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World experience in construction, technology transfer and operation of high-speed railway systems, lessons for Vietnam

Kinh nghiệm thế giới trong xây dựng, chuyển giao công nghệ và vận hành hệ thống đường sắt tốc độ cao, bài học cho Việt Nam

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ABSTRACT

Railway is a field with many advantages, playing an important role in socio-economic development, but is currently a bottleneck in Vietnam's transportation industry, its market share is only around 1%. In the Railway Network Planning 2021 - 2030, vision to 2050, the government aims to complete the approval of investment policy by 2025 and start the construction of North-South high-speed rail (HSR) by 2030. Building a strategy to develop the HSR system in a methodical and consistent manner is very important, with specific targets and measures to match the country's economic development goals to 2030, with a vision to 2050. Regarding international experiences, in which HSR has been developed for nearly six decades, the construction and operation requires huge funds, causing negative impacts on transport policy of a whole country as well as its transport industry development in the long term. Therefore, it is necessary to have a thorough assessment about this topic for Vietnam. The main content of the article is to introduce the development process of HSR from case studies for policy-makers, planners, and managers, then to draw lessons in *construction, technology transfer and operation.*

Key words: Construction management; high-speed rail; policymaking; technology.

TÓM TẮT

Đường sắt là lĩnh vực nhiều ưu thế, có vai trò quan trọng với sự phát triển kinh tế - xã hội, nhưng hiện nay là điểm nghẽn của ngành Giao thông vận tải Việt Nam, thị phần chỉ còn trên dưới 1%. Trong quy hoạch mạng lưới đường sắt 2021 - 2030, tầm nhìn đến 2050, Chính phủ đặt mục tiêu đến 2025 hoàn thành phê duyệt chủ trương đầu tư, trước 2030 khởi công đường sắt tốc độ cao Bắc - Nam (HSR). Việc xây dựng chiến lược phát triển hệ thống HSR một cách bài bản, nhất quán rất quan trọng, với những chỉ tiêu và biện pháp cụ thể để phù hợp với mục tiêu phát triển kinh tế đất nước đến năm 2030, tầm nhìn 2050. Trên thế giới, đường sắt tốc độ cao đã phát triển gần 6 thập kỷ. Việc xây dựng, vận hành đòi hỏi kinh phí khổng lồ, có nguy cơ tác động tiêu cực tới chính sách vận tải của một nước lẫn sự phát triển của ngành trong dài hạn. Vì vậy, cần có những đánh giá thấu đáo cho đầu tư xây dựng lĩnh vực này tại Việt Nam. Nội dung bài báo nhằm giới thiệu quá trình phát triển đường sắt tốc độ cao của một số nước tiêu biểu cho các nhà hoạch định chính sách, lập quy hoạch, kế hoạch và những nhà quản lý, từ đó rút ra bài học trong xây dựng, chuyển giao công nghệ và vận hành.

Từ khóa: Quản lí xây dựng; đường sắt tốc độ cao; hoạch định chính sách; công nghệ.

1. INEVITABILITY IN INVESTING IN HIGH-SPEED RAILWAY SYSTEM IN VIETNAM

Rapid socio-economic development on the North - South corridor leads to an increase in transport demand in the immediate period to 2030 and continues to increase rapidly in the following years, requiring the capacity of the transport sector to respond must always be strengthened. The expensive road industry still plays a key role, the proportion of passenger transport accounting for 94.39% of the total passenger transport volume and freight transport accounting for 77.47% of the total freight transport volume. Railways used to be the mainstream transportation industry, but now the infrastructure has become outdated, lacking investment, and the market share is only approximately 1%. The capacity of the current railway lines is

close to the saturation point and needs to be renovated and upgraded. However, notwithstanding the renovation and upgrading, it will not meet the transportation needs after 2030. In terms of exoenditure, road transport is much higher than other types such as waterway, railway, and maritime. In road transport costs, gasoline takes up roughly 30-35% on average, and road tolls take up practically 10%. In addition, there are also unofficial costs (also known as negative transportation fees), constituting 5% and above. Therefore, Vietnam's logistics costs takes up 20.9% of GDP, double the world and regional average, pushing up commodity prices, affecting macroeconomic stability and competitiveness of the economy. [1]

