



**CETRA** 2018

5<sup>th</sup> International Conference on Road and Rail Infrastructure  
17–19 May 2018, Zadar, Croatia

# Road and Rail Infrastructure V

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TITLE

Road and Rail Infrastructure V, Proceedings of the Conference CETRA 2018

EDITED BY

Stjepan Lakušić

ISSN

1848-9850

ISBN

978-953-8168-25-3

DOI

10.5592/CO/CETRA.2018

PUBLISHED BY

Department of Transportation

Faculty of Civil Engineering

University of Zagreb

Kačićeva 26, 10000 Zagreb, Croatia

DESIGN, LAYOUT & COVER PAGE

minimum d.o.o.

Marko Uremović · Matej Korlaet

PRINTED IN ZAGREB, CROATIA BY

“Tiskara Zelina”, May 2018

COPIES

500

Zagreb, May 2018.

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Proceedings of the  
5<sup>th</sup> International Conference on Road and Rail Infrastructures – CETRA 2018  
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## THE ROLE OF THE RAILWAY INFRASTRUCTURE IN PORTS OF HUNGARY

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### Abstract

Hungary situated in the center of the continent is one of the most loaded transit country in Europe. There are six TEN-T corridors crossing the country. The ports are the most important turning points of transportation of goods. It is very important the coordination and the high utilization of the environment-friendly and economical transport modes like railway and inland navigation. Although Hungary had more seaports in the history, at present there are only few river ports on the Danube. The paper shows the development of some logistics centers on the Danube and deals with the pivotal role of the railway infrastructure in these ports.

*Keywords: sustainability, transport networks, intermodal center, railway infrastructure, port service calculation*

### 1 Introduction

The White Paper published by the Commission of the European Communities sets an international goal of favoring environmentally-friendly and economical transport modes in order to promote sustainable transport. According to its statements:

- “the success of the efforts relating to the redistribution of traffic division depends on the railway
- short sea shipping and inland shipping are two modes of transport that could contribute to solving the issues stemming from the congestion of certain roads and the deficits of rail infrastructure
- at the moment they are not used at their full potential
- technical harmonization between the systems as well as interoperability should take precedence.” [1]

It is imperative that the strategies specified by the European Union are adhered to in Hungary.

#### 1.1 Transport corridors, traffic characteristics

Hungary’s place in the international transport systems is highly dependent on the country’s transport-geographical location. As illustrated in Figure 1, the crossing corridors and their network elements have a significant impact on the development plans for European transport networks. Due to the transit location, it is imperative to carefully consider each transport mode’s long-term role to better facilitate sustainable development. Following the economic recession of 2012, the Hungarian transport industry has been on the rise. Taking all modes the transport performance was 58.4 billion freight-ton-kilometer (which was 5.2 % better than the year before). If we analyze performance based on branches, it can be concluded that the division is very uneven as road transport constitutes two-thirds of all performances, as Figure 2 shows.



