ADBInstitute

policy brief

No. 2024-21 (September)

Key Points

- High efficiency, energy-saving, and sustainability features make high-speed rail (HSR) a highly favored mode of transportation.
- Italy's HSR system is effectively integrated with regional rail services and offers comprehensive first- and last-mile services, demonstrating holistic planning to address geographic disparities through an integrated intermodal network.
- HSR financing in Italy transitioned from secured bank loans to innovative, unsecured capital market solutions, reflecting a significant improvement in financial stability by 2011.
- The financing approach also showcases a commitment to sustainability, with Italy issuing Green Bonds and creating ESG-compliant frameworks for projects since 2013.
- Reevaluating the "door-to-door" model, Italy's strategy involves operating specialized lines and stations, managing train density, optimizing timetable design, and offering differentiated services to improve punctuality and service quality in high-density networks.
- The Italian HSR market, operating under open access principles, is characterized by flexible fares, innovative train designs, and enhanced onboard services, which contribute to increased customer satisfaction and competitiveness.

ISSN 2411-6734
DOI: https://doi.org/10.56506/DHQO1738

Lessons from Italy's High-Speed Rail Development: Planning, Financing, Operating, and Management Strategies

Francesca Pagliara, Associate Professor, Transportation Engineering, University of Naples Federico II, Italy
Mario Tartaglia, Head of Research, Ferrovie dello Stato Italiane, Italy
Pierini Stefano, Head of Finance & Investor Relations, Ferrovie dello Stato Italiane, Italy
Fabio Senesi, Head of Research and Development, Rete Ferroviaria Italiana, Ferrovie dello Stato Italiane Group, Italy
Ka Ying Wong, Capacity Building and Training Associate, Asian Development Bank Institute, Tokyo, Japan
KE Seetha Ram, Senior Capacity Building and Training Consulting Specialist, Asian Development Bank Institute; Visiting Professor, The University of Tokyo, Japan

1. High-Speed Rail: The Favored Mode for Efficiency, Energy Conservation, and Sustainability

Since the inauguration of the *Shinkansen* in Japan in 1964, the development of high-speed rail (HSR) has significantly modified people's travel habits and activities, which has, in turn, changed the way cities evolve.

Globally, substantial investments in HSR systems have been made in the last few decades. There are many advantages to using public funds to build HSR systems, including reduced travel times, enhanced comfort, increased travel demand, a reduction in traffic, and broader economic gains that contribute to the development of less-developed areas (Hayashi et al. 2021).

We have identified 10 benefits of HSR systems:

1. Safest Transport: HSR saves lives and is proven safer than almost all other transport modes. Japan was the first nation to build HSR in 1964 and has, since then, transported billions of passengers without injuries.
2. Infrastructure Capacity Enhancer: HSR enhances capacity. In Italy, in the National Recovery and Resilience Plan, it is stated that by June 2026, it will

This policy brief contains key messages for policy makers identified from ADBI's HSR Webinar Series: Policy Considerations for National High-Speed Rail Network Construction – Case Study in Italy, held on 9 May 2024. The webinar comprised 63 participants, including government officials, policy makers, thematic experts, researchers, and practitioners in the railway sector in Asia and Europe.

only take 2 hours to travel by train between Naples and Bari, compared with 3.5 hours today, and capacity will also be increased from 4 trains per hour to 10 trains per hour along double-track sections. (Italia Domani Piano Nazionale Ripresa E Resilienza 2024).

