A Current Review of High Speed Railways Experiences in Asia and Europe

Aleksander Purba[1,a], Fumihiko Nakamura[2,b], and Priyo Pratomo[3]

[1,3]Civil Engineering Department, Faculty of Engineering, Lampung University, Jalan Sumantri Brojonegoro No 1 Gedung Meneng, Bandar Lampung 35145, Indonesia
[2]Graduate School of Urban Innovation, Yokohama National University, 79-1 Tokiwadai, Hodogaya-ku,Yokohama 240-8501, Japan
[b)]nakamura-fumihiko-xb@ynu.ac.jp

[a)]Corresponding author: aleksander.purba@eng.unila.ac.id

Abstract. High Speed Railways (HSR) is currently regarded as one of the most significant technological breakthroughs in passenger transportation developed in the second half of the 20th century. At the beginning of 2008, there were about 10,000 kilometres of new high speed lines in operation in Asia and Europe regions to providing high speed services to passengers willing to pay for lower travel time and quality improvement in rail transport. And since 2010, HSR itself has received a great deal of attention in Indonesia. Some transportation analysts contend that Indonesia, particularly Java and Sumatera islands needs a high-speed rail network to be economically competitive with countries in Asia and Europe. On April 2016, Indonesia-China consortium Kereta Cepat Indonesia China (KCIC) signed an engineering, procurement and construction contract to build the HSR with a consortium of seven companies called the High Speed Railway Contractor Consortium. The HSR is expected to debut by May 2019, offering a 45-minute trip covering a roughly 150 km route. However, building, maintaining and operating HSR line is expensive; it involves a significant amount of sunk costs and may substantially compromise both the transport policy of a country and the development of its transport sector for decades. The main objective of this paper is to discuss some characteristics of the HSR services from an economic viewpoint, while simultaneously developing an empirical framework that should help us to understand, in more detail, the factors determining success of the HSR as transport alternative based on current experiences of selected Asian and European countries.

1. INTRODUCTION

China and Indonesian state-owned companies have signed a US$5,585 billion deal to build the first high-speed railways (HSR) line from Jakarta to Bandung. The joint venture tasked to construct the Jakarta-Bandung railway is Kereta Cepat Indonesia China (KCIC), which consists of Pilar Sinergi BUMN Indonesia (owning of 60 percent stake in KCIC) and China Railway International Co Ltd (owning 40 percent). The latter is China's largest rail operator. The Pilar Sinergi BUMN Indonesia consortium consists of four Indonesian state-owned companies: Wijaya Karya, Kereta Api Indonesia, Jasa Marga, and Perkebunan Nusantara VIII. KCIC was granted a 50-year concession period that will commence on 31 May 2019 when the HSR is scheduled to become operational. It is expected to require 40 years to reach the breakeven point. HSR services are expected to be able to carry 29,000 passengers per day, with ticket prices expected at IDR 200,000 (approx. US$15.4) per passenger. Train will be able to reach a maximum speed of 250 kilometers per hour. However, building, maintaining and operating HSR line is expensive and the debate regarding the costs and benefits of this transport alternative in Asia and Europe is a long-running debate since most of the previous empirical assessments were based on individual country case studies. According to de Rus [1], some critics with HSR investment point to the high investment costs associated with the construction of a new high speed line. However, the point is not whether the passenger prefers to travel with this technology instead of the conventional modes, nor the high cost of the HSR, but whether the society is willing to pay its opportunity cost. This is of course an empirical question and the answer is context specific. In the real world, most existing HSR services, particularly in Asia region, are characterized by relatively high load factors, or at least higher than other equivalent rail services. This is explained by the fact that HSR lines are specifically designed for passenger traffic in dense traffic corridors, with minimal intermediate stops, and marketing focus centered on the travel time and price [2].

HSR performs very well in terms of market share in corridors of 400-600 km but not as good with other key parameters that do not reach some minimum thresholds to offset the high investment costs associated to the construction of this rail infrastructure. Many lines are heavily subsidized, so high load factors and market shares are compatible with a poor social return. It is not surprising that HSR investment is more popular among politicians and the general public than among economists [3]; [4]; [5]; [6]. In implementing such a program, it is essential to identify the factors that might influence decision making and the eventual success of the HSR project, as well as foreseeing the obstacles that will have to be overcome. By so doing, authors identify lessons for policy makers and investors working on the implementation of HSR projects, particularly current experiences in Asia and Europe regions.

