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COMPETITIVENESS OF RAIL FREIGHT CORRIDORS – CASE STUDY: CORRIDORS X AND IV

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Abstract

After almost 30 years since the first declaration of corridor network of Europe and the same amount of time spent on investments in its development with goal of creating single european transport market, it seems like the era of competitiveness of some of the corridors has begun. The term of corridor competitveness, its significance, factors of competitiveness and comparative analisys of factors for TEN-T Corridors X and IV have been reviewed in this paper. Also, paper reviews methods of evaluation of corridor competitiveness which have been used in other author's work, followed by the method of comparative analisys. As main factors of competitiveness of these two corridors in this moment, this paper specialy marks the length of corridor, travel time - commercial speed of the train, waiting time at border crossings, level of access charges and usage of corridor capacity.

Keywords** – **competitiveness, corridors, railway market, case study, comparative analysis

1. INTRODUCTION

The idea of TEN-T policy, as a result of efforts to ensure mobility, reduce disparities between regions, improve quality of life and encourage economic development of the EU, through providing good transport connections, was borne in 1992 when Maastricht Treaty initially provided the legal basis for TENs[1] in fields of transport, telecommunications and energy infrastructure.

[1] Trans European networks

The list of 14 priority projects was endorsed by Essen European Council in 1994 and after 11 years it was extended to a 30 priority axes. Eventually, in 2004, the list of 30 projects of all modes of transport, have merged into nine „Core network corridors" [*Otsuka, et al, 2017]*.

Since then, the railway transport systems of the EU countries went through the long process of harmonization, market opening, removing bottlenecks and building missing links, supported by the reform packages of legislation. That exact process has brought something new to the EU railway system – a competition.

It's not only about the competition between railway and other modes of transport, now it's rather about a competition between railway companies on the same line, and even the competition between the lines itself! Exactly this kind of competition, competition between lines – corridors is of particular interest in this paper, due to fact that some corridors share the same flows of goods and passengers.

This paper will explain the term of competitiveness and causal effect with the factors describing it, as well as methods of their possible evaluation and provide the definition of corridor competitiveness. Chapter 3 will describe possible methods of competitiveness evaluation with the main goal to choose the appropriate method for observation of competitiveness between two railway corridors. Case study of Corridors IV and X will be implemented in chapter 4.

2. DEFINING COMPETITIVENESS AND FACTORS OF COMPETITIVENESS OF RAIL CORRIDORS

2.1. Competitiveness in general

The concept of competitiveness can be applied to various entities [*Grzesiak, Richert-Kazmierska 2014]*:

- Competitiveness of products and enterprises (a microeconomic approach);
- Competitiveness of industries (a mesoeconomic approach);
- Competitiveness of regions and urban areas (a mesoeconomic approach);
- Competitiveness of national economies (macroeconomic approach);
- Competitiveness of international blocks (mega economic approach).

Competitiveness of transportation or railway sector can be perceived as competitiveness of network industries, but competitiveness of an entity such as rail corridor is rather a mixture of the first three from the list. Several enterprises are operating along corridor (IM's, RU's, forwarders), it also acts as an independent industry (subject to intermodal competitiveness), and it has characteristics of regional or urban areas competitiveness

(geographical distribution, freight flows, passenger distribution etc.). The influence of the states is also unavoidable due to investment and price policies and regulatory aspect.

For an enterprise (or entity), it is one of the basic requirements to perceive its own competitiveness, and to comprehend factors which makes it more or less attractive to the market. In other words, enterprise (entity) needs to know what makes it attractive to the market and therefore - more competitive. There is no consensus in international literature of what is the ultimate definition of competitiveness. According to British „Oxford dictionary", competitiveness is the „possession of a strong desire to be more successful than others", or „the quality of being as good as or better than others of comparable nature".

Competitiveness of enterprises is a multi-dimensional and relative notion without universally approved definition [*Sieradzka, Luft, 2015*]. It is often used to refer to ability of an organization to compete and be successful [*Grzesiak, Richert-Kazmierska 2014*]. It can also be understood as the capacity for rivalry and competition [*Sieradzka, Luft, 2015*]. Competitiveness is frequently identified with price or quality of a product, productivity of resources, production costs or the competitive advantage itself [*Lombana, 2006*].

Also, there are other definitions of competitiveness: *competitiveness is the ability to continue providing added value to enterprise stakeholders* [*Dwyer, Kim, 2003*], or: *to be profitable and maintain a dominant market standing* [*Lombana, 2006*]. It is often related to relationship between enterprises that are selling *similar services* or products at the *same time,* for the specific customer [*Stanikunas, 2009*]. Competition among enterprises practically means the competition among their provided services, their extra value to a customer [*Langviniene, Sližiene, 2012*].

