traffic picture with additional data to facilitate situation analysis,
- complex analysis of traffic flow image and, as a result, vessel traffic management.

The basic components of the VTT system include:
- Automatic Identification System (AIS),
- camera system,
- VHF communication system,
- electronic chart display and information system (ECDIS).

Moreover, the system can be supplemented with a radar system and a GPS differential system.
In principle, the technological solutions are only made available to RIS Centre operators.

b. NtS – Notices to Skippers

Notices to Skippers (Notices to Skippers) are information collected and transmitted by the waterway and shipping administrations on the shipping lane and traffic flows, water levels, ice and weather. The obligation to compile and distribute NtS results from the RIS Directive, where Article 4(3)(d) states that Member States shall "ensure that notices to skippers, including water level (or maximum allowable draught) and ice reports of inland waterways, are provided to skippers in the form of standardized, encoded and downloadable messages". In order to guarantee a harmonized and uniform implementation of RIS in Europe, the European RIS Expert Group on Notices to Skippers has developed a uniform European NtS standard. This standard (from version 2.7) has become officially mandatory in the European Union on the basis of EC Regulation 416/2007 (Masłowska, 2014).

NtS usually consists of two modules:
- an application for the preparation and publication of messages according to the standards developed by the International RIS Expert Group,
- an Internet service for skippers and other interested parties to download and view the messages issued by the administration.

Safety & Defense 8(2) (2022)
DOI: https://doi.org/10.37105/sd.189

In the framework of the pilot implementation of RIS in Poland, the NtS service has been developed in line with the current version of standard 3.0 of 2009. The messages are produced in a standardized data structure, allowing automatic translation of messages into the European Union languages and their integration into electronic navigational charts. The standard shall provide the possibility to complement the messages with supplementary information in the national language. This additional information is not automatically translated by the system (Masłowska, 2014).

Four types of messages can be distinguished:

1. fairway and traffic related messages (FTM) provide information about obstacles on the waterway, e.g., closures of a waterway section or maintenance/modernization works;
2. water level related message (WRM), which provides information, e.g., on water level and clearance under bridges. This type of message can be generated automatically, e.g., at a given time or when a pre-defined alert is exceeded, or the RIS operator can elaborate it. These messages may also concern the current status or the forecasted weather conditions;
3. Ice message (ICEM) is a type of message that informs in a parametric way (no possibility of supplementing with descriptive information) about the ice conditions of a specific section of a waterway, defined by hectometer. The following data constitute an ICEM message:
    a. date of the ice measurement,
    b. Ice state (ice thickness interval),
    c. Waterway Availability,
    d. ice classification,
    e. ice situation.
    f. weather message (WERM), produced by the RIS operator, informs about the meteorological conditions. In the message, the operator specifies the weather category (rain, snow, clouds, hail, etc.) and the parametric values (air temperature, water temperature, wind direction and strength, visibility).