2. ASIA

In this section authors apply a simple implementation framework to four key cases of HSR- network development in Asia region: Japan, China, South Korea, and Taiwan as shown on Figure 1 below. Authors inquiry is based on a review of the extant literature of these cases, as well as on our own research data.

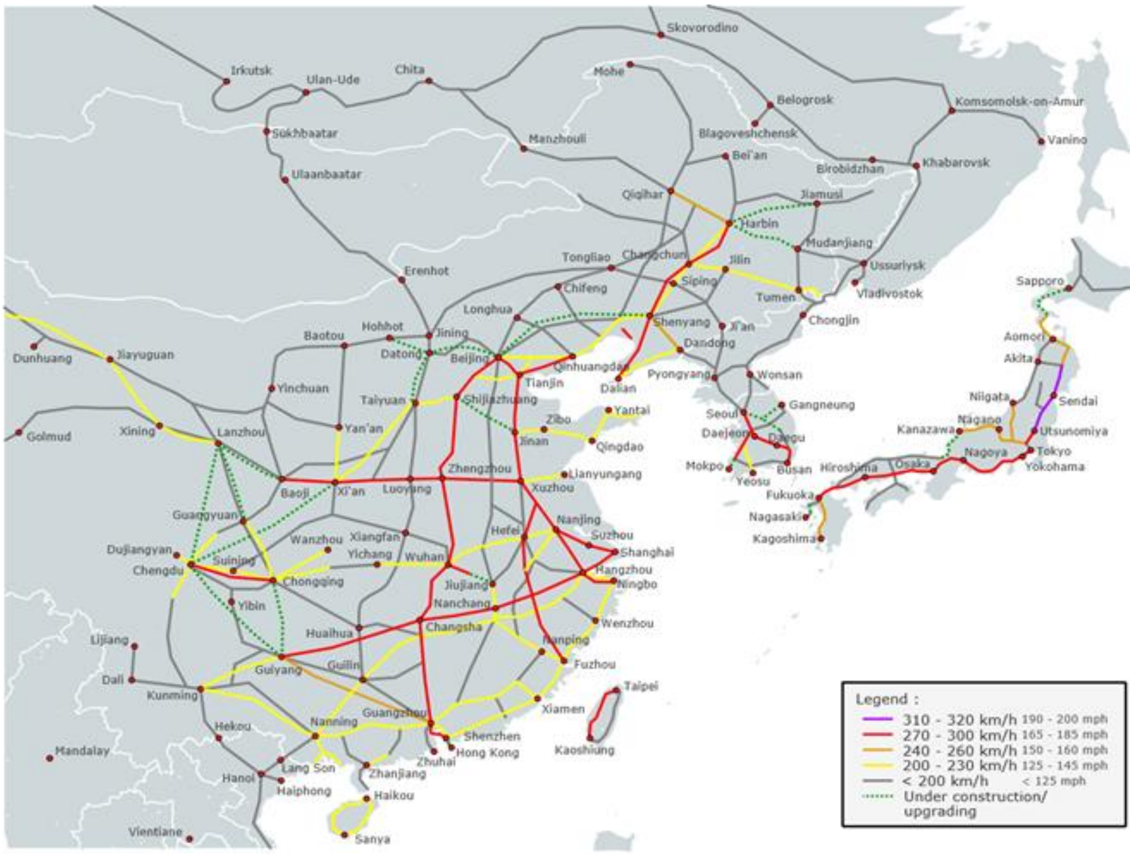

Fig. 1. Network of high-speed rail services in Asia

2.1. Japan

Japan was a pioneer in the building of HSR where the first link in its network, connecting Tokyo to Osaka, came into service in 1964. The world's first HSR line, known as the Shinkansen, was built in a corridor well suited to rail travel, and the train was built to expand capacity on an overcrowded route. Construction was financed with loans from the World Bank and the Japanese government. The railway repaid the loans in seven years. After that, operating profits on the line were used to cross-subsidize local trains. The success of this line encouraged expansion, and the Japanese government continued to build high-speed lines throughout the country. Demand forecasts proved to be underestimated. While the number of passengers-km (million) was 11,000 in 1965, in just ten years it had risen to 35,000. Time savings are estimated at 400 million hours per annum. Population growth offers interesting results. Cities with HSR stations achieved average rates of 1.6%, while those by passed by the service only increased at a 1% rate [7]. It was found that HST stations resulted in marginal population impacts, and that these were more marked in cities with an information exchange industry, access to higher education and expressway access [8]. Employment growth in retail, industrial, construction and wholesaling was 16-34% higher in cities with a HSR station [7] and land value increased by 67%. Studies of the economic impact of HSR show that services were the most favoured economic sector in Japan. Service industries became highly concentrated in the cities of Tokyo and Osaka, resulting in the centralization of this sector in the country's major nodes.

2.2. South Korea

The Seoul-Busan axis is Korea's main traffic corridor. In 1982, it represented 65.8% of South Korea's population, a number that grew to 73.3% by 1995, along with 70% of freight traffic and 66% of passenger traffic. With both the Gyeongbu expressway and Korail's Gyeongbu line congested as of the late 1970s, the government saw the pressing need for another form of transportation [9]. HSR service has not only reduced the travel time to anywhere in South Korea to less than three hours, causing a dramatic change in people's lifestyle, but also had a significant social, economic and cultural impact. Rail passengers have increased, and passengers of private cars, express buses, and aircraft have decreased. There was also a notable change in air travel demand. In the case of the Seoul to Daegu corridor, the HSR reduced air travel demand, which led to the closure of such air travel route in 2007. The opening of the high speed railway reduced the transportation time amongst major cities down to two hours (Seoul-Busan: from 4 hours and 30 minutes to 2 hours and 18 minutes). In the future, it is expected that the establishment of a KTX high speed railway network that connects all regions in the country within one hour will remove the gap between Seoul and local regions by integrating the country