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## IMPACT OF CROATIA ACCESSION TO THE EU ON THE CROATIAN RAILWAY INFRASTRUCTURE, RAILWAY AND MARITIME FLOWS

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**Abstract:** *The goal of this paper is to try to portrait the current state of the railway infrastructure in Croatia, main freight railway flows in the country, the state of infrastructure regarding the Croatian accession to the European Union and the future potential of the railway freight flows especially flows from the Adriatic ports and flows on the so called east-west corridor (the former Pan-European corridor X).*

**Keywords:** *railway infrastructure, railway flows, maritime flows*

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### 1. INTRODUCTION

Croatia currently has 2.722 kilometres of the railway network. The entire network is managed by Croatian railway infrastructure Ltd company which is 100% owned by the Republic of Croatia. A unique company called Croatian Railways (HŽ) "lived" until 2008 when it was divided into five companies and in 2012 a new restructuring left only three independent companies. One of them is HŽ Infrastructure Ltd which manages the railway infrastructure in Croatia today. States Slovenia, Croatia and Serbia form a space which links south of Europe with the East and South East parts of Europe. The freight route that passes through these three countries is the shortest connection between Italy, France, Germany and Austria with Romania, Bulgaria and Greece and the seas like the Black Sea and the Aegean Sea. These two axes have the potential to form main freight flows.

The freight flows generated from the Croatian industry is very hard to expect in the following years due to a hard decline of the industrial production in Croatia. Worth mentioning are the potential flows from the port of Ploče towards the Bosnia and Herzegovina and possibly towards Hungary. In the end the port of Vukovar should be mentioned. It is the only freight port on Danube River in Croatia. There is a possibility that some goods can be transported from Adriatic ports to the port of Vukovar and then onwards by Danube river into Hungary, Austria and into southern Germany. The importance of Vukovar was recognized with latest TEN-T network revision and the extension to the Western Balkans. Vukovar was designated as the core port and the Danube River in the Balkan states became a TEN-T corridor. Also, Sava River from Sisak downstream to Belgrade became a part of TEN-T.

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## **2. CROATIAN RAILWAY INFRASTRUCTURE – FACTS AND FIGURES**

Croatia has an overall of 2.722 kilometres of the railway network. Only 254 kilometres of these tracks are double track. In overall 977 kilometres of the network is electrified with 25kV AC system. Main nod in Croatia is Zagreb with its railway station. Central nodes are Zagreb Main station for passenger transport and Zagreb marshalling yard for freight traffic. First railway line in Croatia was passing through north of Croatia, it was a railway line from Hungarian Nagykanizsa to Slovenian Pragersko. It was the line which connected Budapest Nagykanizsa main line with the Vienna – Graz – Ljubljana – Trieste main line.

### **2.1 Infrastructure and the capacity on the Zagreb – Rijeka main line**

The line Rijeka – Zagreb – Koprivnica – Hungarian border is entirely electrified with the 25 kV AC system and it is 332 kilometres long. Except of 20 kilometres in the Zagreb nod which is double track all the other parts of the line are single track. The axle load on line is 22,5 tons per axle. On the part from Moravice through Zagreb until Hungarian border there is an automatic block system of signalling, while on the 90 kilometres long stretch from Moravice to Rijeka there is only clearance between vehicles (between the train stations) which significantly reduces capacity. The line due to its hauling characteristics can be divided into five sections. Two sections Hungarian border – Koprivnica – Lepavina and Križevci – Zagreb – Karlovac are the sections built on flat terrain allowing good speeds and gradual inclines. That gives the opportunity to haul very heavy trains with only one locomotive. These sections could allow speeds from 140 to 160 kilometres per hour or even higher but the current state of infrastructure limits this from 60 to 140 kilometres per hour. Some parts that pass through Zagreb are limited to only 60 kilometres per hour due to bad track condition. The stretch from Lepavina to Križevci is only 29 kilometres long but offering inclines up to eleven per mile which adds a need for two locos when trains heavier than 1.200 brut tons need to be hauled. The similar hauling conditions apply on the 86 kilometre Karlovac – Moravice. Speeds on these sections vary from 80 – 140 km/h. The last section from Moravice to Rijeka is the most difficult one. The line climbs there to more than 900 meters above the sea. Many parts of the line offer steep inclines from 20 to even 27 per mile. One of the hardest parts of the track is an incline from Rijeka to Plase station. More than 95% of this 29 kilometre long section has a 25 per mile incline at some parts reaching even 27 per mile. One electric locomotive can haul only a 500 brut tons trains here. Modern 6 Mega Watts locomotive can haul up to 750 tons here. On this stretch adding a pushing locomotive to the rear end of the train can significantly increase the tonnage of the train. Unfortunately, although this hauling technique was used before, during the last ten years Croatian railways didn't allow adding a pushing locomotive. Hopefully, this can be changed allowing heavier trains to leave Rijeka. Speed on this section is from 60 to 80 kilometres per hour. The current assessment of the Rijeka main line full capacity differs depending on different section of the line. The Rijeka – Moravice section has the maximum capacity around 5 million net tons (12 million brut tons) of goods per year. This can be also expressed with a figure around 60 trains per day. The sections of that line that lie in a flat terrain can allow almost up to three times this capacity reaching around 16 million net tons (40 brut tons) per year with some 80 freight trains per day. A higher capacity is not possible to reach due to only single track and mixed passenger/goods traffic.