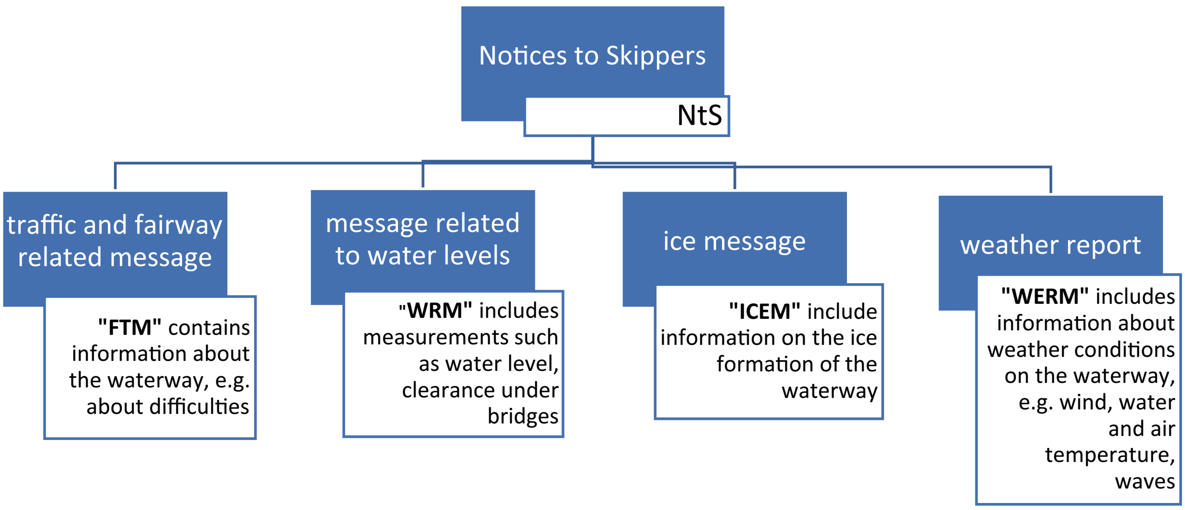

Figure 1. Types of messages to captains
Adopted from: Durajczyk, 2020a p:124

The messages are produced in code and XML and stored in the database of the RIS Centre. By using XML, it is possible to communicate NtS to other RIS systems and services, e.g., electronic navigational charts Inland ECDIS.

Safety & Defense 8(2) (2022)
DOI: https://doi.org/10.37105/sd.189

c. ERI – Electronic Ship Reporting

Electronic Ship Reporting in Inland Navigation allows for quick transmission of the information entered by the shipmaster. This information can be related to cargo, ship, voyage and personal data of the crew. The information obtained in this way can be used in various services (Durajczyk, 2020b).

There is currently an expert discussion in Europe on how to transmit information from the ship to the public administration. Two models are being considered:

1. Introducing an obligation for the master/mariner to report all necessary information before the start of the voyage on a dedicated public administration platform in the country of departure. In this model, international cooperation of waterway administrations to exchange information about a planned cross-border trip is essential, as the idea of ERI is that the information is entered into the system once and the institutions concerned receive it in due time. A major challenge for this information provision model is the need for international exchange of often sensitive data, which is sometimes not compatible with local data protection laws (e.g., in Germany).
2. Data entry into the systems of the ship in question. In this case, the ship is the source of information, which is transmitted to the relevant institutions by means of the country's technical infrastructure. Each authorized institution can obtain only the data it needs from the available data pool (e.g., other data will be provided to the border guard and other to the lock operator). This technical solution is currently at an early stage of development.

d. Inland ECDIS – Electronic navigational charts

Inland ECDIS is an electronic navigation system dedicated to inland navigation. It is based on Inland Electronic Navigational Charts (Inland Electronic Chart), which are supplemented with additional data, e.g., on the movement and position of vessels, support the decision-making of the skipper.

Electronic navigational charts are produced in accordance with the standard adopted by the European RIS Expert Group for Electronic Navigational Charts (currently standard 2.3) and contain, among other things, information on navigational markings, navigational obstructions (including, e.g., additional information on the current clearance under bridges), available transit depth. Additionally, displayed on dedicated devices, they can also be integrated with information obtained from the AIS system (e.g., movement of other vessels), NtS navigation messages, hydro-meteorological sensors, vessel's GPS. Work is currently underway to increase the information provided to the user (e.g., quay availability, additional terminal equipment).

4. Analysis of costs and benefits of RIS implementation

The main benefits of RIS include (Durajczyk 2020b; Durajczyk&Drop, 2021):

- **Better use of vessel capacity** – the use of up-to-date information on waterway navigational conditions (especially current transit depths and clearances under bridges) allows for decisions on vessel loading to be made (a heavier vessel needs more waterway depth but thus has a lower height above the water surface) and will thus contribute to better fleet management
- **Limitation of fuel consumption by inland vessels** – RIS can provide the information necessary for efficient trip planning and more accurate calculation of journey times in timetables. Lock/bridge/terminal operators can use the data collected by the system to calculate the Requested Time of Arrival for a specific vessel and provide this information to the skipper. When approaching a terminal/ lock, the helmsman can decide to adjust the speed and thus achieve a more uniform speed of travel. This leads to lower fuel consumption and, consequently, lower operating costs for the vessel owner.
- **Improving safety** – RIS services offer skippers a comprehensive overview of the current waterway situation. Safety improvements can be considered from the perspective of
  - Waterway user – well-informed vessel managers can make navigational decisions adapted to the current way user perspective. Consequently, knowledge-based navigational decisions lead to reduced incidents, accidents and casualties.
  - Waterway Safety Administration – RIS allows detailed monitoring of the transport of all cargoes, especially dangerous ones, and thus immediate action in case of accidents and/or environmental threats.
- **Improved logistics planning for the transport system** – RIS, by enabling data exchange between the information and communication systems of other transport modes, can be a key tool to improve integration of inland waterway transport with other intermodal transport links in Europe.

