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The Comparison between High-Speed Trains in the World and the Potential of Jakarta-Bandung Express Train in Indonesia

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Abstract— *The aim of this research is to compare from the perspective of railway transportation management and technique between the development project of Jakarta-Bandung Express Train in Indonesia and the experience of development in other countries. This research wants to know the most recent condition and the development potential as well as its impacts on the high-speed train industry in Indonesia. The development is conducted by a consortium and association of national companies of Indonesia and China. Some problems underlying the development of this railway are that the travel using land transport from Jakarta to Bandung and vice versa still take a long time, and traffic jam happens on the route through Puncak Bogor and on Cileunyi Toll. This research uses a qualitative explorative method and descriptive explanation because there is a problem or issue that must be explored. In-depth interviews are done with some informants and source persons from transportation circle by interviewing the development executive of tunnel 11 at KM 124 and KM 125 and in the location of Tegalluar Station, Bandung at KM 155. The result of this Express Train Project research has a significant implication on the medium up to long term cooperation between Indonesia and China. It is expected that in the future Indonesian manpower can do such a train tunnel construction by themselves in other locations.*

Keywords— *Consortium; High-Speed Train; Infrastructure; Transportation Impact; Tunnel.*

I. INTRODUCTION

Railway transportation has come to the era of high speed. Today, high-speed train has been designed for speed, gaining efficiency, conservating energy, and prioritizing safety and comfort. High-speed train has become a topic of conversation among all transportation patterns, resulting in considerable social and economic benefits. One alternative is that many countries make investments in an efficient high-speed railway network to meet the urgent demand for passenger mass transportation [1]. This alternative may also have favorable impacts by reducing the energy consumption and environtmental problems. Researchers in Spain, [2] explain that today high-speed train has been considered as one of the most significant technological breakthroughs in the development of passenger transportation in the second half of 20th Century.

In the early 2008, more than 20,000 kilometers of railway network are built in the world to provide high-speed train services special for the passengers who are willing to pay for shorter travel time and improved quality of train transportation [2]. High-speed train according to Law of 2007 is the train with speed over 200 km/hour [1]. The International Union of Railways, European Union, explains that high-speed railway is the specially built track for the speed over 200 km/hour or 124 mph. The railway track is proposed to enable the highest speed of 220 mph (354 km/hour) [3]. Texas Transportation Department and Oklahoma Transportation Department apply the speed of 165 mph (266 km/hour) or more [4].

The government, through a consort of Indonesian government companies and China International Railway, initiated the construction of a fast train from Halim to Tegalluar with a rail length of 142.3 km and an average speed of 250 km / hour, construction began in 2015 and is expected to be completed in 2020. The problems in the high-speed train planning on Jakarta-Bandung route include; (1) Is it optimal to build the railway track using the land alongside the Cileunyi Toll? (2) Is it necessary to build high-speed railway track for Jakarta-Bandung with the speed over 170 km/hour? The aim of this research is to compare, from the perspective of railway transportation management and technique, the development project of Jakarta-Bandung Express Train in Indonesia with the experience of development in other countries. This research wants to know the most recent condition and the development potential as well as its impacts on the high-speed train industry in Indonesia.

Theoretically, high-speed railway according to International Union of Railways (UIC), European Union [5], is the specially built railway track with the speed over 250 km/hour, or the specially improved railway track with the speed exceeding 200 km/hour. Some researcher [2]; [6]; explain the classification of four railway tracks, namely; 1) Exclusive exploitation model/Dedicated. It is the model like Shinkansen in Japan which has special service using the track of High Speed Rail. Such a system is developed because with

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the existing railway network, the conventional passenger and cargo trains are very crowded; 2) Mixed high-speed model. For example, Train à Grande Vitessemn (TGV) in France; this model specially serves only high-speed trains; 3) Mixed conventional, namely Alta Velocidad Española (AVE) model. The use of trains with mixed conventional model like AVE in Spain serves both high-speed and conventional trains, whereas unstandard railway tracks can only serve conventional trains; and 4) Fully mixed model. In this model, Inter City Express (ICE) in Germany explains that most of railway tracks are compatible with all passenger and cargo trains as well as with conventional trains.