### **2.2 Infrastructure and capacity on the Zagreb – Vinkovci – Belgrade main line**

A part of the railway line Ljubljana – Zagreb – Vinkovci – Belgrade is also entirely electrified. Out of its 320 kilometres that passes through Croatia 216 kilometres is double track. Also from Zagreb to Novska to single track exist, one 105 and the other is 117 kilometres long.

All the line passing through Croatia was built in a flat terrain with most of the curves with long radiuses allow speed for 160 or more km/h on most of the line. Some small radius curves can be found restricting speed between 80 – 120 km/h. All the line is equipped with automatic block

system signalling. Double track parts have a very high capacity for transporting freight. A limiting fact is that the section between Dugo Selo and Novska a single track line. This can be alleviated by using another line parallel to this one which runs from Zagreb to Sisak and then to Novska. It is 117 kilometres long which is only 12 kilometres longer than the line Zagreb – Dugo Selo – Novska. It is also electrified, in flat terrain and allowing speed from 100 – 140 kilometres per hour.

### 3. CROATIAN MARITIME AND RAILWAY FLOWS

#### 3.1 Maritime flows

Port of Rijeka handles all kind of goods. General cargo, wood and cereals come and go to the port. Main inland destinations are Hungary, Serbia and Croatia. TEUs (twenty feet equivalent unit) are also being mostly delivered to the same countries and also in Austria. Out of almost 160.000 TEUs per year most of them are delivered by trucks, around three quarters of them. The rest goes to rail. In port of Split the main type of goods are general cargo, wood, cereals, cement and fuels. Most of these good are transport by trucks. Most of the cereals and cement goes by rail. In port of Ploče alumina, fuels, ore and some other kind of bulk cargo arrives. Most of these good are transported to Bosnia and Herzegovina and about half of the goods travel by rail. In the port of Šibenik mostly bulk cargo is being delivered from inlands of Croatia and Hungary. Large shipments of phosphates for Hungary and Petrokemija in Kutina were also recorded in the recent years. Phosphates are practically 100% delivered by rail. In the port of Zadar small quantities of general cargo and fuels are being recorded. Up to two trains per day drive these good while most of it goes inland by road.

#### 3.2 Railway flows

Goods traffic flows changed significantly in the last thirty years in Croatia. Today in Croatia there is only one railway freight operator and this is HZ Cargo Ltd, which was established in 2008 after a division of a single railway company, Croatian railways. HZ Cargo is 100% owned by the state. Today it has around 80 diesel and 50 electrical locomotives and somewhere around 6.000 wagons. If we compare the data from 1996 where the former Croatian railways still had 430 locomotives and almost 12.000 freight wagons and that number dropped to 280 locomotives and 7.000 wagons in 2005 we can see a clearly bad policy towards the modernisation and extension of the fleet. That is also one of the reasons why the rail numbers declined significantly.

Currently it is clear that the number of goods carried inland in Croatia is declining. One of the reasons for that is the decline of the industrial production and the economical activities in general.

Table 1. Inland transportation in Croatia in 2010, 2011, 2012 by road and rail

	Measure	Overall transport			Market share			Index	
		2010	2011	2012	2010	2011	2012		
Overall goods carried	in millions of tons	87.170	86.439	76.527	100	100	100	99	89
Railway transport	in millions of tons	12.203	11.794	11.088	14	13,64	14,49	96,65	94,01
Road transport	in millions of tons	74.967	74.645	65.439	86	86,36	85,51	99,57	87,67
Overall TKM	millions of TKM	11.398	11.364	10.981	100	100	100	99,7	96,63
Railway transport	millions of TKM	2.618	2.438	2.332	22,97	21,45	21,24	93,12	95,65
Road transport	millions of TKM	8.780	8.926	8.649	77,03	78,55	78,76	101,66	96,9

From the table 1 it is more than obvious that the inland transportation of goods is declining while the market share road/rail remains the same. It is obvious that the most railway transport in Croatia is transit through the country. This transit includes also the goods transloaded in Croatian ports and then carried over the country borders and vice versa.

