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Endemann, Peter

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Peter Endemann

8 LONG-DISTANCE PASSENGER RAIL SERVICES: REVIEW AND IMPROVEMENT

Resume

Abstract
The situation of long-distance in Europe rail has faced different developments at literally different speeds since the fall of the Iron Curtain. Relevant central European parts of the OEM Corridor (e.g. Germany, the Czech Republic, Austria and Hungary) first suffered a considerable decline in cross-border long-distance rail traffic due to the emergence of low-cost airlines and the freedom of car purchase in the 1990s. Since the beginning of the millennium and partly following the 2004 accession of Middle and Eastern European countries to the European Union, a slight renaissance of Eurocity trains and market penetration of high-speed rail products can be perceived. The other countries in the eastern part of the corridor have mostly not recovered from the rail decline and lag behind. In Greece, rail development suffers generally from unfavourable conditions (different track gauges and disproportion of land and population distribution) and a lack of innovation, and has thus been negatively impacted by the abovementioned boom of car and air. Its geographical isolation in Europe also plays a role. The political downturn of former Yugoslavia reinforced the situation. For passenger rail along the corridor, the paper argues that considerable improvements in service quality and travel time reduction can be made without doubtful high investment in high-speed rail infrastructure. Moreover, building up existing rail infrastructure may avoid giving up conventional rail services as shown for some high-speed rail cases.

Keywords
Long-distance transport – passenger rail – high-speed rail – integration – conventional rail

Schienenpersonenfernverkehr: Bewertung und Weiterentwicklung

Kurzfassung

Der schienengebundene Personenfernverkehr in Europa hat sich seit dem Fall des Eisernen Vorhangs mit buchstäblich unterschiedlichen Geschwindigkeiten unterschiedlich entwickelt. Wichtige mitteleuropäische Teile des OEM Corridors (z. B. Deutschland, Tschechien, Österreich und Ungarn) erfuhren aufgrund des Aufkommens von Billigfluggesellschaften und der „neuen" Freiheit beim Kauf des eigenen PKW in den 1990er Jahren zunächst einen erheblichen Rückgang des grenzüberschreitenden Schienenpersonenfernverkehrs. Seit der Jahrtausendwende und teilweise nach dem Beitritt mittel- und osteuropäischer Länder zur Europäischen Union im Jahr 2004 ist eine leichte Renaissance der Eurocity-Züge und die Marktausbreitung von Hochgeschwindigkeits-Bahnprodukten zu verzeichnen. Weitere Länder im östlichen Teil des Korridors haben sich oft nicht vom Rückgang der Schieneninfrastruktur erholt und hinken hinterher. In Griechenland sind die Bedingungen für das System Schiene generell ungünstig (unterschiedliche Spurweiten und Missverhältnis bei Siedlungs- und Bevölkerungsverteilung) und mangelnder Innovation und wurde daher durch den oben genannten PKW-Boom und ansteigendes Luftverkehrsaufkommen negativ beeinflusst. Auch die geografische Randlage Griechenlands in Europa spielt eine Rolle. Der politische Abschwung im ehemaligen Jugoslawien verstärkte diese Situation. Der Beitrag legt dar, dass erhebliche Verbesserungen bei der Servicequalität und der Verkürzung der Reisezeiten ohne fragwürdig hohe Investitionen in den Hochgeschwindigkeitsverkehr auf der Schiene erreicht werden können. Darüber hinaus kann durch einen Ausbau der bestehenden Schieneninfrastruktur vermieden werden, den klassischen Fernverkehr aufzugeben, wie die Entwicklung des Hochgeschwindigkeitsverkehrs andernorts in Europa verdeutlicht.

Schlüsselwörter

Schienenpersonenfernverkehr – Hochgeschwindigkeitsverkehr – Integration – klassischer Fernverkehr

1 Rail development in Europe

The situation of the European rail network is basically a result of state policies and the geographical context. Furthermore, the European rail network development induced a change of morphology in settlement structures. Rail networks throughout Europe were mainly completed by 1910 (Martí-Henneberg 2013). For the countries of the Orient/East-Med Corridor (OEM) it can be observed that by this time Austria and Hungary had quite a dense rail network with Budapest and Wien as important nodes and subsequent radial infrastructure. The network also included continuous lines towards present-day western Romania and northern Serbia, which were part of this Austro-Hungarian Empire. Bulgaria was separated from this Empire in 1878 and saw a further decline in international connections, which is explained by the national-oriented policy promoted by the newly established kingdom (Dzhaleva-Chonkova 2007).

After World War II, considerable network extensions such as the link to Turkey or Thessaloniki and a bridge over the Danube were realized (Dzhaleva-Chonkova 2007). In the territory of former Yugoslavia, the mountainous topography did not allow the development of a comprehensive network, as is also true for the inner area of the Czech Republic and the area of Slovakia, separated in 1993. Poland, divided between different powers when rail network development took place, nowadays faces varied rail network characteristics (Martí-Henneberg 2013).

Before the 1990s but after World War II, some industrialized western European countries such as France, Germany and Italy steadily reduced their network. In contrast, for the eastern European countries, Martí-Henneberg (2013: 136) found that in the post World War II period the historically grown "…railway networks have been largely maintained with relatively few changes (Howkins 1996). When other countries began to close railway lines, the regimes in power in these countries generally sought to maintain their public sector infrastructure. However, subsequent economic difficulties have made it almost impossible to modernize these networks and their rail services."