Concerning high-speed railway track built using Gauge Standard in the width of 1,435 mm, high-speed railway results in social benefits coming from time saving, improvement in reliability, comfort and safety, as well as reducing traffic jams and accidents [2]. The main benefits of high-speed train according to [2] are; (1) time saving; (2) additional capacity; (3) externality reduction from other modes; (4) resulted traffic; and (5) wider economic benefits. According to the information processed from the project data of Fast Train Indonesia China

(KCIC) as the company executing the development of Jakarta-Bandung express train, [7] , the benefits of this high-speed train are hopefully that; (1) it can directly absorb 87,000 labors; (2) the construction period will be three years; and (3) it can be operated for a long term. This railway will also enhance the development of economic potentials alongside the corridor of Jakarta-Bandung, especially Halim Station as the New Capital Gate, the station in Karawang as an industrial city, station in Walini as the area of education and Agro-tourism, and also around Tegalluar Station, Bandung as a technopolis city.

Moreover, it will also reduce traffic jams by carrying 140,000 passengers every day; shortening the travel time to become 35-40 minutes at a low level of accident and pollution; and some other benefits. Another benefit is that it can directly and indirectly enhance the growth of Gross Domestic Product due to the increase of government revenue, one of which comes from goods purchase tax during the period of construction project of Jakarta-Bandung express train and during the construction of Transit Oriented Development (TOD) [7].

Sources: [7]
Fig. 1. Jakarta-Bandung High-Speed Railway Track 2019

Concerning train transportation, in September 2015 the government of Indonesia had decided to choose China as the partner in developing the Jakarta-Bandung Express Train [8]. Of course, the decision has passed through feasibility studies carried out by some parties including China. China can provide six technical services such as research & testing, design & consultation, construction, equipment manufacturing, and operation and maintenance. Some studies discuss the development of Jakarta-Bandung express train, such as [9]; [10]. They study the competition among China, power from non-Western countries, and Japan. The project of Jakarta-Bandung express train in Indonesia also reflects the change of political considerations to contract foreign partners for infrastructural construction (Figure 1).

II. Method

This research is a literature study with more in-depth interviews, and a triangulation process [11]. The technique used was participant observation which was supplemented by in-depth interviews from the leadership of the China – Indonesia Fast Train (KCIC) company. In in-depth interviews such as this focus on the operational technical use of fast trains in Indonesia such as the type of track used, design speed, operating speed, number of fast train lines, project start time and end time, the number of local and foreign workers, maximum speed and minimum train, also headway and passenger carrying capacity. The foundation for reviewing the operation of Jakarta-Bandung high-speed railway track is the comparison among high-speed trains operated by many countries in the world like Europe, Asia, and the USA. Comparison between the use of high-speed train and air transportation is also used.

III. Results and Discussion

A. Regulation

The development project of Jakarta-Bandung express train has been included in the Revised National Medium-Term Government Plan 2015-2019 [12] and it is also included in the document of National Railway Master Plan (RIPNAS 2030). This railway track development has also been stipulated in the Republic of Indonesia Presidential Regulation 2015 [13] and Minister of Transportation Regulation 2011 [14]. Based on the Presidential Regulation, the project financing of Jakarta-Bandung express train does not use APBN funds since this project uses the scheme of business to business. The government only gives the guarantee for the consistency of policy in the high-speed train development and the legal certainty in the form of Business Feasibility Guarantee (SJKU). One of the requirements for executing the project is the existence of concession agreement permit between the government of Indonesia and KCIC.

In this project, the term of consession is agreed as long as 50 years since the end of May 2019. Thus, This review of the development of fast trains in Indonesia in terms of regulation is supported by several previous studies. Previous research based on the Indonesian Government's policy which decides the development of Jakarta's Fast Train infrastructure - Bandung is right [8]. Another rapid train development study on foreign policy and based on spatial law was also conducted by [15]; [16].

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B. The Progress of Jakarta-Bandung Express Train Development Project

This high-speed train project is a common effort between Indonesia and China and is seen as a revolution in the country land transportation system [17]. This development project of Jakarta-Bandung high-speed railway is financed by a consortium of Indonesia-China with Indonesia holding 30 percent of the share, which is managed by several state-owned construction companies [7]. Whereas 70 percent of the share is held by Beijing Yawan HSR, China consisting of five companies. This consortium is under the responsibility of Fast Train Indonesia China (KCIC). The number of labors for the project of tunnel construction now consists of around 12,000 local workers and around 2,000 foreign workers [18]. This Indonesian high-speed train uses double track of 1,435 mm wide, with the designed speed of 350 km/hour and operational speed of 300 km/hour, and will halt only in four stations, namely Halim Station (elevated) to Karawang (ground) as long as 41.166 km, Karawang to Walini (elevated) as long as 55.550 km and Walini to Tegalluar (ground) as long as 45.584 km (see Figure 2).