The biggest amount of the railway transport in Croatia is done on the East-West corridor that includes the railway lines Slovenia – Zagreb – Vinkovci – Serbia and the main line Zagreb – Sisak – Novska. The second busiest line is the one connecting port of Rijeka with Zagreb and Hungary. Two main types of transport can be mentioned here, the first is the one from port of Rijeka towards Hungary and Serbia and the second one is the transport from Bosnia and Herzegovina to Zagreb and then onwards to Slovakia and Poland. This transport mostly includes ores from northern Bosnian territory. So called Dalmatian lines are third with the amount of transport. This does not come as a surprise since three Dalmatian ports depend on these lines, Zadar, Šibenik and Split. Although the amount of goods transported on the former Vc corridor seems small, we must realize that the section between port of Ploče and Bosnian border is only 24 kilometres long. This line serves the port of Ploče taking each year almost two million tons of different goods. The lines in Podravina and Slavonia are next in line serving many enterprises and mostly transport agricultural goods. On these lines there is “Viro” sugar refinery in Virovitica and “Nexe group” factory Našice and they both on the list of 10 biggest companies that use rail in Croatia. Largest users of railway transport are AGIT d.o.o. and C.K.T.Z. Both these companies are logistic operators. First company is owned by HZ Cargo, the other is private. Third largest user is Petrokemija from Kutina which is situated on the East-West railway corridor adding a lot to its transport. It is also important to notice that eight largest users of railway transport increased their transport in 2012 the overall amount of transported goods in decreasing. This might indicate that the so called small users have started using railway services even less. Twenty biggest users of the freight railway services in Croatia transport 88,1% of all the goods transported by rail. Small users therefore transport only 11,9% of all the goods transported by rail and this percentage is getting smaller every year. This might indicate that a transport of goods by rail by current conditions is very unattractive for many smaller users, some of them even with the potential use rail much more than today. That indicates a problem that is been present not only in Croatia, but in the other European countries as well and that is that the railway transport companies are getting further away from small users. But serving only big users in the end gives us less and less quantity of the goods transported by rail every year. This clearly indicates that although the main corridors (like Trans-European Transport Network -TEN-T network) is very important, it is vital that corridor lines are very well connected with regional and local lines, local transport centres and industrial sidings of various scale of transport. This can easily be compared with large rivers which definitely would be so huge if there weren't a large numbers of small rivers and creeks upstream.

#### **4. EXISTING TRAFFIC FLOWS ITALY/AUSTRIA – SLOVENIA – CROATIA AND THE POSSIBILITIES FOR MAKING A NEW TRANSPORT FLOWS AMONG THESE COUNTRIES**

The existing railway connection between Rijeka and Venice/Trieste goes over Pivka and Sežana in Slovenia and it is significantly longer than the road connections. In order to make competitive passenger and passenger operation a new railway line from Rijeka to Trieste is planned. This line should be a logical extension from the new Hungary – Zagreb – Rijeka high speed high-capacity line. The initiative called NAPA – North Adriatic Port Associations is an initiative that joins together four North Adriatic ports in order to boost their cooperation, common marketing and by that to boost potential of all the ports. These ports are Venice, Trieste, Koper and Rijeka.

The possibilities of NAPA are growing even stronger after the 1st of July when Croatia joined the EU. The transport of goods from Rijeka towards the European destinations is now even simpler. This initiative is a good basis for further deeper cooperation among these ports. This alliance

will in the future definitely need a better railway link between each other. Therefore a high capacity and a high speed railway link Rijeka – Koper – Trieste are needed in the future. Since these ports transload the amount of cargo very close to the amount that for example a port of Hamburg does, with common operations, better infrastructure and a good marketing these four ports can become the leading intermodal area in Europe.

East-west corridor in Croatia forms a very good potential link of Italy and Austria towards Romania, Bulgaria, Turkey and Greece. The growing Turkish economy had bigger and bigger need to drive the goods towards the middle and Western Europe and this corridor is one of the best solutions.