into one zone [10]. However, Korea's transport landscape is set to change forever in June 2016 with the entry of a new player into the high-speed passenger rail market. Supreme Railway (SR) will begin operating on the new Suseo high-speed line from Seoul Gangnam to Pyeongtaek, ending the incumbent, state-owned Korail's monopoly of passenger rail services outside of metropolitan areas. Work on the new 61.1 km line, which includes three new stations and its line includes a 50.3 km tunnel, the world's third longest, which runs from Suseo to Jije and was completed in June 2015 after 41 months of construction. SR will initially operate services using Korail-owned 300 km/hour eight-car KTX-Honam trains and will go head-to-head with Korail beyond the new infrastructure on the Gyeongbu line from Cheonan to Busan, and the Honam line from Cheonan to Gwangju-Songjeong and Mokpo.

2.3. Taiwan

Plans for Taiwan's first high-speed rail line emerged in 1989 to tackle the continuing growth in traffic along the heavily travelled western corridor between Taipei and Kaohsiung, Taiwan's two largest cities. The first plans were proposed in a Ministry of Transportation study in 1990. They were then approved by the Executive Yuan in 1992 and the Legislative Yuan in 1993. he Taiwan High Speed Rail (THSR) runs approximately 345 km from Taipei in the north to Kaohsiung in the south. The line uses the international standard gauge of 1435 mm with continuously welded 60-kg rails on concrete slab track. A total 30 trainsets have been supplied based on the 700 series Shinkansen, currently operating on Japan's Tokaido and Sanyo Shinkansen, but modified to meet THSR requirements. The THSR is one of the world's largest privately funded railway construction projects. The total project is valued at US$13 billion and is being funded by the THSRC under a concession agreement by which the consortium has a 35-year franchise to design, finance, build, and operate the THSR and will then hand back the entire project to the government or a third party nominated by the government. Under the Station Zone Development Agreement, the government granted the THSRC a 50-year concession to develop land surrounding THSR stations for commercial, residential, and recreational purposes. Based on the initial forecast, THSRC estimated up to 88 daily round-trip operations transporting over 200,000 passengers at the time of the inauguration. However, these numbers dropped due to the 1997 Asian Currency Crisis, which drastically reduced business passenger numbers [11]. A new structure for THSRC came into effect on July 2015, when the Ministry of Transport and Communications signed two agreements with the company to terminate the original build-operate-transfer concession for the Taipei - Kaohsiung high-speed line. Under the new structure, the Taiwanese government will become the majority shareholder in THSRC, but the company will continue to be privately managed. Government-controlled companies will increase their stake from 22.1% to 63.9%, while large private shareholders will cut their holdings from 37.4% to 17.4%. The remaining shares will be held by smaller investors. THSRC expects to carry 50 million passengers in 2015 and so far has achève punctuality of 99.4% with an average 14.4-second delay per train. Ridership is expected to increase with the opening of new stations in Miaoli, Yunlin and Changwa [12].

