TRANSPORT & *LOGISTICS:*
the International Journal
ISSN 2406-1069

Article history:
Received 20th June 2024
Accepted 27th June 2024
Available online 28th June 2024
DOI: 10.46544/TNL.v24n56.08

Article citation info: Palinský, J., Fabianová., J., Development of high-speed rail in the countries of the Visegrad Group. Transport & Logistics: the International Journal, 2024; Vol. 24, No. 56, https://doi.org/10.46544/TNL.v24n56.08

Development of high-speed rail in the countries of the Visegrad Group

Ján Palinský [1*], Jana Fabianová [2]

[1] Slovak Railway Company, Pri bitúnku 2/D, 040 01 Košice, Slovakia

[2] Institute of logistics and Transport, Faculty of Mining, Ecology, Process Control and Geotechnology, Technical University of Kosice, Letná 9, 042 00 Košice, Slovakia, e-mail: jana.fabianova@tuke.sk*

**Corresponding author: jana.fabianova@tuke.sk*

Abstract:
The Visegrad Group (V4), an informal association of Hungary, the Czech Republic, Poland, and the Slovak Republic, represents a collective effort to enhance regional economic cooperation and development in Central Europe. This paper aims to examine the current state and future plans for high-speed rail (HSR) infrastructure within the V4 countries. Despite historical underdevelopment in railway infrastructure compared to road networks, significant strides are being made. Each V4 country is at different stages of HSR development but key projects aim at rail connecting Budapest, Bratislava, Prague, and Warsaw, achieving speeds between 200 and 350 km/h. This paper outlines the progress, challenges, and strategic importance of initiatives emphasizing the V4 potential to improve regional connectivity and economic integration.

Key words:
high-speed rail, Visegrad group, railway infrastructure

Introduction

Trends in the development of railway transport are influenced by various factors, including economic, social, environmental and technological changes. Growing concerns about climate change and the need to reduce emissions lead to increased support for rail transport, which is seen as a less polluting alternative (de Bortoli and Féraille, 2024). There is an observable trend in the world towards building new high-speed rail (HSR). High-speed rail is a type of rail transport network utilizing trains running significantly faster than those of traditional rail. Many authors of scientific articles deal with research in this issue. For instance, Purba et al.(2017) discussed the factors determining the success of the HSR as transport alternative based on experiences of Asian and European countries. International railway passenger services have seen considerable changes in Europe over the past decades. (Seidenglanz et al., 2021) using international railway connections within and reaching outside

the V4 countries (the Czech Republic, Hungary, Poland, Slovakia) in 1990–2019 explored trends and patterns in that matter. Similarly, Komorousová and Hinke (2023) assessed trends in passenger transport within the V4 countries. HSRs enable faster and more efficient travel between cities and support regional development. Yang et al. (2021) utilized an endogenous innovation growth model including HSR fares and speeds to explain how HSR affected regional technological innovation. HSR can reduce also rural poverty by improving employment rates in the manufacturing and construction industries (Zhang, Wu and Zhou, 2023). The nexus between high-speed rail (HSR) stations and city evolution from an urban science perspective was examined by Loo and Huang (2023). Investments in infrastructure and rolling stock modernization simultaneously led to improved comfort, safety and reliability of rail transport. From this point of view (Zhang et al., 2023) explored the competition and cooperation between HSR and conventional railway. By comprehensively considering the departure and arrival time as the representation of train service quality, they found that the proportion of superior quality service of high-speed train is far higher than that of conventional train. (Zong et al., 2023) performed HSR efficiency benchmarking. Their results revealed difference among countries. Asia's HSR systems exhibited higher efficiency compared to those in Europe, while China's HSR efficiency ranks medium in the HSR multi-stages chain but higher in the service stage.

This article deals with the current state of high-speed rail in the countries of the Visegrad Group (V4). At the same time, it provides an overview focused on the future of the expansion of high-speed railway lines in the V4 member states. For the purposes of the article, a high-speed rail is considered a rail with a minimum speed of 200 km/h.

1 The Visegrad Group V4 and the development of transport within the V4

The Visegrad Group, or the so-called Visegrad Four (V4), an unofficial association of four countries in Central Europe, unites the Central European countries of Hungary, the Czech Republic, Poland, and the Slovak Republic. The Visegrad Group, as a grouping of countries sharing similar economic, cultural, and socioeconomic values, creates, among other things, space for solving issues of economic cooperation and regional development. In all cases, these are post-socialist countries. All V4 countries have been part of the European Union since 2004.