Sources: [18]

Fig. 2. Allignment and Station & Depot Location Train of HSR Jakarta – Bandung Project

There will be 11 high-speed train tunnels (see Table 1) with the total length of tunnel is 2,372.514 meters or 2.372 km. The final tunnel at KM 125 is as long as 1.101 km. In Januari 2020 the project is still in the phase of construction work. It is planned to use Electric Multiple Unit (EMU) train with the type of CR 400 AF fuxing train. The travel time is planned to be 36 minutes for direct train and 44 minutes for stopping-train [7].

Table 1. Locations of Tunnels

Project Name	Length (m)	Location
Tunnel #1	1.885	Halim, East Jakarta
Tunnel #2	1.030	Bunder, Jatiluhur
Tunnel #3	735	Cibinong, Sukatani
Tunnel #4	1.315	Sukajaya & Malangnengah, Plered
Tunnel #5	422	Sempur, Darangdan
Tunnel #6	4.478	Puteran, Cikalong and Rende, Cikalongwetan
Tunnel #7	1.285	Rende, Cikalongwetan
Tunnel Walini	608	Walini, Kanangasari
Tunnel #8	2.190	Mandalasari, PTPN8
GDK99 ~ GDK100 Tunnel	208	Nyalindung, Cipatat
Tunnel #9	385	Cempakamekar, Padalarang
Tunnel #10	1.230	Sukatani, Padalarang
Tunnel #11	1.101	Gadobangkong & Cibeber, South Cimahi

Sources: [18]

The maximum speed of Indonesian High Speed Railway will be 350 km/hour. Based on the information gathered from KCIC Management, the speed will be adjusted to the type of track in the field at a curved or straight point [18]. Headway, initially planned 20 minutes, is still being studied and will be adjusted to the passengers' demand. If the demand is high, it does not rule out the possibility that KCIC will shorten the headway. Otherwise, in term of the loading capacity, one trainset of Jakarta-Bandung Express Train can carry up to 601 passengers and the number of railway coaches per departure of one high-speed trainset of CR400AF will be 8 coaches [18]. Based on the interview with KCC Management, the progress of Jakarta-Bandung express train project starts from 16 October 2015 and is expected to complete in 2021. In the opinion of KCIC Management, KCIC and the contractors of Jakarta-Bandung express train do the best to run the operation as targeted by the government. Based on the data from KCIC Management, the high-speed train project has achieved 42.65 percent of completion with land acquisition having achieved 99.94 percent [18]. Responding some questions on environmental problems, Jakarta-Bandung express train has obtained environmental permit from the Minister of Environment and Forestry of the Republic of Indonesia concerning Environmental Permit for Jakarta-Bandung High-Speed Railway Development Activity as long as +/- 142.3 km and the changes [18]; [19].

C. Progress of High-Speed Train Utilization

1. General

Researchers in Asian Development Bank Institute (ADBI) and Asian Institute of Transportation Development (AITD) have studied various aspects related to the implementation of sophisticated transportation infrastructures [20]. This special matter provides the worldview of experience from the countries that have successfully implemented high-speed train services. High-speed train has shown a strong vitality in modern transportation. Pursuing higher operational speed of train has become a trend around the world. Investment in high-speed train according to [21] can also reduce congestion in the conventional railway network, and the capacity of high-speed train for quick downtown-to-downtown service creates a new possibility for commuter business travel and short-term vacation journey. The high-speed train maximum speed in its commercial operation is the reflection of various interactions between the train and the surroundings, which is the most important indicator in the classification of high-speed train technology, such as around 250 km/hour as the first generation, 300 km/hour as the second and 350 km/hour as the third.

According to UIC, to build a new high-speed train infrastructure attention must be paid to three things; (1) Cost of design and land, including for feasibility studies (technical and economic), technical design, land acquisition; (2) Cost of infrastructure, including the costs related to field preparation and platform development; and (3) Cost of suprastructure, including the specific elements of rail such as guide path (track) and sideways along the line, signal system, catenary and electrification mechanism, communication and safety

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installation [5]. In order to optimize the utilization of high-speed railway system, the government and the railway company can take the advantage of best practices around the world. In term of infrastructure, the influence of exit shape of the tunnel is also studied by some researchers like [22]; [23]; [24]. Whereas the issue about the train passing through the tunnel has ever been studied by [25]; [26].

