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Impacts of Water Transport Development on the Economy and Society

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Abstract

In this study, we analyze the impacts of water transport development on the economy and society in the Slovak Republic. We compare water transport with other modes of transport and analyze the possibilities of using water transport for sectors of the national economy. We will focus primarily on strengthening water transport at the expense of road transport. The main reason is the capacity limit of the road network. The results of the analysis represent an economic estimate of the effects of the relocation of part of the transport flows from road to water transport. The analysis works sensitively with the transfer of part of the load from road transport to water transport, in order to avoid the liquidation of road transport, but to offer an alternative from which road transport can also benefit.

Keywords: water transport, economy, society, transportation costs, transportation performance

1. Introduction

Water transport is one of the available modes of transport in the Slovak Republic and in the EU environment it is the preferred ecological transport mode (Galierikova et al., 2018). It is necessary to examine how water transport can be used for the economy - considering the specific features of the Slovak economy and its sectors (Kalina et al., 2016).

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If we identify the intersection of the needs of the economy and the possibilities of water transport, it is necessary to determine the conditions under which water transport can be significantly usable (Dvorak et al., 2020).

In line with the principles of modern economic policy in the EU environment, we assume that the promotion of the use of the transport mode (in this case water transport) should be based primarily on economic and generally positive incentives, not on directive measures (Stopka et al, 2021). Furthermore, the state should primarily create an accessible and high-quality water transport infrastructure, create a regulatory framework and a system of incentives (Lizbetin, 2019). However, it is not his necessary task to carry out the transport itself.

Waterways, a necessary condition for water transport, have a significant specificity compared to other modes of transport: their existence and development is not only of transport importance. Any other type of transport takes up space to fulfill its only function: to allow the transport of people and goods (Wen et al., 2019). The waterway does not always take up space (it is at least partly given by nature), the fulfillment of its transport function is connected (and sometimes inseparable) from other functions: water management, climate, or energy (Galierikova et al., 2016). We take this multifunctionality of waterways into account, as well as the intertwining of economic, ecological and other dimensions of transport, when analyzing several problems in this study.

The impacts of the development of water transport on the national economy are diverse. They can represent direct savings for the industry (due to cheaper transport), through saved social costs due to lower negative extensibilities, as well as through savings in infrastructure costs to additional revenues in energy (Rybicka et al., 2018). To this can be added the difficult-to-quantify induced effects in the form of the development of coastal services, tourism, incentives for the development of shipbuilding and maintenance, etc. On the other hand, the scope for the growth of road transport will be limited. This study analyzes these effects and makes suggestions for their solution.

2. Impact of Water Transport on Industries

The starting point is the calculation of 1 mil. ton-kilometers (as a measure of traffic performance). The obtained values are then adjusted according to the estimated number of ton-kilometers (estimated parameters of water transport performance). As we estimate the parameters for the currently insufficiently used transport mode, the work with real measured values is very limited. We also use data obtained from studies and analyzes of inland waterway transport in Europe (Via Donau, 2019, AQUATIS & EY, 2017). We assume that selected data from these studies are, with a certain tolerance, also applicable to Slovak conditions.

When estimating the impact on manufacturing industries (or more precisely, industries producing tangible goods, including agriculture, mining and industrial production), this is a saving of internal costs (included in production prices). These are the transport costs incurred in securing the inputs and distribution of business outputs. Transport services account for about 2.7% of intermediate consumption in the Slovak economy and on average about 2% of the costs of the Slovak economy.

Due to the insufficient amount, opacity and time variance of available data, we also implemented the mystery shopping. We entered a request for the transport of fictitious goods to transport companies and we requested a price proposal. From these data, we determined an estimate of the savings in the substitution of road transport by water (bottom row of Table 1). Price calculations vary significantly according to the type of means of transport, the length of the route, regularity, volume of transport and several other factors. Therefore, all stated values should be understood as indicative.

Table 1. Input data for estimating transport costs according to transport modes.