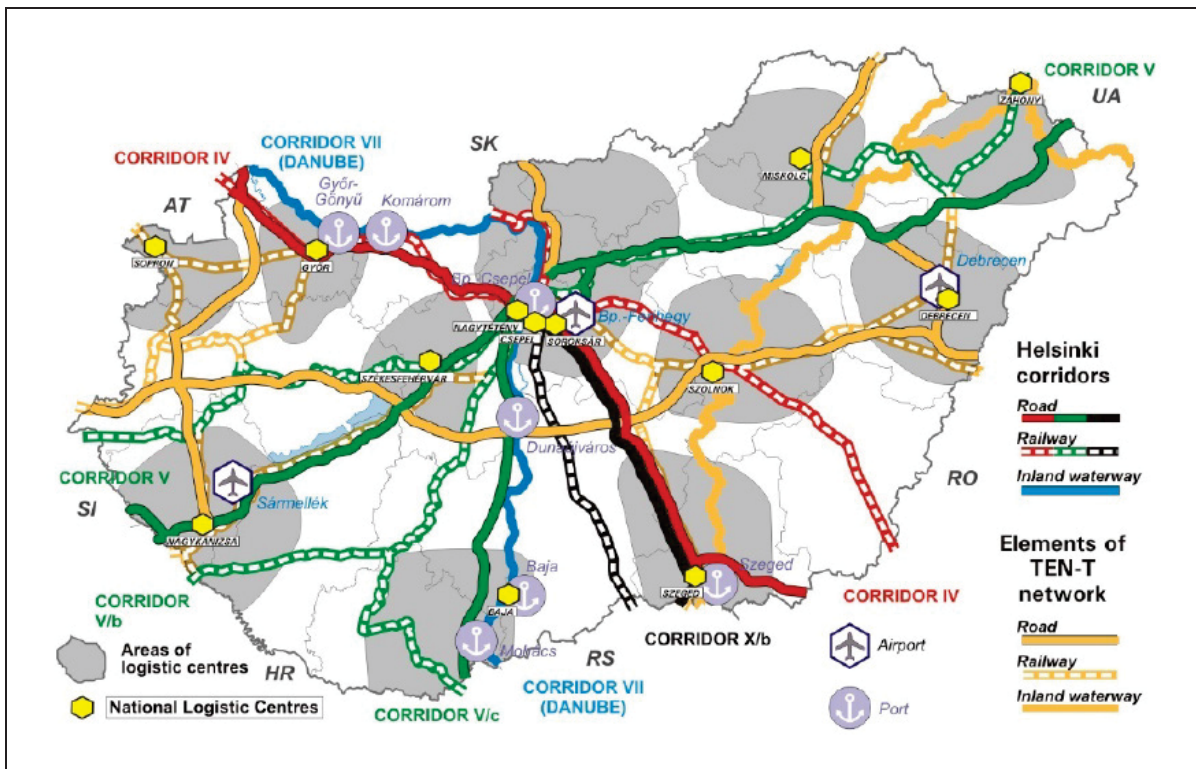


Figure 1 Helsinki corridors / TEN-T network in Hungary [2]

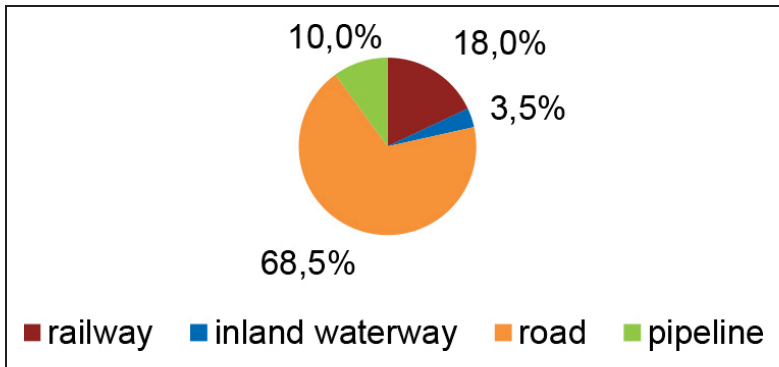


Figure 2 The division of transport performances in Hungary in 2016 [3]

## 2 The historical background of the relationship between ports and rails

Since the development of rail transport in Hungary, initiatives for developing port connections have always been put forward. The first officials who came up with these plans were famous Hungarian historical figures, István Széchenyi, Gábor Baross, and Lajos Kossuth.

### 2.1 Sea links

In the Austro-Hungarian Empire the general idea was to establish the Monarchy's connection with the international transport through the Adriatic Sea. The Austrian Southern Railway (Süd-Bahn) began building the Vienna-Semmering-Grätz-Marburg-Leibach-Trieste route in 1848. Due to the region being surrounded by the Alps, constructors needed to develop revolutionary methods to build this railway which opened for transport in 1854, [4]. This is when Vienna's main train station, designed by Flettich was built as well as the train station in Trieste, which was the Monarchy's only train station located on the seaside where they could unload the

goods that arrived by ships and transport them on the two main routes. Later, at the beginning of the 20th century, Voheirnerbahn built their own final destination in the city, which they named Campo Marzio to compete with Südbahn.