2. Indonesia

Initially the planning of Jakarta-Bandung express train was studied by Yachiyo Engineering, a transportation consulting company from Japan, reviewing appropriate route for Jakarta-Cirebon high speed train as a prioritized part of Jakarta-Surabaya high speed train plan by comparing between Bandung and North Coastal route) [27]. In addition to those two routes, the route of Jakarta-Bandung-Gedebage (Figure 3) is analyzed as well.

Sources: [27]
Fig.3 Initial Study on the Jakarta-Bandung High-Speed Railway

Among the three alternative routes, the route selected is based on technical, economic, and financial analysis, and the schematic scheme of the selected route. On Bandung route, there is also a study on the height difference approximately 700 m between Jakarta and Bandung with a steep gradient. The consultant from Japan, Yachiyo Engineering, also explains that the high-speed railway should avoid disaster hazard areas like landslide and as many mistakes as possible [27]. Moreover, the high-speed railway also needs to avoid the areas that have bad impacts on the natural environment and animal protection. Meanwhile, Bandung route has a steep gradient and needs relatively long tunnels. Therefore, the structure must have adequate earthquake resistance. In the other side, Japan is experienced in the design and construction to overcome the similar problem.

The consultant concluded some considerations; (1) topographical characteristic, maximum steep slope is used to overcome the height of 700 m; (2) relation to other modes of trasportation, it is connected to conventional tracks in the main cities and has satisfying accessibility to the planned international airport; and (3) risk of disaster, relatively resistant to disaster because of the high ratio of tunnel cross-section which is less affected by meteorological conditions. Acceptance and willingness to pay for the high-speed train have been surveyed and the convertion ratio of the existing trains, long distance buses and passenger cars have been reviewed quantitatively. Then, the initial tariff for Jakarta-Bandung express train is proposed as much as IDR 200,000 each passenger [27].

A transportation observer, [8], explains that; (1) Jakarta and Bandung have high economic potentials, so the government concludes that the development of Jakarta-Bandung express train infrastructure is correct and it becomes the choice of modernization in mass transportation which can build the intercity-interprovince connection, and area development; (2) The development of Jakarta-Bandung express train will open optimum job opportunities, establish train industry by using local content, and transfer of technology; (3) This railway track will reduce carbon emission by reducing the emission of renewable source of energy. The process of designing and developing Jakarta-Bandung express train is carried out by the government using Design Build Lease system which results in Financial Internal Rates of Return (FIRR) achieving 15.8 percent [8]. This indicates that the project is both financially and economically feasible, and it is supported by the government.

The environment researcher in Indonesia, from environmental perspective says further that, according to Wahana Lingkungan Hidup Indonesia (WALHI), the project of Jakarta-Bandung express train will indeed increase the potential degradation of environment quality along the railway track [8]. The development of Jakarta-Bandung express train will take advantage of 56.6 Hectare of production forest land. In addition, indirect impact will occur in the form of functional change of agricultural land as wide as 150 Ha to become non-agricultural land around the stations and high-speed railway tracks. The problems found in the field during the development are the use of reserve forest land and production forest, as well as landslide vulnerable areas.

However the project can be finished due to the complete documents of Analysis of Environmental Problems and Impacts (AMDAL) and the use of cutting-edge technology [8]. In addition to the environmental problem, there is also a social problem where the project will displace 1,200 up to 3,000 households. But this social problem can be solved by deciding that the development of Jakarta-Bandung high-speed railway is done elevatedly alongside the toll highway, so that the displacement does not occur. From literature study, the development project of Jakarta-Bandung Express Train has ever been studied by [8], adding that the relevant “high” risks are those of lateness and increased cost of land acquisition, geotechnical obstacles at unpredicted locations, mistakes in design, late completion of the construction, cost of construction exceeding the plan, and natural disasters. From the spatial plan, this development project of high-speed train has ever been studied by [16], explaining that it should follow the spatial planning law, where a space utilization plan must be mentioned in the Spatial and Area Planning (RTRW).