	Road transport	Railway transport	Water transport
Price of transport (EUR per 1 mil. tkm), Germany 2005 PLANCO (2007)	143,000 at 200 km 88,000 at 1000 km	160,400 at 200 km 74,000 at 1000 km	27,300 at 200 km 19,500 at 1000 km
Price of transport (EUR per 1 mil. tkm), various European countries for 2017 Schienen – Control, 2017		Slovakia 188,000 Austria 255,000 Germany 292,000 Hungary 188,000	

Price of transport (EUR per 1 mil. tkm), countries of Central and Eastern Europe, average daily supply from various destinations. Calculated from *DELLA Freight Transport Prices (2020)*	50,000		
Price of transport (EUR per 1 mil. tkm), on various routes *mystery shopping* authors (2020)	49,000	69,000 (in case of large volumes of transport) 124,400 (for small volumes)	16,800
The different between water and road transport in the conditions of Slovak Republic at least EUR 32,200 per mil. tkm.			

Source: (PLANCO 2007, Schienen-Control, 2017, DELLA, 2020, Mochel et al. 2019, Černá et al. 2020, Čarný et. al. 2020, Data obtained from the price offers of transport companies by interviewing the authors)

In this case, it is a benefit for the sectors that use transport services. They can count on cost savings of an average of over EUR 32,000 per million tkm of freight they decide to move by waterway (if water transport replaces road). This difference resulted from the authors' own survey of transport costs (data for "mystery shopping" in Table 1). Other estimates show a larger difference (also in Table 1, but also in the "Study of the feasibility of navigating the lower Váh River", 2017), but we stick to a more conservative approach. The stated volume of savings of EUR 32,200 per million tkm can be perceived as a minimum saving. Reduced transport costs in these sectors will also mean a reduction in the growth of revenues of transport companies in road transport.

Differences in costs between modes of transport are partly due to the burden of fees, taxes, tolls, etc. (Konecny et al., 2018, Poliak et al., 2019). For example, in 2018, a toll was collected from road transport in the amount of 213.45 mil. EUR (SkyToll, 2018). In contrast, international waterways are free of charge. So, the transfer of part of the transport services from toll roads to free waterways also means an adequate shortfall in the volume of charges.

2.1. Contribution to the energy sector on the Váh waterway

The contribution to energy as one of the industries can also be included in this section. The prerequisite is the need to create water works on the river Váh. These allow navigability for commercial shipping and will help boost electricity production. The findings and data are from the Study of the feasibility of navigating the lower Váh River (2017), which also describes in detail the need for an additional waterworks Sereď - Hlohovec.

In this case, it is not a conversion to tkm, but the total annual volume of sales of electricity (Table 2). We expect the same revenue from the sale of electricity at different levels of water transport performance.

Table 2. Revenues from generated electricity from the additional waterworks Sereď – Hlohovec.

Revenues from electricity sales	EUR 11,4 mil. per year

Source: (AQUATIS & EY, 2017, p. 134).

2.2. Stimulus for the development of services related to tourism, recreation and sports

The strengthening of passenger shipping is also an incentive for a positive impact on a wider range of services. The feasibility study for the establishment of a national carrier in inland waterway transport in the conditions of the Slovak Republic (2018) identified several induced effects for the development of services.

Passenger shipping has a positive impact on:

- Sector of real estate activities (increasing rarity and usability of real estate when accessible by passenger shipping)
- The industry of widely understood tourism,
- Sports and recreation sector,

• Development activities (combining engineering services and construction).

The development of passenger transport also provides a business opportunity for the companies carrying out the voyages themselves (shipping companies), but also for the multiplier effect for the service networks in the ports and for the related services on the hinterland. It also creates potential scope for industries by allowing industrial (especially engineering) companies to offer their capacity to build vessels, floating and other equipment, equipment, maintenance and repairs. An engineering base for such activities is available.

3. The Impact of Water Transport through the Reduction of External and Infrastructure Costs

3.1. Less value of negative externalities in water transport

Negative externalities represent costs that do not enter into cost calculations. Enterprises cause them by the activities of the whole society and are not considered in the price of their production. They apply to the whole society. In the case of transport, the economic valuation enters here:

- emissions,
- traffic accidents, casualties,
- noise effects,
- climate impact,
- occupying otherwise usable space in the country, etc.

The obtained data on external costs are heterogeneous (Table 3). These were obtained by different methodologies, not all of which considered the full range of externalities. Quantifications originated in different periods. It can be generalized that:

- In each available analysis, the highest external costs in road freight transport were calculated. The position of rail and freight shipping was alternating, depending on the method of calculation, period and country, both water and rail appeared in second and third place. But both modes are far behind road freight.
- In none of the above analyzes did the external costs of water freight transport reach even half of the external costs of road freight transport.

