EXPRESS FREIGHT TRANSPORTATION BY HIGH-SPEED RAIL: THE CASE OF CHINA

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Introduction

Since the first high-speed rail (HSR) Shinkansen launched in Japan in 1964, many countries such as China, Japan, France, Germany, Italy and Spain have developed HSR to shorten the commuting time between major cities (Jiang & Zhang, 2016). Nowadays, HSR has become a usual transport mode for tens of thousands of passengers. At first, HSR is only designed for passenger transport. In the 1990s, with the maturity of the high-speed rail network in Europe, railway companies in some countries attempted to express freight transportation by high-speed rail, which yielded remarkable economic and social benefits. The representatives are freight trains launched in France and Germany for delivery of letters, parcels and other light cargoes. In recent years, Euro Carex project using the existing HSR network and high-speed trains to transport cargoes and link major European logistics sites is implementing step by step.

China begins to construct high-speed rail later compared to some developed countries. The first high-speed inter-city railway line between Beijing and Tianjin came into service on August 1, 2008, indicating China's entry into the era of high-speed rail. However, high-speed rails have been developing rapidly in China over the past several years, making transportation between big cities such as Beijing and Shanghai much more accessible. At present, China has owned the longest HSR system in the world with more than 20,000 km of track in service, constituting a HSR network with four rail lines north to south, and four lines east to west. At the beginning, the HSR lines only have passenger-dedicated lines (PDLs), in recent years, passenger-freight mixed lines are also introduced.

Influenced by China's economic slowdown and economic restructuring, the transport volume of railway black goods (generally, coal, coke, steel and ore are collectively referred to as black goods, while the other high value-added goods are referred to as white goods) declines dramatically. In contrast, the transport volume of white goods is rising, mainly due to the boom of e-commerce. The express delivery sector has become one of the fastest growing sectors in China. With the popularization of the Internet and the rapid development of e-commerce, online shopping has become a popular way of shopping, which has driven the dramatic growth in the demand for express delivery services. China's express delivery volume has ballooned by more than 50% annually since 2012. According to the 2014 annual report on express delivery market published by the State Post Bureau of China, China has surpassed the US to become the world's largest express delivery market in 2014. The statistics from the State Post Bureau of China shows that China's express delivery volumes exceeded 30 billion in 2016, rose by 51.4%, continue to top the world. At present, China's express transportation mainly relies on highway and aviation, while railway express service accounts for only a small part. The surging demand for express delivery provides a broad opportunity for the development of HSR freight in China. HSR freight will not only offer a new option for consumers but also provide a new profit growth point to the railway sector.

HSR freight in Europe

Europe is the earliest region to transport freight by HSR. France has more than 30 years of experiences in HSR freight. Other European countries such as Germany, Italy and Spain also began HSR freight business many years ago. With the improvement of the Trans-European high-speed rail network, a European HSR freight project named Euro Carex has been set up in 2009.

France

France is the first country to carry out HSR express freight service. France's national state-owned railway company SNCF and France postal carrier La Poste cooperated to transport parcels and mails as early as 1984 (Troche, 2005). In October 1984, the special TGV postal train was operated between Lyons and Paris. The maximum speed can reach 270km/h. These TGV units are transformed from TGV Sud-Est trainsets without seats in order to load more packages. La Poste receives packages and mails in the daylight, so the TGV postal train operation time is during the night (K.Tan & C. Zhang, 2014). However, given the continued decline in mail traffic and road competition, La Poste decided to end this business in 2015 (Steinmann, 2014).

The good operation of TGV postal train prompts SNCF subsidiary Sernam (a logistics company) to consider transporting high-added cargoes in high-speed rail. Since 1997, locomotive-hauled freight trains have been permitted to run in France's high-speed lines (LGV) which are only used by TGV trains before. In October 1997, Sernam launched 160 km/h trains from Paris to Bordeaux and Toulouse and to Orange(Avignon). This service known as Sernam 2000 mainly focused on the express freight transportation. And this the train units are modified from conventional G13 freight train units. This scheme was considered to be more economically viable than high-speed TGV freight trains. However, the train can only load 18 tons at 160 km/h; the axle load will be constrained to 11 tons if the speed reaches 200 km/h due to the braking system (Troche, 2005). This means the train running in high-speed rails must make a balance between speed and capacity.