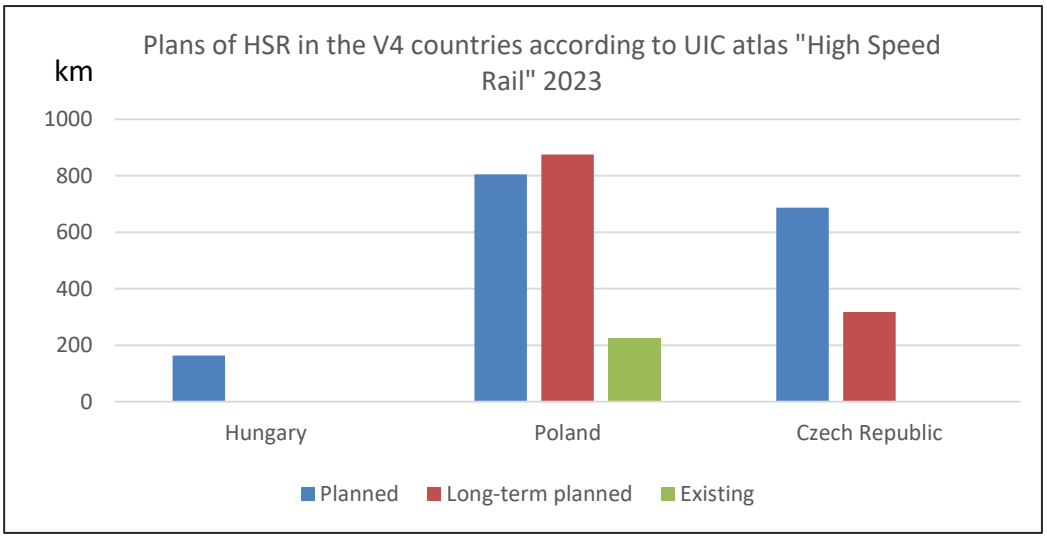

Fig.1 *The length of the railway network in the member countries of the V4*

Source: (Central Intelligence Agency, 2023b)

It is typical for V4 countries that the development of the railway infrastructure lags behind the development of the road network (Kalmár László and Lehoczky László, 2007). Poland has the most developed railway infrastructure in terms of the length of railway lines. An overview of the length of railway lines in individual V4 countries is presented in Fig. 1.

In 2018, the Hungarian government decided to support the intention to build a high-speed line Budapest - Bratislava - Prague - Warsaw. Subsequently, in October 2018, at the meeting of the V4 countries, the Declaration of the V4 Ministers on the intention to cooperate on the HSR project in Central Europe was signed. In May 2019, the countries' transport ministers expressed interest in the construction of high-speed railways in the V4 countries. Based on the recommendation of the European Commission, the Joint Declaration of the ministers of the V4 countries followed on the project of the high-speed railway network in Central Europe and its financing, with all four countries committing to carry out national feasibility studies. The line is planned from Warsaw to Brno, where it is to split in the direction of Prague and Bratislava and Budapest. The expected track speed will be from 200 kilometres to 350 kilometres per hour on individual sections.

The goal is to build a connection between the capitals of the V4 countries by high-speed rail. These will be part of the TEN-T corridors. The plan for the development of high-speed lines for the year 2023 in the V4 countries is presented in Fig. 2.