Since the fall of the Iron Curtain, rail network and long-distance rail in Europe face different developments at literally different speeds. Relevant central European parts of the corridor (e.g. Germany, the Czech Republic, Austria, Hungary) first suffered a considerable decline in cross-border long-distance rail traffic due to the emergence of low-cost airlines and the freedom of car purchase in the 1990s (Martí-Henneberg 2013). Since the beginning of the millennium and partly following the 2004 accession of east European countries to the European Union, a slight renaissance of Eurocity trains and market penetration of high-speed rail products can be perceived in central European countries (see Chapter 4: Long-distance rail: Between snail and power speed). The other countries in the eastern part of the corridor mostly have not recovered from the rail decline and lag behind. As will be shown in Chapter 3, the quality of rail infrastructure could be in better shape, as put in a nutshell by this quotation from the corridor report: "Hungary is the border between the densely used, well maintained Northern part of the corridor and the less densely used and less maintained Southern part of the corridor" (Panteia 2012: 28). This difference is also confirmed by the illustration of population development. Whereas population in central European countries still increased from 2007 until 2017, the population in the countries east of Hungary, including the latter, decreased by 3% (Greece/Hungary) to 6% (Bulgaria) including Serbia with a 5% decrease.[1]

Further to the south, Romania and, even more so, Bulgaria suffer most from the declining quality of rail and network (Panteia 2012). For Greece, this can also be observed though rail development suffers generally from unfavorable conditions such as different rail gauges and mismatches in land and population distribution. Most of the rural network is built in narrow gauge whereas only the main lines are built with the standard gauge of 1435 mm (Efstratiadis 1959). For further railway development to link the important centers there is little space in the narrow valleys where lines could be exploited. Mainland Greece accounts for 81% of the area of the country but only

1 http://ec.europa.eu/eurostat/web/population-demography-migration-projections/population-data/main-tables (July 13 2018).

66% of the population; the capital in the south absorbs 18% of the population. Density is 50 inhabitants per km^2 on the mainland. The population is mainly concentrated along the coast and within 0–200 m height (66%) but this part of the territory only accounts for 33% of the area of the country (Efstratiadis 1959). Greece's geographical isolation in Europe also plays a role. The political decline of former Yugoslavia reinforced the situation, at least by the fact that all through-running trains such as the Hellas-Express (Verona–Athina) or Attika-Express (München–Athina) were closed. Athina became the end of the rail corridor, since the narrow gauge lines towards the Peloponnese peninsula had been removed. However, once Romania and Bulgaria entered the European Union in 2007, Greece became more internationally oriented, though there is a considerable relationship with the adjacent Western Balkan (Panteia 2012).

Fig. 1: Same corridor – two different rail worlds at each end: Hamburg Main Station (largest station in Germany) and the modernized Athina Larissa Station 2017[2] */ Source: Author (left); Mathias Niedermaier (right)*

2 Context of this paper

The paper provides an overview of long-distance rail along the corridor and assesses the potential for improvements based on existing plans and literature. To do so, it reflects on the suitability of high-speed rail for the corridor and then analyses the existing supply, explores the potential for better train services, and includes planned measures for infrastructural and operational improvement of the lines. The paper first looks at long-distance travel in general and its development. It then provides an inventory of rail passenger services along the corridor, identifies gaps and potential for improvement, predominantly expressed in terms of gained travel time. The projects identified by the European Union and in the countries, as known basically from the Connectivity Agenda summits and – if possible – national documents or inquiries with experts will be considered. Based on existing literature the appropriateness of long-distance rail strategies such as high-speed rail will be assessed.

2 The new Larissa Station with more platforms was opened in 2017 next to the former station.

Prior to continuing, in this paper the original names of the cities and their stations are used as is common in international rail. This work focuses on long-distance rail passenger traffic and covers the entire Orient/East-Med Corridor.

3 Infrastructural situation of the corridor for passenger rail

The work plan issued by the Coordinator for the Orient/East-Med Corridor, Mathieu Grosch, intends to monitor the fulfillment of some so-called key performance indicators for the rail lines of the corridor such as electrification or line operational speed at 100 km/h minimum (Grosch 2018). Single-track lines predominantly exist in Romania, Bulgaria and in parts of southern Greece but also to a lesser extent on two German coastal lines and on the Slovakian-Hungarian border. By 2015, 26% of the corridor was still single-track. Beyond the scope of this EU-corridor but relevant for the development of the full axis is the 350 km line from Budapest to Beograd. From Beograd to Velika Plana (southern Serbia) the line is still single track and then becomes fully double-track. With respect to electrification, the Serbian part of the corridor is fully electrified.[3] The OEM Corridor is 89% electrified. Only small segments in Germany, Greece and from the Romanian City of Craiova to the Bulgarian border are lacking electrification. For the development of high-quality competitive passenger rail, line operating speed is relevant. With 78% compliance along the corridor, the infrastructure's performance is quite well in line with the work plan's requirement of a minimum 100 km/h speed. Only Bulgaria is behind since the full segment from the Romanian to the Greek border is affected with speeds not exceeding 60–90 km/h. Nonetheless, there are several nodes along the corridor with similar performance problems such as Brno, Budapest and Arad, stressing a relevant gap that affects line operation as well (European Commission 2016). The Budapest–Beograd–Thessaloniki stretch also suffers from

Fig. 2: Corridor capacity and performance challenges Budapest–Beograd: waiting times at borders (e.g. Kelebia, Hungary, left) and single-track infrastructure produce travel time losses / Source: Author

3 http://www.srbvoz.rs (November 14, 2017).

low speeds. The OEM-study demonstrates that cross-border infrastructure management is still a challenge which also contributes to considerable time losses in freight but also passenger travel. Herein, the corridor segment Hungarian-Romanian border to the Bulgarian-Greek border is worth mentioning since cross-border time losses are also due to a lack of technical harmonization resulting from varied compliance with key performance indicators (Grosch 2016). This technical obstacle becomes an administrative issue when considering the time of almost 1 hour that passenger trains wait at both sides of the Hungarian-Serbian border due to customs and shunting activities on the border.

