POSSIBLE STRATEGIES AND BENEFITS OF INLAND WATERWAY TRANSPORT DIGITALIZATION IN HUNGARY

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Abstract

There has been an explosion of smart transport solutions and data sharing activities in recent years, focusing on seaports and inland (hinterland) gateways, as exceptional players in modern supply networks. Sharing the non-sensitive technical data amongst shippers, port and warehouse operators and transportation companies, transport authorities and other stakeholders as well can contribute to the establishment of a more resilient, effective and sustainable logistics system. In our paper, we investigate the available new solutions and techniques of port and inland waterway transport digitalization based on the literature and recent innovation projects. We are also presenting and evaluating local and national developments and findings. The goal of the research is to provide a conceptual framework for the evaluation and scenarios for the implementation to the Hungarian inland waterway transport sector, especially freight transport. Beside the prospective benefits we also identify critical factors (like trust, or the willingness of data sharing amongst partners), and form strategies for the first steps of supply chain digitalization.

Key words: inland waterway, freight transport, port digitalization

1. INTRODUCTION

Ports and waterways are playing a key role in modern economy and supply networks, and their smooth operation is crucial for the health of daily business operations.

Current trends and research directions towards wide-scale data sharing between transport partners lead to a fundamentally new type of logistics business model. As business excellence was previously based on exclusive information available to closed groups of supply chain participants, future trends show that information sharing within the port and shipping communities is inevitable as the focus shifts to data management and operational excellence.

Even today, we see many examples of data sharing between neighbouring actors in the supply chain and the leading organization that plays the role of system integrator. In the new model, this data privilege will no longer be valid. The main factors contributing in the change are the ever-increasing freight demand, the energy crisis, the need for more resilient supply networks, and the constant pressure on transport and storage capacities (while at the same time capacity utilization of road transport vehicles in many cases is still low).

Value-added transport management decisions should be based on real-time, accurate information, in which the digitalization of ports and waterway transport activities are key components.

In the case of port and waterway digitalization the journey starts with the paperless communication between actors and authorities, and ends with digital data communities alongside the whole supply chain. In this organic evolution the first steps are the digitalization of the processes of participants, then exchange information at the port, later alongside the extended supply chain. Research results are showing that the digitalization is ongoing, whether the partners of the freight transport network favour or support it or not – their conservative attitudes are changing as they realize, that protest against sharing non-sensitive transportation data amongst partners and transport community members is not a competitive approach any more. They face the responsibility, whether they contribute and actively create the framework of cooperation, or leave it to other actors.

2. THE DIGITAL TRANSITION

One of the European aims is the technological-digital transition of the whole society, including administration, businesses and citizens. This digital transition is based on key enabling technologies such as big data, the IoT, cybersecurity and more.

The goal of the EU is to generate a common European data space to contribute in the acceleration of digital transformation, to lead to a genuine European space respecting the rights of individual persons and business over data. Data is a non-rival good, in the same way as streetlight or a scenic view: many people can access them at the same time, and they can be consumed over and over again without impacting their quality or running the risk that supply will be depleted. The volume of data is constantly growing, and - as an untapped potential - 80% of industrial data is never used. The new rules of the Data Act will make more data available for reuse, which aims to make the EU a leader in our data-driven society (EC, 2022).

In this respect, many research projects are willing to support public administrations in improving data policies making use of actions and cases deployed in the specific sea port environments. The objectives of these seaport and inland waterway port digitalisation projects are to implement pilot actions for reusing the data generated with port authorities and companies, ensure fairness in the allocation of data value and co-generated IoT data. According to the aims to be able to establish data communities in transportation it is necessary to benefit all partners and stakeholders in each region by sharing innovative solutions and policies, and strengthen the blue circular economy among them contributing to the Green Deal objectives with focusing on policy instruments to support the data exchange through the implementation of data spaces.