As this venture proved to be a success they continued to connect more and more seaside areas to the network, and subsequently the Trieste-Pivka-Rijeka route was completed which resulted in the influx of tourists in Opatija. Even Franz Joseph himself travelled there and enthusiastically wrote to his wife Sisi that he boarded the train at 5 in the afternoon and arrived at the seaside by 7 in the morning.

Constructing the mountain route from Karlovac to the seaside was a great example of the Hungarian efforts. The construction took place between 1802 and 1812 and was lead by Lieutenant General Vukassovich. The most difficult section was called “Lujza út” (Louise route), the maritime port was reached at “Porta ungarica”. The cost of the construction was 2 110 194 silver forints. Kossuth was very impressed, he called it one of the most important masterpieces of the Monarchy, and exclaimed that they needed a railway just like the one in Rijeka [5]. The Hungarian State Railways was established in 1868 and opened one of the routes built by them between Zákány and Zagreb in 1870.

It should be noted that Hungarian politics and economics has always placed a huge emphasis on Rijeka. The missing section between Karlovac and Rijeka was opened in 1873. The route goes through a rough terrain thus substantial earthworks were needed and also several structures were built. Here are a few pieces of data to illustrate the characteristics of the terrain: 40 % of the Karlovac-Rijeka section contained elevations of 0.6-2.5 %, as a result only small radius curves could be designed there. Given the fact that parts of the Zákány-Rijeka route were operated by South Railways, it was strategically important for the Hungarian State Railways to operate the middle section between Zagreb and Karlovac in order to have a national rail route directly to the Adriatic Sea.

The rail route’s largest station was the Rijeka railway station with 1200 meters. Due to the narrow spaces the station was built on landfill to make the loading and unloading of the ships possible. Rijeka’s (and its railway’s) development continued until 1918. During the construction works they made efforts to adapt to the rise of sea traffic with regards to railway and port infrastructure development.

Rijeka’s importance is highlighted by its history and strategic importance. Livius called it “Oeneum”, Stabon called it “Tersactica”, in Latin its name was Flumen Sancti Viti, its German name was Veit am Pflaum, and in Croatian they first called it Reka and then later Rijeka. According to the documents, 75 ships were built and 1415 big ships and 57,876 seaside tourists arrived there between 1825 and 1833. In 1840 the value of unloaded goods was 1,147,303 and the value of loaded goods was 2,965,523 pengos (Hungarian currency), [5]. Until the nationalization of the Southern Railways-owned Buda-Nagykanizsa route in 1931, the only direct route to the Adriatic Sea on Hungarian soil was the Pusztaszabolcs-Dombóvár-Gyékényes rail route [6].



Figure 3 The traject of Bogojevo [6]

As for the connection between the Alföld (Eastern Hungarian region) and the Adriatic Sea, several ideas were born. In the end, the Oradea-Szeged-Subotica-Bogojevo-Villány route was chosen. The rail routes crossed several rivers so bridges were built in each crossing, except for the river Danube. The other fascinating fact is that up until 1911 a steam traject was operation on the Danube. Due to its slowness, the steam traject (Figure 3) substantially distorted the railway operations' effectiveness. The Danube bridge in Bogojevo was built later, between 1910 and 1911 when the Hungarian State Railways was operating there

## 2.2 Danube connection

Before World War I Hungary owned more than 500 merchant ships which were inherited by the successor states. With the Treaty of Trianon, the country lost a huge part of its territory including its sole maritime port in Rijeka. As Budapest is situated 1640 kilometers from the sea, in order to regain its place in the international market, they developed a waterborne transport connection between the Danube and the sea. The first ship (Figure 4) set sail on 14<sup>th</sup> August 1934 on the Újpest location of Ganz és Társsa Rt. company and was named Budapest; it left for its first trip to Alexandria on 6th October 1934 [7].