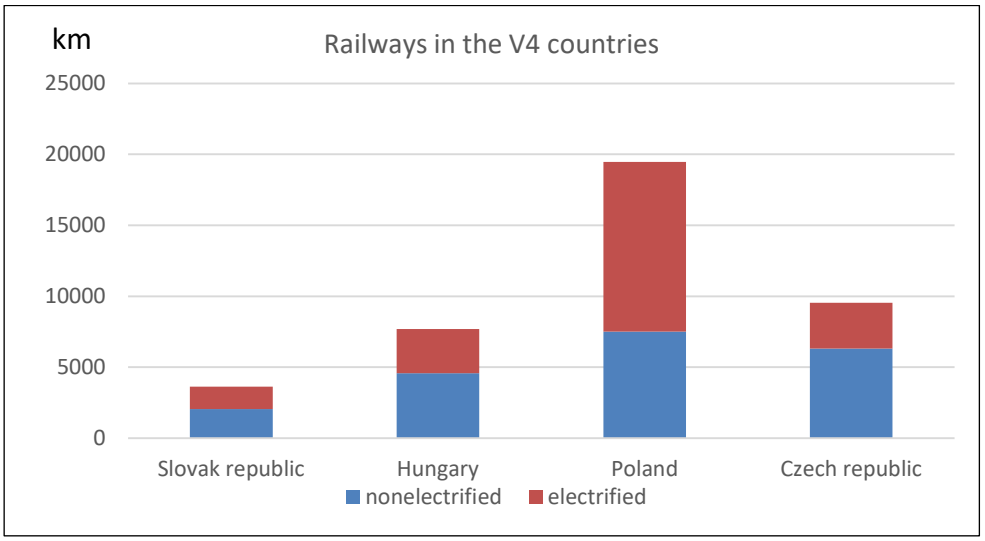

***Fig. 2** Plans of high-speed rail in V4 countries*
Source: (Central Intelligence Agency, 2023a)

2. High-speed railways in the context of EU trans-European transport policy

The aim of the EU's trans-European transport policy (TEN-T) is to build a multimodal network of railways, inland waterways, short sea shipping routes, and roads throughout the EU (Fig. 3) for sustainable economic growth (Antolini, 2023). Despite the significant technical achievements achieved throughout Europe, high-speed railways do not yet form a network across Western Europe, and there is no high-speed network in Central and Eastern Europe. Indeed, there is currently almost no HSR infrastructure in the Member States that joined the EU in the recent enlargement waves (EU-Rail, 2023).

Currently, the countries of the Visegrad Group lack a sustainable high-speed alternative to personal road transport. The increased accessibility of cities served by high-speed rail can expand markets and boost the productivity of firms located in the newly connected region.

This, in turn, could strengthen the economic specialization of the affected regions as well as the overall economy. (Scordamaglia, 2015).

Fig.3 *Current view of TEN-T CORE CORRIDORS in the V4 countries*
Source: (EIB, 2023)

3 Railway Infrastructure in the V4 countries

High-speed rail connections are almost completely absent in Central and Eastern Europe. The state of the existing railway infrastructure in the V4 countries does not allow significant progress without major investments. Nevertheless, the current situation in individual V4 countries differs, as outlined below.

3.1 Hungary

Within the Hungarian infrastructure, most of the main railway lines have a maximum speed of 120 km/h. Currently, trains can run at a maximum speed of 160 km/h on certain sections of the Budapest-Hegyeshalom main line, more precisely between Tata and Hegyeshalom stations, which speeds up traffic on the main corridor between Budapest and Vienna.

At that time, the construction of the new Budapest-Belgrade railway line was underway, as the first stage of the planned international railway connection Budapest-Belgrade-Skopje-Athens. The Hungarian section should be completed in 2025. In the section from Budapest to the border with Serbia, the maximum speed will be 160 km/h.

In the future, Hungarian State Railways (MÁV) infrastructure should include sections on other existing lines. MÁV will increase there the speed limit to 160 km/h: between Püspökladány and Debrecen from 120 km/h to 160 km/h; between Százhalombatta and Pusztaszabolcs also from 120 km/h to 160 km/h; between Asód and Hatvan, the permitted speed will be increased from 100 km/h to 160 km/(Hirado, 2023).

3.2 Czech Republic

The Railway Administration, as the manager of the railway infrastructure, is interested in implementing several projects in the framework of the construction of high-speed lines in

the territory of the Czech Republic at various levels of development, whether at the level of territorial-technical study, feasibility study, environmental impact assessment, or the construction itself.

Where possible, the intention is to build tracks with a maximum speed of 320 km/h. The network of high-speed lines should connect the entire Czech Republic. In addition to speeding up passenger transport, emphasis is placed on the sustainability and relief of existing railway lines. According to the summary "High-speed lines in 2022", updated in October 2023, there are currently 1,005 km of high-speed lines planned in the Czech Republic (Tab. 1).