3. DIGITALIZATION OF PORTS AND WATERWAYS

Regarding the waterway infrastructure, a clear distinction can be made between digitalisation measures that are intended to optimise the physical waterway infrastructure (assets) and traffic management ('digital infrastructure'), and those measures that relate to information concerning the current availability (transport route) and current use of the infrastructure (ongoing transports) ('digital information services') (Sys et al, 2020):

- Digital infrastructure (main users: infrastructure operators): infrastructure (asset) management systems (maintenance and expansion of the waterway infrastructure, bedload management), automation and remote control of lock and weir facilities, lock management (optimised chamber utilisation), marking of waterways (remote monitoring of shore-side and water-borne fairway signs), generation of basic data (bathymetric survey, gauges), compilation and visualisation of the data in geographic information systems.
- Digital information services (main users: boatmasters, fleet operators, logistics specialists): Fairway information services as part of the River Information Services (water levels, information on shallow sections, route and lock availability, vertical clearance under bridges, Notices to Skippers), digital Aids to Navigation (virtual fairway signs in electronic navigational charts), berth occupation and berth booking systems (current availability).

The role of data sharing is becoming more and more critical in multimodal, intermodal and especially in the new, innovative synchromodal solutions:

- In multimodal transport, which is characterised by the transport of goods using two or more different transport modes (e.g. change from waterway to rail) the availability of loading infrastructure is critical regarding not only the operations, but the planning phase as well, because in order to change the means of transport, transhipment of the goods is required. In doing this, the strengths of the several individual transport modes can be used and the cheapest and most environmentally friendly combination can be chosen. Since each transhipment involves additional time and causes additional cost, multimodal transport is often used for long-distance transport where delivery time is not an important factor.
- In intermodal transport – as a special form of multimodal transport - the goods are transported in the same loading unit or with the same road vehicle on two or more modes of transport. Supporting the process with actual data is especially important when changing transport means, where only the loading units or the road vehicles are switched, while the goods remain in the same transport receptacles (such as containers or swap bodies). Since only loading units or the road vehicles (and not the goods themselves) are reloaded, this method saves time

and cost. In addition, the risk of damage to the goods during transhipment is minimised. As these solutions require special loading units and loading infrastructure, the additional investments are feasible only when the quick mode change is reliably supported by information technologies. Combined transport is a special type of intermodal transport in which the major part of the trip is performed by inland vessel or railway and any pre- and end-haulage carried out by truck is minimised. When rail or waterway transport is used for the main leg, combined transport represents an environmentally friendly transport alternative.

- Synchromodality comprises several elements and enables efficient and eco-friendly transport chains with switches in transport mode in real time. Synchromodal transport chains allow real-time switches in transport mode; consignors book their transport regardless of the mode, which means that they only define the framework conditions, but not the means of transport that will be used. Horizontal cooperation is another important aspect of synchromodality; it describes collaboration between companies that could actually be competitors. The aim of synchromodality is to improve capacity utilisation of transport modes and to increase the quota of transports conducted by rail and inland waterway.

The synchromodality platform created in the Netherlands with participation of logistic companies and supported by national institutions, defines synchromodality as "the optimally flexible and sustainable deployment of different modes of transport in a network under the direction of a logistics service provider, so that the customer (shipper or forwarder) is offered an integrated solution for his (inland) transport" (Solvay, 2018).

The European technology platform ALICE (Alliance for Logistics Innovation through Collaboration in Europe) encourages the integration of synchromodal services in intermodal transport by "synchronizing intermodal services between modes and with shippers, aligning equipment and services on corridors and hubs and integrating these into networks".

In the current transport network, a lack of services' synchronization between multimodal operations continuous to exist. Therefore, within the H2020 research programme of the EU promoting of a smart, green and integrated transport, synchromodality is one of its research and implementation priorities. The creation of a synchromodal transport in Europe is already covered in some current EU H2020 projects. Most relevant ones contributing to the synchromodal field are SELIS - Shared European Logistics Intelligent Information Space, AEOLIX - Architecture for EurOpean Logistics Information eXchange, and SYNCHRO-NET - Synchro-modal Supply Chain Eco-Net. (Solvay, 2018).