In accordance with stated definitions and classification, authors in context of this paper, bring the following definition of rail corridor competitiveness*:* Competitiveness of a rail corridor is related to the capacity of the corridor as a system, to compete and to be attractive on the transportation service market compared to its direct rivals (competing corridors or other transportation modes).

2.2. Factors of competitiveness of rail freight corridors

As starting point of this chapter, the table of variables identified to influence freight rail movements and costs will be used. Important note it the fact that most of the authors from the table were dealing with the corridor competitiveness in general and their factors are (dominantly)

applied to corridor's intermodal competitiveness. Table 1 shows the breakdown of literature and variables associated with freight rai

Table 1: *Rail variables and associated literature [Seedah et al, 2014]*

	Track design (grade, rise and fall)	Tonnage	Train speed	Length of train	Idling at sidings	Terminal dwell time	Total trip delay	Terminal operation cost	Fuel	Labor	Capital investment cost	Cost of expansion	Cost of maintenance	Bottlenecks	Annual growth rates	Emissions	Track capacity
Seedah et al. (2010)	✓								✓	✓	✓		✓				
Chen et al. (2010)						✓		✓									
Fekpe (2010)			✓	✓	✓	✓						✓	✓				✓
Harrison et al.(2010)		✓												✓	✓		
Lai et al. (2009)							✓				✓	✓					✓
Morgan et al. (2007)												✓		✓			✓
Cambridge Systematics (2007)		✓		✓				✓				✓	✓		✓		✓
Prozzi et al. (2006)		✓										✓		✓		✓	
Resor et al. (2004)	✓							✓	✓	✓							
Arnold et al (2003)						✓		✓									
Prentice (2003)														✓			✓
General Accounting Office (2003)											✓						
Lubis et al. (2003)												✓			✓		✓
AAR (2001)									✓	✓							
TRB National Research Council(1998)		✓												✓		✓	
Hay (1980)	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓				✓
DeSalvo (1967)	✓	✓						✓									

Tonnage, terminal costs, capacity and cost of expansion are variables of highest interest to rail industry. Out of all 18 sources, at least 6 of them discussed these variables. Both, track design and bottlenecks were also common, with five sources for each of these variables.

For the reference, Paul (2016) used set of factors: distance, transport time and cost per TEU to measure competitiveness of corridors. In addition, bottlenecks, region connectivity and port access were discussed. Jugovic et al. (2006) used following factors in their multi-criteria optimization of the Pan-European corridor V: port and inland transport costs, transit time, geographic availability (distance), commercial availability, service frequency, capacity and information technologies. With the exception of commercial availability and IT implementation, consistency can be found. Kennedy (2012) also claims main factors to be distance, transit time, transport tariffs and number of border crossings. Technical, legal, infrastructural and political bottlenecks were discussed.

Bearing in mind that this paper deals with the competitiveness of a rail corridor from the perspective of forwarders (final users), and does not take into consideration intermodal competition, it is possible to create relatively simple model and establish the set of factors. All variables related to costs (track design, terminal costs, fuel, labour, costs of maintenance, access charges etc.) can be expressed through the *cost of transportation service*. That is the final price forwarder is paying for provided service, and it has all variables affecting the cost of train movement included. Train speed, condition of infrastructure, border crossings, total trip delay, bottlenecks, idling at sidings and terminal dwell time all can be expressed through the *commercial speed*.

Track capacity and tonnage remain last two important factors to discuss. For the purpose of this paper tonnage can be assumed as common for both of corridors (standardized cars and intermodal containers) as well as the capacity (railways in this part of Europe do not have high volume of traffic in general), and therefore both could be excluded from the model. On the other hand, track capacity stands for the whole set of technical indicators (V_{max}, electrification, rail vehicles, traffic organization, but also the quality of the service) that can, collectively, represent great competitiveness factor. From that perspective, *track capacity* should be kept in the model.

Finally, it is necessary to add *length of the corridor* as a significant factor, which does not require further explanation. To summarize, there are four main factors of corridor competitiveness and the set of variables influencing each of those. Factors and variables are given in table below.

Table 2: *Factors and variables of corridor competitiveness*

Factor	**Distance (Km)**	**Commercial speed (Км/н)**	**Costs (EUR/TEU)**	**Track capacity (train blocks/day)**
Variables	/	Infrastructure	Fuel	Technical limitations
		Trip delay	Labour	Electrification
		Bottlenecks	Maintenance	Service quality
		Idling at sidings	Access charges	Type of vehicles
		Terminal dwell time	Terminal costs	Maximum weights
		Border crossings	Etc.	Traffic organization

In order to act on corridor competitiveness it is necessary to change some of the variables, which results in change of the chosen factor.