Euro Carex project

Euro Carex (Europe Cargo Rail Express) is founded in April 2009 as an international non-profit association. The Euro Carex is a truly European scale project that aims at using the existing high-speed rail network in Europe to transport some air freight, substituting high-speed trains for trucks and short/medium-haul air cargo flights (EuroCarex, 2011). This project is supported by European Commission, national and regional governments, railway and airport companies and express delivery giants such as FedEx and TNT. The primary project members include SNCF (France's national state-owned railway company), Air France Cargo, FedEx, La Poste and TNT. The motivations for the project come from a sustained demand for express and cargo from major European airports and limitations on the number of night-time flights in order to reduce the noise pollution as well as the fluctuation of fuel price and pressure of carbon emissions reduction.

The improvement of the high-speed rail network in Europe and the deregulation of the European rail freight market build a strong foundation for the launch of Euro Carex project. In March 2012, Euro Carex finished the first test of a high-speed freight train between Lyon St Exupéry airport and St. Pancras International Station in London (Crossland, 2012). The successful operation of the express rail Euro Carex marks the establishment of the trans-continental distribution network for next-day delivery.

The project moves high-value, fast-moving air cargo from the current mixture of air and truck to rail. In the future, traditional freight could also be transported by high-speed freight trains. The achievement of Euro Carex project is based on the experiment of HSR freight in France, German, Italy etc. It also needs an excellent coordination between many sectors, including the main European airports which are members of Euro Carex, the infrastructure managers, the operators and the customers.

Euro Carex service destinations and phasing are determined by the freight operators involved in the project on the basis of the volumes of freight appropriate to transported by HSR and the continuing construction of European high-speed rail links. The project has three stages. In stage one, the new high-speed rail service will connect the freight airport areas in Amsterdam Schiphol, Liège, Lyon St Exupéry, Roissy CDG, the London basin and Germany. More cities such as Strasbourg and Bordeaux will be connected in the second stage. In the last stage, the network will extend to Spain and Italy (EuroCarex, 2011).

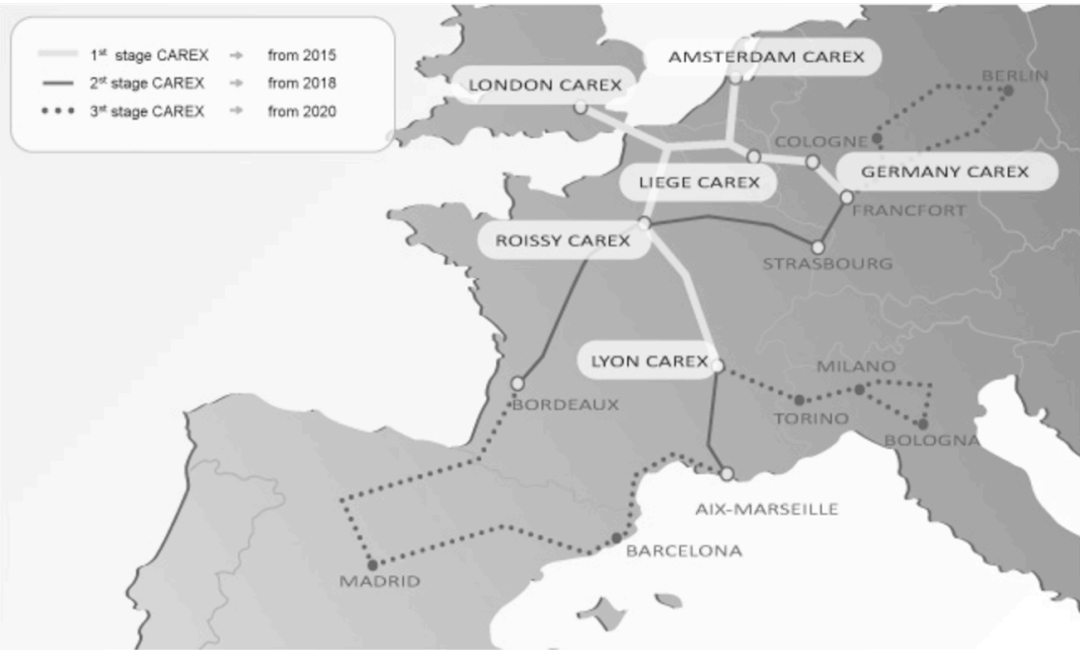

Figure 1: The three stage of the Euro Carex project
Source: http://www.eurocarex.com/

