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Analysis of the Possibilities for Establishing an International Rail Corridor in the Context of Ongoing and Planned Linear Investments Along Its Route

Abstract: The key condition for the implementation of the Three Seas Initiative, is the creation of a modern transport network with infrastructure along the north-south axis - one which integrates the economies of the countries included in this area and creates favorable conditions for the development of economic cooperation. This applies in particular to rail and cross-border connections, which - in order to achieve the standards of connections on the east-west axis - require huge investments and construction of new routes that could enable the process of railway network integration across the Three Seas region. This paper focuses on outlining the assumptions for the construction of the route with the working name "Rail Adriatica", which is an alternative variant (shifted to the east) of the RFC 11 Amber corridor. The aim of the proposed investment is the creation of a route, which would consist of four railway corridors with high operational parameters (construction of new sections along with modernization and revitalization of existing sections), that would connect the most economically productive areas of the Three Seas countries, including Poland, the Czech Republic, Slovakia, Hungary, Slovenia, Croatia and northeast Italy. The route would by design connect these areas with the main Adriatic and Baltic ports of the Three Seas Initiative, creating new revenue streams for the entire region.

Keywords: Railway connections; Three Seas; Transport network

Introduction

This article is an invitation to an open debate on the directions for the development of railway connections in the Three Seas region. The proposed Rail Adriatica railway corridor presented here aims to illustrate the scale of the investment effort being implemented and planned by the railways of the countries along this corridor and to highlight the opportunities that can arise from integrating national projects into a single common international initiative. The opportunities resulting from the synergy of actions by the interested countries accelerate the realization of a goal that will eventually emerge: a modern corridor connecting the most important Baltic and Adriatic ports with the most productive economic centers of the Three Seas region.

Political and Historical Background

The Three Seas Initiative was launched in 2015 by the President of Poland, Andrzej Duda, and the then-President of Croatia, Kolinda Grabar-Kitarović – Fig. **1**. However, the Three Seas is not just a political initiative that emerged with Andrzej Duda's assumption of the Polish presidency. The significance of this important political project is based on a deep analysis of the history of the countries that now make up the Three Seas region.

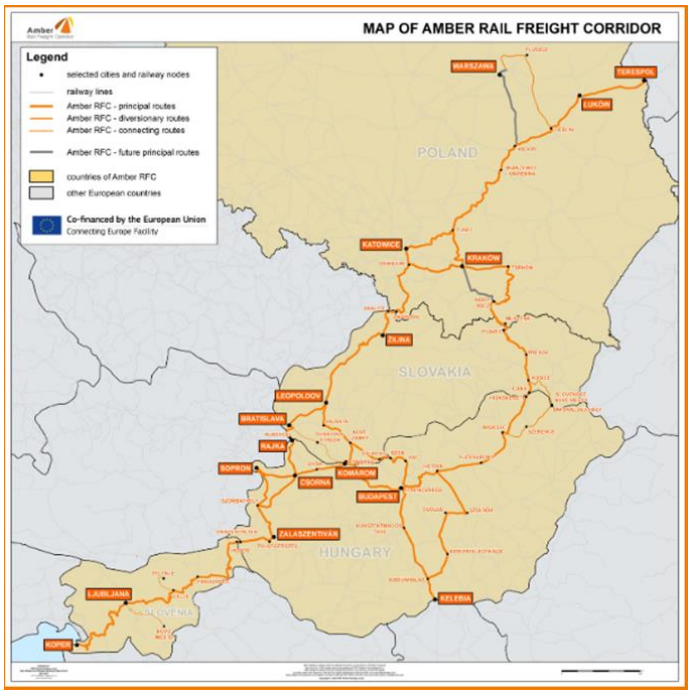
1. Architects of the Three Seas project: Andrzej Duda and Kolinda Grabar-Kitarović [16].

Historically, the Three Seas region - although never named as such - existed as the part of Europe that, belonging to the Western Christian civilization (or, in the case of the lands of the Grand Duchy of Lithuania, falling within its sphere of influence), maintained its distinctiveness and political autonomy both from the Holy Roman Empire of the German Nation and the Great Horde and its political successor, the Muscovite state, which was eventually transformed into Russia. From a geopolitical perspective, the Three Seas region has always been situated between various German states and different iterations of Russia. The history of the Three Seas is, in part, a history of struggles to maintain independence from both neighboring powers. Therefore, the contemporary Three Seas Initiative is a practical consequence of the region's difficult history. The imperative for integration, closer cooperation, and the building of strong political and economic ties stems from the obvious conclusion that, over centuries, the only guarantee for the safe and prosperous existence of the Three Seas nations has been their unity. It is no coincidence that the apex (though brief) period of economic and political power of the Three Seas coincided with the rule of the Jagiellonian dynasty over the lands between the Adriatic, Baltic, and Black Seas. Since then, everything has changed, except for the awareness that for the nations of the Three Seas, the key path to building a safe and prosperous existence is their unity. This was aptly described by Grzegorz Górny, president of the Polska Wielki Projekt foundation: if we do not organize this part of Europe ourselves, others will do it for us. This strongly realized sense of a shared fate and experiences since 1989 drives the countries of Central and Eastern Europe towards integration. Its political dimension depends on the strength and intensity of mutual economic relations, which cannot be built without the construction of modern transport corridors. After years of subordination to the USSR and years of building parallel connections to the countries of the "old Union," there was a realization that the political and economic autonomy of the Central and Eastern European region also requires mutual integration, which cannot be achieved without efficient north-south transport networks - particularly railways. This conviction formed the basis for the preparation of the present idea, which already has some history. Ten years before the announcement of the Three Seas Initiative, there was a serious - but unsuccessful at the time - attempt to outline the proposed corridor discussed in this paper. In the autumn of 2005, the Italian, Slovenian, and Hungarian railways joined forces by forming a consortium to participate in the privatization of Železničná spoločnosť Cargo Slovakia, which was being prepared by the then Slovak government. The Polish railway was also invited to join this consortium and declared its interest in participating. The involvement of PKP SA and PKP Cargo significantly increased the project's chances of success. Unfortunately, political factors intervened: the prospect of upcoming elections first slowed down the actions of the Slovak side, and as a result of the June elections, in which the leftist opposition emerged victorious, the entire process was annulled.