3. EVALUATION OF COMPETITIVENESS

Using indicators to define some sort of competitiveness index is a very common method of competitiveness evaluation. But by using it, it brings double-folded problem best defined by Jin (2003). *There are two categories of the index: measuring and analyzing. Measuring index is an outcome of competitiveness or the final expression of competitiveness; however, analyzing index is a cause or a key element of competitiveness.*

One example is World Economic Forum (WEF), which is using global competitiveness index (GCI) to rank world countries by their competitiveness (macroeconomic approach). Index is derived from 114 indicators grouped into 12 pillars [*Schwab, 2016*].

In a study performed on Lithuanian freight transport market (competitiveness of industries) following method was used: primarily, the analysis of scientific literature was conducted. Afterwards, statistical data analysis and qualitative (deep interview) and quantitative survey (questionnaire) were carried out. Statistical data analysis helped to shed light on general trends of Lithuanian freight transport market, while deep interview was performed to clarify preconditions for competition. Questionnaire was filled by transport service providers, and it helped to disclose situation from their point of view [*Langviniene, Sližiene, 2012*].

Chantruthai et al (2013), discusses competitiveness between low cost airlines and high speed rail using multinomial logistic regression model and binary logistic regression model, applied to the chosen set of factors.

To conclude, competitiveness is indeed a multi-dimensional and relative problem, and it can be observed and measured by variety of methods. Literature research confirmed that majority of the studies and scientific papers used numerical factors in order to quantify competitiveness, mostly by forming a competitiveness index. The second most used method was comparative analysis of factors, adjusted to a particular problem [*Kennedy, 2012, Dumitrescu 2013, Paull, 2016*]. Third place is held by several mathematical methods, such as multi-criteria optimization, [*Jugovic et al, 2006*], gravity model [*Chmelik et al, 2010*], logistic regression model [*Chantruthai et al 2003*] etc.

Due to the fact that most of transport related competitiveness problems, and competitiveness problems between two entities with similar

characteristics were observed using comparative analysis, that particular method is chosen to be applied for Corridor X and IV in this this paper.

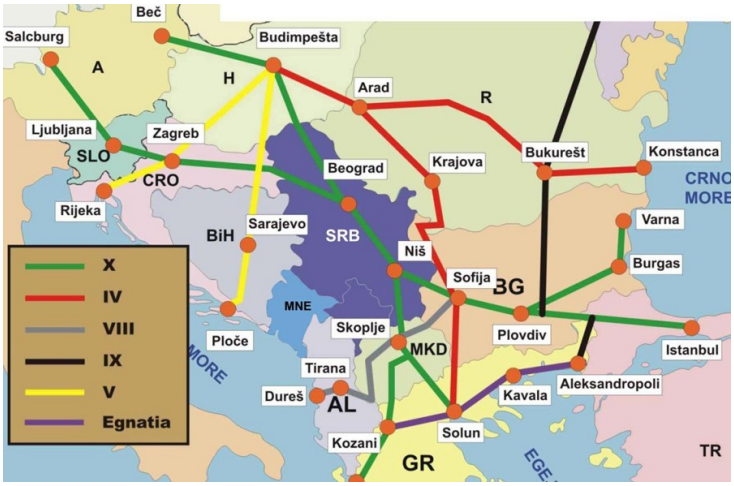
4. CASE STUDY: COMPETITIVENESS OF RAIL CORRIDORS X AND IV

4.1. Corridors potential

China Ocean Shipping Company (COSCO) in year 2009 won 35-year concession for the two of three port terminals in port of Piraeus, and in January 2016 formally acquired 67% share for 370 million euros. Furthermore, the company has announced another 350 million euros of investments in next five years, increasing the port capacity from 1 to 7 million TEUs [*National Bank of Greece, Sectorial report, 2013*] which marked the port of Piraeus as a new logistics hub of Europe.

Reliable indicator of the future traffic potential is Hewlett-Packard (HP) decision from 2013 to relocate major part of its distribution operations from Rotterdam to Piraeus, and to use rail transport from Piraeus for distribution to the Balkans, Hungary, and Czech Republic. East-Asian companies like ZTE, Samsung Electronics, Dell, Lenovo, and LG have also expressed interest to use Piraeus as a gateway to South East and Central Europe. Estimated trade in 2016 between Central Europe and Asia is 1.8 million TEUs, and Southeast Europe and Asia around 0.9 million TEUs [*Piraeus Port Authority, Financial report, 2015*]. Cargo coming from Asia is shipped to one of the Mediterranean or North European ports where it is reloaded to a smaller ship, which then transports it to the final destination (trans-shipment). Alternatively, cargo is reloaded to rail or truck and arrives at final destination by land (transit).