4 Long-distance rail: Between snail and power speed

The European Union issued the White Paper on Transport in 2011. Passenger-related issues comprise a trebling of high-speed rail infrastructure by 2030, a shift from road and air to rail for medium distances by 50% and a target reduction of CO_2-emissions of 60% by 2050. For rail, these ambitious goals would require substantial investment (European Commission 2011). Speaking of high-speed rail, this means the construction of infrastructure with an operating maximum speed of 250km/h or higher if new infrastructure is considered, but also of 200km/h and upwards if services are run on upgraded conventional rail lines (Council of the European Union 1996). Though high-speed rail (HSR) has achieved some positive changes in mode split, there are some impacts that should be briefly reviewed. Building one kilometer of high-speed rail is expected to cost at least 5 million euros. This is derived from an analysis based on HSR-constructions in 2005 according to Nash (2015). This analysis reveals that for Europe, costs per kilometer can be estimated at around 25–29 million euros as was found for Italy or Germany. Presumably the prices are higher nowadays and further increase is to be assumed if considering relevant constructions such as bridges or tunnels (Nash 2015). A conventional line is supposed to cost 20% less, as seen while considering the discussion on the British High-Speed 2 project linking London to metropolises such as Birmingham or Manchester (Nash 2015). Furthermore, high-speed rail is beneficial if larger cities of around 500,000 inhabitants and more are connected and trains calling at stations 120–150 km apart (Vickerman 2015). For rail services running over distances of up to 700km competition with air is feasible. Speed is anyhow a relative term. While the maximum speed of the Tokyo–Osaka line in Japan is 270km/h, it attains a higher average speed of 213km/h compared to the 171km/h of the fastest German HSR-line Köln–Frankfurt am Main with a maximum speed of 300km/h (Arnone/Delmastro/Endemann et al. 2016). Adding a new stop leads to a loss in average speed but at the same time may open the door for new customers. Thus, a trade-off between speed/travel time and potential ridership is required (Givoni 2006). Vickerman (2015) discusses the potential of HSR generating demand among commuters, as is the case for the Javelin HST, which allows daily commuting from Kent to London, and the French TGV in the Nord-Pas de Calais region. Analyses from the Roma–Napoli corridor suggest that around 6% of trips are made for commuting purposes, but a high proportion of trips are made for business reasons (ranging from 38.7% on Sundays to 57.4% on weekdays), while education-related trips (percentages ranging from 3.4% on Sundays to 6.2% on weekdays) and ‘other purpose’ trips (percentages ranging from 52.5% on Sundays to 30.2% on weekdays) show lower but still very significant rates (Cascetta/Coppola/Velardi 2013). In addition to trip purpose, the mode shift effect for HSR needs to be assessed. Shifting demand from air to HSR is one aspect. This is confirmed by the substantial shift that can be observed for the Paris–Lyon line and the Madrid–Sevilla lines 3 years after their opening in 1981 and respectively in 1991 (Givoni 2006). In the case of Madrid–Sevilla, the market share of air travel was reduced from 40 to 13%, while train ridership rose from 16 to 51%. For Paris–Lyon, the share of air travel dropped from 31 to 7% and train travel increased from 40 to 72%. The impact on the amount of car travel is lower if one considers the overall increase in train trips of 37% in the Paris–Lyon case and 35% with respect to the Madrid–Sevilla line (Givoni 2006). Nonetheless, the car is an important competitor for HSR, especially for shorter distances. For the Barcelona–Madrid HSR line, opened in 2007, a survey carried out in 2009 revealed that 44% of the customers used the car before shifting to rail, 8% used the bus, 16% made their trip by plane and another 23% 'moved' from other conventional trains to HSR. The remaining 10% can be considered induced traffic (Frontier Economics/Atkins/ITS Leeds 2011). A before-after study in Italy comparing the modal split between 2009 and 2013 made by Cascetta and Coppola (2015) proves that HSR can gain market shares also from the car, which was reduced by 19% in relative terms, but started from a higher level than the airplane. The number of air trips was reduced by 29%, but its share is relatively low. HSR increased by 81% from 2009 to 2013, but conventional train travel lost about 52% of its users within these four years. This latter case and the Madrid–Barcelona case reveal another aspect: the loss of customers for conventional rail services. Givoni and Dobruszkes (2013) report that up to 94% of users in the case of Madrid–Sevilla no longer used conventional trains once HSR was introduced. On the Sanyo Shinkansen line in Japan (from Osaka 554km to Fukuoka in the south), 55% of the traffic was diverted to the new line from conventional rail services, while the remaining demand arises from other travel modes (23% from air, 16% from car and bus, and 6% induced demand; quoted by Givoni 2006). In view of this information, the cost of rail infrastructure designed to deliver air substitution should be discussed as the land-use transport nexus may be threatened as mentioned above. The emergence of new stations at the edge of towns or in greenfield areas, which the authors qualify as 'TGV-generation stations', are supported as a driver of development by the European Commission (2010). However, such stations make integration between rail and land-use and between conventional rail lines and their supply more difficult (European Commission 2010). Although the OEM Corridor is very long, its suitability for high-speed rail appears to be limited since it is comparatively small if compared to the 1300km Rhine-Alpine Corridor with some 70 million inhabitants. Furthermore, there is little potential for large metropolises to be connected, the countries are small and the international and the more relevant domestic markets appear to be limited. Related to this, several border-crossings may act as limiting factors for generating corresponding traveler volumes. This is suggested according to several experts' interventions at a workshop organized in Praha and summarized by Jandova et al. (2016). The workshop also concludes that an approach similar to Germany should be pursued, which means upgrading lines and building new high-speed rail lines where capacity restraints most require it. In view of the costs for a dedicated HSR-line, such an approach appears to be more promising. In the next section, the supply levels along the corridor are described.