Assumptions Underlying the Development of the Concept

The concept of the Trans-European Transport Network (TEN-T), developed since the 1990s, still does not fully address the needs of our region. Poland, when considering its population per capita and its area, has one of the lowest participation rates in the TEN-T network in Europe. In Central Europe, traditional east–west connections have long been preferred, clearly undervaluing north–south connections. The intention of the project is to create a modern, interoperable railway artery that connects the most productive areas of the Three Seas region countries with key Baltic and Adriatic ports, which serve as natural gateways to the world for these areas. The expected result of establishing such a corridor is an increase in trade turnover between regions situated along its route, which should, in turn, enhance the competitiveness of companies operating in this area. The guiding idea of the initiative was to build, based on the existing railway network between the Baltic and Adriatic Seas, a corridor that would become the communication backbone of the Three Seas Initiative.

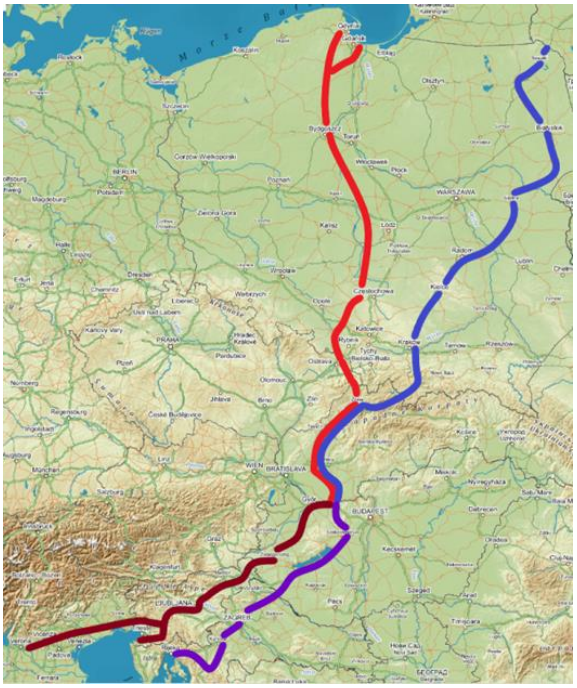
Geographically, the proposed Rail Adriatica corridor connects central, southern, and eastern Poland, a small fragment of the Czech Silesian-Moravian Basin (the Zaolzie region), the western parts of Slovakia, Hungary, and Croatia, Slovenia, and the northeastern part of Italy. Its natural continuation towards the Baltic countries is the under-construction Rail Baltica railway line, which serves as a functional extension of the northeastern corridor of the Rail Adriatica route. The proposed alignment of the corridors comprising the Rail Adriatica route largely overlaps with the existing or planned railway corridors in this area, primarily the RFC 11 Amber corridor – Fig. **2**.



2. The course of the RFC Amber corridor [7].

The route was delineated almost exclusively based on existing or planned railway lines, with two exceptions. The first is the proposed construction and reconstruction segment running from Rabka through Nowy Targ-Trstena to Kralovan - a segment without which it is impossible to construct any rational alignment for the entire northeastern corridor of the Rail Adriatica route. The second segment, Vrutky-Nitra-Nove Zamky, constitutes an alternative alignment of this corridor in Slovakia, significantly shortening its length while also relieving the main (albeit currently uncongested) Slovak railway line connecting Bratislava with Žilina, Poprad, and Košice.

Given that the vast majority of the railway sections along which the Rail Adriatica route – Fig. **3** is planned are covered by the interoperability standards of the TEN-T corridors, a gradual pursuit of achieving these parameters is to be expected. A key assumption of the corridor is to achieve high commercial speeds (reducing travel time), thereby ensuring high competitiveness compared to other north–south axes. Hence, the proposed alignment of its corridors avoids major hubs (Silesia, Bratislava, Budapest).