The Port of Piraeus is currently not reaching that market. „Only" 200.000 TEUs are being unloaded in Greece and are in transit to Central and Southeast Europe, and currently 25% of those 200.000 TEUs is shipped by rail (Corridors IV and X). COSCO and Trainose, a Greek railway operator, are very interested in becoming a player in that 2.7 million TEUs market. Their goal is to integrate port and rail operations and to provide quick and seamless shipping to the hubs in Hungary and Czech Republic. Undoubtedly, Port of Piraeus has a sufficient capacity to service the entire market but the rail infrastructure is not up to speed, making the ports in the Adriatic Sea and the Black Sea more viable routes [*Bauranov, 2016*].



Picture 1: *TEN-T network Balkans (indicative extension)*

4.2. Comparative analysis of rail corridors X and IV

Due to geographical distribution of these two corridors, distribution of flows and data unavailability, the model for comparative analysis of competitiveness of Corridor X and Corridor IV has the following assumptions [*Stanojevic,et al, 2018*]:

- Due to fact that section Athens – Thessaloniki (493.5 km) is mutual, as well as the section after Budapest, case study reviews Thessaloniki – Budapest section only;
- Due to unavailability of data, waiting time at border crossings for each station at Corridor X is assumed as an average value of two neighbouring border stations (cumulative was available);
- Waiting at border crossing is based on real time, not scheduled;
- Data for Corridor IV is acquired from Corridor information document (CID), Transport market study (TMS) and other documents available at the website of RFC7;
- Data for Corridor X is acquired from CEAM project document, paper „Port of Piraeus – opportunity for railways in SE Europe“, and SEETO reports;
- Due to unavailability of the data for track capacity, only track capacity utilization will be used in purpose of discussion.

4.2.1. Distance

Corridor X stretches 1033 km on section Thessaloniki - Budapest while Corridor IV is 342.2 km longer: 1375.2 km. Therefore, the length can be assumed as significant (potential) advantage of Corridor X. Lengths of the corridors and sections in each country are given in table below.

Table 3: *Lengths of corridors in each country*

Corridor X		**Corridor IV**	
Section	**Length**	**Section**	**Length**
Budapest-Kelebia	173 km	Budapest-Lőkösháza	220.8 km
Subotica-Presevo	568 km	Curtici–Golenti	539.1 km
Tabanovci-Gevgelia	213 km	Vidin-Kulata	470.9 km
Idomeni-Thessal.	79 km	Promachon-Thessal.	144 km
Total*:	**1033 km**	**Total*:**	**1375.2 km**

*Distances between border stations included

Source: infrastructure managers Network statements for 2017 on given countries

4.2.2. Commercial speed and transit time

Commercial speed is crucial factor of competitiveness, because it represents the current condition of infrastructure, maximum speed limits, bottlenecks, waiting at borders etc. Also, it is manifested by transit time which is among most important factors when forwarders make their transport decisions. Table below shows commercial speeds and transit times (waiting at borders excluded) *of freight trains* for each country.

Table 4*: Commercial speeds and transit times for each country*

Corridor X			**Corridor IV**		
	Commercial speed	**Transit time**		**Commercial speed**	**Transit time**
Hungary	*38 km/h*	*4.5h*	Hungary	*90 km/h*	*2.45h*
Serbia	*27 km/h*	*21h*	Romania	*70 km/h*	*7.7h*
FYROM	*47 km/h*	*4.5h*	Bulgaria	*60 km/h*	*7.85h*
Greece	*70 km/h*	*1.2h*	Greece	*60 km/h*	*2.4h*
Total transit time:		**31.2h**	Total transit time:		**20.4h**

When waiting time at border crossings is taken into account, the outcome is radically different as shown in table below.