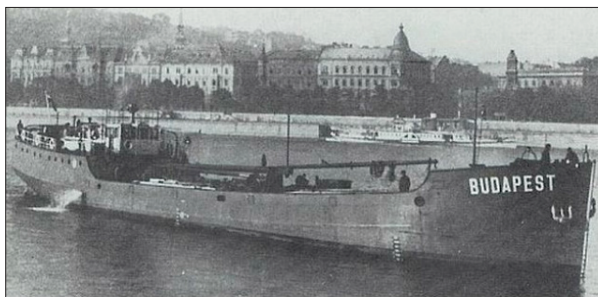


Figure 4 The first river-sea going vessel [8]

To adapt to the new trends in transport politics, Magyar Királyi Duna-Tengerhejőzási Részvénytársaság (major Hungarian waterborne transport company) was established in 1936, and the Csepeli Nemzeti- és Szabadkikötő (Budapest Freeport) that was opened in 1928 took the name Magyar Királyi Nemzeti Szabadkikötő és Tengerhajózási Vállalat.

Since 1969 the company's 11 ships were transporting goods between the Danube and the sea, the last of these ships, called Cegléd was built in 1965. Later, the ships were sold one by one to foreign transport companies and had been taken out of service by the 1980s. Instead of this transport mode, they introduced a combined transport with barge carrying ships was introduced, to eliminate the need for reloading between the transport on rivers and seas. In 1978, a company called Interlighter was established to carry out these operations.

## 3 Intermodal centers along the river Danube

The yellow dots in Figure 1 show the locations of national logistics centers in Hungarian transport development. Three of those are located along the international course of the Danube, there are the ports of Budapest-Csepel, Baja, and Győr-Gönyű. Throughout their history, ports are going through continuous transformation, so they are always changing. These changes influence a port's size, reach, infrastructure, tools, capacity, and even its location.



### 3.1 The evolution of the port of Győr-Gönyű

A The characteristics mentioned above are all illustrated by the unique history of the loaders in Győr. The transformation included a change of location, with the following main stages:

- In the middle ages smaller ships and longboats arrived at the castle of Győr, directly along the castle walls in the estuary of 3 rivers, Duna-Rába-Rábca.
- With the improvement of trade
  - on the Moson arm of the Danube (14.3 rkm right coast) water crafts could anchor near a newly built quay, along which a marketplace was opened (Dunakapu tér) where a special type of lighters called “burcsella / scow” could arrive as they transported not only the goods but also the sellers to the city.
  - loading houses were built on the river Rába, along the walls of Klastrom (monastery)
- At the turn of the century tracks were built next to the marketplace as well as the storehouses; these can be seen in Figure 5 which is a photo of old Győr.
- To keep up with the industrial developments, they needed to supply the plants on the eastern part of the city, so they
  - built an industrial port (Moson part of the Danube, 13.6 rkm, right coast) with connections to railway sidings
  - they also built a separate canal (industrial canal with “basin port”) with its own supplying tracks next to the outer production and trade warehouses to enable more connections: 1915-1926
- After 1990 the city loaders were not used anymore, and the national public traffic port was beginning to develop outside of the city, along the area between Győr and Gönyű, partly due to the restrictions of shipping on the Moson part of the Danube and partly due to the modernization of the economic and transport infrastructure.