3. High Energy Efficiency Provider: HSR is the most favored transport mode for its high-efficiency and energy-saving features.
4. Congestion Problem Solver: HSR is the only form of transportation not subject to congestion delays. HSR not only delivers a new form of fast transportation but also relieves congestion on highways and runways, making both systems function more effectively.
5. Friend of the Environment: Compared with roadways, civil aviation, and other transport modes, railways are recognized as a greener transport mode (Goo 2023).
6. Tourism Promoter: HSR can boost tourism for the cities served; according to a Revealed Preference survey conducted in June 2013 in Madrid, 15–20% of new trips were for tourism purposes, mainly around the Madrid central node (Pagliara et al. 2015).
7. Job Creator: HSR can create jobs during its development stages, which can boost overall employment rates.
8. Economic Growth Contributor: HSR systems contribute to the economic growth of a country. In Italy, HSR has contributed to additional GDP growth of +2.6% in 10 years of operation (Hayashi et al. 2021).
9. Social Equalizer: HSR can provide more comfort and be more inclusive compared with other modes of transportation.
10. Land Value Booster: HSR has a major effect when the distance of the property from the HSR station decreases; therefore, these systems can have a positive impact on property values.

Given that HSR offers such significant benefits, it should be widely planned and built, making it worthwhile to examine a successful case study like the Italian model. This policy brief focuses on the Italian HSR network due to its notable achievements in transforming national transport options and connectivity. It will first describe the history and development of the Italian HSR network, followed by an analysis of its funding sources and financial aspects. It will then examine the operation model. The last section presents the lessons learned and conclusions.

2. History of Italy's High-Speed Rail

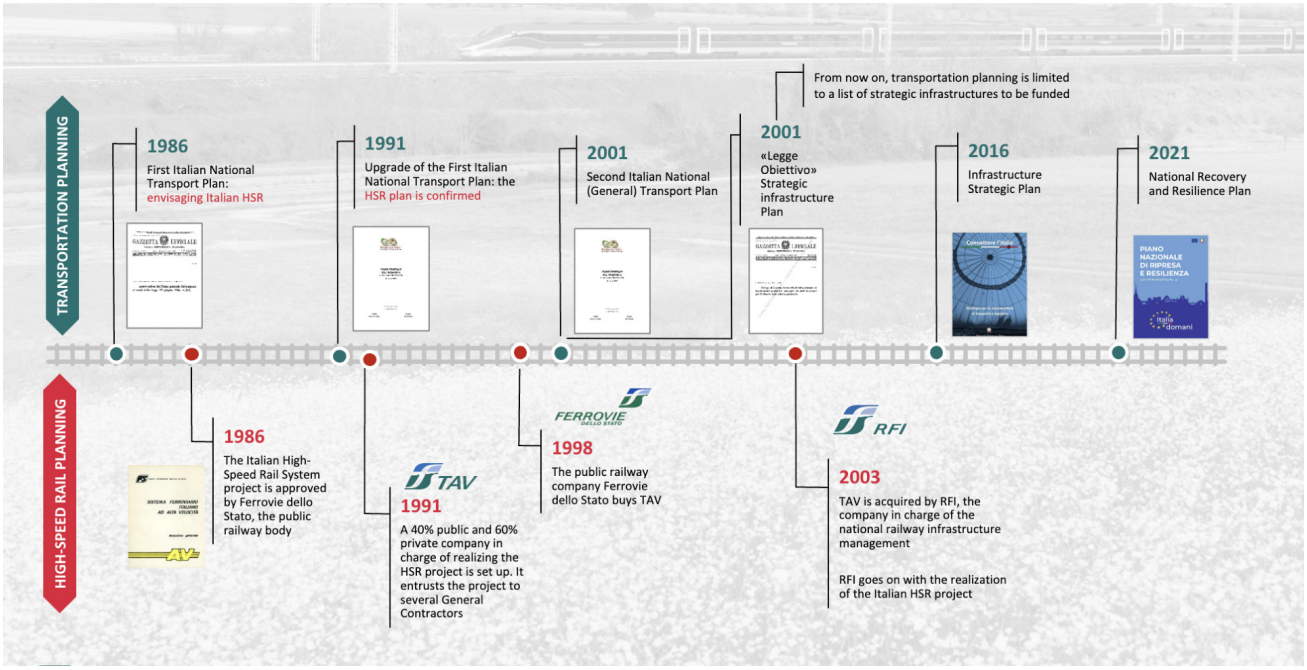
The planning process of Italian HSR started in the mid-1980s with the planning and system design phases, respectively, based on the 1986 National Transport Plan and the commitment to the state railway company Ferrovie dello Stato, later renamed Ferrovie dello Stato Italiane (FS) (Council of Ministers Presidency of the Italian Republic 1986; Ente Ferrovie dello Stato 1986). After an attempt to entrust the project to a public–private company, since 1998, the project has been continuously coordinated by FS. In the 2000s, soon after FS transformed from a state enterprise into a joint-stock company group, it began using some of its subsidiaries for the HSR project: RFI (in charge of infrastructure management), Italferr (the engineering company), and Trenitalia (the incumbent undertaking company) (Figure 1).