3. The course of the planned Rail Adriatica corridors

Description of the Corridor Alignment

The proposed route consists of four corridors - two northern and two southern - converging at Komarno/Komarny on the Danube River:

- Northwestern Corridor:

Its starting point comprises both Tri-City ports - Gdańsk and Gdynia. From there, the corridor follows the Coal Trunk Line towards the Silesian agglomeration, bypassing it from the west to reach the border in Chałupki. From there, a short stretch through the Czech Zaolzie region leads to the Jabłonków Pass, from which it continues on the Slovak side through Žilina, Leopoldov, Galanta, Nove Zamky, and finally to Komarno. The total length of the corridor is 926 km from Gdańsk and 945 km from Gdynia.

- Northeastern Corridor:

It begins at the Lithuanian border in Trakiszki and proceeds to Białystok via the Polish section of the under-construction Rail Baltica line through Suwałki and Ełk. From Białystok, four potential alignments are proposed for further analysis, with the optimal route recommended through Czeremcha, Siedlce, Łuków, Dęblin, Radom, Kielce to Kraków. In Kraków, this corridor has a single established alignment utilizing the initiated project "Podłęże Piekiełko" connection through Szczyrzyc and Mszana Dolna to Rabka. From Rabka to Kralovan, a new line needs to be constructed - partially on a new alignment and partially following the closed Suchogórska Line, further extending on its modernized (and partially rebuilt) Slovak continuation to the junction station Kralovany on the main line from Košice to Bratislava. The corridor then proceeds to Žilina, where it connects with the northwestern corridor and continues to Komarno. For further analysis, it is proposed to supplement the project with the aforementioned alternative alignment from Vrutky through

Nitra to Nové Zámky. The total length of the corridor, considering the recommended Białystok–Kraków segment, will be 1,170 km, and after implementing the proposed Vrutky–Nitra–Nové Zámky connection, it will be reduced to 1,098 km.

- Southwestern Corridor:

This corridor largely overlaps with the existing RFC 11 Amber railway corridor, which runs from Poland through Slovakia, Hungary, Slovenia to the port of Koper, allowing - though to a limited extent - for handling freight traffic from the port of Trieste and Northern Italy (especially serving freight traffic from Italy to Northern Europe's major transshipment center in Verona). Historically, a significant portion of this corridor's route was one of the most important lines of the Habsburg monarchy - the Southern Railway connecting Vienna with the port of Trieste. From Komarno, the corridor runs through Győr, Celldömölk, and Zalaegerszeg to the border station Hodos, from where it continues on the Slovenian side through Pragersko, Ljubljana to Divača, where the corridor splits into branches to the port of Koper and to Trieste (via Villa Opicina). Currently, the length of this corridor is 600 km to Koper (596 km after the commissioning of the new Divača-Koper line) and 582 km to the border at Villa Opicina. It should be noted, however, that these distances will be reduced upon the completion of the new railway lines planned by the Slovenian Railways. From the perspective of launching the final connection to Verona, the segment Ljubljana-Gorizia is essential. The total length of the corridor from Komarno to Verona will be 795 km (including 544 km to Gorizia itself).

- Southeastern Corridor:

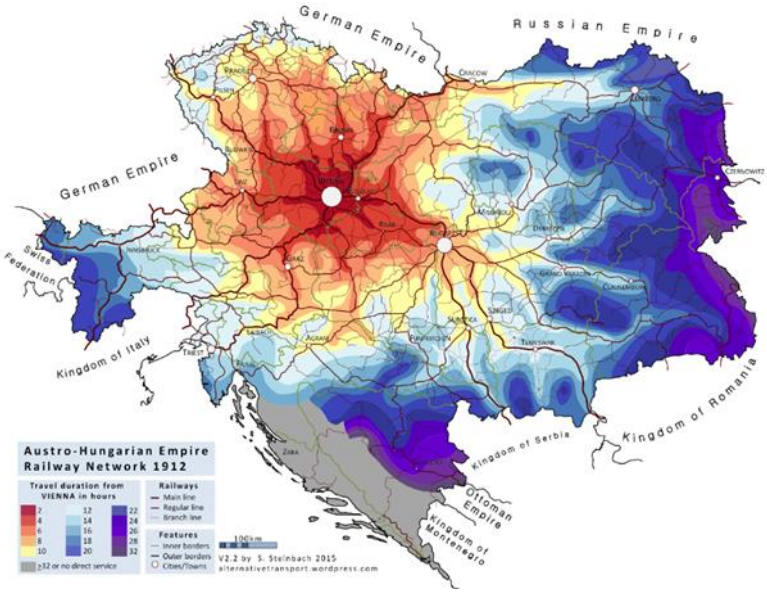
This corridor connects to the port of Rijeka, following largely the route of the historical connection between Budapest, Zagreb, and Rijeka. It runs from the Hungarian Komarno through Székesfehérvár and Nagykanizsa to the border bridge over the Sava River in Botovo, from where it continues through Zagreb to Karlovac. In Karlovac, the corridor segment ends, which can be adapted to requirements through modernization. The further segment to Rijeka - in its current alignment - is unsuitable for modernization and must be replaced with a new line currently being designed by the Croatians. The total length of the railway route is currently 593 km, and after completing the new line from Karlovac to Rijeka, it will be reduced to 542 km.