5 Long-distance rail supply and demand along the corridor

To assess the supply along the OEM Corridor, the timetables from the year 2016 were analysed. Three main sources were used for this and a typical Tuesday selected as a reference to gain an impression of daily train movements.[4]

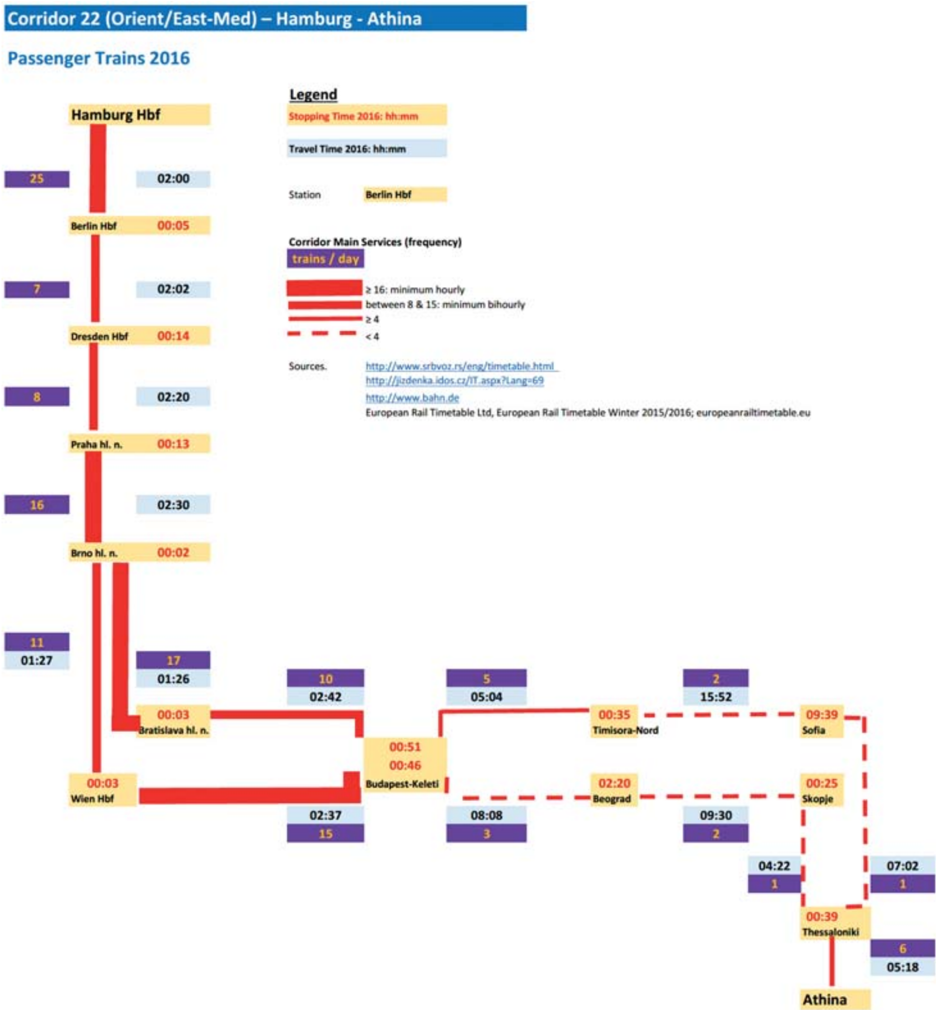

Fig. 3: Overview of long-distance rail services in 2016 / Source: Author's elaboration based on timetables[5]

4 Sources used: www.bahn.de (German Railways); http://www.srbvoz.rs/eng/timetable.html (Serbian Railways); European Rail Timetable Ltd, European Rail Timetable Winter 2015/2016, europeanrail timetable.eu and Czech Railways http://jizdenka.idos.cz/IT.aspx?Lang=69 which was very helpful for calculating rail distances.

5 www.bahn.de (German Railways); http://www.srbvoz.rs/eng/timetable.html (Serbian Railways); European Rail Timetable Ltd, European Rail Timetable Winter 2015/2016, europeanrailtimetable.eu and Czech Railways http://jizdenka.idos.cz/IT.aspx?Lang=69.

Figure 3 visualises the number of trains on relevant segments of the corridor, travel time between the respective rail stations and time in the stations which in most cases is also transfer time until the next train leaves.

Concerning the connections, the most dense services can be found between Hamburg and Berlin, within the Czech Republic and from there towards Bratislava as well as between Wien and Budapest. On these stretches, train services are offered almost every hour. For the other connections in central Europe there are at least bihourly connections. The transfer or stopping time is reasonable. It is important to stress that when travelling along the OEM Corridor, in most cases a transfer in Praha is necessary. Then direct services exist from Praha to Budapest via Brno and Bratislava and to Wien and further south to the Austrian city of Graz.

Fig. 4: Czech-Austro Railjet train in Wien (left) allowing seamless transfer for trains to Budapest-Keleti with hourly services (right) / Source: Author

Wien can be considered an interesting interchange point since the aforementioned north-south axis meets an important west-east line München–Wien–Budapest. In essence, from Hamburg to Budapest there exists an integrated network with frequent and interconnected services without considerable time losses. Of course, there is potential for higher commercial speeds. Beyond Budapest – at least in the neighboring countries towards the east – the standard of travel times is substantially lower. This is due to larger transfer times, fewer services, losses following infrastructural restrictions and border issues as shown hereafter (Tab. 1).

In these east European countries commercial speed levels are quite low at around 50 km/h. It is Greece where speeds are slightly higher, allowing almost 100 km/h of commercial speed with six train services throughout the day. However, according to the information given in the meeting in Athina in November 2016, there are also competing bus and plane services between Athina and Thessaloniki. For the whole corridor Hamburg[6]–Athina, Table 1 and Table 2 evidence some of the time losses that appear avoidable if the technical standards were harmonized or services better

6 For further explanation see CODE24 action 17 team (2015).

integrated. Note that only time losses longer than 15 minutes are noted. A minimum of 15 minutes was considered acceptable to make sure that train transfers can be made or if a train needs to change direction in a station. This threshold was determined at an expert roundtable held in a European project and applies to both Table 1 and Table 2 (CODE24 action 17 team 2015). Following this exercise, there is a loss of around 3:31 hours if travelling from Hamburg to Athina via Beograd and even 11:44 hours via the Romanian city Timisoara and Sofia. The latter is mainly due to the fact that the connection in Sofia requires an overnight stay.