Differences between external costs per mil. tkm in road and water transport ranged between EUR 23,000 – 45,000. In an effort not to overestimate the effect of substitution of transport modes, we will work with a conservative value of EUR 23,000 (bottom row of Table 3).

Profiting from external cost savings requires replacing, or at least modernizing and remotorizing a relatively obsolete fleet in the Slovak Republic.

Table 3. Input data for estimating external costs according to transport mode

	Road transport	Rail transport	Water transport
External costs (EUR per 1 mil. tkm). Incomplete, no delay costs in covoy Unspecified region, according data from 2005. Allianz pro Schiene (2020)	29,800	9,500	6,900
External costs (EUR per 1 mil. tkm) EU-27 average values* CE Delft, INFRAS, Fraunhofer ISI (2011)	50,500	7,900 (electrified track) 6 600 (diesel track)	11,200
External costs (EUR per 1 mil. Tkm) Average values for Germany 2017 INFRAS, Allianz for Schiene (2019)	45,000	20,000	22,000

External costs (EUR per 1 mil. Tkm) for EU 15 + Switzerland and Norway Bund für Umwelt und Naturschutz Deutschland e.V. (BUND, 2006)	87,800	17,900	22,500
External costs (EUR per 1 mil. Tkm) For Germany 2005 PLANCO (2007)	20,000	11,300	2,800
External costs (EUR per 1 mil. Tkm) For EU 28 2016 European Commission (2019)	43,000	11,000 (electrified track) 17,000 (diesel track)	20,000
Estimated difference between water and road transport in the conditions of the Slovak Republic EUR 23,000 to mil. Tkm			

Source: (Allianz for Schiene, 2020, CE Delft, 2011, Fraunhofer ISI, 2011, Allianz pro Schiene, 2019, BUND, 2006, European Commission 2019)
*excluding Malta and Cyprus, but including Norway and Switzerland

3.2. Reducing infrastructure costs

Differences between transport modes also arise in the financial complexity of establishing and maintaining a transport route (different financial complexity of infrastructure). Following an older analysis by the consulting company PLANCO, a more up to date analysis was published by the European Commission (see Table 4). Its data also included alternative transport infrastructure costs. The data of the European Commission are more up to date, they not only indicate the situation in Germany - therefore we take these into account when estimating the savings in the substitution of transport modes (bottom line of Table 4).

Table 4. Input data for estimating infrastructure costs according to transport mode

	Road transport	Rail transport	Water transport
Infrastructure costs (EUR per 1 mil. tkm) for Germany Via Donau (2019) with reference to PLANCO (2007)	45,210	48,420	12,600
Infrastructure costs (EUR per 1 mil. tkm) EU 28, 2016 European Commission (2019)	23,000	31,000	19,000
Estimated difference between water and road transport in the conditions of the Slovak Republic EUR 4,000 to mil. tkm			

Source: (Via Donau, 2019, PLANCO, 2007, European Commission, 2019)

3. Results

Considering the above calculations, it can be summarized that when replacing 1 mil. tkm of road freight transport can be expected to save EUR 32,200 due to savings in transport costs. Another EUR 23,000 due to savings in external costs and EUR 4,000 to save on infrastructure costs. **In total it is EUR 59,200 / mil. tkm.** Producers of transported goods (savings in transport costs), the public sector (savings in infrastructure costs and costs of externalities) and the household sector (reduction of negative externalities) benefit from this saving. For road haulers, this is a constraint on future revenue growth.

Table 5 summarizes the benefits in terms of savings of these three types of costs (transport, external, infrastructure) with different additional cargo freight performance. We start from the ideal assumption that additional services of freight shipping will arise primarily at the expense of road transport. (It is an idealization; water transport can also be substituted by rail. However, the aim is to substitute road. Although by stepwise, indirect substitution: water transport will take over part of the rail and rail performance from the road.)