In Vietnam, the railway industry is currently lagging behind. The total length of the railway network is 3,163km, with more than 84% being 1,000mm gauge, a type that most countries no longer use. The average speed of 50-60km/h for freight trains and 80-90km/h for passenger trains is also a lagging point. For advanced countries, the average speed for passenger transport is about 150-200km/h, high-speed rail is over 300km/h and the super high-speed can be up to more than 500km/h. Additionally, Vietnam's railway system is on the second technology platform, the diesel technology (the first technology is steam locomotives). Developed countries are using the third technology - electrification technology and the fourth technology - electromagnetism. Being a dominant transport force in the past, now the railway's passenger and freight transport is continuously below the average level of the transport industry, even experiencing negative growth (the total industry averagely increased by 7.3-11. 7%, while railways in the period 2001-2010 only increased by 1.3% and in the period 2011-2020 decreased by up to 3.6%) [2]. It can be said that current rail transport does not really contribute much to the country's economic development.

The high-speed rail on the North-South axis has many features superior to other transport industries such as large transport capacity, high travel speed, safety and dependability, convenient, and environmentally friendly. Should it is built, it will sustainably meet the increasing demand for transportation. Specifically:

- Enhancing the competitiveness of the economy: The HSR system helps bring the two ends of the country be closer together in economic development thinking, contributing to saving passengers' travel time with an estimated value being about 2 billion USD and the society's travel costs are about 6.5 billion USD in the year 2050. [3]

- Establishing harmony and sustainability between modes of transport on the North-South corridor: With the country's morphology stretching from North to South, all material flows tend to confluence and operate along the vertical axis. HSR will serve as a backbone to help re-establish harmony and sustainable development of the North-South transportation system. Investing in HSR combined with upgrading the existing railway is an underlying solution to save, revive and modernize the railway transport industry once considered a symbol of the national industrialization.

- Restructuring urban and distributing population, labor along the North-South corridor: The formed HSR system will eliminate limitations in geographical conditions, shortening time and change the conception of space between localities and regions; accelerating tourism development as well as the urbanization process in cities on the North-South axis; helping commercial advantages and development resources be shared between regions.

- Improving environmental conditions: HSR generates very little harmful emissions of CO and CO2 compared to other modes of transport such as cars and airplanes. With modern infrastructure conditions, travelling mainly on viaducts, HSR also contributes to the reduction of dust pollution, which is currently extremely high in urban areas, supporting the implementation of the commitment that net greenhouse gas emissions equal to 0 in Vietnam by 2050.

- Appropriate with relevant strategies and planning: The investing in HSR construction is completely consistent with the strategic planning for transportation development in general and railways in particular, simultaneously consistent with the development planning of other relevant sectors and localities. Furthermore, due to the geographical conditions of our country having a narrow width and stretching with two major economic centers, Hanoi and Ho Chi Minh City located at the two ends of the country, developing traffic connecting these two areas and connecting cities, industrial parks, export processing zones, and tourist areas along the route is of critical importance. Thus, investing in high-speed railways is a long-term investment for the future, in order to meet the country's development demand and in line with the world's prevalence.

2. VIETNAM'S POLICY ON HIGH-SPEED RAILWAY DEVELOPMENT

Since the early 2000s, Decision No. 06/2002/QD-TTg dated January 6, 2002 of the Prime Minister on the Master Plan for Vietnam's Railway Transport Development to 2020 has oriented the construction of the high-speed railways on the North - South axis [5]. Implementing the plan, constantly from 2005 up to now, the Ministry of Transport and domestic and foreign organizations have conducted many studies, specifically as indicated below:

+ In the period of 2005 - 2008: The Government received support from the Korean Government through the Korea International Cooperation Agency (KOICA) to conduct feasibility studies for two sections of Hanoi - Vinh and Nha Trang – Saigon.