Geographical Characteristics and Infrastructure Conditions of Countries Located on the Rail Adriatica Corridor

In geographical and infrastructural terms, the Rail Adriatica corridor consists of two very different areas, separated by the Carpathian barrier. The area north of these mountains - excluding a small fragment of the Czech Zaolzie - comprises solely Polish territories. A distinctive feature of the railway network in Poland is the significant presence of modern infrastructure built after regaining independence, which serves to clear north-south axis connections. This naturally should encourage the development of transportation along this axis also in international relations. Thanks to the construction of two modern corridors - the Coal Trunk Line and the Central Rail Corridor - Polish railways today have the infrastructural potential to develop large-scale transportation along the north-south axis.

Unfortunately, the situation south of our borders is not as favorable. The planned corridor almost entirely runs through areas that were part of the Austro-Hungarian Empire, utilizing a railway network almost entirely created during the time of the dual monarchy – Fig. **4**. Naturally, this negatively affects the characteristics of these corridors. The main drawback is the significant extension resulting from the network's architecture, which over the years continues to reflect the radial layout of lines converging to both capitals: Vienna and Budapest. To a large extent, this is also a result of inadequate financing of these investments - budget constraints negatively impacting the line parameters, especially those built in difficult

mountainous areas. A lack of funds for building a sufficient number of (albeit expensive) tunnels, bridges, and viaducts forced designers to bypass difficult sections, which not only lengthened routes but also deteriorated the geometric profile of the constructed lines.



4. Map of the Austro-Hungarian railway network [2]

The problem of an unfavorable profile of key mountainous sections of the planned corridor, and consequently their insufficient operational parameters, practically makes it impossible to adapt many of their sections to the TEN-T network parameters, forcing Slovenians and Croatians to design completely new lines fully adapted to contemporary standards and requirements. The first step in this direction is the already under-construction new 27-kilometer railway line to the port in Koper. This line sets the standards to which the infrastructure of both corridors should be adapted. This impressive investment effort by the small country of Slovenia (2 million inhabitants), realized using EU aid funds, demonstrates, on one hand, the scale of necessary investments in the railway network of our region, and on the other, the potential that can be gathered for their realization.

In the context of these planned investments, attention should also be paid to local traffic congestion (especially in Slovenian sections), which may accelerate the commencement of the mentioned projects. It is important that they form a coherent, complementary whole, with simultaneously implemented investment tasks ensuring an appropriate level of financing and taking into account the very diverse needs and conditions of the network in each participating country.

Poland

The vast majority of Poland is located in the Central European Lowland. Lowland areas cover as much as 75% of the country's area, and these are most often flat regions where achieving an optimal railway line profile does not involve technical difficulties or high costs associated with constructing engineering structures. An illustration of this state of affairs can be seen in the north-western corridor, where perhaps only one technically difficult section is the descent from the moraine of the Kashubian Lakeland to Gdynia (the so-called “golden cut”), where trains overcome a large height difference over a short distance. However, in the case of the north-eastern corridor, a significant part runs through the undulating highland areas of Lesser Poland and ultimately has to traverse the mountainous terrains of the Island Beskids and the

Gorce Mountains, which involves implementing investment programs that have been postponed for decades in this area.

5. Map of Poland's railway network [10].

Although the average density of the railway network in Poland – Fig. **5**, at 6.2 km per 100 km², is higher than the EU average (4.8 km per 100 km²), it is very uneven - ranging from 3.89 km per 100 km² in the Podlaskie Voivodeship to 17.71 km per 100 km² in the Silesian Voivodeship, which is a decrease from the period of the partitions when the network was largely developed. Despite the construction of many new railway line sections realized both during the Second Polish Republic and the communist era, the disparity in access to railways between the former Prussian territories and the remaining two partitions is visibly noticeable. This is despite the closure of over 5,000 kilometers of railway lines carried out almost exclusively in the former Prussian areas, which was the result of the collapse of Polish railways after 1989, the effects of which the railway - especially the infrastructure - still feels today. Strategic decisions made in the 1990s to redirect funds from railway network development to the construction of highways and express roads led to deep underinvestment in railway infrastructure, resulting in the degradation of many active lines, a decrease in the commercial speeds of trains, and consequently a reduction in the competitiveness of railways.