Within the Alice Roadmap for future European logistics the following research areas were indicated: Development of data analytic in logistics, predicted methods for connecting demand and supply, the definition of synchromodal operation principles, define hub business model principles and ITS Logistics architecture for connected applications - operational (ITS), tactical (service design) and strategic (business intelligence).

As Solvay (2018) summarize (based on the research of Putz et al. and Phoser et al.) the main research areas for synchromodal transport developments are interdependent:

1. network cooperation and trust,
2. sophisticated planning and simulation,
3. information, data and use of ICT and ITS,
4. physical infrastructure,
5. legal and policies issues,
6. awareness and mental shift and
7. cost, service and quality.

Brunila et al (2021) are giving a broad overview about the road towards smart ports and inland waterway developments, and state that it is vital that the ports carefully decide and compare, which technologies are to be integrated or newly installed into the daily operations. The transition towards a 'digital' or 'smart' port is difficult and complex process. In the end, digitalization will evidently improve operational efficiency and productivity, increase safety, reduce emissions, and improve sustainability. However, in the initial phases of digitalization, disadvantages of digitalization are likely to emerge. According to several authors, the processes and operations in port communities are often quite conservative, when it comes to applying and collecting data driven operation solutions in the case of shipping. The level of digitalization varies between ports according to their size as well. Large ports often have more resources in their disposal, and they tend to be more active in development programs and collaborative research and innovation actions. The three generations of digital transformation in ports are: (1) paperless procedures, (2) automated procedures, and (3) smart procedures. In practice, and sadly, in too many (port) cases, 'going digital' simple means small transitions on the first step (moving to paperless procedures). These are early steps in digitalization but too often particularly small ports satisfy to stay on the first early adoption level (paperless procedures). The Digital Maturity Model (DMM) of ports (developed by Buck et al.) identifies four port maturity levels. They indicate the functional maturity of digitalization with the following categories: 1. Digitization of individual parties in the port; 2. Integrated systems in a port community: paperless data flows; 3. Logistics chain integrated with hinterland; 4. Connected ports in the global logistics chain resulting into digitalized port networks.

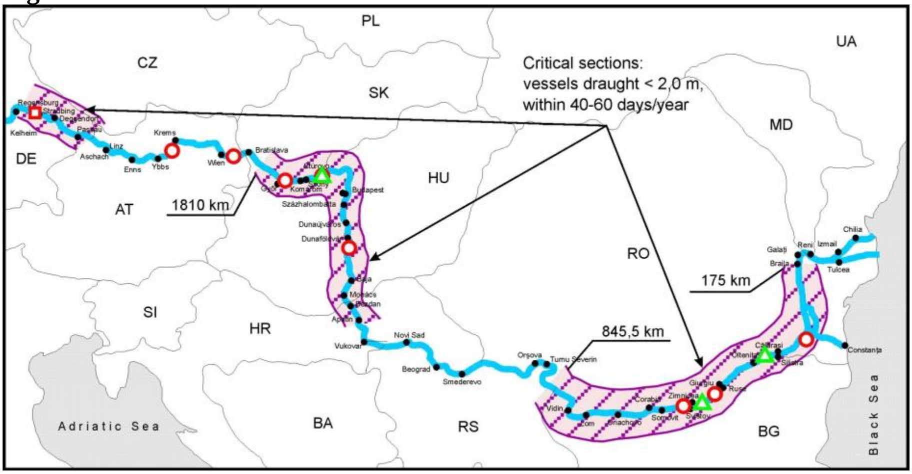
As a conclusion of current research activities it can be stated that the need for digitalisation emerges alongside the whole supply chain, the interconnected ports can only be competitive on the transportation market if the transition to become digital is evenly distributed.