+ In the period of 2008 - 2010: The Government assigned the Ministry of Transport to research and make an investment report and submit it to the National Assembly. Vietnam - Japan consulting joint venture (referred to as VJC) implements the project. The project was presented to the National Assembly in 2010 and has not been approved because some issues about the feasibility and investment efficiency of the project must be clarified.

+ In the period of 2010 - 2013: The Government received technical support from the Japanese Government through the Japan International Cooperation Agency (JICA) to carry out "Research on project planning for HSR projects in the Ha Noi - Vinh and Ho Chi Minh City - Nha Trang sections". The consulting consortium selected by JICA conducted a comprehensive study of the entire project and in-depth research for the two sections Hanoi - Vinh and Ho Chi Minh City - Nha Trang.

However, there are many concerns about the feasibility, huge amount of capital (the total estimated investment in this stage is 50 billion USD) and project effectiveness. It was not until 2017 that the concept of "high-speed railway" officially appeared in the Railway Law No. 06/2017/QH14. In February 2019, the Ministry of Transport submitted to the Government a pre-feasibility study report for the North-South high-speed railway project passing through 20 provinces, 1,435 mm gauge, using electrification, with the designing speed of 350 km/h and operating speed of 320 km/h. The starting point is Ngoc Hoi station (Hanoi) and the

ending point isThu Thiem station (Ho Chi Minh City), with the length of 1,545km.

Currently, according to Decision 1769/QD-TTg dated October 19, 2021 on approving the Railway Network Planning in the period between 2021 and 2030, with a vision to 2050, railways have been identified as one of three strategic breakthroughs need prioritizing to be invested. This includes the North-South high-speed railway, which is the most important route, considered the "backbone", linking trade activities of urban chains and economic zones throughout the whole territory. Specifically, by 2030: Completing the investment preparations and arrange resources to start construction of a number of new railway lines, with priority given to the North-South high-speed railway line. [6]

In November 2021, the Ministry of Planning and Investment and the Ministry of Transport agreed on a plan to research the North-South high-speed passenger railway, with a design speed being 250 km/h and an operating speed being 180-225 km/h, submitted to the Politburo, being the basis for reporting to the National Assembly for approval of investment policies.

In February 2023, the Politburo issued Conclusion 49-KL/TW with the orientation to strive to complete the approval of the Project's investment policy by 2050; commencing the construction of priority sections in the period 2026-2030 (including Hanoi - Vinh and Ho Chi Minh City - Nha Trang); completing the entire route before 2045. Most recently, in May 2023, based on the proposed investment scenarios, the Ministry of Transport researched and supplemented the passenger-cargo combination plan, as well as continued to review and refer to international experiences, updating and completing the Pre-Feasibility Report. At the same time, technical and economic experts are mobilized and symposiums to contribute commentations to complete the Report are organized.

It can be said that HSR development has been posing many challenges to the Vietnamese government, of which the most prominent are: the need for investment, development scenarios, transport objects, selection and technology transfer, investment resources, specific policies, environment, human resource training, project efficiency. Thus, promoting research on other countries' experiences and drawing lessons for Vietnam is crucial and useful in today's circumstances.

Within the scale of the article, the author introduces the high-speed railway development process in some typical countries, focusing on the fields of *construction, technology transfer and operation, drawing profound lessons.*

3. EXPERIENCE OF SOME COUNTRIES IN DEVELOPING HIGH-SPEED RAILWAYS (REGARDING CONSTRUCTION, TECHNOLOGY TRANSFER AND OPERATION)

High-speed railways in the world have come a long way with nearly 6 decades of development. Slowing down during the Covid-19 pandemic, many countries are currently on a roadmap to resume investment and development of new high-speed railway lines.

As of September 1, 2022, according to the data reported by the International Union of Railways (UIC), the total high-speed railway routes around the world currently being exploited and operating are 58,839 km. At the same time, 19,710 km are under construction.