The Euro Carex test train is SNCF TGV rolling stock with the potential load up to 120 tons of freight, equivalent to a Boeing 747-400 cargo plane. However, Euro Carex is not satisfied with the current rolling stock, requesting Alstom and Siemens to design the freight train fitted with the loading units can transport pallets and air freight containers at the speed up to 300 km/h. The loading/unloading time is within 15 minutes.

HSR freight in China

In China, HSR freight business is still in its infancy. In 2013, China Railway Corporation (CRC), which is the former Ministry of Railways, implemented the first freight reform since its establishment. HSR freight was added as its seventh freight operation. However, the detailed plans about HSR freight are made by regional branches respectively, China Railway have not made a unified project yet. In 2014, China Railway Express(CRE), a subsidiary of China Railway began to provide HSR freight service in more than 100 cities. In fact, some branches have already tried the HSR freight business before. Guangzhou Railway Corporation is the first branch to attempt HSR freight. At the end of 2011, express service is provided between Guangzhou station and Changsha station via high-speed passenger trains (Zhengwei & Hong, 2015). Later, Guangzhou Railway Corporation cooperated with China EMS, SF Express and FedEx etc. to transport express freight between Guangzhou station and Changsha station via the dynamic inspecting train.

Since October 20, 2016, CRH (China Railway High-speed) express service has been launched on trial in China's 505 cities where have access to the high-speed rails, offering customers high-end door-to-door small parcel express service (China Railway, 2016). The main goods resource is small-quantity and high-value business documents, e-commerce parcels, medicines, cold chain foods, and emergency goods. It includes present day delivery, next morning delivery, next day delivery and the day after next delivery. In 2016, 170 high-speed trains are used to help e-commerce platforms deliver parcels between Nov. 11 and 20 which are the busiest period of time every year for express transportation, since Singles Day (Nov. 11) is the largest online shopping festival in China (Luo & Hua, 2016).

HSR freight transportation mode

There are mainly four ways of coordinating high-speed freight and passenger traffic (Troche, 2005). Nowadays, in China, the dynamic inspecting train (an ordinary HSR passenger train departs without passengers at 4:40 AM every day to check the track lines for the security) and passenger EMUs (Electric Multiple Units) are the two chief schemes for the freight transportation in HSR (Liang, Tan, Whiteing, Nash, & Johnson, 2016). The former is operated by China Railway branches and the latter is operated by China Railway Express.

1. Using the dynamic inspecting train

Taking the advantage of the dynamic inspecting train to express freight is a good way to utilize the spare capacity of the train. Usually, the freight will be placed in seats and luggage storage. Since the dynamic inspecting trains don't carry on passengers, the loading and unloading process will not conflict with passengers. However, the capacity is limited because only one dynamic inspecting train runs between two destinations every day.

2. Railway passenger and freight within the same carriage

This mode could fully utilize carriage space without additional reformation and investment costs. However, the available space is limited, so it is only suitable for the delivery of small-volume parcels. The freight could be only placed in the large luggage depository on the two sides of the carriage and the luggage rack. For the security of freight, special supervisors should be designated. The loading and unloading of freight will disturb the boarding and alighting of passengers.

3. Railway passenger and freight within different carriage

When spare capacity exists in the off-season, one or two carriages of high-speed passenger train could be converted into special express carriage. Such mode completely utilizes the unoccupied carriage space and the loading and unloading of freight will not disturb the passengers. In addition, it would be easier to realize concentrated management, thus decreasing freight supervision personnel.

4. Specialized high-speed freight train

In case of considerable freight delivery demands, EMU passenger trains could be transformed as pure high-speed freight train by dismantling all the passenger facilities. Considering the large capacity and high operation costs, pure high-speed freight trains should have stable freight sources by establishing long-term cooperation relationship with logistics companies. Besides, the high-speed freight trains should coordinate the operation time and lines with the high-speed passenger trains.