The development of the Italian HSR infrastructure, which allows speeds up to 300 km/h, occurred in stages from 2005 to 2017, complementing the existing Roma–Firenze HSR line launched in 1992 (Figure 1). The network was largely completed by the end of 2009 with the opening of the Bologna–Firenze section, which finalized the backbone line between Roma and Milano. Such completion allowed huge travel time savings, from 4 hours 30 minutes to 2 hours 45 minutes, between the country's two main cities, Roma and Milano.

Taking advantage of such infrastructure, the first High-Speed "AV" train brand was launched in 2007 by Trenitalia, connecting Milano and Napoli, in addition to the existing Eurostar fast train already operating along the main national railway lines. But a real turning point was the introduction of Trenitalia's new high-speed train brands, led by the fastest one—Frecciarossa (Figure 2). They started operating in 2009, just before the completion of the main backbone line. In April 2012, NTV Italo, the first HS competitor, started operating in the HSR market, initially on the Naples–Rome–Milan line and later on the rest of the HSR network.

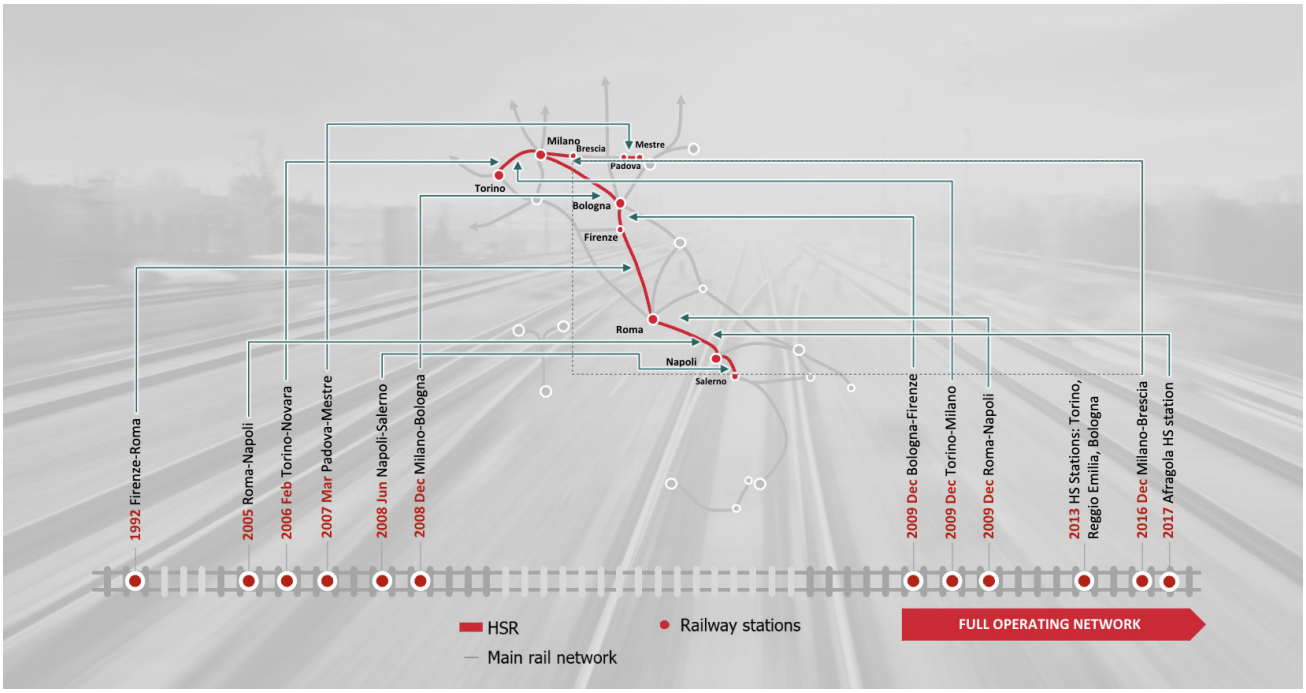
The introduction of the Italian HSR network introduced several new service features. First, there was a dramatic improvement in rolling stock quality by both revamping existing stock (Trenitalia, since 2006) and purchasing new rolling stock (NTV 2012, 2017; Trenitalia 2015). New levels of service were adopted instead of the prior two-class supply system, available on both Frecciarossa (since 2011) and Italo trains (since 2012). Moreover, new fare systems were established, including various price types and discounts, together with several ancillary services.