***Tab. 1** High-speed lines in Czech Republic, 2023*

Area	Country/Region	Status	Section	Max.Speed (km/h)	Year	Length (km)
EUROPE	CZECH REPUBLIC	3. Planned	Prague - Poříčany (- Brno)	320	2028	22
EUROPE	CZECH REPUBLIC	3. Planned	Prague - Poříčany (- Hradec Králové)	320	2028	29
EUROPE	CZECH REPUBLIC	3. Planned	Modřice - Rakvice	320	2028	35
EUROPE	CZECH REPUBLIC	3. Planned	Rakvice - Břeclav	200	2028	23
EUROPE	CZECH REPUBLIC	3. Planned	Přerov - Ostrava	320	2029	73
EUROPE	CZECH REPUBLIC	3. Planned	Plzeň - Domažlice - German border	200	2030	58
EUROPE	CZECH REPUBLIC	3. Planned	Brno - Přerov	200	2030	80
EUROPE	CZECH REPUBLIC	3. Planned	Prague - Litoměřice	320	2030	58
EUROPE	CZECH REPUBLIC	3. Planned	Poříčany - Světlá nad Sázavou	320	2030	71
EUROPE	CZECH REPUBLIC	3. Planned	Velká Bíteš - Brno	320	2030	32
EUROPE	CZECH REPUBLIC	3. Planned	Světlá nad Sázavou - Velká Bíteš	320	2032	81
EUROPE	CZECH REPUBLIC	3. Planned	Prague - Beroun	200	2043	25
EUROPE	CZECH REPUBLIC	3. Planned	Litoměřice - Ústí nad Labem	250	2045	23
EUROPE	CZECH REPUBLIC	3. Planned	Ústí nad Labem - Dresden	200	-	56
EUROPE	CZECH REPUBLIC	3. Planned	Ostrava - Bohumín - Polish border	200	-	21
EUROPE	CZECH REPUBLIC	4. Long-term planning	Poříčany - Hradec Králové	320	2040	67
EUROPE	CZECH REPUBLIC	4. Long-term planning	Odb. Veltrusy - Most	250	2040	85
EUROPE	CZECH REPUBLIC	4. Long-term planning	Brno - Přerov	320	2050	74
EUROPE	CZECH REPUBLIC	4. Long-term planning	Rakvice - Břeclav	320	2050	23
EUROPE	CZECH REPUBLIC	4. Long-term planning	Hradec Králové - Trutnov - Polish border	250	2050	69

Source: (UIC, 2023b)

3.3 Poland

In 2022, Poland had 224 km of tracks in operation with a maximum speed of 200 km/h (UIC, 2023b), most of them on several sections of the Central Rail Line (Polish: Centralna Magistrala Kolejowa, CMK) and on the line from Gdynia to Warsaw. In the near future, these lines should be joined by high-speed lines built as part of the CPK project (Polish: Centralny Port Komunikacyjny), with an operating speed of ≥250 km/h.

CPK is a transport project in Poland, which includes a new airport and a new network of high-speed railway lines with 10 corridors leading from the airport between Warsaw and Łódź. In total, approx. 2,000 km of new high-speed railway lines and 3,700 km of modernized railway lines are to be built (Fig. 4). Further development of CPK should be based on the Memorandum of Understanding signed by the manager of Czech infrastructure “Railway Administration”, Polish PKP and Ukrainian Railways. In addition, CPK and Ukrainian Railways signed a cooperation agreement in January 2023 to implement a high-speed rail connection from Poland to Ukraine. (Railtech, 2023)

Fig.4 *Map with the high-speed network development plan in Poland*
Source: (UIC, 2023a)

3.3 Slovak Republic

There are currently 197 km of tracks in Slovakia with a maximum speed of 160 km/h. On the main corridor Bratislava – Žilina – Košice at that time, works are underway to increase the quality of travel and the traffic speed to 160 km/h on most sections. The Railways of the Slovak Republic awarded a contract for the development and delivery of a national feasibility study of a high-speed line connecting the V4 countries (ŽSR, 2024b) for track sections on the territory of Slovakia in December 2022 to a selected Czech-Slovak association of companies by the end of 2024. The subject of the contract is the provision of services, i.e., to develop and deliver a national feasibility study entitled "National Feasibility Study of the High-Speed Line Connecting the V4 Countries" for the track sections on the territory of the Slovak Republic as part of the international project "High-Speed Rail Connection of the V4 Countries Budapest - Bratislava - Prague - Warsaw".