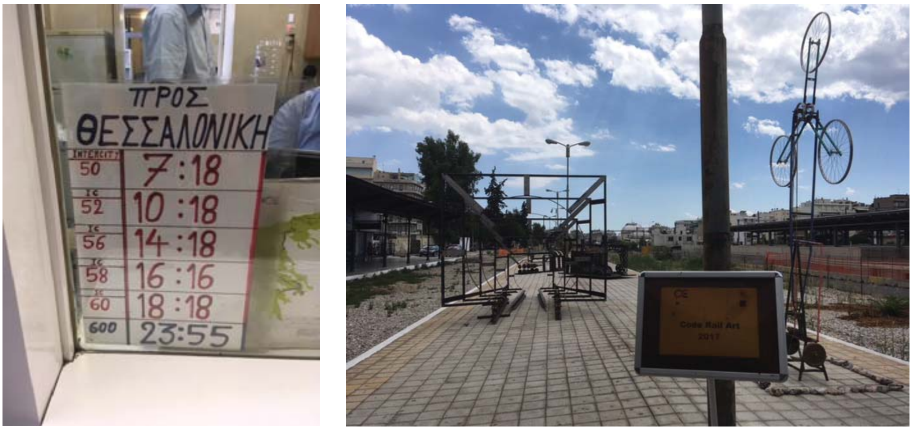

Fig. 5: Athina Larissa station: timetable at a glance for the five daily and one night services Athina–Thesaloniki and new art at the former platforms / Source: Irini Frezadou

Station	Time losses > 15 min
Budapest Keleti (→ Timisoara/Sofia)	00:51
Budapest Keleti (→ Beograd/Skopje)	00:46
Timisoara Nord	00:35
Beograd	02:20
Sofia	09:39
Skopje	00:25
Thessaloniki	00:39

Tab. 1: Considerable time losses in stations mainly due to transfer times / Source: Author's adaptation from railway timetables for the year 2016

With respect to time losses 'en route' according to Table 2, around 4 hours between Hamburg and Athina will be lost if travelling through Beograd and a bit more than 2 hours if using the axis within the European Union. Of course, the longer stay in Sofia makes travelling on this axis less convenient. From Budapest to Beograd, there are three daily services. Then a transfer is necessary to continue towards Nis and Thessaloniki. In 2016, there was only one daily service Beograd–Thessaloniki and return. The number of daily train services east of Budapest also decreases considerably if travelling via Romania and Bulgaria. From Budapest to Timisoara in Romania, there are five train pairs a day, then only 2–3 connections between Timisoara and Sofia are offered. It is worth mentioning that within Romania, 2–3 additional connections exist.[7] From Sofia to Thessaloniki there is only one daily train pair currently requiring a transfer at the border. Inside Greece, the number of trains increases up to six direct trains Thessaloniki–Athina (Fig. 3).

Stretch	Time losses > 15 min
Budapest – Beograd	00:58
Budapest – Timisoara Nord	00:50
Timisoara Nord – Sofia	01:39
Beograd – Sofia	01:36
Sofia – Thessaloniki	01:17
Beograd – Skopje	00:16
Skopje – Thessaloniki	00:32

Tab. 2: Considerable time losses along some stretches due to stopping time in stations / Source: Author's adaptation from railway timetables for the year 2016

Excursus: a look backwards

As indicated in the introduction, the corridor suffered from the consequences of the Balkan crisis in terms of standards of service and travel times. The timetable of the year 1983 identifies three daily through train services (central Europe)–Beograd–Athina. The travel times at that time were 2 hours longer than in 2016. However, for the remaining connection Beograd–Thessaloniki the journey was actually 1 hour longer in 2016 than in 1983 (SBB 1983). Brezina/Abramović/Shibayama et al. (2018) illustrate impressively the decline in frequency and service quality for the former Yugoslavian trunk line Ljubljana–Zagreb–Beograd. Rail quality achieved a certain peak by the end of the 1980s with 22–27 daily services between these cities and an increase in the average commercial speed – defined as the average running speed between two stations without considering stopping time – of up to 76km/h in 1990. Since the war on the former Yugoslavian territory this speed has remained at a lower level of 61–63km/h. Observations end in 2015 when the lowest number of only five daily train services can be observed. This seems even to be deteriorating as the timetable of 2018 only indicates two daily services.[8]

7 https://cfrcalatori.ro/ (November 14, 2017).