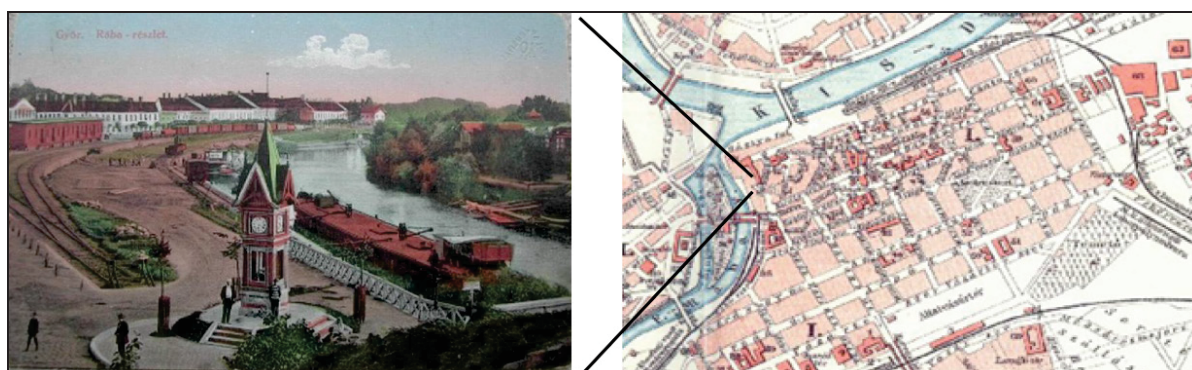


Figure 5 The railway connection of Győr's city center [9]

In the 1990 development plans for inland shipping infrastructure, the port of Győr-Gönyű was prioritized. Its 25-year-old history is closely connected to the history of the entire Hungarian shipping transport and thus clearly represents the problems that recently came to light. The initial plans were to develop a multimodal logistics center.

However, the construction works coincided with the social, political and also economic changes in Hungary. For this reason and also due to the southern Slavic crisis that took place at the same time, this period was also the era of deterioration for the Hungarian transport shipping industry. Consequently, development works slowed down and the trading activity could not gather pace. The 12 kilometer long side tracks to Gönyű from the Vienna-Budapest rail route were completed only by 2008. However, these sidings did not reach the coast (200 meters of rail tracks were missing) thus an in-between transport mode was needed to make the loading of goods from the ships to the trains possible. It was only in 2016 when the direct railway connection was established with 2200 meters of new rail tracks (marked with red on Figure 6). During this project they added new quay berths so now there is a total of 8, [10].

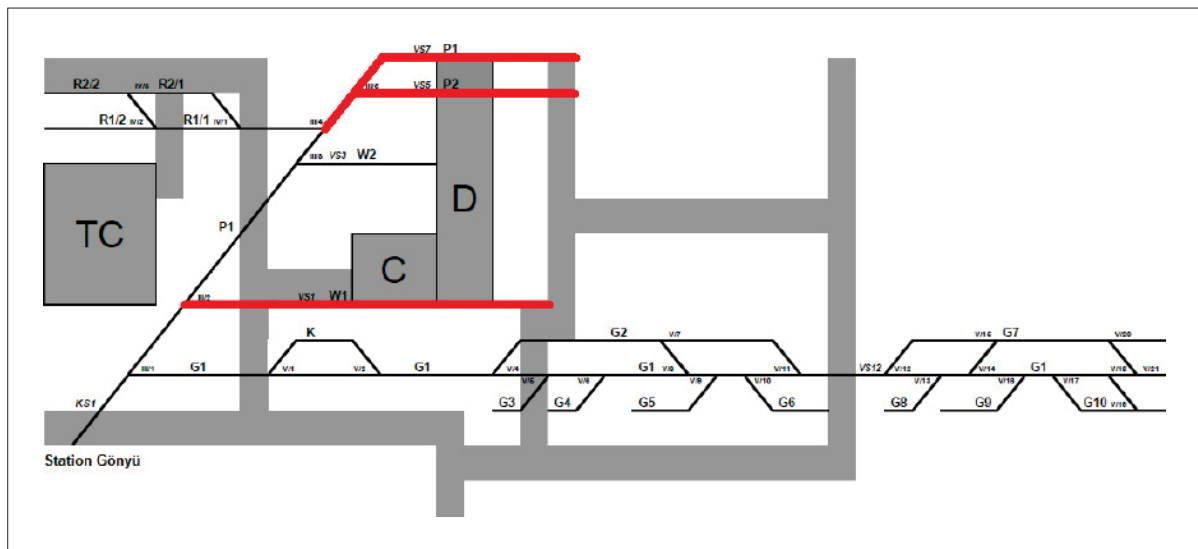


Figure 6 The rail network of the Győr-Gönyű national transport port [11]