Advantages of HSR freight

With the improvement of the high-speed rail network, the advantage of HSR freight will be further reflected. High-speed trains are seldom influenced by the weather conditions and the punctuality rate is far higher than airplanes and trucks. Compared with airplanes, the high-speed trains will not be affected by traffic control and it can transport some of freight prohibited or restricted by the airplanes. Compared

with trucks, the high-speed trains can load more freight and the speed is much faster. Therefore, the delivery time is guaranteed. In addition, the stable operation could ensure the safety of freight and avoid unnecessary losses during the delivery process. Apparently, the HSR freight has a huge potential in terms of express transportation.

Besides, high-speed rail is an environmental-friendly way of transportation. Since the high-speed train takes electrical power as the driving force, the train will not discharge any exhaust gas in the driving process and meanwhile prevent dust, smoke and other exhaust gas pollution. It is regarded as a sustainable mode of transportation (Jehanno, Palmer, & James, 2011).

Bright future of HSR freight in China

We believe HSR freight service will have a good prospect in China. First of all, the extensive HSR network in China provides a solid foundation for developing HSR freight. Besides, the express market is big enough and grows continuously at a very rapid speed. In recent years, one of the significant characteristics of the Chinese economy is the prosperity of e-commerce. More and more Chinese consumers prefer going to online shopping websites such as Taobao and JD. The online supermarkets even provide vegetables, fruit and meat which need fast logistics speed. The boom of e-commerce brings a surge in demand for express delivery. In Figure 2, we can see that in recent years the express delivery volume increases dramatically at a high growth rate. The average year-on-year growth rate is over 50% in the past six years. However, at present, most of the express is transported by airplanes and trucks. With the speed advantage of high-speed rail, HSR freight could capture a larger slice of the fast-growing express market.

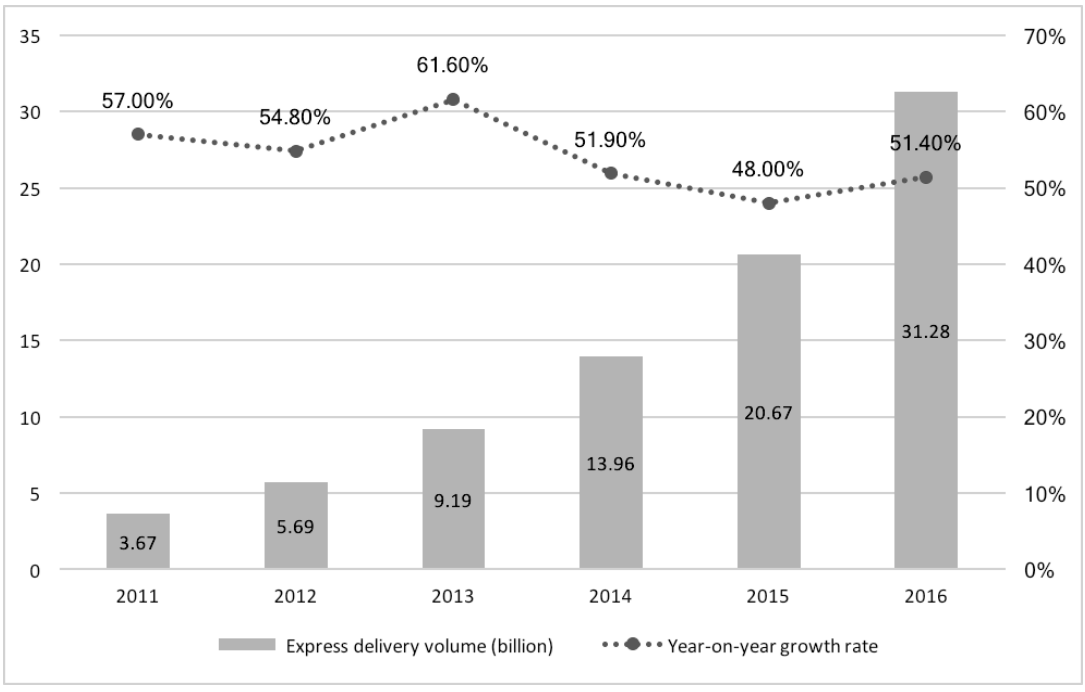

Figure 2: The statistics of express delivery volume and year-on-year growth rate in China.
Source: State Post Bureau of China