4. CHALLENGES IN FREIGHT TRANSPORT ON THE DANUBE IN HUNGARY

The navigable Danube River in Hungary is about 378 km long and represents 15,6% of the total 2415 km navigable river length. The whole Hungarian section is a free flowing stretch, characterized by very dynamic river bed formations consist of mainly gravel and raw sand (Danubeportal, 2022).

The Hungarian section of the river as inland waterway is vulnerable to climate change because river navigation depends on precipitation and water levels for its operations. Droughts and floods have the most disruptive impacts for inland waterways because low water levels impose limitations to navigation services. Besides the environmental factors emerges the technical difficulty occurring at the Gabcikovo locks, why recent years the sector faced unexpected and short termed announced closure of the daily traffic. These closures severely impacted the reliability and functioning of the sector, both freight and passenger carrying.

Figure 1. Critical section on the Danube



Source: National Directorate of General Water Affairs (2018) Danube Navigability Map

At the current stage, where the lack of navigable waterway determine the whole shipping industry the transported goods are mainly the less time-sensitive agricultural products – to be able to involve more, high value-added supply chains in inland waterway shipping it is inevitable to solve the problems of low water situations (waterway development by building the proper infrastructure helps not only the shippers, but mainly the agriculture sector and the power sector – in the same time no efforts have been made on this field by any government since the successful protest against dams on the Danube more than forty years ago).

As harnessing the potential of intelligent transport systems has strategic importance for a resource-efficient economy the National ITS Strategy of Hungary was prepared in 2015 and it has a separate chapter which is dedicated to inland waterway navigation. Digitalization and the share of mass transport data is one of the fundamental objectives of this ITS Strategy. An Action plan of Intelligent Transport Systems was also prepared in 2015, which is an integral part of the Hungarian ITS Strategy and defines measures to develop ITS services of inland waterway navigation. Both the Strategy and Action Plan need to be revised as they based on the technological environment 7 years ago.

The Hungarian ITS Strategy addresses ITS services by transport modes and horizontal focus areas (e.g. sustainability and environmental protection, transport safety, interoperability). One of the transport modes is inland waterway navigation. Status quo analysis of the ITS Strategy recognizes that ITS service deployment in inland waterway navigation is at different levels. Elements related to safe navigation are relatively widespread and comprehensive while other information systems that could e.g. support more efficient navigation are often the result of cutting-edge researches however their usage and integration are not fully resolved and there are many remarkable but rather isolated ITS solutions. The Strategy defines 3 strategic measures for inland waterway navigation:

- maintaining, improving and expanding the current River Information Services (RIS)
- developing and harmonising integrated international and national information systems supporting multimodal passenger and freight transport.
- defining quality of service levels and ensuring their sustainability

Based on the National ITS Strategy the KIR system - National port management system of Hungarian Danube ports - was established, developed and continuously managed since by RSOE (financed by the CEF project). To deliver on the overall objective, the project develops, tests and validates an integrated inland port information system. In addition, they analyse cross-border options and opportunities for interconnection. The main activities of KIR project are the design and operation of the pilot system, pilot system implementation and testing in various ports and exploitation of the results.

The central information system will capture all automatic and manual data inputs, including the planned and current entry into port of various water and inland transport vehicles (ship, lorry and rail) and freight traffic (loading and unloading). The central system aggregates and processes the data and serves users in the form of appropriate notifications and queries based on their eligibility levels. It informs the carriers about their exact point of loading within the port, helps the freight forwarder to keep track of the merchandise and provides general port statistics to the ministry.
The pilot integrated port information system will monitor the incoming and outgoing transport flows into and from the port, record the volume of cargo loading and unloading, contribute in port traffic management, modernize the registration system of port terminals and the port management supervision, and automatize the port charges and electronic invoicing. It will also provide electronic data to ministries, national statistics office and EUROSTAT, an enhanced security system and monitor the implementation of port rules and licenses.