Table 4.1*: Waiting at borders and corrected values (Corridor X)*

Corridor X				
		Waiting time at border (h)	**Transit time (h)**	**Commercial speed (km/h)**
Hungary	*Kelebia*	*4.2*	*8.7*	*19.9*

Serbia	*Subotica*	*4.2*	*29.2*	*19.45*
	Presevo	*4*		
FYROM	*Tabanovci*	*4.1*	*12.6*	*16.9*
	Gevgelia	*4.1*		
Greece	*Idomeni*	*4.1*	*5.3*	*14.9*
	Total transit time and speed:		**55.8**	**18.51**

Table 4.2*: Waiting at borders and corrected values (Corridor IV)*

Corridor IV				
		Waiting time at border (h)	**Transit time (h)**	**Commercial speed (km/h)**
Hungary	*Lokoshaza*	*0.5*	*2.95*	*74.91*
Romania	*Curtici*	*2.33*	*12.36*	*43.61*
	Calafat	*2.33*		
Bulgaria	*Vidin*	*3.05*	*13.9*	*33.9*
	Kulata	*3*		
Greece	*Promachon*	*3.66*	*6.06*	*23.76*
	Total transit time and speed:		**35.27**	**39**

Commercial speed and transit time on Corridor IV can be considered as its main advantage, with commercial speed as twice as Corridor X, resulting in 20h less transit time (despite the difference in length). It has to be emphasized, that 44% of time is spent at borders for Corridor X, which is along with bad quality of infrastructure, main reason for long transit time.

4.2.3. Costs

Specific cost of transportation depends (among other factors) on negotiation power of each railway operator. Railway operators are often not familiar with the price along the whole route, and that information is rather classified as confidential. Only information available to the authors, was one that Corridor X is approximately 5.000 EUR cheaper than Corridor IV per one intermodal train [*Bauranov, 2016*], which can be considered as merit, and supports Corridor X competitiveness.

For the purpose of comparison, table below shows railway access charges along corridors. Railway access charge often represents competitiveness of a railway sector, and it determines the level of market development as well as the final price (up to 30% of final price stands for access charges).

Table 5: *Access charges on Corridors IV and X (2016 data)*

Corridor X		Corridor IV	
Country	**Access charge (EUR/tkm)**	**Country**	**Access charge (EUR/tkm)**
Hungary	2.05	Hungary	2.05
Serbia	0.83	Romania	2.90
FYROM	2.94	Bulgaria	1.50
Greece	1.05	Greece	1.05

When length of the section in each country is taken into account, access charge (from Thessaloniki to Budapest) for minimal package is roughly 1330 EUR cheaper (52%) on Corridor X than on Corridor IV per one freight train.

4.2.4. Track capacity

In general, both of corridors have sufficient capacity for present and near-future traffic flows. Romania and Greece on Corridor IV have slight potential for lack of capacity in case of major increasing in traffic demand. Important note is that, according to UIC methodology, capacity utilization for tracks with mixed traffic should not exceed 75%. Due to unavailability of precise percentage, we can only claim Romania and Greece to have potential for utilization being higher than 75%. Also, quality of the service is an important indicator (variable) of competitiveness, and it is possible to conclude that, sections with utilization higher than 75% have lack of service quality. Table below shows capacity utilization for Corridors X and IV.

Table 6: Corridor X and IV: capacity utilization

Country (Corridor X)	Capacity utilization	Country (Corridor IV)	Capacity utilization
Hungary	< 49%	Hungary	< 49%
Serbia	< 49%	Romania	50-89%
FYROM	< 49%	Bulgaria	< 49%
Greece	< 49%	Greece	50-89%

Source: *Implementation plan of RFC7and SEETO Multi annual plan 2018*

5. CONCLUSION

In this paper, on the basis of literature research, comparative analysis was chosen as suitable method of evaluation for corridor competitiveness. Also, based on literature review, the unique model of factors and variables was created in order to quantify competitiveness of two corridors. Paper showed that most significant factors of corridor competitiveness are distance, commercial speed, transport cost and capacity.

Case study was performed on TEN-T corridors X and IV, and it showed the distance and cost (and capacity conditionally) are factors advantageous for Corridor X, while commercial speed is the (crucial) advantage of Corridor IV. According to the fact that Corridor IV guaranties almost two times higher commercial speed for freight trains operating along its path, which results in 20 hours shorter transit time, and that is definitely a competitive advantage of the Corridor and cause why it is more viable option for freight forwarders and cargo flows originating from the port of Piraeus in Greece to Budapest and further to Central Europe.

Also, as paper shows, 44% of Corridor X transit time is „wasted" on border crossings, and it represents the opportunity for transit time reduction. It is emphasised that Corridor X is 342 km shorter on Thessaloniki-Budapest section, which has influence on the transport price.

Finally, capacity utilization was discussed, and paper shows that both of the corridors have sufficient capacity for present and near-future traffic demands, but Corridor IV is in slight potential of having shortage of capacity for major increasing of cargo flows in future.

Anyway, for more relevant results, it is necessary to collect more detailed and harmonized data or to perform long lasting observations in order to get data based on real condition, or to even include wider set of factors and variables which were excluded from the model due to lack of data. For example, it is necessary to include precise amount of transport price, data for track capacity and waiting at borders for each individual station.

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