8 www.bahn.de

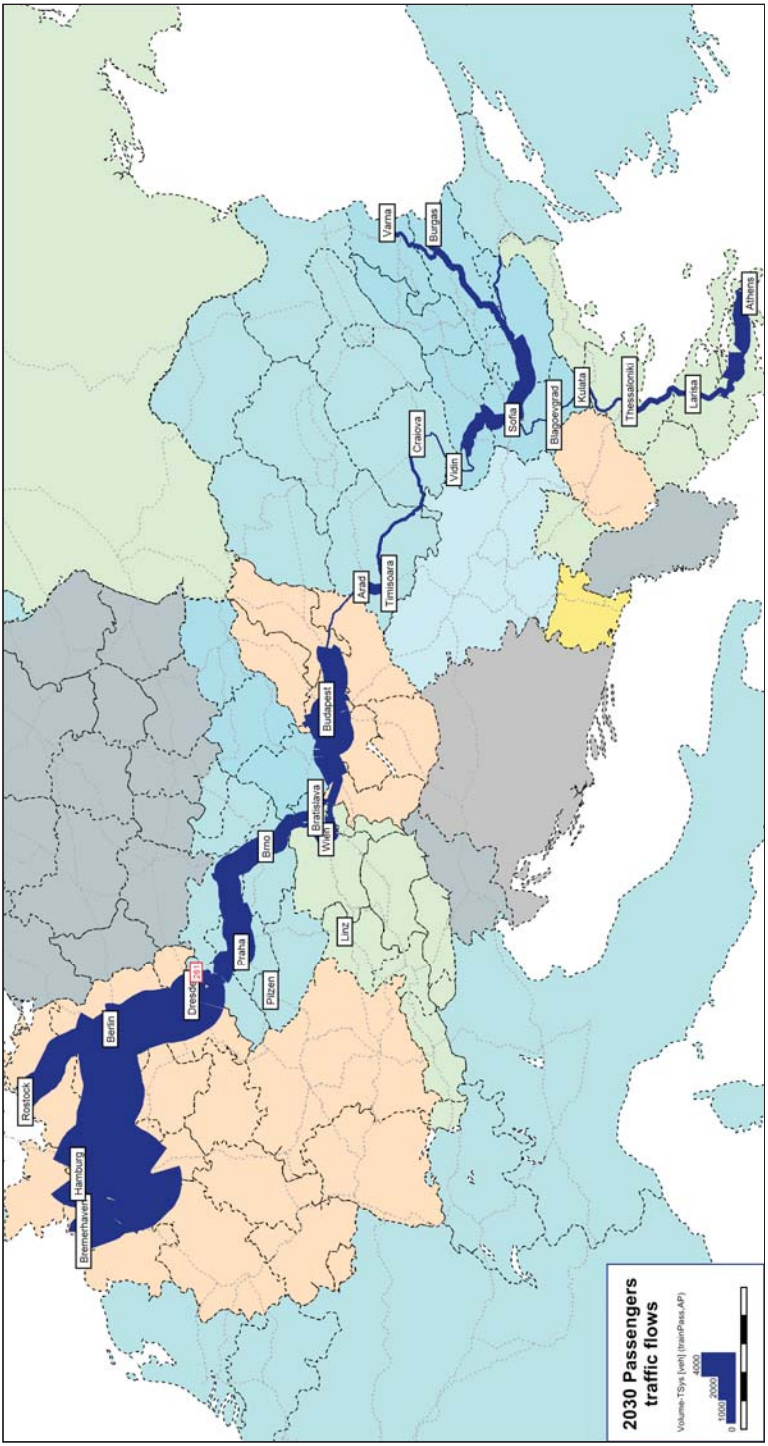

Fig. 6: Predicted interzonal passenger traffic by rail for the year 2030 in 1000 pax / Source: European Commission 2014

This stresses the negative impact of the deterioration of rail development in the Western Balkan countries such as Serbia and its neighbors. Another aspect to consider is that even after the fall of former Yugoslavia, the timetable for the year 2000 reveals travel times between Beograd and Budapest of 7 hours compared to 8 hours as indicated for the timetable of 2016.[9] Thus, political turmoil paired with infrastructure maintenance problems may have caused a decline in quality and frequency.

Information on rail passenger demand is not easily available. Figure 6 gives an impression of the predicted flows between NUTS 2 zones (regions) for EU countries along the corridor for the year 2030. These figures correspond to those observed for the year 2010 as baseline year for the predictions (European Commission 2014). It can easily be perceived that the abovementioned 2016 based levels of supply are reflected in the demand today and in future. West of Budapest, rail is heavily used, east of Budapest, the figures are more modest.

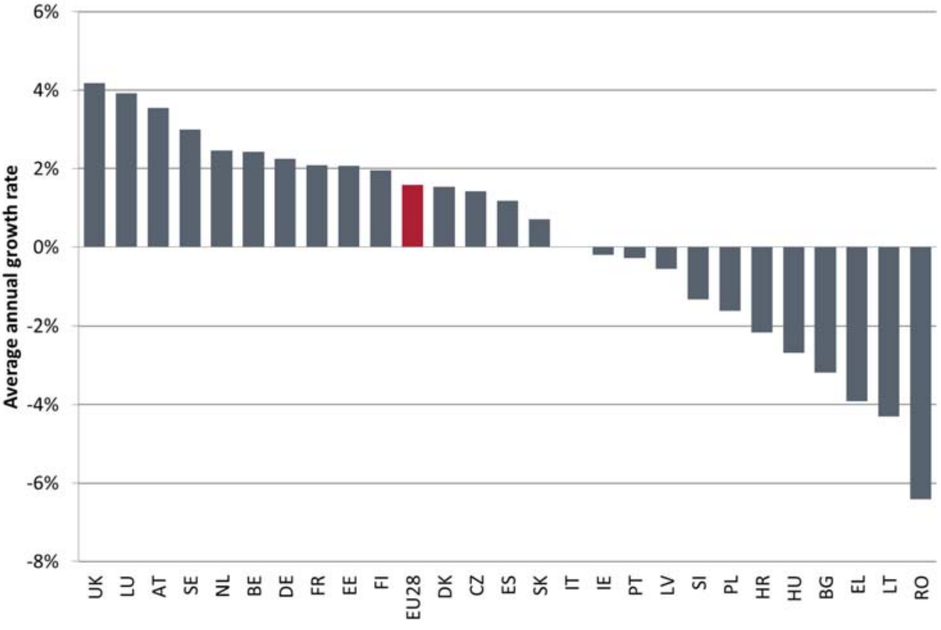

Fig. 7: Relative change in rail use in EU-countries 2003–2013 / Source: European Commission 2016: 6

Available data on demand for the EU Members show that in 2013 Austria (AT), Germany (DE) and Hungary (HU) showed the highest amount of kilometers travelled per inhabitant, followed by Hungary, the Czech Republic (CZ) and Slovakia (SK). Bulgaria (BG), Romania (RO) and Greece (EL) are located at the lower end. What is even more striking is the relative change in national rail use in the respective Member States with

9 Thomas Cook Timetable for 2000, retrieved from https://www.drehscheibe-online.de/foren/read.php?30,7421240 (May 21, 2019).

even reversing trends that reinforce the discrepancies between central European and eastern European countries. Another issue is the decreasing population figures in some of these countries (Fig. 7). While ridership increased in central European countries such as Austria, Germany, the Czech Republic and Slovakia, demand decreased in Hungary, Bulgaria, Greece and Romania. It can thus be concluded that rail demand is related to declining supply levels in these eastern European countries, though Hungary may be an exception as it still has considerable train service levels.

6 Potential for improvement

The market studies made by the European Commission have already revealed some potential for improvement, i.e. through compliance with key performance indicators such as line speed, electrification, elimination of single-track lines, cross-border interoperability and filling gaps in the high-speed network. The objective is to remove these bottlenecks and to develop the corridor (European Commission 2014). This list includes the nodes of Berlin, Budapest, Bratislava and Sofia, the high-speed lines from Dresden to Wien, high-speed modernization of a segment in Romania (Arad–Caransebeş) on the line Budapest–Sofia and modernization/electrification of other lines not yet fulfilling the corridor compliance criteria. There is a further project list by the European Union and the Western Balkan countries in the context of the Connectivity Agenda which includes the rail connection from Nis to Sofia (European Commission 2017). These lists do not contain expected effects on better connectivity and subsequent travel time savings. However, during the IAK group's 3 years of work, some information from Austria, Bulgaria, the Czech Republic, Germany, Greece and Serbia could be collected which led to an estimation of travel time changes along certain segments of the corridor.