It should be noted that from the perspective of our railway network's efficiency, the long-term degradation of many main trunk lines and first-class lines, leading to a permanent trend of cargo loss to road transport, is more dangerous than the closure (or decommissioning) of 5,000 kilometers of secondary lines of little importance in the transport system. The change in this situation only came with Poland's accession to the EU and the provision of stable financing for the reconstruction and modernization of the railway network. Visible for about a dozen years, the intensification of investments is beginning to improve the state of railway infrastructure, but - as many experts point out - the benefits of these investments are mainly enjoyed by passenger carriers who can expect increases in the maximum speed of passenger trains and reductions in travel time. Paradoxically for freight traffic, corridor upgrades often constitute limitations, if not barriers, to the development of transportation. The source of the problem is ensuring the efficient passing or overtaking of trains on sections where, as part of the modernization, stations were eliminated, lengthening interstation sections to as much as 30 km, which restricts the throughput capacity of entire corridors. Alongside the reduced station density comes the elimination of handling infrastructure, which limits the economic effect of modernizing such corridors. The last parameter limiting freight traffic concerns the lack of adaptation of the modernized infrastructure to accommodate trainsets of 740 meters in length, which also significantly reduces the competitiveness of our railway lines, posing a barrier to the development of freight transportation. Without the systematic removal of these

barriers, it is difficult to think about constructing modern international connections, despite having many undeniable advantages.

The most important of these advantages is the possibility of real separation of freight and passenger traffic, resulting from the development of a traffic organization model and the division of transport tasks between the Coal Trunk Line and the Central Rail Corridor. A strong point of the Polish railway network is the high percentage of electrified lines (62.9%) as well as a high percentage of double-track lines. Equally important, our railway network is characterized by a relatively low elongation factor compared to southern neighbors.

Slovakia

Slovakia is a country with a very diverse topography, dominated by undulating and mountainous areas – Fig. **6 - 7**.

6. Western Slovakia - physical map [9].

7. Map of the western part of the Slovak Railways railway network [8].

Flat areas constitute only 22.4% of the country's area, occurring mainly in the Danube Lowland and the Eastern Slovak Lowland, and are separated by the mountainous areas of the Inner Slovak Carpathians. Such landscape diversity shapes very different conditions for the development of the railway network, which in the area of the planned routes of both northern corridors of the Rail Adriatica corridor should be considered relatively favorable. In the northern part of Slovakia, railway lines follow river valleys: the Váh and Kysuca. The natural shaping of these valleys—apart from short sections of mountain cuts - did not pose significant problems for both the construction (and modernization) of railway infrastructure with good parameters. It is different with the line in the Orava Valley - the poor profile and insufficient parameters do not result from the layout of this corridor but from cost-saving in the corridor

construction, where only two bridges were built along the heavily meandering river. These problems are completely absent on sections running through the southern part of the country, in the flat terrain of the Danube Lowland. For the intended final route of the northeast corridor, the area of the Nitra-Turč Basin, forming a natural corridor connecting the Nitra Basin area (already part of the Danube Lowland) with the Upper Váh Valley, should also be taken into account.

The Slovak railway network, against the backdrop of the presented geographical conditions, is characterized by a high average density index—7.39 km per 100 km². Of all the countries in the Rail Adriatica corridor, only lowland Hungary can boast a better result. However, this network is unevenly distributed—the highest density and concentration of connections are in the western part of the country. This results from its layout during the time of the Habsburg monarchy and later the Czechoslovak state. For over seventy years, Slovakia was part of Czechoslovakia - more attention was given to the east-west connection, neglecting the north-south axis. Hence, higher parameters and better maintenance standards of lines in this area (although traditionally high in Czechoslovakia). Unlike Poland, in Slovakia after 1989, only a small percentage of operated lines were closed, which resulted both from the relatively good condition of these corridors and the relatively mild (compared to, for example, Polish railways) transformation process of Slovak Railways. On the other hand, joining the European Union did not become an impetus for launching large network investments. Besides the progressively carried out modernization of the country's main line connecting Košice and eastern Slovakia with Bratislava, significantly larger investments are concentrated only in the western part of the country, on key connections leading to Western Europe, with particular emphasis on Germany - the most important trading partner and at the same time one of the most important investors in Slovakia. All this happens at the expense of other investment needs, such as the electrification of the network, whose rate (43.77%) is not only much lower than in Poland but also below the EU average.

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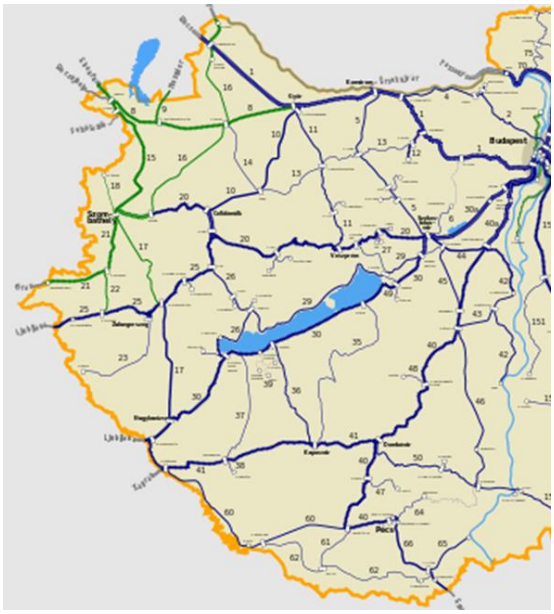
Hungary