Being not mentioned in the City/Regency RTRW means that this project does not obey the established RTRW. From economic side, due to the success of Indonesia in the

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cooperation to develop Jakarta-Bandung express train, the government of China enhances their belief in the ease of making investment in Indonesia, and in the long term other countries see the big opportunity to invest their capital in Indonesia with China as the guarantee. This project has significant implications on the medium up to long-term cooperation bertween Indonesia and China [28]. They add, this project opens the opportunity for Indonesia to accelerate its agenda of infrastructure development in order to improve the slowdowning economy.

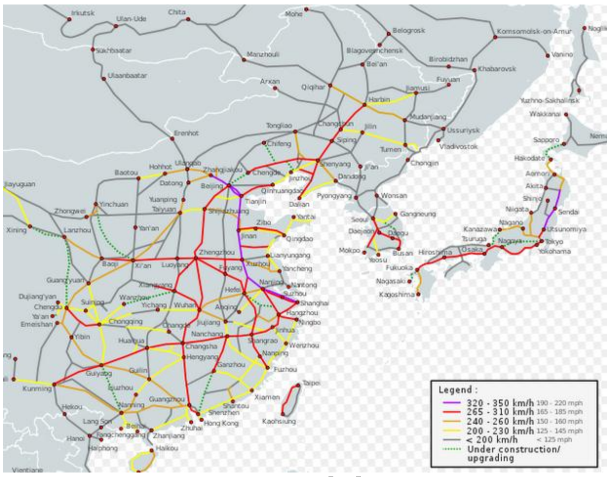
3. Asia

The main competitor faced by Chinese high-speed train in the globalization era is Japan. China and Japan have different strengths and weaknesses in technology, policy and capital for high-speed train. In October 1964, Shinkansen was inaugurated as the first high-speed train system that operated in the world and it was the only one until 1981 [29]. Since that time Shinkansen has developed and always shows very high performance. The inauguration of Shinkansen express train service of Tokyo-Osaka, Japan, with the maximum operational speed of 210 km per hour about 40 years ago marked the return of train as an important mode of passenger transportation [30]; [31].

Since then, high-speed train service has been introduced to many countries. Modern construction in 1994 aims to develop high-speed rail using Variabel Gauge Axles (VGA) system to allow a train operates on the Shinkansen network with a standard size of 1,435 mm and also in the conventional network with narrow gauge (1,067 mm). Initially, high-speed train in Japan is of speed enhancement on the exixting railway track with standard gauge (1,435 mm) [32]. Gauge Change Train (GCT) is a project starting in Japan in 1990s to study the feasibility of producing electric multi-unit (EMU) train which is able to operate Shinkansen high-speed network with standard gauge (1,435 mm) [33]. The simultaneous operation of Shinkansen and tourist train according to [34] can increase tourism demand significantly. In particular, although it has a big influence on tourism demand in the first year, the influence becomes insignificant in the second year.

Chinese high-speed train network is the biggest in the world (Figure 4), carrying so many passengers through urban network [35]. Until the end of 2013, China Railway has built high-speed railway network as long as 10,000 km [36]. The network is built quickly with the unit cost relatively lower than the similar projects in other countries. The big scale high-speed railway network in China has significant influences on accessibility and connectivity, but little attention is paid to their impact on connectivity [37]. Changes in connectivity mostly affect the external intercity connection so that influence the urban network structure. In the beginning of 21st century, many high-speed train producers around the world try to enhance the maximum operational speed to be over 350 km/hour [38].

Only in China the CRH380 succeeds in the operation at the speed over 350 km/hour. China finds the optimum compatibility between train and its dynamic environment, basically between train and the railway track. This China's experience accelerates the progress of the third generation high-speed train technology development in other countries. The cost of rolling stock maintenance has ever been studied by [40] from the high-speed trains in Hong Kong and Mainland China. Their research explains that high-speed train has the biggest positive Net Present Value among three modes of passenger transportation due to its excellent performance in ticket revenue, travel time and safety. Whereas in Taiwan, [41] recommends some policies beneficial for the transportation system regulator, central government, and local government to find a comprehensive strategy of high-speed train plan for a more integrated transportation system.