Figure 1: The Italian HSR Planning Process



Source: Compiled by authors.

Figure 2: Evolution of the HSR infrastructure in Italy



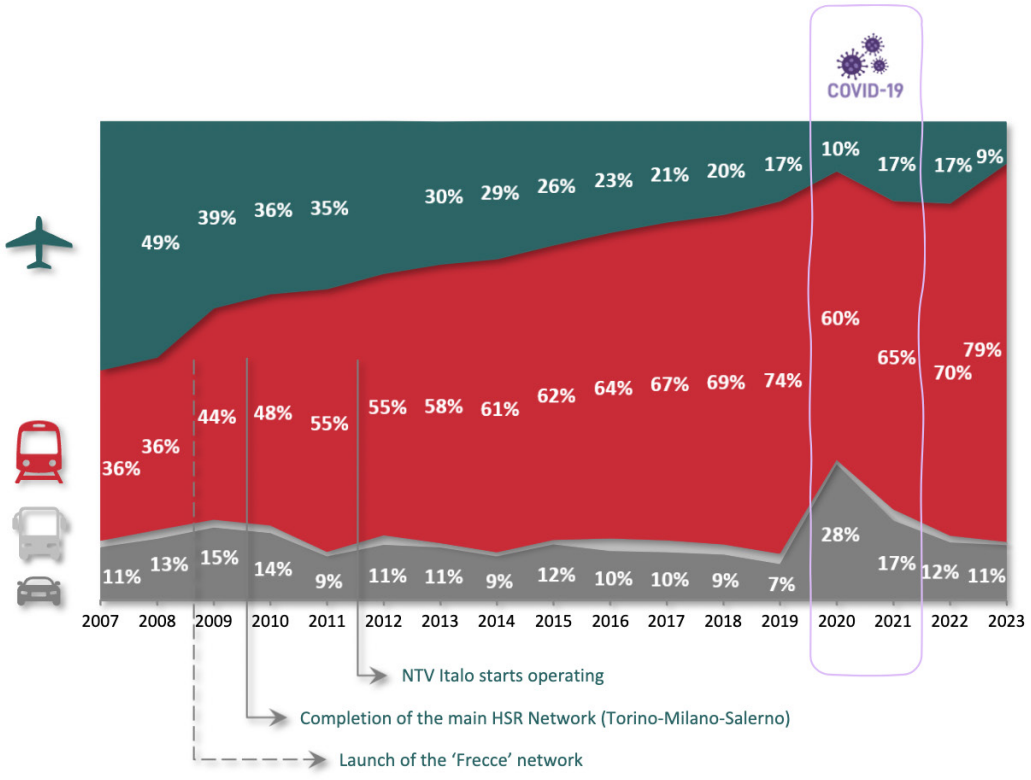
Sources: Adapted from Mario Tartaglia, Competition in High-Speed Rail. The Italian Experience. Symposium: NextRail17. Combining Strategic Planning and Flexibility, 7 September 2017, Lausanne, Switzerland.