Due to the small number of comparative studies and the relatively short period of time the system has been in operation, it is difficult to determine clearly the cost-benefit ratio of implementing RIS services. An analysis carried out at the University of Missouri's Center for Transportation Studies indicates that the main benefits of implementing RIS include:

- improved shipping safety,
- enhanced environmental protection,

- improved competitiveness of inland navigation vis-à-vis other modes of transport,
- optimal use of the technical infrastructure of the fairway.

In summarizing the project, the authors concluded that the total benefit-cost ratio is [Centre for Transportation Studies, University of Missouri 2005]

- for the public 5 to 1,
- for skippers 3.5 to 1,
- for water authorities 1 to 1.

5. Conclusions

IWT is one of the most underestimated transport modes in Europe. In spite of its indisputable advantages, such as the possibility to transport goods with high weight and volume at the lowest unit transport cost, low environmental impact and thus the lowest external costs, IWT does not play a significant role as a transport mode (Kulczyk et al., 2013; Kulczyk&Winter, 2013). To a large extent, one of the reasons for this is the general perception in European society of inland shipping as an outdated mode of transport that is not very innovative compared to other modes.

This is partly due to the fact that for centuries inland navigation has been used primarily for the transport of bulk cargo (mainly aggregates, sand, and stone), and modern transport is based primarily on containerized cargo. More and more containerized cargo is transported by inland waterways, although it should be stressed that this trend is more visible in Western Europe (Durajczyk, 2020b). In Poland, mainly due to the condition of the waterways, it is not observed at all. Also, in inland navigation, one can observe an attempt to implement innovative solutions concerning the way of cargo transportation, ship construction and equipment (e.g., autonomous ships, ships powered by alternative energy sources, and electric ships) (Niedzielski et al., 2021).

With reference to Schumpeter's theory of waves of innovation (long waves of economic prosperity), which attempts to identify the main innovations that are the "engines" of change in particular periods, it can be stated that such innovations include information and communication technologies, which allow the development of intelligent transport systems in all branches, including inland waterway transport. The Internet or information and communication technologies as breakthrough innovations or "general purpose technologies" also influence innovation processes in all transport branches, including solutions in the area of infrastructure operation in all transport branches, among others, through the development of intelligent transport systems (ITS). The development of intelligent transport systems is aimed at increasing their capacity and operational safety, reducing the negative impact on the environment, including congestion costs, user/business – infrastructure manager interaction and opportunities for intra- and inter-industry cooperation between carriers or logistics operators in general. Innovative processes in the field of the development of intelligent transport systems, including the River Information System (RIS), are also part of the phenomenon of the increasing role of knowledge resources in management processes, indicating at the same time the role of the state and supranational organizations in shaping a modern transport infrastructure, or a modern transport system more broadly. River Information System (RIS) is a key innovation in inland waterway transport, as it provides information and enables data exchange between the widely understood users of inland waterway transport, including river pilots, shipping companies, lock, port and terminal operators, RIS operators as well as waterway authorities and emergency services. This enables, among other things, better use of vessel capacity, a reduction in fuel consumption by inland vessels, improved safety, and better logistical planning of the transport system.

The implementation of digital information services has contributed to reversing the negative trend of relegating shipping to the margins of the transport systems of the EU Member States and has shown the potential for the development of this transport mode, a good example of which is the Lower Oder River RIS system implemented in Poland on a short stretch of the Oder Waterway.

Declaration of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

References

1. Center For Transportation Studies, University Of Missouri, 2005, GIS for Tracking Vessels on the Inland Waterways. Inland Waterway Lock/Vessel Optimization Study Upper Mississippi River Locks 20-25. web publication http://www.corpsnets.us/docs/InlandNavApptSys/presentations/vesseltracking.ppt.
2. Directive 2005/44/EC of the European Parliament of 7 September 2005
3. Durajczyk P., 2014, Benefits of implementing a river information system RIS. w: Logistyka 6/2014