2.4. China

In terms of HSR length, China now leads the region and even the world. The HSR program started in 2003 with a 404 km line between Qinhuangdao and Shenyang operated at a maximum speed of 250 km/hour. It rapidly gained momentum with the Mid-to-Long Term Railway Network Plan adopted in 2004, and updated in 2008, which laid out the railway development plan through 2020. The Beijing–Tianjin HSR, the first of a new generation of HSR, opened in August 2008 with a maximum speed of 350 km/hour. In addition, China has built a number of new 200 km/hour express passenger railways and 200 km/hour mixed-used railways. In China, HSR lines on high density corridors such as Beijing-Shanghai and Beijing-Guangzhou tend to have a maximum design speed of 350 km/hour. HSR corridors with more modest volumes of passengers have a maximum design speed of 250 km/hour. Generally, both of these types of HSR are passenger-dedicated lines (PDL) and are newly built as green-field projects. At the end of December 2013, most of the metropolitan regions in China are either connected, or in the process of being connected, to lines with a maximum speed of 200 km/hour or above [13]. The China HSR system will span 30,000 kilometers, connect more than 250 cities and regions with a total population of about 700 million, mobilize 4 billion travelers per year, and add 1,600 billion kilometers to China's domestic passenger throughput annually (i.e., four times the total domestic passenger throughput in Japan today) by 2020. Many economically challenged cities in west and central China will be revitalized because of the hub effect created by the HSR system. Some cities will even see passenger flow growing by as much as 10 times in the coming decade, making them strategically important targets for many industries such as hotel, catering, logistics, and properties. Until now, most of China's economy vibrancy has been trapped on the eastern and southern coasts of China, and as one travels across the region, the huge asymmetries in economic development make different cities look more like different countries. Those who visit Shanghai-centered coastal China, for instance, will find this region more like well-developed countries such as the US and Europe and less like central and western China, even though the coastal region and the central/western regions occupy the same continent. While regional economic differences are not rare in a global economy, China's regional differences are by far the most disparate of any in the world [14].

3. EUROPE

Figure 2 presents the HSR services network throughout Europe. UK is now closer to building HSR infrastructure but until now they have been reluctant to give the definitive approval, and the money allocated to HSR has not gone beyond financing the cost of the evaluation of its economic and financial viability. Other countries, like France and Spain, have been keener on HSR than other European countries like Norway or Sweden, for example, whose governments are still studying whether this type of investment is socially worthy. Spain is a unique case because with much less traffic density than other countries (and much less congestion) in the conventional rail network, it is going to very soon be one of the first countries in the world measured in HSR kilometers. HSR has since remained firmly on the European rail agenda and has led to an expansive HSR network, together with plans to grow the network from under 10,000 kilometres in 2008, to 22,000 kilometers by 2020, and in excess of 30,000 kilometers by 2030 [15].