Table 1.1: Length of high-speed railway lines in operation in 20 countries around the world as of September 1, 2022 [7]

No.	Country	Starting year	Length of high-speed railway in operation by 2020
1	Japan	1964	3.081 km
2	Italy	1977	921 km
3	France	1981	2.734 km
4	Sweden	1990	860 km
5	Germany	1991	1.571 km
6	Spain	1992	3.661 km
7	Finland	1995	1.120 km
8	Belgium	1997	209 km
9	USA	2000	735 km
10	United Kingdom	2003	113 km
11	China	2003	40.474 km
12	Switzerland	2004	176 km
13	South Korea	2004	873 km
14	The Netherlands	2006	90 km
15	Turkey	2009	1.052 km
16	Austria	2012	254 km
17	Poland	2015	224 km
18	Saudi Arabia	2018	449 km
19	Moroco	2018	186 km
20	Denmark	2019	56 km
	Totsal		**58.839 km**

Some typical cases in the development of HSR networks in the world will be introduced below. The content is mainly cater to providing information to policy makers, planners, and managers in the areas of construction, technology transfer and operation of HS, therefore lessons in practice can be drawn for the HSR development in Vietnam.

3.1. Japan's experience

Japan was the first country to develop HSR system, namely Shinkansen, connecting Tokyo with Osaka (560km long) and having put into use since 1964. The goal of the planners was initially to reduce time travelling between the two cities, boosting travel demand as the economy had grown rapidly after World War II. By 2022, Japan had had a network of 09 high-speed railway lines (with a total length of 3,081 km) serving 22 major cities in the country and stretching across 3 main islands and 3 more lines are under construction..

Japan's large cities are far apart (several hundred miles), consequently high travel demand is a favorable factor for the investment in developing the HSR system. The system is designed to carry both passengers and freight, independent of the conventional rail system. Maintenance and repairs are carried out at night.

In construction investment expenses, the cost of infrastructure (cuts, embankments, viaducts, bridges, tunnels) accounts for a major proportion since 30% of the total length of the train line runs through tunnels. With the Sanyo line, this cost takes up 58% of the total investment. Land prices are the second largest, making up about a quarter. The construction of roads connecting to city centers increases both construction complexity and the overall expenditure [8]. In addition, transporting both passengers and freight also elevates construction costs.

Japan has complex terrain conditions, with many hills and mountains. The volume of construction is large, therefore the development of train technology prioritizes the design of long noses and a high level of tightness to be able to operate when cross-section in the tunnel is narrowed. Distributed train dynamics allowing for the reduction of axle loads will save money for bridge construction. Owing to the large transport demand, the train is designed to have a large carrying capacity and is operated exclusively for passenger trains. Curve radius is limited so independent bogies should be used. [3]

3.2. China's experience

China's current high-speed rail network as of September 2022 is 40,474km, being forecast to be over 45,000 km in the long-term strategy and longer than the remaining countries in the world in total [7]. In the first phase, China had a policy of self-research and development of new railway technology and carried out the implementation from 1992 - 2003 but failed because China did not grasp the core technology know-how of HSR. The first high-speed rail line was in 2003, modeled on Japan's Shinkansen system. Subsequently, China imported most of the high-speed rail technology through joint venture contracts with HSR technology manufacturers in the world including Bombardier - Canada, Kawasaki - Japan, Siemens - Germany and Alstom - France to build the corresponding generations of trains CRH-1, CRH-2, CRH-3 and CRH-5.

With great capacity, China has mastered the core technology of HSR and since 2008, China has developed its own technology with the first generation of train being CRH308A. It is noticeable that China imports all types of HSR technology in the world, but interestingly they have been able to unify the same type of ship using EMU distributing dynamics and information transmission system using GMS-R waves. Such a major country as China, with all the characteristics of natural and social conditions, it is reasonable to research and apply a variety of trains with different technological origins.