Sources: [39]

Fig. 4. East Asia High-Speed Railway Network

Especially in South-East Asia, some researchers like [42]; [43]; [44], explain that China is eager to participate in developing high-speed railway track in ASEAN countries, which can improve the regional economic integration of ASEAN. For non-ASEAN countries, China is the main external investor and contractor for their infrastructure development, and with the initiative of One Belt One Road (OBOR) China forms the core of new foreign policy [43]. The train in Thailand connects Port of Chiang Khong in Chiang Rai with Laos using standard gauge of 1,435 mm at maximum speed of 200 up to 250 km per hour [45]. Thailand will benefit much from the railway development project in many aspects. This includes time saving and comfortable travel, reduction of traffic jams and airport congestions, being regional center, as well as promoting the wider economic benefit to undeveloped cities. Thailand considers the Chinese HSR project as the only first step to reach the ambition to be the center of land transportation in Indochina [9]. Researches in Thailand as conducted by [45]; [46] explain that the domestic political conditions, i.e. interparty conflict, judicial intervention, and the existing bureaucratical procedure, have obstructed the realization of China-Thailand express train project. There will also be extraordinary cost and other negative impacts following the railway development project.

4. Europe

Italy becomes the second country that opens the second high-sped railway track in the world in 1977, connecting

Rome and Florence [47]. Italy now has two tracks connecting Turin and Venesia, Milan and Salermo. Purba adds that some parts of Milan-Salermo track are still in development. Italy has incrementally tried to expand its tracks to connect big cities by high-speed trains. The third HSR system in the world built in France is called TGV of which first track was opened in 1981 connecting Paris and Lyon. TGV System in France has been expanded to Belgium, Germany, Italy, and Switzerland and now is the longest track in Europe which can operate at maximum speed up to 322 km/hour. [21] in his study also explains that the initial success of TGV encourages other countries to expand their LGV network and TGV offerings (Figure 5).

The railway track from France is 1895 km long, with the route of Paris-Brusssels, Belgium and Paris-London. The route of Paris, Brussels, Amsterdam and Cologne is served by Thalys whereas Eurostar serves the route of London, Brussels and Paris through tunnel track.

Sources: [21]

Fig. 5. High-Speed Train Systems in Europe

The introduction of high-speed train in Germany causes a capital shift to train transportation especially for medium distance between 150 and 400 km [48]. Following France and Italy, in 2014, Germany developed high-speed railway with totally eight tracks having the length over 1,620 km. Subsequently in 1992 Spain opened its first high-speed railway track and now has four separated networks. In 2014, Spain had a high-speed railway system as long as 1,768 km and was the second longest track in Europe [47]. In Europe, there are two groups of countries: France and Spain with a little lower development cost rather than Germany, Italy, and Belgium [2]. This is explained not only by geography and the similar existence of underpopulated areas outside downtowns, but also by the construction procedure. Asian and European high-speed railways have been studied by [49] who explains the production efficiency and service effectiveness of high-speed railway.

This research reveals the significant differences between Asia and Europe. Doomernik also reveals that high-speed train can be represented as a Multiple-Input Multiple Output (MIMO) system with two inputs and two output variables for the purpose of benchmarking. One of the most important problems in construction of high-speed railway is the cost estimation. The infrastructure cost of high-speed railway of the previous projects and find that it may vary from 5 to 66 million euro per kilometer [2], and add that to build a new high-speed railway infrastructure it needs a special design which is intended to get rid of all technical limitations that can limit the speed for commercial operation under 250-300 km/hour. European Union Commission explicitly considers the high-speed railway expansion as the priority in the trans-European network, aiming at enhancing the market share of train transportation.

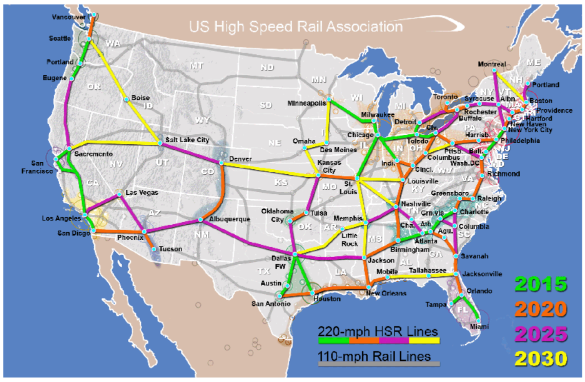
A well-known railway observer in Europe [50], explains that high-speed train is best designed to replace conventional railway services in the routes where much higher capacity is needed and to reduce the travel time. However, high investment in high-speed railway infrastructure cannot be justified in an uncertain economic condition. Givoni also recommends that the train can reach an average speed over 200 kilometers per hour. A study in Spain by [51] shows that big cities at the network periphery location are generally preferred to be the high-speed railway network, whereas satellite cities are more possible to achieve a higher efficiency in tourism.