Construction of a new high-speed line and/or modernization of existing railway lines, i.e., the implementation of the proposed measures and solutions at the operational and infrastructural level will be implemented in an economically efficient manner, within a reasonable time horizon and at acceptable financial costs, which will be compatible with probable future financial restrictions and other needs of the Slovak Republic.

Technical solution of the infrastructure

• Development of a study on the optimal speed for each section, tentatively suggested for a speed between 160 km/h and 300 km/h.
• New track/modernization of existing tracks.
• Determination of border crossings.

• The connection to the existing railway line will always be solved to the nearest existing transport facility within the Bratislava hub according to the variant unless the proposed operating concept requires wider infrastructure modifications and to evaluate the feasibility of such proposed technical solutions.

Transport-technological solution

•The new HSR will be dealt with in detail, or modernized track state border HU/SK – Bratislava and all sections of the existing infrastructure directly affected by the construction and operation of the Project.

•The need to build a new line in the Bratislava - Sekule section (as a parallel high-speed or freight corridor to the existing railway line) will be assessed.

•The construction of a new HSR in the section Sekule – Kúty – state border will also be dealt with in detail for smooth connection to the HSR network in the Czech Republic and its comparison with the existing modernized line.

•In Bratislava, consider integration with other long-distance trains (in the form of one station for high-speed and other long-distance transport).

The Railways of the Slovak Republic signed a contract for the work with the construction contractor entitled "ŽSR, Modernization of the railway line Devínska Nová Ves - state border SR/CR". It concerns the modernization of part of the 73 km section. The track in question is placed on the TEN-T Corridor Orient/Eastern Mediterranean (usually also referred to as Rail Freight Corridor No. 7).

The Orient/Eastern Mediterranean Rail Freight Corridor connects Southeastern Europe with North Sea ports in Germany via Central Europe. It runs through eight EU member states: Austria, Bulgaria, the Czech Republic, Germany, Greece, Hungary, Romania and Slovakia. (RFC7, 2024). The main element is the complex reconstruction of the track, platforms, traction lines and safety equipment in the section between the Devínska Nová Ves railway station (except for the reconstruction of the Devínska Nová Ves station) to the Malacky railway station, including this railway station and the section from the Kúty railway station (excluding the reconstruction of the railway station itself Kúty) to the crossing point Kúty state border, and it is 30 km long (Fig. 5).

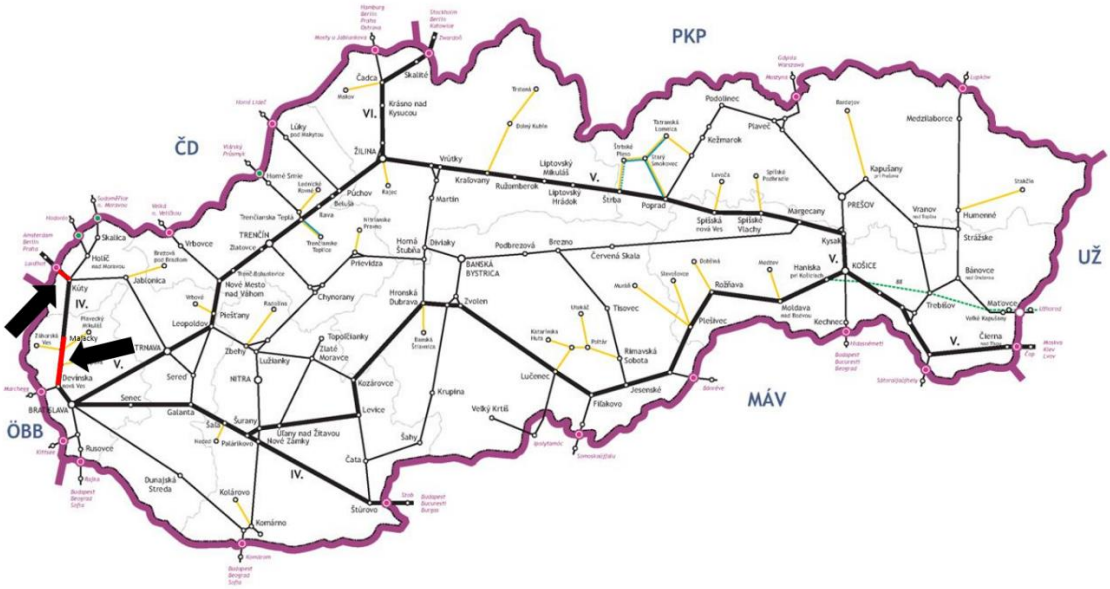

Fig.5 *Map of the railway infrastructure with markings of the sections Devínska Nová Ves – Malacky and Kúty – Kúty state border. (ŽSR, 2024a)*

Between these two sections (from railway station Malacky to railway station Kúty) is a 43 km long section on which the GSM-R system will be built as part of this modernization.