From developing internal production capacity, in recent years China has won investment contracts and built high-speed rail networks in other countries around the world such as Laos and Indonesia. These achievements are attained first of all because China has strategically planned to develop the railway system in a methodical, consistent and fundamental way. Moreover, focusing on investment in technology development is also an important reason helping this country quickly achieve a modern high-speed railway system. [3], [9]

3.3. Korea's experience

Korea's transportation development strategy clearly states: Roads are the lifeblood of economic development in the 20th century, railways are the main lifeblood of socio-economic development in the 21st century. By 2025, South Korea is expected to invest more than 70 trillion won to build a high-speed rail network with the target of connecting major cities nationwide in 2 hours and reducing travel time in the capital area to 30 minutes. Presently, Korea is concentrating on developing an environmentally friendly KTX-Eum train system, replacing diesel trains, helping reduce greenhouse gas emissions from 235 thousand tons in 2019 to 165 thousand tons in 2029. [10]

Korea's terrain is 70% mountains with many valleys, therefore roughly half of the high-speed rail system's infrastructure is in tunnels or on bridges, and the construction cost is 3 times higher than that of France as a result. To ensure that high-speed trains run at the fastest speed, Korea has maximized straight distances, refraining the train from having to go up and down excessive times.

The Seoul - Busan economic corridor is a crucial and strategic route for Korea: 70% of the Korean population lives along this corridor; 75% of Korea's gross national product (GNP) is supplied there. The high-speed railway connects the ports and airports of the two major cities Incheon and Busan, with 65% of passenger transport volume and 70% of freight transport. Keeping the route run constantly is the government's top priority. Therefore, developing a high-speed rail system is an optimal solution. The railway has a length of 412 km, mostly running through hills and mountains, including 190 km running through tunnels and 120 km running on viaducts. It is estimated that 120 million passengers use it each year, making it the "busiest" route in the world. Travel time between Busan and Seoul is shortened from 4 hours 10 minutes to 1 hour 56 minutes. [11]

During the construction investment process, the Korean High Speed Rail Construction Agency (KHRC) has selected French technology and signed a contract with Alstom and Eukorail (Alstom's subsidiary) to establish a joint venture providing a network of 46 Korea Train eXpress (KTX) trains, traffic control systems, line services and maintenance. Immediately upon project implementation, a specialized team for technical systems and test operations was established with the task of monitoring the entire project progress until test operation. ALSTOM and Eukorail have coordinated strategic planning to come up with an effective team organization capable of working smoothly in a complex and multi-ethnic environment. Synchronous coordination between the design and investment parties is the key to the project's success.

Technology transfer, operating knowledge, locomotives, carriages, and on-board control systems have been carefully exercised. Management and exploitation are carried out based on electronic information technology, which has gradually been localized due to the persistence and perseverance of Korean engineers. Korea's railway lines were initially assigned to the National Railway Administration for management. The Department manages all work from ticket sales to train operations and railway construction. However, the Government believes that if it continues to entrust the operation of a new system such as high-speed rail to the Department, it will be difficult to manage, deploy and upgrade technology. Therefore, the Government decided to establish the Korea High-Speed Railway Construction Agency, operating independently, in charge of all projects related to high-speed railways, including technology reception. Currently, Korea is

one of the countries possessing the leading modern railway network in Asia.[12]

Not only successes, Korea also has lessons of failure because of inadequate calculation of demands and costs. The high-speed rail line linking Seoul to Incheon International Airport, the main gateway to Korea, had to close after 4 years of operation in September 2018. The operating unit cannot bear large losses due to competition from bus routes running on the highway. The Korean government spent more than 300 billion won (270 million USD) to build this route despite many warnings about the travel demand. On average, the route carries just over 3,400 passengers per day, reaching 33% of capacity. On weekdays, the carriages are almost empty. [13]