Hungary is a country located in Central Europe, whose topography directly favors the development of rail transport. It is almost entirely situated in the Pannonian Basin, characterized by a lowland landscape with a predominance of plains, which directly supports the development of rail transport – Fig. **8**. The density of the railway network exceeds the average for European Union countries, but its technical condition is worse than that of most EU countries – Fig. **9**. Insufficient financial investments in the maintenance and modernization of the network over recent decades have led to a significant deterioration of its condition and repair backlogs. As a result, its current parameters are far from adequate, and the pace of modernization remains too slow. This is despite the fact that these lines feature favorable profiles, and upgrading their parameters through reconstruction would not involve major engineering challenges or high expenditures. It is only in recent years that the decades-long process of the rail network's aging has been halted by launching a series of investment programs aimed at modernizing the severely neglected, outdated, and infrastructure that does not meet current needs, thereby ending the decades-long aging process.

8. Western Hungary - physical map [3]



9. Map of the western part of the Hungarian Railways railway network [1]

The most serious flaw of the Hungarian railway network is the limited capacity of its main routes, many of which are single-track lines. This is partly a consequence of the humiliating post-war conditions imposed on Hungary by the Treaty of Trianon, which mandated the elimination of the second track on all their lines. This does not change the fact that among the many lines modernized in recent years, only a few sections have had a second track added. Consequently, on the planned 220 km southwest Rail Adriatica corridor, the total length of double-track sections is merely 47 km. Similarly, in the case of the southeast corridor: out of a 265 km route, only 10 km are double-track lines. Worse still, there is no clear priority in Hungarian railway modernization programs to expand track layouts to standard double-track systems (even for TEN-T lines).

Slovenia

Slovenia lies at the intersection of four European geographical units: the Alps, the Pannonian Plain, the Dinaric Mountains, and the Mediterranean Sea, creating nine typical landscape types: Alpine mountains, Alpine hills, Alpine plains, Pannonian hills, Pannonian plains, Dinaric plateaus, foothills and Dinaric plains, Mediterranean hills, and Mediterranean

plateaus – Fig. **10**. The terrain has had a significant impact on the formation of the railway network in this country. This is illustrated by the route of the corridor described here, which entirely consists of lines built before World War I. In Slovenia, favorable conditions for building railway lines occur almost exclusively in the eastern part of the country, where flat landscapes of the Mura and Drava plains are interspersed with hilly terrains. Further east from Pragersko to Ljubljana, the Alpine Foothills begin. After the Celje Basin, the terrain does not yet pose a significant problem, but further east, noticeable limitations arise from the necessity to adapt the lines to the terrain's topography. However, the real challenge is the Slovenian Karst area, which separates the country's capital, located in a deep basin with Adriatic ports, from Italy. Similar to Hungary, the Slovenian railway network – Fig. **11** almost exclusively relies on lines built during the Austro-Hungarian era, with the Südbahn (Southern Railway) being a key route connecting imperial Vienna with the port of Trieste. This route constitutes the vast majority of the planned corridor, stretching from Pragersko to the border at Villa Opicina. Noteworthy are the relatively high technical parameters of this line (for example, the allowable axle load is 221 kN along almost the entire route) and modern solutions in railway traffic control (the ETCS system is available throughout the entire route).

10. Slovenia physical map [12]

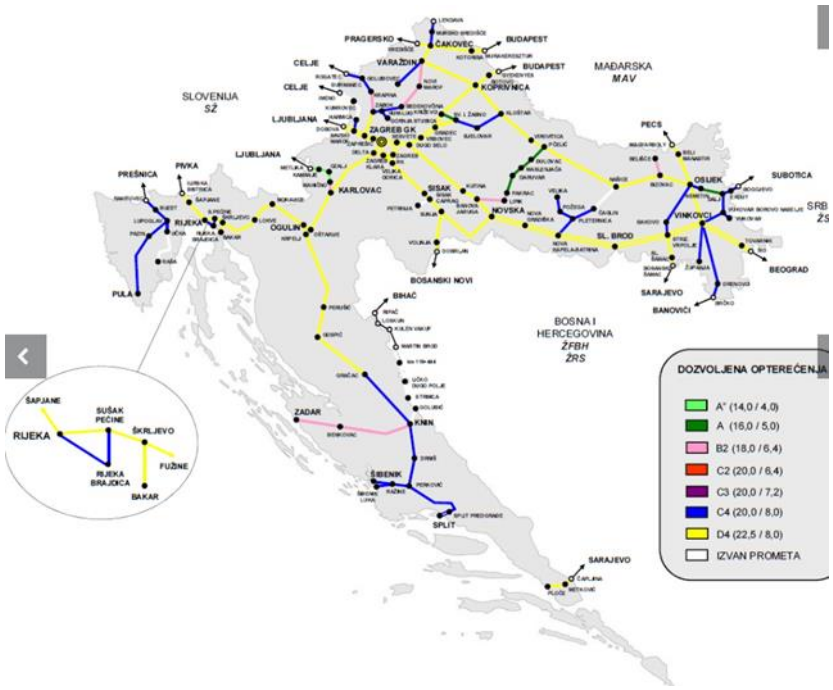
11. Maps of the Slovenian Railways rail network and its development directions [17]