The reconstruction of the track on the 43 km long section, platforms, traction lines, and safety equipment should be the subject of another construction project, which is currently in project preparation. Modernization is carried out for the most part in the existing body.

It is expected that the 73 km section will be completed by 2030. The train will travel at 200 km/h for 62 kilometers, at 160 km/h for 9 kilometers, at 140 km/h for 1 kilometer, and at 100 km/h for 1 kilometer.

3 Conclusions

The Visegrad Group has embarked on a transformative journey to develop high-speed rail infrastructure, aligning with the broader goals of the EU's trans-European transport policy (TEN-T). Despite a lag in railway development compared to their road networks, these post-socialist countries are collectively advancing ambitious projects to enhance regional connectivity and economic integration.

The development of the high-speed rail network, particularly the proposed Budapest-Bratislava-Prague-Warsaw line, reflects a significant step towards modernizing transportation infrastructure in Central Europe. Each V4 country is actively engaged in upgrading existing lines and constructing new HSR routes to achieve speeds between 200 and 350 km/h. This initiative promises to enhance regional mobility, reduce reliance on road transport, and stimulate economic growth.

Hungary, the Czech Republic, Poland, and Slovakia are at various stages of HSR development. Poland is leading in current operational high-speed tracks and extensive future plans. Meanwhile, Hungary and the Czech Republic are making notable progress in upgrading existing lines and planning new ones, while Slovakia focuses on feasibility studies and strategic modernization projects.

The V4's commitment to HSR is set to transform their transportation landscape, integrate them more closely with Western Europe's rail networks, and contribute to the EU's vision of a cohesive, multimodal transport system. As these projects advance, the Visegrad countries will not only enhance their internal connectivity but also position themselves as pivotal players in the broader European transport network.

Finally, it is necessary to mention the importance of HSR in terms of environmental protection and sustainability. High-speed railways contribute to environmental protection in several significant ways. HSRs reduce greenhouse gas emissions and are generally more energy-efficient per passenger km than cars and airplanes. HSR contributes to land conservation, air quality improvement, and noise reduction. Compared to expanding road networks, high-speed railways require less land for infrastructure and produce zero direct emissions at the point of use. Overall, high-speed railways play a crucial role in sustainable transportation systems by offering low-carbon transport, thereby contributing positively to environmental protection efforts.

Acknowledgement

This paper was developed within implementation of the projects: KEGA_010ŽU-4/2023, KEGA_005TUKE-4/2022, VEGA 1/0674/24, APVV-21-0195, and the operational program Integrated infrastructure with ITMS: 313011T567.

References

Antolini, A., 2023. *NoCommon – Environmental issues, TEN-T: TEN-T network as key instrument to ensure better connectivity within the EU and neighbouring countries, including Ukraine and Moldoviahttps*. [online] JTTRI. Available at: <www.jttri.or.jp/topic_europe_20240123_02_en.pdf> [Accessed 14 Jun. 2024].

de Bortoli, A. and Féraille, A., 2024. Banning short-haul flights and investing in high-speed railways for a sustainable future? *Transportation Research Part D: Transport and Environment*, 128, p.103987.

Central Intelligence Agency, 2023a. *Atlas: High speed rail 2023*. [online] Available at: <https://uic.org/IMG/pdf/atlas_uic_2023.pdf> [Accessed 14 Jun. 2024].

Central Intelligence Agency, 2023b. *The world factbook*. [online] Available at: <https://www.cia.gov/the-world-factbook/> [Accessed 14 Jun. 2024].

EIB, 2023. *TEN-T Core Corridors*. [online] Available at: <https://www.eib.org/attachments/thematic/the_route_map_to_a_connected_europe_en.pdf /> [Accessed 14 Jun. 2024].