Table 5. Summary of annual benefits of changing the mode of transport (from road to water) in various model variants of the increase in the performance of freight shipping (by substituting road transport by water)

Variant	Performance or economic benefit parameters
V0: Initial performance in mil. tkm in water freight transport (based on 2017)	880
Economic benefit in the form of savings, in mil. EUR/year	52.1
V1: Performance in mil. tkm in water freight transport	1,000
Performance increase compared to V0 in mil. tkm	120
Economic benefit in the form of savings, in mil. EUR/year	59.2
Change in economic benefits in the form of savings, compared to variant V0, in mil. EUR/year	7.1
V2: Performance in mil. tkm in water freight transport	1,500
Performance increase compared to V0 in mil. tkm	620
Economic benefit in the form of savings, in mil. EUR/year	88.8
Change in economic benefits in the form of savings, compared to variant V0, in mil. EUR/year	36.7
V3: Performance in mil. tkm in water freight transport (exceeding twice V0)	2,000
Performance increase compared to V0 in mil. tkm	1,120
Economic benefit in the form of savings, in mil. EUR/year	118.4
Change in economic benefits in the form of savings, compared to variant V0, in mil. EUR/year	66.3
V4: Performance in mil. tkm in water freight transport	2,500
Performance increase compared to V0 in mil. tkm	1,620
Economic benefits in the form of savings, in mil. EUR/year	148.0
Change in economic benefits in the form of savings, compared to variant V0, in mil. EUR/year	95.6
V5: Performance in mil. tkm in water freight transport (exceeding three times V0)	3,000
Performance increase compared to V0 in mil. tkm	2,120
Economic benefits in the form of savings, in mil. EUR/year	177.6
Change in economic benefits in the form of savings, compared to variant V0, in mil. EUR/year	125.5
V6: Performance in mil. tkm in water freight transport	3,500
Performance increase compared to V0 in mil. tkm	2,620
Economic benefits in the form of savings, in mil. EUR/year	207.2
Change in economic benefits in the form of savings, compared to variant V0, in mil. EUR/year	155.1

Source: authors calculations

The estimated volume of water freight transport in the forecast year 2035 is 5.3 mil. tons per year. If we adjust this to ton-kilometers, it means a performance of slightly over 2 milliard tkm. The closest is variant 3 in Table 5. This is associated with savings of at least approximately EUR 118.4 mil. Per year due to the use of water freight transport in current prices (compared to the situation without water transport). Compared to the initial variant V0 (in which water transport has certain outputs), this saving is higher by at least EUR 66.3 mil. per year. In the substitution of road transport by water transport, this is associated with the loss of trucks, which would take up almost 19 km long rows (compared to the situation without water freight transport).

Conclusions

As already mentioned, the ideal structural change is to strengthen water transport at the expense of road transport (which encounters capacity constraints on the road network). This occurs either directly (when the water transport takes over part of the performance from the road) or indirectly (the water takes over part of the performance from the railway and the railway uses the released capacity to take over part of the road). In this study, we focus primarily on the substitution of road transport by water.

If we start from the data on transport prices in Table 1 and combine them with the data on the increase in water transport performance (2.02 million tkm in 2035 minus 0.88 million tkm in the baseline period = 1.14 million tkm), we obtain the following impact estimate (model year 2035):

- Loss of revenues of road carriers (1.14 mil. tkm · EUR 49,000 per mil. tkm) in the amount of EUR 55.9 mil. per year at current prices.
- Increase in revenues of water carriers (1.14 mil. tkm · 16,800 euros per mil. Tkm) in the amount of 19.2 mil. euros per year at today's prices.
- Cost savings of producers of goods (1.14 mil. tkm · EUR 32.2 savings per mil. tkm) in the amount of EUR 36.7 mil. per year at current prices.
- In support of structural change in transport, the state should build economic policy in such a way that road transport is not "liquidated", but that an alternative is offered here, from which road transport can also benefit:
- It is possible to favor road transport operators (domestic and foreign carriers) who use water transport services in certain situations (e.g. transporting an entire Ro-Ro truck by ships to bridge times when trucks stay, during holidays, during non-working days, road closures etc.). Direct and indirect instruments to support road haulers using water transport services on certain sections in accordance with competition rules could be considered.
- Water transport can take over from road transport the load with the greatest pressure to reduce prices. Road transport will thus at least partially relieve itself of the pressure to reduce the prices of its services. One of the effects of strengthening water transport is the change in the specialization of road transport, and this can be used so that it will also be beneficial for road transport. This shows the possibility of a win-win situation for water and road transport.
- The anticipated construction of the Váh waterway would mean a large increase in demand for road transport performance as well. At the time of construction, the revenues of road haulers would increase significantly.

Limiting the growth of revenues in road transport is an obvious accompanying phenomenon of the revival of water transport. However, economic policy in transport can create situations where the existence of water transport will also have usable benefits for road transport.

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