Fig. 8: The new site of the Beograd Centar Station (left, opened in 2017) at the periphery of the centre but enabling through services unlike the former central station (right) / Source: Author

The following Table 3 thus contains quantifiable improvements that are expected from these measures or that were specified in other documents, mainly issued by state ministries, rail networks or rail operating companies. It also includes information the working group received and collected during its working phase. Furthermore, it was assumed that waiting times could be reduced to a maximum of 15 minutes at stations or at borders as was suggested in Table2.

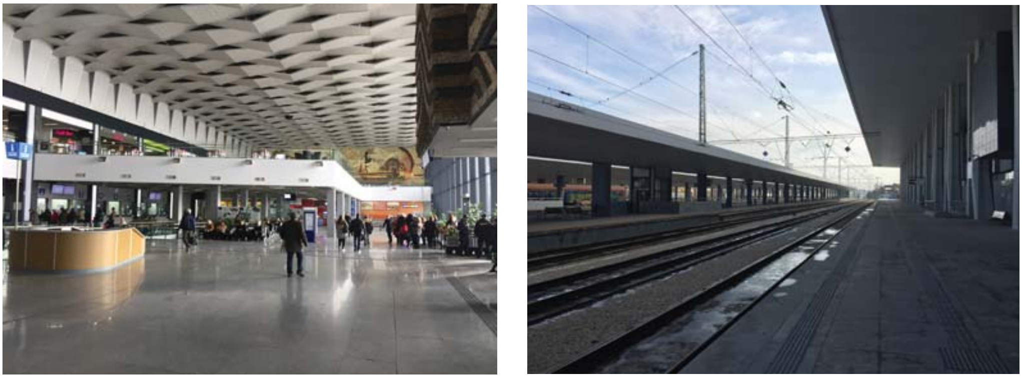

Fig. 9: The modernised central station of Sofia nowadays hosts few train services / Source: Author

Regardless of the unknown travel time effects of better network characteristics after having realized the projects in the corridor work plan, travel time could be further reduced by addressing the stopping times figured out in Table 2 in Section 5. Some of them are already included in projects such as the Budapest-Beograd line. For the remaining gaps and considering the outcome presented in Table 3 above, the following travel times may be achieved in the future while assuming that all waiting times will be reduced to a maximum of 15 minutes. Better customs and train logistics at the border may allow a further reduction of travel time. Table 4 consequently reveals considerable travel time reductions for connections via Czech Republic and Serbia as well as Bulgaria as information was available for these countries. Also, the reduction for the connection Thessaloniki–Athina will increase rail competitiveness for international travel and especially for the Greek domestic market. However, for the segments Beograd–Thessaloniki and Budapest–Sofia, the journeys still will take more time. The basis for Table 4 was the 2016 timetable using the corridor as outlined in Figure 3.

It should further be noted that the improvements along this corridor will also contribute to maintaining demand on this axis. If no measures are realized, the connections from Hamburg or Berlin to Wien via Nürnberg would be more competitive with better travel times and more services than travelling along the corridor. In the future, Sofia will be potentially better connected with services via Beograd once the upgraded Budapest-Beograd line starts operations. These shorter travel times are thus presented in a special column 'competitive routes'. Thus, Beograd becomes more important. This is reinforced by the introduction of the new station Beograd Centar in 2017, allowing some additional travel time savings and through-running services without locomotives needing to change direction. Greek locations are anyway better connected to central Europe using the route via Beograd. An integration of Serbia with the hub Beograd would widen the opportunities since the travel times from Budapest will be considerably shorter if stopping in the Serbian capital.

Stretch	Distance of Stretch (km)	Travel Time 2016 (h)	Travel Time 2030 (h)	Travel Time Savings (h)	Travel Speed (Kph)	Identified Measures Achieving Travel Time Savings	Year	Source
Hamburg - Berlin	297	**02:00**	01:40	00:20	178	Sped-up services nonstop (2018 1:43 h)	2030	1
Berlin - Dresden	178	**02:02**	01:20	00:42	134	upgrade "Dresdner Bahn" by 2018 and to 200 kph max design speed	2028	1 , 2
Dresden - Praha	140	**02:20**	00:52	01:28	162	a) Dresden- Ústí n. Labem New HSR line (mixed transport); max design speed 230 kph b) Ústí n. Labem - Praha New HSR-line (passenger), max design speed 250-350 under discussion	a) 2035 b) 2035+	a) 2 b) 2, 3
Praha - Brno	210	**02:30**	01:15	01:15	168	HSR-line; Rapid Services (Brno 1 hour to Praha); partly upgrade 200 kph	2030	4, 5, 6
Corridor Segment Brno --> Bratislavia --> Sofia --> Athinai								
Brno - Bratislava	141	**01:26**	01:10	00:16	121	HSR-line; Rapid Services partly upgrade 200 kmh	2027	4,5
Bratislava - Budapest	214	**02:42**	02:26	00:16	88	Timetable 2018	2018	6
Budapest - Timisoara	310	**05:04**	04:44	00:20	65	Timetable analysis, effective borders		7
Timisoara - Sofia	711	**15:52**	14:50	01:02	48	Timetable analysis, effective borders in Romania New line Vidin-Sofia (5h --> 2:30 hours)	unknown 2030	7,8
Sofia - Thessaloniki	356	**07:02**	06:15	00:47	57	Bulgaria Sofia-Kulata (4--> 1:30 hours) Modernisation, timetable analysis, effective borders	unknown 2030	8, 9
Thessaloniki - Athinai	511	**05:18**	04:40	00:38	110	new line/upgrade for HSR	2018	10
Corridor Segment Brno --> Wien --> Beograd --> Athinai								
Brno - Wien	135	**01:27**	01:12	00:15	113	Upgrades Brno-Breclav for HSR (Nordbahn 3:45 to Praha; today 3:56)	2027	11,12,13
Wien - Budapest	247	**02:37**	02:20	00:17	106	upgrade Ostbahn	2022	12