3.4. France's experience

France is the country that researches and develops HSR technology after Japan. The policy for developing the HSR system is oriented by the state based on the correlation between costs and commercial exploitation ability, focusing on the volume of transport between large cities. Due to the government's hierarchical and centralized policy-making mechanism, the French National Railway Company (SNCF) focused on commercial purposes to demonstrate that state-owned enterprises could gain profits from exploiting this system. The average financial return is 15% and the social return is 30%. Therefore, the distribution of the HSR network is not widely debated or subject to much pressure from society and localities. The first high-speed railway line Paris - Lyon (also known as TGV Sud Est) was built from 1975 - 1983, funded entirely by debt from SNCF, with revenue mainly from the operation and implementing passenger and cargo transportation services. The total number of passengers increased from 12.5 million in 1980 to 22.9 million in 1992, with an amortization period of 12 years. [14], [15]

Different from Japan, France has a mixed HSR infrastructure system. Since 1990, new HSR routes have been planned as separate networks, along overloaded routes, utilized together with traditional railway services on less crowded routes and connected to big cities when construction and site clearance costs are at risk of being overwhelmingly high.

France has quite flat terrain, therefore trains mainly run on embankments. French trains tend to increase comfort and improve train speed. The volume of the project is small, thus not much attention is paid to reducing axle loads, leading to the use of concentrated power allowing to reduce maintenance costs and noise levels for passengers. Advantageous terrain conditions allow for the use of large radius curves, so shared bogies can be used to intensify stiffness and increase train speed. French technology can be used for passenger and cargo sharing and between high-speed trains and regular trains. Nevertheless, France is now gradually shifting to exclusively exploiting high-speed passenger trains. [9]

The investment rate for high-speed railway construction in France and Spain is lower than that of Japan and Germany because the design of high-speed railways in these countries is only for passenger trains [Preston, 2013]. Also, in France, the investment capacity of railway construction is minimized by allowing design standards to be applied larger longitudinal slopes, that is to say, using a longitudinal slope of 35‰ (instead of the previous 15‰) to refrain from the construction of viaducts and tunnels with large investment costs. [16]

3.5. Spain's experience

Spain is the 4th country in the world to build high-speed railways, with the current total length being 3,661km, just behind China. The first high-speed railway was built in the mid-80s of the 20th century to solve the problem of making a route to avoid the Despeñaperros pass - a traffic bottleneck from the capital Madrid to the south of the Iberia, where the terrain is complex and uneven. The implementation process is in the form of PPP, the state-owned company Renfe under the Spanish Ministry of Urban Programs and Transport and Ineco Company is in charge of infrastructure and rail projects, while Alstom Company from France creates locomotives and the German's company AEG Siemens is responsible for electrical lines for the entire project. Within just 6 years since finalizing the plan, Spain has built the first 471-km high-speed railway. It is worth mentioning that Spain has solved the difficult problem of terrain during the construction process. The Iberian Peninsula has extremely complex terrain, so that to be able to build infrastructure for high-speed trains moving at speeds of 250 - 300km/h, the tracks are required to have an inclination of no more than 3% and separate constructions of tunnels and viaducts are also needed. Track foundations require rigorous and stern specifications. [17]

The Spanish government regards the high-speed rail system as a priority area in transport policy. One-third of the total investment (making up 82.96 billion euros) in the national strategic plan is dedicated to develop this system until 2020. Spain has already owned one of the most advanced railway systems in the world in terms of length, modernity, commercial speed, and punctuality index. With an average commercial operating speed of 222km/h, the system has served more than 400 million people, about 100,000 people/day, connecting 47 cities. The number of users always increases steadily annually, standing at up to 22.4 million customers in 2019, increasing 5% over the same period last year. [8]

High-speed rail investment has turned this industry into one of the main driving-forces to the economic and social development, generating more jobs both directly and indirectly, bolstering regional connectivity, and opening doors for new markets. The outstanding factors in the competition between high-speed railways and other means in Spain are the speeds of up to 350 km/h, high quality and stable investment in infrastructure and equipment, modern signal information, ensuring safety and punctuality. [18]

4. LESSONS DRAWN FOR VIETNAM

From the analysis of the experiences in developing HSR systems of the above countries, a number of useful lessons can be drawn in construction, technology transfer and operation. This increases feasibility as well as the ability to avoid the most common project obstacles. Particularly:

- The aspects of construction preparedness:

+ The first critical issue that needs to be discussed when it comes to building HSR is whether to build and operate an HSR network that carries both passengers and goods. Some countries choose to build expressways exclusively cater for passenger services; others choose to share upgraded rail lines with freight transport to foster industrial linkages even if this means they cannot achieve high speeds and have to undergo higher expenditures.