These included on-board services (e.g., snacks and beverages, quiet areas, entertainment such as cinema and news); last-mile transport support services (e.g., car rentals, car sharing, bike sharing, parking at stations); and visitor and tourist support (e.g., discounts and deals with hotels, museums, exhibitions, events at destinations).

The Italian HSR network has not only achieved domestic success but has also gained global recognition for pioneering competition in the high-speed rail market. Following European regulation aimed to liberalize the rail market, the Italian rail network was the first to showcase competition in the market for High-Speed services within an open-access regime (Cascetta and Coppola 2014). The undertaking company, NTV, a newcomer, adopted a full-range competition model, which included cost leadership, product differentiation, and a focus on niche markets. As NTV provided high-quality services with new rolling stock, Trenitalia reacted promptly, achieving the same service quality well before the NTV entry. Moreover, NTV took advantage of lower industrial costs due to a different work contract while shaping a service network very similar to Trenitalia's (Beria and Grimaldi 2016). Currently, in general, the two competitors' supply is very similar, and they started sharing the whole market more or less in proportion to their production rates (Cascetta and Coppola 2017).

The implementation of Italy's HSR system has been transformative, achieving several positive outcomes. It enabled a huge growth in supply due to the development of new capacity, thereby promoting competition. City-to-city speeds increased as well, along with a remarkable improvement in the level of service. As a consequence, there was a considerable increase in demand with the rearrangement of Trenitalia's services and the improvement in their quality, even before the actual start of competition. Later, as soon as competition took place, a remarkable price decline occurred. Moreover, the introduction of High-Speed rail produced some effects on national modal shares, especially during the start-up time frame. Higher modal shift effects have been registered on the area directly served and on some corridors, such as the Milano–Roma route (Figure 3). Finally, HSR has had positive impacts on accessibility, tourism, economic integration, and employment.

Figure 3: Modal Share Changes in the Milano–Roma Corridor Based on Passengers per Kilometer



Source: Adapted from Ferrovie dello Stato Italiane, Investor Relation, various years.

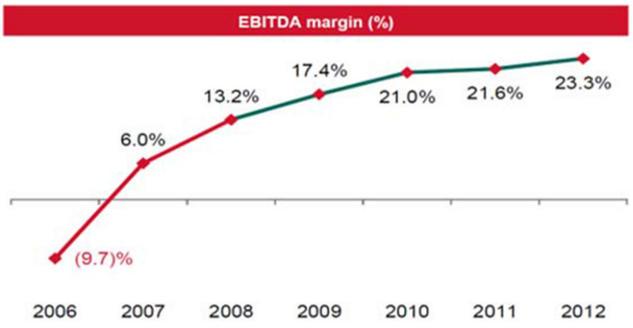
3. Evolutional and Innovative Financing of High-Speed Rail in Italy

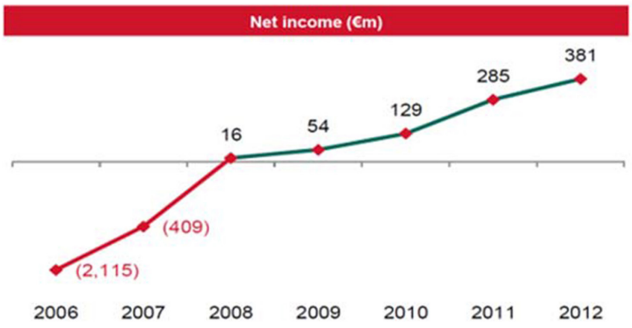
The evolution of financing for the Italian HSR project illustrates a shift toward increasingly sophisticated and sustainable financial strategies. Initially, the financing of the Italian HSR project was directly managed by FS beginning in the late 1990s and via its subsidiaries from the 2000s onward. Following the entry of the first sections, rationalization of business took place in 2007–2008, including the identification and segregation of different business segments, rationalization of the portfolio (disposal of loss-making businesses), review of labor conditions, use of price leverage, redesign of production processes, and rightsizing of the organizational structure eliminating redundancies and inefficiencies (Ferrovie dello Stato Italiane 2024). After the completion of the main network, a repositioning phase followed between 2009 and 2010 by reviewing the structure of both Transport Public Service and National Rail Investment, the latter split between capex and service sections. This led to an increase in productivity and efficiency of the main industrial process, in addition to an optimization of asset allocation, enabling a substantial improvement in financial indicators (Figure 4).