Tab. 3: Current and potential future travel times for long-distance trains along the corridor / Source: Author's adaptation from different sources mentioned hereafter:

- > *Deutsche Bahn (2015): Mehr Bahn für Metropolen und Regionen, Presentation 18 March 2015 (source number 1)*
- > *SMWA/Deutsche Bahn (Study 2015) by SMWA-Ministry 2018 (2)*
- > *CZ Ministerstvo dopravy/SMWA (Study 2015) by SMWA-Ministry 2018 (3)*
- > *Švehlík, M. (2015) (4)*
- > *https://www.szdc.cz/en/pro-media/tiskove-zpravy/studie-praha-brno.html (5)*
- > *www.bahn.de (6)*
- > *Assumptions by the author of down to 15 min travel time savings (cf. CODE 24 Action 17 Team 2015) (7)*
- > *http://www.optransport.bg/upload/docs/OPTTI_ENG_17112014_verision_1.pdf (8)*
- > *Danailova, N. (2017). Presentation at IAK-meeting, Sofia, 21 November 2017 (9)*
- > *Greek Ministry of Economy and Development/ERGOSE (2017). (19)*
- > *CZ Ministerstvo dopravy (11)*
- > *BMVIT (2018). Written communication on Austrian/ÖBB-plans (12)*
- > *https://ec.europa.eu/transport/sites/transport/files/oem_project_list.pdf (13)*
- > *Meeting with Milutin Ignjatovic, Serbian Institute of Transportation (CIP), April 2017 (14)*

Connection	2016	2030	Competitive Routes
Hamburg - Praha	06:41	04:11	
Hamburg - Wien	10:53	06:53	09:21 h via Nürnberg (2016)
Berlin - Budapest	11:28	07:31	
Berlin - Beograd	20:22	10:31	
Berlin - Wien	08:48	05:08	08:15 h via Nürnberg (2018)
Praha - Budapest	06:39	04:52	
Praha - Beograd	15:33	07:37	
Wien - Beograd	11:31	05:20	
Wien - Sofia	24:59	22:24	23:30 h via Boegrad (2018)
			15:42 h via Beograd (2030)
Bratislava - Sofia	25:04	22:46	24:23 h via Beograd (2018)
			16:04 h via Beograd (2030)
Budapest - Thessaloniki	24:45	16:49	
Budapest - Athinai	30:42	21:44	
Beograd - Athinai	20:14	18:44	
Timisoara - Thessaloniki	32:33	21:35	
Sofia - Athinai	12:59	11:10	

Tab. 4: Current and potential future travel times for long-distance connections / Source: Author's adaptation based on outcome of previous table

7 Conclusion

The analysis of the current passenger train connections, underlying infrastructure and operational situation showed some potential for saving travel time along the corridor. Apart from the plans in the Czech Republic, the line upgrade Budapest–Beograd and the plans in Bulgaria, all other known measures indicate potential for improvement without huge investments. Concerning the latter, it is beneficial to long-distance and regional passenger as well as freight rail. The look back in time also suggests that rail can achieve a lot more. Furthermore, it can be assumed that many of the stations served nowadays will also be connected in the future.[10] Of course, the eastern European countries still need some increases in commercial speed in order to raise the competitiveness of rail in the domestic as well as the international market. Such an underlying 'conservative' and generally less costly approach appears more promising than developing pure high-speed lines. The investment in high-speed rail first requires

10 Meeting with the Serbian Transportation Institute.

high volumes of financial resources may contribute to increasing disparity and even not be beneficial since the level of demand would not justify the necessary finance that would then be missing for other investments. This is criticized for many Spanish peripheral regions where the station at the edge of the city or between two cities often lacks good access to public transport or even rail (Martí-Henneberg 2013). It may be a lesson to learn for the Balkan part of the corridor. Apart from this, given the somewhat small amount of population along the lines, HSR would cannibalize conventional rail and further make integration into the existing rail network difficult with consequences for regional accessibility. Rail may also forfeit its function as a backbone for development and even a trigger for more balanced development of central and peripheral regions in these countries, as was the situation at the turn of the 19th/20th century (Martí-Henneberg 2017). Nowadays, there is even a risk of emptying the rural areas in addition to the general reduction of population, as is the case in some eastern European countries such as Bulgaria (Troeva 2017). This does not mean that all places are equal, but all areas and regions have similar opportunities according to their location and function in the system of central places, as Christaller suggests. For these countries, European coherence in a geographical sense and beyond a pure EU-perspective will open opportunities faster than the projects envisaged for these countries. This is not a plea against the development of rail infrastructures in these cohesion countries. It is a recognition that geographical and transport movements cannot be determined by administrative borders or even burdens. It is important to recall that development of the axis through Romania and Bulgaria needs to be pushed to encourage national and interregional cohesion in this area. The axis through Serbia may fulfil another important, predominantly transit function in better connecting Greece with central Europe for passenger rail – and of course also for freight, as suggested by Panteia (2012). Strategically, the Balkan link via Serbia cannot be neglected although it appears logical that, as part of the OEM Corridor, Greece's access to the remaining part of the European Union plays an important role in terms of getting infrastructure more easily funded.

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Author

Peter Endemann *(*1970), holds a Master in Urban Planning and Urban Design (Université de Montréal, Québec, Canada) as well as a Diploma in Spatial Planning (Universität Dortmund, Germany). He is employed at Regionalverband FrankfurtRheinMain (Germany), an intermunicipal planning institution. Before, he was a transport planner in the municipality of Ettlingen (Germany) and a researcher at the ILS institute in Dortmund (Germany). His main activities comprise travel behaviour analysis, regional rail activities and corridor development with a focus on freight and passenger rail. He is a member of several transport related committees, author of numerous papers, and regularly reviews articles of international transport journals.*