EU-Rail, 2023. *Smart and affordable rail services in the EU: a socioeconomic and environmental study for High-Speed in 2030 and 2050*. [online] Available at: <https://rail-research.europa.eu/wp-content/uploads/2023/01/HSR_Executive_Report_Final_240123.pdf> [Accessed 14 Jun. 2024].

Hirado, 2023. *Egyre több hazai vonalon robog majd óránként 160 kilométeres sebességgel a vonat*. [online] Available at: <https://hirado.hu/belfold/cikk/2023/08/04/egyre-tobb-hazai-vonalon-robog-majd-orankent-160-kilometeres-sebesseggel-a-vonat> [Accessed 14 Jun. 2024].

Kalmár László and Lehoczky László, 2007. The common questions of the railway transport companies in the countries of Visegrád. In: *microCAD 2007 International Scientific Conference*. [online] Miskolci Egyetem Innovációs és Technológia Transzfer Centruma.pp.213–218. Available at: <http://hdl.handle.net/10890/2111> [Accessed 14 Jun. 2024].

Komorousová, V. and Hinke, J., 2023. Passenger Transport Trends in the V4 Countries. *LOGI - Scientific Journal on Transport and Logistics*, 14(1), pp.317–328.

Loo, B.P.Y. and Huang, Z., 2023. Location matters: High-speed railway (HSR) stations in city evolution. *Cities*, 139, p.104380.

Purba, A., Nakamura, F., Dwsbu, C.N., Jafri, M. and Pratomo, P., 2017. A current review of high speed railways experiences in Asia and Europe. *AIP Conference Proceedings*, [online] 1903(1), p.060004. Available at: </aip/acp/article/1903/1/060004/856869/A-current-review-of-high-speed-railways> [Accessed 13 Jun. 2024].

Railtech, 2023. *A high-speed rail network from the Baltics to Central Europe is one step closer*. [online] RailTech.com. Available at: <https://www.railtech.com/infrastructure/2023/01/19/a-high-speed-rail-network-from-the-baltics-to-central-europe-is-one-step-closer/?gdpr=accept> [Accessed 17 Jun. 2024].

RFC7, 2024. *WHO WE ARE*. [online] Available at: <https://www.rfc7.eu/whoweare> [Accessed 17 Jun. 2024].

Scordamaglia, D., 2015. *Briefing European Parliamentary Research Service*.

Seidenglanz, D., Taczanowski, J., Król, M., Horňák, M. and Nigrin, T., 2021. Quo vadis, international long-distance railway services? Evidence from Central Europe. *Journal of Transport Geography*, 92, p.102998.

UIC, 2023a. *Atlas*. [online] Available at: <https://uic.org/IMG/pdf/atlas_uic_2023.pdf> [Accessed 14 Jun. 2024].

UIC, 2023b. *High speed lines in the world*. [online] Available at: <https://uic.org/IMG/pdf/20231001_high_speed_lines_in_the_world.pdf> [Accessed 14 Jun. 2024].

Yang, X., Zhang, H., Lin, S., Zhang, J. and Zeng, J., 2021. Does high-speed railway promote regional innovation growth or innovation convergence? *Technology in Society*, 64, p.101472.

Zhang, G., Liu, Y., Jing, Y., Chen, H., Wang, Y. and Wang, Z., 2023. Unraveling the supply-service relationship between high-speed railway and conventional railway: A temporal perspective. *Frontiers in Environmental Science*, 11, p.1057812.

Zhang, Y., Wu, Y. and Zhou, W., 2023. High-speed railway and rural poverty alleviation. *Applied Economics*, [online] 55(36), pp.4165–4176. Available at: <https://www.tandfonline.com/doi/abs/10.1080/00036846.2022.2126817> [Accessed 13 Jun. 2024].

Zong, Y., Wu, J., Yu, K. and Yang, X., 2023. Efficiency benchmarking and its determinants in high-speed railways: Reference for China. *Research in Transportation Economics*, 102, p.101355.

ŽSR, 2024a. *Modernizácia dvoch úsekov železničnej trate Devínska Nová Ves – štátna hranica SK/CZ*. [online] Available at: <https://www.zsr.sk/4589/> [Accessed 17 Jun. 2024].

ŽSR, 2024b. *Národná štúdia uskutočniteľnosti vysokorýchlostnej trate prepojenia krajín V4*. [online] Available at: <https://www.zsr.sk/24087/> [Accessed 17 Jun. 2024].