Croatia

Located on the Adriatic Sea, Croatia consists of two regions. The southern part of the Pannonian Basin, Slavonia, encompassing the northern and northeastern parts of the country, is mostly a lowland area with a predominance of plains. It is complemented by the Pannonian Island Mountains, which did not hinder the development of the railway network in this area, characterized by a relatively high density of the railway network compared to the rest of the

country. The situation is entirely different for Dalmatia, which stretches along the Adriatic and covers the southern and western parts of the country – Fig. **12**. This region is entirely located in the mountainous and karst area of the Dinaric Alps, posing a challenge for the engineers who built the railway network there – Fig. **13**. This also results in a relatively low network density (lower than in Poland) throughout the country. However, the biggest weakness is the technical condition of the Croatian railway network - the worst among all the countries discussed here. This is due to numerous factors, starting from historical reasons - neither during the Austro-Hungarian period nor, more so, during Yugoslavia's time was the expansion and modernization of the railway network in Croatia a (to put it mildly) priority for the authorities. The initial period of the country's independence was also difficult: alongside the typical post-communist economic transformation challenges, Croatia endured the consequences of the Balkan Wars.

12. Western Croatia - physical map [4]



13. Map of the Croatian railway network (permissible axle loads of the lines are marked) [13]

A significant drawback for Croatian railways is the low electrification rate of the lines and an even lower proportion of double-track lines. The situation improved with the country's accession to the European Union and the availability of substantial aid funds, which began to

finance many railway modernization programs. This reversed the negative trend of infrastructure aging but did not advance the plans for its development - namely, the construction of much-needed modern railway lines. For a long time, the European Union, critically assessing the economic feasibility of railway projects, consistently denied their support through its funds. This significantly delayed the implementation of even Croatia's key railway investment - the construction of the so-called lowland railway to Rijeka, without which the port cannot compete with its Adriatic rivals - Trieste and especially the rapidly developing Koper. High-parameter lines are essential for the creation of the proposed southeast corridor of the Rail Adriatica route; without them, the corridor loses its purpose, and the port of Rijeka will be condemned to gradual marginalization.

Economic Background of the Project

As mentioned at the outset, the idea behind building the "Rail Adriatica" corridors is to connect, along a single rail transport axis, the most developed and productive economic areas of the Three Seas Initiative countries with their most important Baltic and Adriatic ports, as well as with major logistics centers in Northern Italy. Such an economic axis can be a way to break the dominance of east–west economic relations. These relations, which in the initial period after the fall of communism and the accession of Eastern and Central European countries to the European Union brought significant developmental impetus and unquestionable economic benefits, have also created a model of economic dependence that ultimately became a barrier to further economic development and the advancement of these countries to Europe's economic forefront. The cooperation model in which the stronger and wealthier economies of Western European countries (especially Germany) strive to solidify dependent economic ties with their Central European partners, relegating them to complementary economies, is now unacceptable, and the Three Seas Initiative is an expression of this. The proposed communication corridor comprising the construction of four corridors should accelerate the process of bringing the Three Seas countries to the forefront of Europe's economy. For many companies in our region, this will open the opportunity to move from their current roles as partners, subcontractors, and suppliers to becoming producers of highly processed, technologically advanced goods that generate high added value.

Special Potential Presented by Economic Centers Located Along Both Western Corridors

Starting from the north, these are:

1. Gdańsk Industrial Region: In addition to the traditional shipbuilding industry, it hosts Poland's second-largest refinery, "Lotos," the "Pipeline" plants in Żarnowiec, and "Radwar," owned by WB Electronics.
2. Bydgoszcz-Toruń Industrial Region: Primarily representing the chemical industry (Bydgoszcz's "Zachem," Toruń's artificial fiber production plants, "Anvil" and "Nobiles" plants in Włocławek, soda plants in Inowrocław and Janikowo, cement plants in Barcin and Wapienna) and the machinery industry (PESA Bydgoszcz).
3. Łódź Industrial Region: A former center of the textile industry, where major conglomerates producing household appliances have established their plants, including Philips, Bosch, Siemens AG, General Electric, and Indesit.
4. Silesian Industrial Region: The most important industrial hub in Poland. Heavy industry still dominates here: the mining industry (13 coal mines) and the metallurgical industry (15 metallurgical plants besides Huta Katowice), coke production (4 coke plants). The chemical industry is also heavily developed (Zakłady Azotowe in Chorzów, Zakłady Azotowe Kędzierzyn, Zakłady Chemiczne Blachownia, Synthos in Oświęcim). The machinery industry in the Silesian Industrial Region is represented by two car factories:

GM in Gliwice – Fig. **14** and Fiat in Tychy, as well as the Alstom Konstal rail vehicle factory in Chorzów. Additionally, Gliwice's Bumar Łabędy and the Military Mechanical Works in Siemianowice are important producers of military equipment. The Silesian Industrial Region is also a significant part of Polish energy production (8 power plants, including two combined heat and power plants).