In the freight operations the east-west corridor in Croatia can also be a very good link between the NAPA ports and the Black Sea ports in Romania and Bulgaria. Further intermodality options appear when these rail traffic flows are combined with the Sava and Danube rivers and the ports of Vukovar, Belgrade, Slavonski Brod, etc. A great possibilities can be seen with a suggested new high-capacity and high-speed line between Zagreb and Maribor. This line railway line, together with the new Zagreb – Rijeka high-speed line and with the new Semmering basis tunnel in Austria could form the shortest and the fastest both passenger and freight connection between the port of Rijeka, Graz and Vienna. This railway partially new railway line could offer very gradual inclines which makes a possibility to haul heavy freight trains all the way with only one locomotive. This kind of operation saves energy, nature and of course offers lower costs of transport as well.

Unfortunately, new Zagreb – Maribor railway corridor was not recognized in the latest TEN-T revision in May 2013. Also, by “Regulation (EU) No 913/2010 of the European Parliament and of the Council of 22 September 2010 concerning a European rail network for competitive freight Text with EEA relevance” on the first page it is clearly stated “In order to be competitive with other modes of transport, international and national rail freight services, which have been opened up to competition since 1 January 2007, must be able to benefit from a good quality and sufficiently financed railway infrastructure, namely, one which allows freight transport services to be provided under good conditions in terms of commercial speed and journey times and to be reliable, namely, that the service it provides actually corresponds to the contractual agreements entered into with the railway undertakings.” This new railway line would cut the travelling times both for passengers and the freight to one third of today’s time and finally make him competitive with the road transport.

Into the regulation EU No 913/2010 regarding the freight corridors there is a need to add new corridors and connections to the existing corridors in order to boost the freight connection between Italy, Austria, Slovenia and Croatia. On the page 12 on the list of initial freight corridors under corridor number 5 there is a branch listed Graz – Maribor – Ljubljana – Koper/Trieste. Another branch should be added Graz – Maribor – Zagreb – Rijeka – Koper/Trieste. Under number 6 with the branch Koper – Ljubljana – Budapest – Zahony another branch should be added: Ljubljana – Pragersko – Čakovec – Nagykanisza – Budapest. Also two new freight corridors should be added to this list, the first is Ljubljana – Zagreb – Sisak – Vinkovci – Belgrade and the other Rijeka – Zagreb – Koprivnica – Gyekenyes – Budapest.

## 5. CONCLUSION

Croatia has 2.722 kilometres of the railway network and out of those only 254 kilometres of double track railways. In overall 977 kilometres of the network is electrified. This clearly shows that the railway network in Croatia was newer built to a satisfactory extent. Boosting promotional activities, more research and more legislative support is needed to boost transit transport, transloading in ports and intermodal transport in general. Besides these activities a new infrastructure capacities must be planned in order to help the boost of the railway transport and intermodal transport. Ports definitely need better connections towards inland, but

these new railway infrastructure capacities should not avoid the possibilities to serve as long-distance and local passenger links and local freight links also. In cross border operation a huge potential for interoperability already exists. Links between Croatia and Slovenia is possible to overcome by using multiple system electric locomotives and links between Hungary, Serbia, Bosnia and Herzegovina and Croatia can be achieved by the existing fleet of mono system locomotives. Further legislative and organisational steps are needed to make this possible. Croatian Adriatic ports already have large possibilities in transloading goods. This especially works for the ports Rijeka and Ploče which even today transload a significant amount of goods. Port of Rijeka is already making possible to transload around 600.000 TEUs per year but better organisation of rail transport and better railway infrastructure is needed. The strongest railway flows can be recognized in three areas. Hungary – Zagreb – Rijeka axis, Slovenia – Zagreb – Vinkovci – Serbia axis and Dalmatian ports – Zagreb axis. A lot of freight transport also goes from port of Ploče to Bosnia and Herzegovina. All these flows can be boosted even with the existing railway infrastructure by promotional and organisational measures. The existing legislative in Croatia today allows the excess of all the European operators to the network. Since Croatia only joined the EU and the new legislative measures just took the first steps in cannot still be seen that other operators than Croatian HŽ Cargo is running the railway freight operations. But the concessionaires in the port of Rijeka already announced the possibilities to engage the other operators for the operation of transporting goods from and to the port. It would be also very good that the planned new railway line Zagreb – Maribor enters TEN-T in the next revision. This would offer the shortest, fastest and most economical railway connection between Rijeka, Zagreb, Maribor, Graz and Vienna. Also, a new branches and corridors should be added into the list of initial freight corridors (EU No 913/2010). The branches are Graz – Maribor – Zagreb – Rijeka – Koper/Trieste and Ljubljana – Pragersko – Čakovec – Nagykanisza – Budapest. Two new freight corridors should be added as well: Ljubljana – Zagreb – Sisak – Vinkovci – Belgrade and Rijeka – Zagreb – Koprivnica – Gyekenyes – Budapest.

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