Győr The Győr-Gönyű port is connected to Győrszentiván – which is part of the Budapest-Hegyeshalom route – with an 11 kilometer rail section. With this, the port is in direct connection with the 4<sup>th</sup> TEN-T rail network. Trains can go directly (without changing directions) between the station next to the port and Győr and also to other stations on the western side of the Dunántúl region. The port’s railway station has 5 tracks, with a utilized length of between 470 and 640 meters. The 5 tracks specialization tracks (loading, handover, recipients, bypass, scaling) were perfectly up-to-date compared to technologies used in other stations. Scaling tracks were necessary for cars entering into and leaving the internal network system. On the bypass tracks, goods wagons are handed over to the internal crew. Trains leaving the internal network and enter the national network arrive at the handover tracks. The station has its own network for internal use, which provides a direct connection to the port. The port development’s third stage began in 2017, they are rehabilitating the water-level of the Moson arm of the Danube with the building of a complex (lock) estuary structure thus it will become a “basin port”, [12].

#### 4 The effectiveness of port trade

In terms of port trade, the synchronization of the two transport modes with the biggest capacity – which are shipping and rail – should be examined. To give a good basis for the synchronization, the number expected trading activities should be estimated. It is known in the realm of loading technologies that the loading processes are most crucial and defining aspects of a warehouse. During the loading period when the trains are standing still there are important transportation legal sections and questions of railway operations, that’s why it is important:

- to correctly determine the maximum loading time and to have it written down in a contract
- it could be an advantage for the internal port network if the trains are able to be loaded at the same time.
- this feature can be limited by the loading equipments’ specifics and number
- the internal network’s supplying and loading activities should be organized and harmonized so that the train cars and locomotives should be occupied minimally
- last but not least the calculated loading times should be inserted into the bloc train schedule.

#### 4.1 Calculating the loading times

Based on the above the most critical aspect is the time required for loading ( $T_L$ ). Loading activities between ships and trains are usually calculated as per below:

$$T_L = T_s + T_{mr} \quad (1)$$

Where:

$T_s$  – the loading activity's (using loading equipment) real time [h];  
 $T_{mr}$  – time spent with moving rail equipment [h].

The time spent on loading depends on the total weight of the goods moved ( $V_g$ ) [t] or [ $m^3$ ] the number and performance norms of the loading equipment that can be used simultaneously ( $c_{ci}$ ) [t/h] or [ $m^3/h$ ] – that is, the quantity of goods that can be unloaded in a given time, the calculation is as below:

$$T_s = \frac{V_g}{\sum_{i=1}^n c_{ci}} \quad (2)$$

The time required for moving rail equipment depends on the norm time ( $t_{mr}$ ) of moving car groups (moving it on and off of the loading track) and the number of moving activities needed ( $n_m$ ) (counting the ins and outs separately).

$$T_{mr} = t_{mr} \times (2n_m - 1^*) \quad (3)$$

\* in case of trains ready by start

The number of moving activities need for a given loading process depends on the quantity of goods, the transport capacity of wagons ( $C_w$ ), and the number of wagons that can be loaded simultaneously ( $n_w$ ) (the size of the carriage group that can be on the loading tracks):

$$n_m = \frac{V_g}{C_w \times n_w} \quad (4)$$

The detailed calculation formula of the loading time is:

$$T_L = \frac{V_g}{\sum_{i=1}^n c_{ci}} + t_{mr} \times \left( 2 \frac{V_g}{C_w \times n_w} - 1 \right) \quad (5)$$

Similarly to these calculations, the loading norm of each quay berth, and consequently of the whole quay can be calculated. The road and rail capacity needed to continuously supply the port can be determined. The yearly performance can be calculated, which compared to the completed loadings can show the port's utilization.

## 5 Conclusions

In the history the ports played a significant role in the development of the railway network. To promote sustainable transportation of goods the effective cooperation between railway and inland navigation is very important, and the synchronization of port processes can contribute to it.

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