

Study on the improvement of passenger rail connections between the Friuli Venezia Giulia Region and the Western Balkans, with a focus on the Trieste - Ljubljana - Zagreb - Belgrade route

EXECUTIVE SUMMARY

The study examines potential demand and infrastructure requirements for a new cross-border rail service along the Trieste-Ljubljana-Zagreb-Belgrade corridor. This route, spanning approximately 680 km across four Countries (Italy, Slovenia, Croatia, Serbia), in the past, supported extensive cross-border and international rail passenger services. Despite a decline in international rail traffic registered in recent years, the route represents a strategic connection between the European Union and the Western Balkans.

This is proved by the designation of such route as part of the recently established **Western Balkans-Eastern Mediterranean** (WBEM) European Transport Corridor (ETC). Reestablishing this rail connection would indeed mean:

- enhancing cross-border connectivity and improving accessibility of the Adriatic-Ionian (AI) Region;
- fostering exchanges, stimulating economic growth and, in so doing, improving regional cohesion;
- providing sustainable transport alternatives to private mobility which remains the predominant mode of passenger transport within the Region.

* * *

This study, starting from the analysis of the characteristics of the existing railway infrastructure and of the ongoing investment, estimates the potential demand for a first hypotheses of international rail service between the stations of Trieste, Ljubljana, Zagreb, Belgrade and other regional hubs of local rail transport, assessing the impact on modal shift and climate change (in terms of reduction of CO2 equivalent emission per year).

The potential **catchment area** for such renewed international rail service includes the cities of Trieste, Ljubljana, Zagreb, and Belgrade, along with key transit hubs such as Pivka and Zidani Most in Slovenia, and Vinkovci and Slavonski Brod in Croatia, selected for their strong centrality within regional rail networks. A catchment area for these potential “hub” stations was defined as a 45-minute driving distance from each location. According to socioeconomic data from EUROSTAT and the Serbian Statistical Office, this catchment area includes approximately 6.6 million people, with an overall GDP of €93.8 billion. Serbia represents the largest population share within this area, while Slovenia contributes with the highest economic output.

Travel demand estimates use socioeconomic and transport data from the EUSAIR Master Plan of Transport (i.e. with a base year 2017), appropriately adjusted to reflect variations in demand compared to the base year, such as the reduction in cross-border demand caused by the COVID-19

pandemic. The nature of the socioeconomic contexts, combined with the limited supply of cross-border rail services, reveals that most trips by railways (83%) are within national borders; cross-border railway travels (17%) are equal to approximately 250.000 trips per year. The Ljubljana–Zidani Most route sees the highest passenger numbers, while Ljubljana–Trieste has the highest international demand. A modal share of 1.8% (accounting for about 1.5 million rail passenger trips per year) is estimated for railways services, with most of the demand in the area met by car and long-distance bus travel.

The **infrastructure analysis** highlights significant interoperability challenges, including three distinct rail signalling systems (SCMT, ETCS, INDUSI/PZB) and two electrification voltages (25KV and 3KV). Key bottlenecks include the **Italy-Slovenia border**, where sharp curves and a switch from the SCMT to the ETCS signalling system restrict trains to 50 km/h, and the **Slovenia-Croatia border**, where transitioning from ETCS to INDUSI/PZB systems and changing voltage limits speeds to 30 km/h. Additional challenges arise in other sections, particularly along Croatia's Dugo Selo – Novska segment, the corridor's only single-track portion, as well as near Vinkovci and Belgrade, where alternating signalling systems and low speeds impact performance (speed, capacity and service reliability). Moreover, increasing freight demand could further constrain passenger service capacity, complicating the line service management.

Cross-border passenger rail services along the route are currently limited (June 2024) to connecting some major cities along the corridor, specifically the Trieste-Ljubljana service, operated by Trenitalia and OBB, and the Ljubljana-Zagreb connection, operated by the Slovenian (SŽ) and Croatian (HŽPP) railways. Connections between Belgrade and the rest of the corridor, namely Zagreb, were suspended in 2020 due to COVID-19 and have not yet resumed. The performances of the available cross-border rail services are constrained by the state of the infrastructure, forcing lower speeds, thus making rail travel times less competitive than the private car and bus services, such as Flixbus, BlaBlaCar Bus, and on-demand shuttles like GoOpti, which also offer intercity and airport connections with a highly competitive service range.

Infrastructure bottlenecks—such as single-track segments and signaling systems switches—represent the most notable obstacles to the improvement of the rail service. In order to tackle these issues, **national and international infrastructure development plans** foresee upgrades across the corridor; particularly:

- **Italy** has planned the signalling upgrades to ETCS on the Trieste–Villa Opicina line by 2029;
- **Slovenia** is upgrading the Divaca–Sezana, Koper–Ljubljana, and Zidani Most–Dobova sections, and has plans to expand the capacity of the Ljubljana rail station;
- **Croatia** is building the second track along the Dugo Selo–Novska section and has planned several enhancements in the Zagreb node¹;
- **Serbia** is aiming to alleviate bottlenecks along the Belgrade–Šid section by extraordinary maintenance works and technology upgrades expected by 2028.

The implementation of the above-mentioned investment would significantly reduce travel times along the corridor and make rail services more competitive with other travel modes (see the estimates in Table 1).

¹ Most notably, the modernisation of the section Zagreb Kustošija – Zagreb West Station – Zagreb Main Station.

	TRIESTE	LJUBLJANA	ZAGREB	BELGRADE
TRIESTE		2h	3h 50min	10h
LJUBLJANA	2h		1h 50min	8h
ZAGREB	3h 50min	1h 50min		6h 15min
BELGRADE	10h	8h	6h 15 min	

Table 1 - Estimated travel times between the major cities following the opening of the new rail service

The proposed rail service could induce a **modal shift** from auto and bus to rail, up to 4% overall, ranging between 2% and 7% depending on origin-destination (OD) pairs. Shifting travel from road to rail would yield significant **environmental benefits**, reducing CO₂ equivalent emissions by approximately 55,7 ktons annually.

An optimization model was employed to design an efficient rail service along the corridor, aiming to minimize **operational costs** while maximizing **potential demand**. The objective function weighs operational costs against potential revenue losses from unmet demand due to capacity limitations. The model evaluates multiple route configurations (e.g., Trieste-Belgrade, Trieste-Zagreb, ...), strategically allocating daily train pairs to achieve an optimal balance between cost efficiency and service coverage. Based on demand forecasts, an **optimal service configuration** includes nine daily train pairs: six between Trieste and Zagreb and three extending to Belgrade. This design aligns with demand distribution, which is highest on the segment between Trieste and Zagreb.

The recommended phased rollout suggests initially operating six daily train pairs between Trieste and Zagreb, where the infrastructure upgrades are expected to be ready by 2027; once the Dugo Selo–Novska section's doubling and modernization works are complete (estimated by 2029), the service could be extended to Belgrade with three additional daily train pairs (departing from Trieste). Full operations would require a **fleet of 11-14 trains, delivering approximately 51,000 train-km per week**.

In conclusion, since the service along the route would improve regional accessibility, and foster economic cooperation across borders, it could qualify for EU funding under the **Public Service Obligations (PSOs)**, subject to approval from participating countries (see Regulation 1370/2007 and the relevant interpretative guidelines).