The strategic credit enhancement initiatives undertaken after the completion of the main HSR network aimed to bolster financial stability. Following the completion of the main HSR network, a credit enhancement strategy was implemented to further strengthen financial stability in 2013. Prior to 2013, the Italian HSR Network was mainly funded through two initiatives. First, a vehicle company (Infrastrutture S.p.A. ISPA), established in 2003, issued limited recourse notes and provided limited recourse funding loans to fund the HS Turin–Milan–Naples. ISPA's debt has been recorded as Italian Government debt. Second, financing was provided by the use of lending via the national promotional bank Cassa Depositi e Prestiti and European Investment Bank, whereby debt service was fully covered by State transfers or by guarantees according to national legislation. It is worth noting that in 2003, FS started shifting from a "Bank Financing" approach to "Capital Markets," also widening the role of supranational entities, which are traditionally the best positioned to raise money for the longest maturities and steadily increasing unsecured financing with debt serviced by FS cash flows, thanks to an improvement in the financial fundamentals of FS (Ferrovie dello Stato Italiane 2024). The first European Investment Bank (EIB) Corporate Loan (without any guarantee or collateral) was signed by FS Italiane in 2011.

Figure 4. Evolution of Selected Indicators of Ferrovie Dello Stato Italiane

(€m)	2006*	2007*	2008*	2009†	2010	2011	2012	Delta 2012-2011
Operating revenues	6,703	7,680	7,816	7,821	7,985	8,264	8,228	0%
EBITDA	(650)	461	1,035	1,358	1,673	1,782	1,918	8%
EBIT	(1,928)	(23)	443	435	507	664	719	8%
Net income	(2,115)	(409)	16	54	129	285	381	**34%**
	ITA GAAP			*IAS–IFRS GAAP*				





Source: Ferrovie dello Stato Italiane Financial Statements, 2006–2012. Rome, Italy.

The financing mechanisms for rolling stock evolved to include various secured and unsecured options. For rolling stock, financing before 2013 was primarily obtained through secured bank loans and bonds. Before 2013, it was mainly funded through secured bank loans, collateralized lending via the European Investment Bank, and private placement bonds fully subscribed by the supranational entity Eurofima, with collateral of (i) pledge on rolling stock and (ii) Italian Economy and Finance Minister undertaking about the effectiveness of the Italian Law (no. 348/1958), which states and recognizes the Eurofima Convention (Ferrovie dello Stato Italiane 2024). In 2014, EIB accepted the substitution of several bank guarantees (covering a Trenitalia loan signed in 2005) with an FS parent guarantee, formally recognizing the creditworthiness of FS (with an investment-grade profile). Besides Supranational entities, debt capital market transactions (better if unsecured) are the best solution to match long durations, according to an asset liability management approach.