5. THE NEED FOR CULTURAL CHANGE

On the workshop held by KTI Institute for Transport Sciences, Department of Transport Management and Hungrail Hungarian Railway Association on 12th of September 2022, the experts (17 persons) present from various representative rail and waterway transport companies and organizations were surveyed in the frame of pairwise comparison related to the necessary action should made to shift freight from road to rail and waterway:

- Creating labour mobility for train drivers plays a key role in increasing the service level of cross-border rail freight traffic and ensuring faster border crossing, this would ensure progress in increasing the competitiveness of rail freight transport at a cost level appropriate for technological developments (100 on the normalized scale)
- Ensuring the navigability of the Danube is a necessary and essential condition for inland waterway transport - as long as this is not done in accordance with international expectations and previous domestic commitments, we cannot expect a significant increase in inland waterway freight transport (83,67 on the normalized scale)
- The improvements and modernizations on the vehicle and track side in themselves, even without significant development of the domestic storage and loading infrastructure, provide adequate conditions for diverting road freight transport to rail and waterways (63.27 on the normalized scale)
- Renovation and modernization of the existing sidings, which are used to a limited extent or not at all, could also result in a significant increase in the diversion of road freight traffic to the railway (26,53 on the normalized scale)
- The development of the necessary infrastructure for the rail transport of non-craneable semi-trailer stock preferred by road carriers is in the national economic interest (26.53%)
- Increasing the number of semi-trailers that can be craned can effectively contribute to shifting road freight transport to rail (16,33 on the normalized scale)
- Reviewing, modernizing and fully digitizing the complex railway regulatory environment and technical-economic operating model, as well as providing appropriate IT support and data sharing for supply chain partners can greatly contribute to increase the competitiveness of rail and waterway freight transport (0 on the normalized scale!)

While the statement about the necessity of waterway infrastructure development got 83.67 on the normalized scale (2nd place after cross-border rail process development) the need to establish data communities (towards advanced multimodal and synchromodal transport systems) got the last place (after all "hard" infrastructure development needs).

In spite of the fact that data community developments are still considered "less-expensive" solutions compared with physical infrastructure developments, in the background of this priorization order there can be independent and strong reasons identified:

- experts directly face these physical barriers in their daily work, so they feel stronger than the virtual collaboration system that has not yet been developed
- experts still represent the conservative approach of the competitive (and not yet cooperative) viewpoint of transport modes
- benefits of transport data communities are considered less to be able to overcome the risk and trust issues

6. CONCLUSIONS

Establishing data communities in transportation is inevitable to successfully overcome recent challenges on the field of energy and climate crisis and the ever-growing logistics needs. Inland waterway transport has an important role in the future inter- and synchromodal distribution of goods, but it is achievable only if besides the IT infrastructure development the cultural change happens between supply chain partners. It is necessary to invest more resources in sharing the best practices of international ports and research centres and form the frame of knowledge transfer solutions.

In the case of Hungarian inland waterway digitalisation there are promising results in port digitalisation, but the need for physical waterway infrastructure developments are considered more critical in shifting road freight to rail and waterway.

Regarding to the recent low-water crisis in 2022 one of the possible and feasible data sharing pilots – based on the results of the KIR system development - can be an integrated barge-and-truck management system, which supports the cooperation between the port warehouse and loading operator and the road transport company from the side of the product (grain) owner. It is necessary for the efficient management of the road transport to get notification of the forecasted arrival of the barge, the availability of the loading infrastructure and the planned amount of products (depending on the actual water level on the Hungarian Danube section, strongly connected to weather conditions). With an efficient management of the shared information the timing of the truck fleet is becoming easier and cheaper, which makes the whole loading process less time-consuming (there will be less time wasted on allocating enough trucks, in the meantime the truck fleet can provide other shipments at the case of barge delays, etc).

The demonstrative projects can extend the shipper-authority data interchange approach towards the digital port community solutions, as many partners can benefit of sharing the technical data, and none of the business or trade sensitive data is becoming available to non-authorized actors.

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