14. The new Opel factory from a bird's eye view [5]

5. Moravian-Silesian Metropolis: An old mining and metallurgical region where metal industry companies still dominate. Coal mining is nearing its end - once there were several mines, but today only two large ones operate. The condition of the metallurgical industry is significantly better - here, there are two (the only ones in the Czech Republic) full-cycle metallurgical plants: Třinecké železárny and Liberty Ostrava – Fig. **15**; both operate within the Nová Huť complex in Ostrava. Additionally, Vítkovice Steel operates here, along with the important steel processor ŽDB Drátovna in Bogumin. This region is also a major center for the machinery industry. Alongside the well-known Škoda Vagonka rail vehicle manufacturer in Ostrava, the automotive industry is developing. In Kopřivnice, the Czech truck manufacturer Tatra is based, while the Korean company Hyundai has opened a car factory in Nošovice. Kopřivnica is also home to the important automotive parts manufacturer Brose CZ.

15. ArcelorMittal's metallurgical complex in Ostrava [14]

6. Western Slovakia with Bratislava: Dominated by the automotive industry; numerous automotive enterprises have moved their production plants here - Volkswagen (plant in Bratislava), Peugeot (production in Tarnów), Kia Motors (Žilina) – Fig. **16**, Jaguar Land Rover (Nitra). Western Slovakia has also become a center for electronics production. In the past dozen years, factories of electronic conglomerates such as Samsung Electronics (Galanta) and Sony (Trnava and Nitra) have been established here. Alongside them, the chemical industry is developing. Its largest plants are located in Bratislava (Slovnaft, Istrochem), Šala (Duslo) in Nováky (Fortischem), and Puchov (Continental Matador

Rubber tire factory). Additionally, the western Slovak region hosts factories for pharmaceuticals, plastics, and synthetic fibers.

16. KIA car factory in Žilina [6]

7. Western Hungary: Primarily an automotive industry hub. Companies like Suzuki (in Esztergom - 10,000 employees) – Fig. **17** and AUDI (in Győr - 11,500 employees) have built their factories here. Additionally, the Hungarian truck manufacturer RABA operates in Győr. In Budapest, the pharmaceutical conglomerate Richter Gedeon is headquartered. Western Hungary also hosts large metallurgical plants (aluminum plant in Ajka and steel plant in Dunaújváros).

17. Suzuki Plant in Esztergom, Hungary [11]

8. Slovenia: Arguably the most industrialized country in the entire Three Seas region. Industrial production accounts for 34.5% of the country's GDP. Symbols of Slovenia's industrial strength include brands like Gorenje – Fig. **18** and Krka, and productions in this country are developed by companies such as Siemens (rail vehicles) and Renault (passenger cars).

18. Gorenje household appliances factory [15]

9. Northern Italy: The economic heart of the country and one of the most important economic and industrial centers in Europe, generating vast flows of cargo and trade exchanges.

Economic Potential Comparison

Compared to the economic potential of the areas located along the western corridors, those along the eastern corridors are significantly lower. The role of the eastern corridors is to create incentives and conditions for development, especially in areas that have lost most of their production potential due to economic transformation after the fall of communism. This includes regions like historical Lesser Poland with Kraków, Radom, Kielce, and areas around the capital cities of Budapest and Zagreb. These regions lack new industrial investments, and factories such as Mercedes Benz in Kecskemét (4,700 employees) remain the exceptions.

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Summary

The Three Seas Initiative presents an opportunity for the development of the entire Central and Eastern European region. It offers a chance to bridge the gap separating us from Western countries, contributing to increased stability and security of the region's states. Meanwhile, the main communication routes (as well as the gas and oil transmission pipelines) in Europe are situated along the east-west axis, which does not favor the economic independence and empowerment of the region. Effective construction of economic connections between Three Seas countries is conditioned by the creation of modern communication corridors along the north-south axis. Intensifying efforts in this area is necessary to gradually close the gap with Western European countries, enabling the region's economies to become innovative and competitive. Without this, the much-anticipated effects of trade creation and shift will not materialize.

Cooperation among the countries belonging to the Three Seas Initiative can contribute to developing solutions that will be elements of economic strength growth and the civilizational advancement of the Central and Eastern European region. The main area of this cooperation is the still highly demanding transport infrastructure, especially the most neglected - the railway infrastructure. Relying on infrastructure dating back to the 19th and at most the early 20th century will not allow for the formation of modern supply chains and trade exchange routes. In addition to deep modernization, new lines fully adapted to contemporary requirements are needed. The construction of the "Rail Adriatica" corridor requires securing funds for the realization of very costly investments, which cannot be financed from the national budgets of the countries lying on this corridor. Many nationally significant projects essential for the corridor's development have very distant completion dates. Therefore, a coalition of states determined to implement such a joint project is needed, along with consistent efforts to obtain financial support from the European Union that is adequate to the scale of the undertaking. The EU strongly emphasizes the need to increase the share of rail in transportation and the importance of shifting goods from road to rail as part of its environmental and climate protection strategies.

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