The positive market response to FS's credit enhancement efforts marked a significant milestone in its financial strategy. The first extremely positive response from the market regarding FS's credit enhancement was in 2011 when FS signed its first unsecured committed line of €1.5 billion (3-year tenor). A successful syndication process enabled FS to close the deal with 8 domestic and international banks as Bookrunners and Lead Arrangers. The committed line is a fundamental step toward FS's first credit appraisal by rating agencies in view of the establishment of its Euro Medium Term Notes (EMTN) program. In 2013, the FS senior unsecured EMTN Programme—for institutional investors—was listed on the ISE (Irish Stock Exchange). The EMTN proceeds were mainly used for investments in new rolling stocks. In 2013, FS and its EMTN Programme received the same long-term senior rating as the Republic of Italy by Fitch and S&P, besides being regarded as a strong "Investment Grade" credit on a stand-alone assessment (Ferrovie dello Stato Italiane 2024).

Finally, the shift toward green finance highlights FS's dedication to sustainability, as it took the decision to allocate new debt to the most suitable investments complying with ESG principles. Following this strategy, a Green Bond was issued for Trenitalia financing in 2017, followed by a second Green Bond Framework, including eligible green projects extended to the cargo sector in 2018. There were new ESG transactions in 2020, a Sustainable-Linked Loan (RCF) and a corporate Green Bond subscribed by EIB in 2021, and finally, a Green Bond Framework including eligible green projects extended to the infrastructure manager RFI in 2022 (Ferrovie dello Stato Italiane 2024).

4. The Strategic Operating Model of High-Speed Rail in Italy

The Italian system operates within a liberalized market model characterized by high competition and extensive network coverage. Unlike more closed systems seen in many European countries, Italy's HSR model is open and interconnected, allowing for frequent interchange with conventional lines. This open model enables HSR to operate alongside regional and intercity trains, enhancing connectivity and accessibility across the country. For instance, on the "Direttissima" route between Firenze and Roma, the system manages up to 12 trains per hour in each direction during peak times, with a mix of high-speed, regional, and intercity services. This results in a high density of traffic compared to other European long-distance systems, which often have specialized lines and facilities, as seen in Spain and France.

The open and mixed-traffic nature of the Italian HSR network has transformed the lifestyles of millions of Italians by reducing travel times and providing more flexible travel options. However, this model also presents challenges, particularly regarding managing infrastructure capacity and minimizing delays. High train frequency increases the likelihood of delays due to disruptions, such as train or infrastructure breakdowns. These delays can easily cascade, affecting multiple trains and causing significant service interruptions.

To address these challenges and enhance service quality, a reevaluation of the existing "door-to-door" model is necessary. To improve punctuality indexes, it is not only necessary to reduce the risks associated with anomalous events but also to evaluate a new and different "door-to-door" operating model, with trains no longer arriving in the heart of cities. The volumes achieved in recent years warrant thinking about a turning point and a change whereby it is no longer feasible to route all trains to "Roma Termini" or "Milano Centrale" stations due to the limits of the systems themselves. Specialization of lines and stations should therefore be considered. For example, it is possible to increase transport capacity through the use of double-composition trains, also freeing up hourly slots. It would also be useful to seize new market opportunities, better serve other parts of the cities, improve social benefits, and differentiate the urban

routes of north–south trains. In the meantime, work is already underway on the possibility of differentiating routes in urban railway nodes, which could also benefit travelers. Punctuality is significantly impacted by traffic density on the network. Train timetables are designed to ensure trains encounter green signals and include safety margins for travel times, allowing for minor delays to be absorbed and providing a buffer between trains. However, if delays exceed these buffers, trains encounter red signals, leading to stoppages and potentially cascading delays. Larger delays and closely spaced trains exacerbate this effect. To reduce this, trains should be more spaced out (i.e., fewer trains) and have longer travel time margins. However, this would mean reducing service frequency and speed. Speed differences between trains are also due to product differentiation: fast trains to travel quickly between Milano and Roma or between Bologna and Roma/Milano; standard trains to serve more capillary routes (e.g., Firenze–Roma, Torino–Reggio Emilia). If there were fewer trains, all with the same stops, either all fast or all standard, punctuality would likely improve.