+ Some projects that integrate conventional rails with dedicated HSR lines to match traffic levels in a corridor or to provide access to central business areas demonstrate lower construction costs. The root causes of this strategy is to avoid high costs during site clearance and connection system construction - a

factor that multiplies costs. Using traditional railways for this purpose can significantly reduce the cost burden.

+ Many different costs need to be taken into account in the investment preparation process. Site clearance costs will greatly push up initial investment costs, which is a key factor when there are too many HSR lines going into densely populated areas and districts in the city center. For this reason, France opts to use traditional routes to enter major metropolitans in lieu of paying exorbitant costs for construction and site clearance. Similarly, building more bridges and tunnels also tremendously raises construction costs. Finally, arising costs are likely to be very high in most projects, and managers should anticipate that the final total construction cost will be much higher than the initial estimate.

+ The public-private partnership (PPP) method needs to be studied to take pressure off the use of state budget capital, sharing risks, and enhancing construction and exploitation quality. France is the country that applies many different financial patterns, developing in accordance with the external elements and project effectiveness. In the first phase, the investment capital was completely borrowed from the government, then France applied the PPP form, with the government investing in infrastructure section (including: construction; mechanical and electrical equipment; site clearance; maintenance). This is operated in two ways: Franchise exploitation and operation to private investors or the government to operate and exploit.

- *Technology transfer aspect:* Technology selection and exploitation speed range need to be analyzed and compared right from the anticipation stage. China and Korea are telling examples in the field of HSR technology transfer and localization. At first, China invited companies from Japan, Canada, Germany, and France to establish joint ventures and asked the parties to share technology. With the determination to focus on investing and developing the technology, China now possesses cutting-edge technology, with the construction costs far cheaper than many other countries and has exported railway technology and equipment to more than 100 countries and territories. In Korea, the Korea High-Speed Railway Construction Agency was established, based on a modern technology platform to specifically manage high-speed railways. It is thanks to a specialized agency that has the capacity to make strategic decisions that the HSR system goes up rapidly.

- *Operation aspects:*

+ Mobility impacts: HSR's competitive advantage over aviation and road is clearly evident on routes from 150 to 800 km long. In addition, this type of transport has a high reputation of comfort levels (passengers can use their electronic devices during train travel), with the average train delay of only 2 minutes and being subject to less stringent security regulations.

+ Impacts on the economy and region: Cities with a high proportion of service industries in their economic structure (tourism, trade) will benefit more from the HSR system.

+ In order for the high-speed railway project to be invested and exploited effectively, the State and the Government needs to have a high political determination, in which the prerequisite is a capital allocation plan, capital structure building and mobilization of different resources to deploy investment phasing for each section of the railway in accordance to the planned roadmap.

5. CONCLUSION

Developing transport infrastructure in general and the high-speed railway system (HSR) in particular is essential to engender motivation for socio-economic development, but must not cause risks or costs, especially for a developing country like Vietnam. Furthermore, it is necessary to ensure the economy's resilience against possible risks and challenges. The North-South HSR project is a large-scale project with complex technology and techniques, so the investment needs to be strategic and synchronous, accompanied by high requirements for safety and technical capacity. Techniques and management must be consistent with the natural and socio-economic conditions of the country. The article summarizes the process of investment in construction, operation, and technology transfer in several countries with developed HSR systems in Europe and Asia, having geographical and/or economic and social characteristics somewhat similar to Vietnam. These are important suggestions to help the government refer to the investment process of building the North-South expressway system, appropriate with the country's policies and resources.

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