Safety & Defense 8(2) (2022)
DOI: https://doi.org/10.37105/sd.189

4. Durajczyk P., 2016, Implementation of RIS in Poland. The current state and plans for future development. Autobusy. Technika, Eksploatacja, Systemy Transportowe, Radom 2016
5. Durajczyk P., 2020a, Improvement of security on the border section of the Odrzańska Droga Wodna with the use of the river information system RIS, in: Łachacz T., Polish-German interactions in the area of security, Wyższa Szkoła Policji w Szczytnie, Szczytno
6. Durajczyk P., Drop N. 2021, Possibilities of Using Inland Navigation to Improve Efficiency of Urban and Interurban Freight Transport with the Use of the River Information Services (RIS) System-Case Study, Energies, 14(21):7086 DOI: 10.3390/en14217086
7. Durajczyk, P., 2020b, The Analysis of the Possibility to Improve the Efficiency of Container Transport Via the Oder Waterway with the Use of the RIS System. NAŠE MORE: Znan. Časopis Za More I pomorstvo 67, 199-208 DOI:10.17818/NM/2020/3.3
8. Grant-Muller S., Usher M., 2014, Intelligent Transport Systems: the propensity for environmental and economic benefits, Technological Forecasting & Social Change, Vol. 82
9. Gust-Bardon N.I., 2012, Innovation in economic thought from the 18th to the 20th century. Analysis of selected issues, Acta Universitatis Nicolai Copernici. Ekonomia XLIII, 1/2012, Toruń, p. 105-120
10. Inland Waterways Shipping Office in Szczecin – https://szczecin.uzs.gov.pl/ Intel,Corporation https://www.intel.pl/content/www/pl/pl/transportation/overview.html [15.04.2022].
11. Kamerchen, D.R., McKenzie R.B., Nardinelli C.,1991, Economics, Economic Foundation NSZZ “Solidarność”, Gdańsk
12. Kozioł-Nadolna K., 2013, Internalization of R&D activity in shaping innovation processes of enterprises in Poland, CeDeWu Publishing House, Warsaw
13. Kozłowski M., 2014, Developing guidelines for ensuring high quality VTT services together with identifying potential recipients of VTT services and determining the principles of data exchange. Technical and legal analysis of the possibility of making camera images available on the Web. Inland Waterway Shipping Office in Szczecin, Szczecin
14. Kulczyk J., Dubiecki A., Olearczyk D. (ed.), 2013, Odrzańska Droga Wodna: stan obecny i perspektywy [The Oder Waterway: current state and prospects]. Dolnośląskie Wydawnictwo Edukacyjne, Wrocław
15. Kulczyk J., Winter J., 2013, Śródlądowy transport wodny. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław
16. Masłowska M., 2014, Analysis of pilot implementation of NtS services in Poland. Analysis of RIS Centre software in terms of the possibility of visualization of messages on electronic ECDIS maps. Urząd Żeglugi Śródlądowej w Szczecinie, Szczecin
17. Ministry of Maritime Affairs and Inland Navigation – https://mgm.gov.pl/
18. Niedzielski P., 2003, Polityka innowacyjna w transporcie, Wydawnictwo Naukowe Uniwersytetu Szczecińskiego, Szczecin
19. Niedzielski P., 2013, Creativity and innovation processes on the transport services market. Ujęcie modelowe, Polskie Towarzystwo Ekonomiczne Odział w szczecinie, Szczecin
20. Niedzielski P., Durajczyk P., Drop N., 2021, Utilizing the RIS system to improve the efficiency of inland waterway transport companies, Procedia Computer Science Volume 192, 2021, Pages 4853-4864, DOI: 10.1016/j.procs.2021.09.264
21. Nowicka K., 2015, Intelligent transport system in the city on the example of Białystok, Zeszyty Naukowe Uniwersytetu Szczecińskiego nr 875, Problemy Zarządzania, Finansów i Marketingu nr 41 t.2, Szczecin, p. 317
22. PIANC International Navigation Association, 2003, Guidelines for Sustainable Inland Waterways and Navigation. Report of Working Group 6 of the Environmental Commission. Brussels
23. PIANC International Navigation Association, 2004, Guidelines and recommendations for River Information Services. Edition 2.0, Brussels
24. Regulations of the Council of Ministers of 7 May 2002 on the classification of inland waterways
25. Regulations of the Council of Ministers of 7 May 2002 on the classification of inland waterways and the AGN Agreement of 19.01.1996, Annex III (iii). (iii).