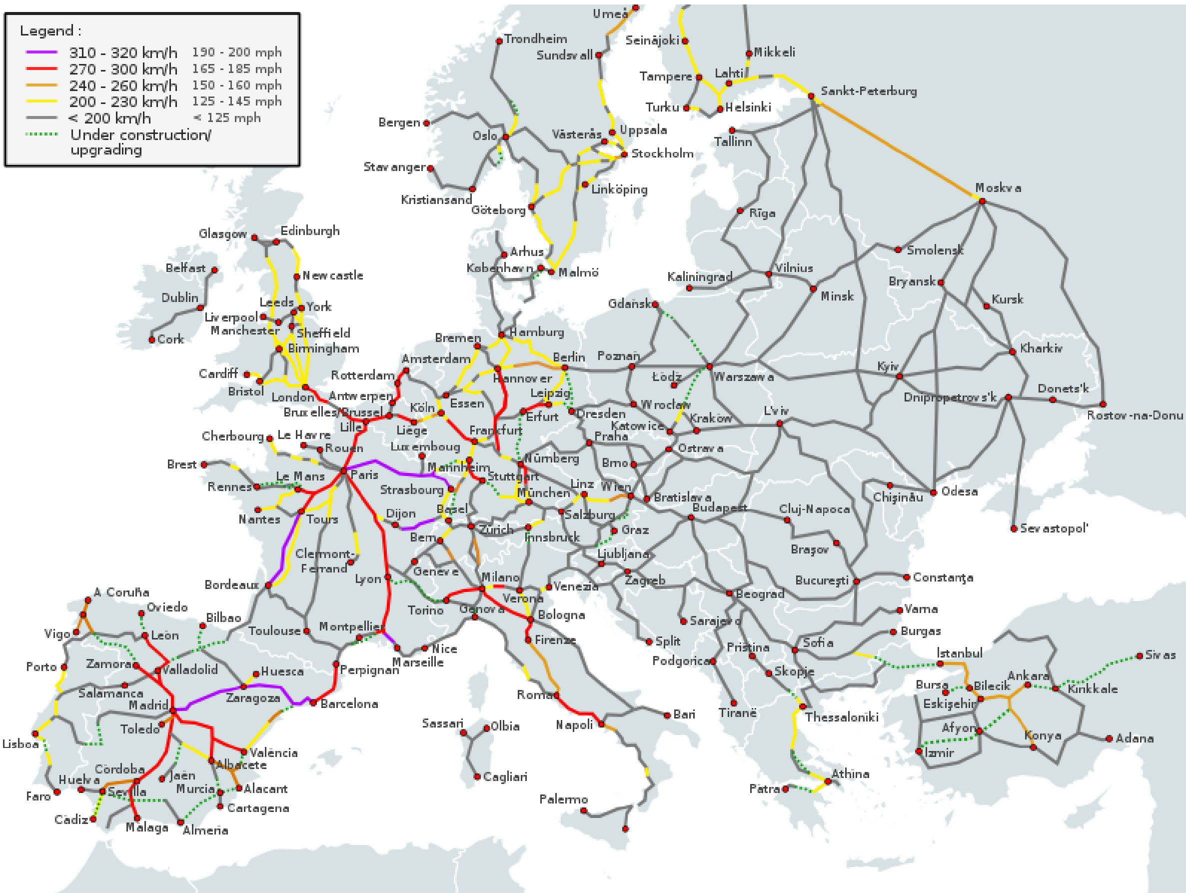

Fig. 2. European network of high-speed rail system

3.1. France

France was the HSR pioneer in Europe; with a Paris to Lyon line being opened in 1981. While other governments across Europe have been cutting back on national spending, France is one of the few countries that has continued the extension of its HSR network. In fact, French authorities have decided to accelerate the expansion of their network, lately relying on public private partnership (PPPs) in order to finance this development. In 2010, the RFF estimated an average basic construction cost for expanding the network by 2020 by another 2000 kilometers at 20 million euros per kilometer, resulting in the requirement for 40 billion euros to finance their ambition plan [16]. These additional finance requirements prompted the move towards PPP financing models. The initial French TGV lines were financed mainly by SNCF debt on the basis of their estimated profitability, with investment proposals being evaluated according to both expected financial and social rates of return [17]. The French strategy was to construct the more profitable lines first. The first line, from Paris-Lyon (on TGV Sud Est) was financed entirely by SNCF debt on the basis of an expected minimum 12 percent financial rate of return. As a result of its spectacular success, in terms of both traffic and revenue generation, this return has been surpassed, and with financial rates of return estimated at between 15 percent and 30 percent per year in socio-economic terms it was fully amortised by the end of 1993 after only 12 years in service. Encouraged by the success of the TGV Sud Est, the French government committed a 30 percent contribution to the construction costs of the TGV-Atlantique. The government cited the regional development potential expected from this development, with a substantial expected social rate of return of 23 percent. By the late 1990’s, TGV Atlantique was reported to be making a net return of 22 percent of the gross revenue after allowing for infrastructure costs, rolling stock and direct costs, and TGV Sud Est 38 percent. Likewise, the TGV Nord proposal was deemed financially viable with estimations of a minimum 12 percent financial rate of return [18].