5. Lessons Learned from High-Speed Rail Development in Italy

Italy's High-Speed Rail experiences offer key insights for developing Asian countries undertaking HSR projects. Its journey provides valuable lessons regarding design, financing, and operation and management, serving as a reference. These experiences demonstrate how a combination of holistic planning, innovative financing, strategic operational adjustments, and a commitment to sustainability can drive successful HSR initiatives. Following are some key lessons:

(i) Holistic Transport Planning

Italy's HSR system exemplifies holistic planning through its well-integrated intermodal transportation network. The excellent first- and last-mile services, such as regional and urban rail services, local transit options, car rentals, and bike-sharing systems such as FrecciaLink and ItaloBus, help link HSR stations with other parts of the country. This comprehensive approach addresses geographic and regional disparities by ensuring smooth travel between HSR and rural (or less accessible) areas. Developing Asian countries undertaking HSR projects can benefit from adopting similar strategies to bridge interregional gaps and improve overall connectivity.

(ii) Strategic Financing Evolution

Italy's HSR financing tools illustrate a strategic evolution from traditional secured bank loans to innovative financing solutions. Initially, funds were secured through bank loans and bonds, with collateral provided by rolling stock and government guarantees. By 2011, FS began transitioning to unsecured financing and capital markets, reflecting improved financial stability. Depending on improvements in financial stability, countries can learn from Italian experiences by diversifying their funding sources and gradually reducing dependence on government guarantees.

(iii) Innovative Green Finance

The significant shift to green finance highlights FS's commitment to sustainability, with the company issuing Green Bonds and establishing robust frameworks for ESG-compliant projects since 2013. With many developing Asian countries also committed to decarbonization, they can learn from Italy's transition, exploring the potential of green finance. This helps explore new financing sources for capital-intensive HSR projects, aligning investments with ESG principles while supporting financial stability.

(iv) Rail Network Capacity Optimization

To enhance punctuality and service quality, FS's reevaluation of the "door-to-door" model offers critical insights. By considering new operational strategies, such as operating specialized lines and stations, managing train density and timetable design, and offering differentiated services (e.g., fast trains vs. standard trains), FS addresses capacity constraints and improves efficiency. Developing countries constructing HSR can learn from this approach, improving their rail networks' reliability, capacity, and overall performance while meeting diverse passenger needs, optimizing network use, and adapting to growing urban demands.

(v) Customer-Centric Operations

Italy's High-Speed Rail operates in a competitive market driven by open access principles, where operators share the market in proportion to their production rates. FS has integrated operation

and management, fostering innovation in management strategies to enhance customer satisfaction. For example, FS has implemented flexible fare systems with various price points and discounts to cater to varying customer needs. The design of trains, including seating arrangements and vehicle aesthetics, is carefully tailored for comfort. Onboard services, such as snacks, beverages, quiet zones, and entertainment options, further enhance the travel experience. In addition, strong support for visitors and tourists includes discounts and partnerships with hotels, museums, and events. While open access is rare outside Europe, developing Asian countries constructing HSR can adopt similar customer-centric strategies to elevate service quality and customer engagement.

6. Final Remarks

Despite some challenges, the Italian HSR system is widely regarded as one of the best in Europe, or even in the world, and serves as a useful reference for other countries. Its ability to provide frequent, efficient, and reliable services while facilitating regional connectivity and capitalizing on innovative investment is a significant achievement, particularly given Italy's complex geography. Italy has the largest number of railway tunnels in Europe—more than twice as many as France, despite the latter having a larger territory. The system's success in managing a high volume of trains despite numerous tunnels and challenging terrain demonstrates its effectiveness and resilience. Ultimately, the goal remains to maximize the benefits for passengers and leverage infrastructure investments to meet evolving travel needs. The country's experiences serve as a valuable case study for other countries looking to develop their HSR systems.

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Asian Development Bank Institute
Kasumigaseki Building 8F
3-2-5 Kasumigaseki, Chiyoda-ku
Tokyo 100-6008
Japan
Tel: +813 3593 5500
www.adbi.org