For China Railway, developing HSR freight business is an exploration for further marketization. The profitability of HSR in China has been disputed continuously (Minter, 2016). China Railway is saddled with debt. The total liabilities of China Railway reached 4.14 trillion yuan (about $640 billion)

by the first quarter of 2016 (Barrow, 2016). The HSR freight business will broaden China Railway's income resource and increase its profitability. Therefore, China Railway has a strong will to develop HSR freight and it is actively promoting this business. The number of the city covered by HSR delivery service increased sharply from 224 in 2015 to 505 in 2016, which means this service is now able to serve all the cities across China which are directly connected to the high-speed rail system.

In the future, with the increasing transport volume, it is necessary to launch high-speed trains designed for freight transportation. In fact, to enhance the transport volume, China Railway has already decided to accelerate the research and development of high-speed freight multiple units (Bingyang, 2014). CRRC Corporation, China's high-speed rolling stock manufacturer, has advanced high-speed rail manufacturing technology, so freight multiple units are technically unobstructed. Compared to passenger multiple units, freight multiple units have greatly reduced components, interior and equipment, decreasing the manufacturing cost. The speed of freight multiple units will be set between 200-250 km/hour, which is slightly lower than the passenger multiple units' maximum speed between 300-350 km. The train will directly use the existing high-speed rail lines which means the current passenger-dedicated lines will be transformed to passenger-freight mixed lines. The freight multiple units will mainly transport white goods which are high value-added, small-package.

When it comes to the policies in support of developing HSR freight, the Chinese government has revised the medium- and long-term plan to expand the railway network. The new plan is an updated version of the national railway plan issued in 2008. According to the new plan, by the year 2020, China's high-speed railway network will be 30,000 km, servicing more than 80% of large cities. By the year 2030, the high-speed railway network will have been comprehensively expanding to "eight rail lines north to south and eight lines east to west" based on "four rail lines north to south and four lines east to west" network which has been formed in 2014 (NDRC, 2016). The adjacent large- and medium-sized cities will be connected by lines ranging from 1 to 4 hours. Apparently, the continuing rapid expansion of the rail network will shorten the transit time and help to fuel growth in HSR Freight. Besides, the new plan emphasizes developing HSR express and light cargo transportation.

Existing problems

Since HSR freight business only exists a few years in China, it still exists many problems and faces challenges.

HSR in China is mainly designed for passenger traffic, so its operation plan does not consider freight traffic needs, causing HSR freight needs are not fully satisfied. At present, HSR freight service mainly uses the vacant space in high-speed passenger trains. Therefore, the operation time, operation section and schedule of HSR freight services are constrained by passenger traffic. Therefore, it is necessary to launch the specialized high-speed freight train. However, if using the high-speed freight train, the operation of passenger train may be influenced due to the longer stay time of freight train in stations.

The loading and unloading of freight are still operated by labor now, thus the efficiency of operation is greatly influenced. Since the HSR stations in China are constructed for passenger traffic, HSR stations do not have freight operation conditions such as freight warehouse, stacking area. Besides, it is hard to use handling machines. Usually, the stay time of high-speed trains at stations is very short, in order to improve the efficiency of the loading and unloading, it is necessary to reform the HSR stations to be appropriate for the freight traffic.

Another concern is the weight limit of loading. The infrastructure of HSR in China is designed for passenger trains. All high-speed trains are subject to strict weight limits. Therefore, HSR freight service is only suitable for the delivery of small and light goods with high added values.

Conclusion

Compared to Europe, China owns the world's largest express delivery market with a rapid growth rate and its high-speed railway network is widespread. Therefore, we believe the HSR freight business will have a better future in China than in European countries. HSR is an efficient and environmental-friendly and energy efficient transportation tool for both passenger and freight traffic. Constrained by the lack of data and materials, we only made general summary and analysis of freight transportation by HSR in this paper. We will continue to pay attention to the development of HSR freight transportation in China and worldwide.

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