The third train generation in Spain has average speed of 170.5 km/hour with standard gauge (1,435 mm) [53]. The Magnetic Levitation (Maglev) technology in France has been proposed for intercity and regional tracks in Germany, Japan, the USA, and other countries [54]. The Maglev developer claims that their system can reach a higher speed, have lower energy consumption and cost of life cycle, attract more passengers, and result in less noises and tremors than high-speed train. According to [55] a high-speed train can run at the speed up to 230 km/hour. Most of high-speed train services in Europe spend most of their travel on conventional tracks.

5. United States of America

Since 2009, concerning the prospect of developing high-speed railway in the USA according to [56], many people support as well as criticize it. Some researches have been conducted to see how a high-speed train operates around the world and to ascertain whether the high-speed railway system can really succeed in the USA. In 2017, California High-Speed Railway Authority was executing the project passing through Central Valley in the USA [57]. Phase I is planned to finish in 2029, and Phase II is estimated to finish before 2040 (See Figure 6). Research by Deakin, (2010) in the USA, primarily in California, reveals that the use of high-speed train has an impact of noise, depending on the frequency and speed of service.

Positively, air pollution reduction and vehicle emission avoidance will also depend on how many passengers are interested in high-speed train and how many passengers will go by car or regular train. Some researcher, in their study explain that with the increasing demand and cost of fuel, the travel time and cost of intercity passenger transportation mode are getting more relevant [59]; [60]. The potential demand for high-speed train in the United States' corridor based on some criteria such as the population size of city and metropolitan area, distance, GDP, and the existing intercity transit system.



Sources: [61]
Fig. 6. US High Speed Rail Network Map
Fully Integrated, Multi-layered National Rail System Built in 4 Phases

6. Comparison between High-Speed Train and Air Transport

According to [59] high-speed train around the world is regarded as a way to reduce the demand for road and airport transportation. From the perspective of the whole transportation system, high-speed train can act as a substitute or supplement for the other modes of transportation [2]. This becomes a competition when providing an alternative transportation service which has been provided by air transportation, road transportation (private or public), maritime service or conventional train service. Some researches comparing the use of high-speed train mode with air transportation such as conducted by [62] explain that Public Authority in the West Europe increasingly relies on high-speed train, of which the efficiency is expected to result in capital shift from aircraft.

However, the development of high-speed train is still limited compared with the increase of air services. Competition between low cost carrier airlines and high-speed has occurred in the recent years, asking whether airline industry is able to compete with high-speed train [62]; [63]. According to [64], European governments have more liberal attitude to their aviation sector especially low cost carrier rather than the government of Japan to its high-speed train. The influence of high-speed railway service on the demand for air transportation is also studied in South Korea [65].

High-speed train is the best mode of transportation to substitute conventional train services in the routes where much higher capacity is needed and to reduce travel time which will improve train services, compared with the transportation mode of intercity bus or sea transportation. [50]. Another reseacher add that the role of train in air transportation industry is usually limited to providing access to airport. The integration can offer positive alternatives to aircrafts in some routes and direct the train travel to airport which now becomes a part of air transportation services. High-speed train is able to successfully compete with road transport, air transport, and conventional train in the crowded route [21]. Other researchers, [67], explain that high-speed train is an appropriate substitute rather than air transportation. In China, the result of research conducted by [68] indicates that the cities having high-speed trains especially in the center and east of China, offer regional connection tracks, whereas the cities and dominant hubs having air transportation are evenly spread throughout China and most of them offer inter-tregional connection.

Thus, based on the description above, the results of this study are supported based on literature studies, previous research, several key informant opinions, comparison of the construction of high-speed trains in several countries in Europe, i.e. France, Italy, Germany and Spain, in Asia, i.e. Japan, China, and Taiwan, as well as in the United States of America.

IV. CONCLUSIONS

Train can play a bigger role in cooperation with airlines to provide integrated transportation services for medium distance travel. Having high capacity and service frequency, train can reach the average speed over 200 kilometers per hour. High-speed train is able to successfully compete with road transport, air transport, and conventional train in the crowded routes where people are willing to pay for the relatively high tariff. High-speed train can also be an appropriate substitute rather than air transportation. The high-speed train project in Indonesia has significant implications on the medium to long term cooperation between the government of Indonesia and China.

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