3.2. Spain

Spain is located in Southwestern Europe on the Iberian Peninsula and is bordered by France to the north and Portugal to the west. Seventy-seven percent of the Spanish people live in areas designated as urban. Madrid, the country’s capital, is the largest city with 5.7 million people, followed by Barcelona with 5.0 million people. Spain maintains a robust high-speed rail network, currently comprising of over 2,000 km with an additional 1,770 km under construction. Furthermore, Spain has plans for future development of 1,700 km of high-speed rail lines, although the recent financial crisis may delay or put some of that development in doubt. The first Spanish high-speed line opened in 1992 between Madrid and Seville, stretching from the center of the country to the southern end of the Iberian Peninsula. Several sources speculate that the motivation to implement high-speed rail between Madrid and Seville, instead of between Madrid and Barcelona, could have been political in nature. The Administrador de Infraestructuras Ferroviarias or Administrator of Railway Infrastructures (Adif) published several narratives on Spanish high-speed network development and adds that the existing conventional rail line between Madrid and Seville was a singletrack line with capacity issues traveling through difficult terrain. Any upgrade to the existing rail infrastructure would have been costly; therefore, the decision was made to implement the new high-speed infrastructure in this corridor. Adif notes that the success of the first French high-speed line was an influence. The high-speed rail service on the corridor reduced travel time from over 7 hours using conventional rail service to less than 3 hours when initially instituted. Journey time is now further reduced to 2 hours 20 minutes, according to Adif. Since the opening of the first line, Spain has rapidly expanded their high-speed service network. The Ministry of Public Works Strategic Infrastructure and Transport Plan 2005-2020 (PEIT) calls for all the provincial capitals to be connected with Madrid via high-speed rail. Madrid is located in the center of the country, while much of the other population centers are located along the coast. Therefore, Spain has developed a radial HSR system connecting through Madrid. The comprehensive high-speed rail network plan in the PEIT would connect 90 percent of the Spanish population with high-speed train service if fully implemented [19].

3.3. Germany

Germany is located in Central Europe bordering nine countries including Belgium, the Czech Republic, France, Poland, Switzerland, and the Netherlands and is largely urbanized with 74 percent of the population residing in urban areas. The capital of Berlin is the most populated city with 3.4 million, followed by Hamburg (1.8 million) and Munich (1.3 million). Almost 1,300 km (800 miles) of high-speed rail lines currently exist in Germany, with an additional 1,500 km (650 miles) either planned or under construction. Beginning in the 1970s, German federal transportation plans called for high-speed rail lines in response to increasing congestion levels on the existing rail network and to make rail competitive with other modes. The first high-speed lines were built to also accommodate conventional passenger and freight train services. This incremental approach raised the conventional passenger train speeds up to 200 km/hour on several segments. Newer lines are exclusively for high-speed train operations, with the fastest speed of 300 km/hour. The high-speed rail system, known as Intercity Express (ICE), stretches a reported 1,285 km, with an additional 1,048 km under construction or planned. The German high-speed network is designed to connect many hubs, including the major cities in the country and markets outside Germany. Passenger and freight rail operations are controlled by Deutsche Bahn (DB) Holdings, which was formed in 1994 following the reunification of West and East Germany. European Union directives to separate rail infrastructure ownership and operations resulted in the creation of separate subsidiaries of DB, including an infrastructure owner, DB Netze, and a train operations unit, DB Bahn, that operates regional and long distance passenger trains. DB Fernverkehr is the long distance business unit of DB Bahn where high-speed train operations are controlled. Financing for line construction comes mostly from the federal government, but also from states and local governments [20]. Thompson [21] also points out that because the DB Holdings conglomerate of companies is profitable, it is able to borrow on commercial markets. The German ICE high-speed rail system has steadily grown since accounting for 5.1 million passengers in 1991. The system carried more than 73.7 million in 2009.

3.4. Italy

In Italy, the very first high-speed track was completed in 1977, as the first high speed route in Europe. It connected Rome and Città della Pieve (in central Italy). Meanwhile, the "direttissima" was under construction and by 1992 the high-speed line connecting Rome and Florence was completed. In the 2000s the Milan-Rome high-speed track was completed, after the construction of the Milan-Bologna in 2008 and the Bologna-Florence in 2009. Currently, the "direttissima" Rome-Florence is being adapted to the new HSR standards. The Milan-Rome track is part of the main north-south corridor, going from Turin to Salerno. With the construction of HSR, several technological and time savings innovations were implemented. In fact, the travel time between the main Italian cities has been progressively reduced [22]. In the Milan-Rome non-stop HSR track, for example, it went from 4 hours 30' in 2007-2008 to 3h30' in 2009 and currently is 2h55'. It is also expected to be reduced to 2h30' in 2017 [23]. Therefore, from 2007 till now, the time travel between Rome and Milan was reduced by more than 35%, and it is expected to be reduced by more than 44% by 2017. However, the construction of HSR lines on which trains can run faster than 250 km/h stopped in 2009, and is now counting 923 km [24]. The Italian HSR infrastructure is mostly built on a north-south perspective, with most density in the north. Also, in the Turin-Salerno track the higher speed is available. With regard to the railway distances, the Italian HSR sector is a peculiarity in Europe, as the distances between the nodes are shorter than other countries and with different speed levels.

4. FACTORS DETERMINING HSR SUCCESS

There are several factors that help determine the success of HSR. Despite the Jakarta and Bandung have the highest Indonesian population, it is dwarfed by most of European and Asian cities particularly in terms of population density near the rail station. Since HSR requires high urban densities, particularly those concentrated close to major rail stations, extending HSR to places without the ability to encourage high densities is unlikely to be successful. According to the long experiences of Japan and France, HSR depend on population density to operate efficiency. To compete with the airlines, HSR must depart frequently but they must also fill, or nearly fill, their seats to generate enough ticket revenue to cover their operating costs. Both the population size of a city and the concentration of economic activity in the central business district and near the HSR stations are important determinants in the percentage of people who ride rail transit. Connectivity of rapid transit is the other major factor. In Tokyo, Paris, Shanghai and other Asian and European cities served by HSR passengers can arrive at stations and travel by heavy rail or commuter rail to nearly all the destinations in the urban area. A short taxi ride or bus ride may be necessary to reach one's final destination. In Indonesia, particularly along the Jakarta-Bandung line, very few metro areas are sufficiently dense or have the extensive transit systems necessary to make this possible. And since transit usage is one of the greatest indicators for rail success, ridership is important: only in the Jakarta urban area does transit account for more than 15% of total travel. In Bandung and other cities along the HSR line, it is less than 15%. Contrast this with Tokyo where it is 60% and Paris where it is 25%. This figure does not bode well for the success of high-speed rail in Indonesia particularly within short to middle period.

5. CONCLUSION

It must be recognized that Indonesia lacks some of variables that make high-speed rail successful in other countries. For starters, Indonesia has neither the population density near the rail station nor the land use regulations necessary to support the development of high speed rail. It lacks a pre-existing, successful passenger rail system, and far less on urban public transport usage than Tokyo, Paris and other Asian and European cities. Further, high speed rail cannot work in the absence of large urban populations clustered around city centre's rail terminals and extensive public transport systems that allow passengers to easily complete their journeys. If those variables do not exist, high speed rail will never be an appealing transportation choice to most travellers. Otherwise, as HSR systems become more sophisticated and continue to increase in size in Asia and Europe, other countries including Indonesia are set to benefit from the technological improvements and research investments that countries are pouring into this transport alternative.

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