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Parcels and Mail by High Speed Rail

-A Comparative Analysis of Germany, France and China

Xiao-Hong Liang[a*], Ke-Hu Tan[a], Anthony Whiteing[b], Chris Nash[b], Daniel Johnson[b]

[a] School of Economics and Management, Beijing Jiaotong University, 100044,Beijing,China

[b] Institute for Transport Studies, University of Leeds, LS2 9JT, Leeds, UK

Abstract: As rail freight reform develops further, parcels transport by the high speed rail network is expanding in China. We explore the optimal operational method through case studies. Both France and Germany have operated parcels trains on their high speed networks, at a speed of 270 km/h and 160 km/h respectively; following the literature we consider both as high speed freight trains. The business model, transportation organization and performance are compared between Germany, France and China. The findings of our analysis suggest dedicated high speed freight trains are better than mixed trains at exploiting advantages of high speed railways and achieving economies of scale. However, the sensitivity analysis tells us the dedicated high speed freight train in China will require at least 5% mode share on the busiest routes like Beijing-Shanghai and Guangzhou-Shanghai and over 30% on less busy routes like Chengdu-Changsha. From German and French experience, volume guarantees seem crucial for the operation of high speed freight trains. Competitive price is also important to attract enough volume. The construction of a limited high speed rail freight network on key routes will permit exploitation of economies of scale. Also night trains are a better choice for parcels and mail delivery companies.

Key words： Parcels; Mail; High Speed Rail; Business Model; Transportation Organization; Sensitivity Analysis

1. Introduction

With the wide take-up of internet, customers' shopping habits have changed tremendously over the last decade. E-commerce and mobile shopping market developed very fast and the market size is increasing. The Global Express Association (GEA) expected e-commerce to continue to grow substantially in the future with double-digit growth to be the norm (GEA, 2015). IResearch, a famous research corporation in China, also reported that the Chinese online shopping market reached 2.8 trillion CNY (China Yuan) in 2014 with an annual growth rate of 48.7%. According to the European Express Association, 16% of EU companies' sales revenues are dependent on express deliveries (expected to increase to 21% in 2020) and 30.3% of E-commerce sales revenue of EU-6 countries (including UK, France, Germany, Italy, Netherlands and Poland) are dependent on express delivery services. The express delivery industry is becoming one of the fastest growing industries in China. From 2011 to 2014, the annual growth rate of express deliveries in China has been consecutively over 50%.

Meanwhile, most express delivery companies rely mainly on road and air

* Correspondence to:
School of Economics and Management, Beijing Jiaotong University, 100044, Beijing, China.
E-mail address: tsxl@leeds.ac.uk (Xiao-Hong Liang).

transportation because of their reliability and flexibility. Therefore, the fast development of the express delivery business has increased the demand for speedy transport especially air express freight (Zhang and Zhang, 2002). Much cargo is carried on overnight flights when there is capacity at airports. But increasing airport congestion and restrictions on night flights, adverse effects of noise in the vicinity of airports, as well as concerns about the rising cost of fuel and restrictions on carbon emissions limit the development of air freight (Basner and Samel, 2006; Chapman, 2007). In terms of road transportation, congestion is increasingly severe. Truck transportation is not fast enough over long distances and can adversely affect the environment with high energy consumption (Forkenbrock, 2001; WBCSD, 2001; Ohnell and Woxenius, 2003; Chapman, 2007). In contrast, railways, especially high speed rail (HSR), run faster than road but are cheaper than air. Trains will emit less carbon dioxide than the combined road and air services currently operated and will also create less noise than lorries and planes (WBCSD, 2001; Shaw, 2003; Bonnafous and Raux, 2003; Chapman, 2007). Furthermore, over long-distance transport, HSR can achieve overnight delivery which is unachievable by road. HSR offer a viable alternative for express delivery companies under fluctuating fuel prices and limited night flights (highspeedmix project, summary report, 2000).

Both France and Germany have operated parcels trains on their high speed networks, at a speed of 270 km/h in France and 160 km/h in Germany; following the literature we consider both as high speed freight trains. Parcels and mail with high value and time sensitivity from mail and express delivery companies are the major source of HSR freight in these countries. Therefore, our focus of HSR freight is mainly on parcels and mail transport by HSR. In this business, different railway companies, terminal operators and parcels and mail delivery companies are included, such as SNCF, La Poste, DB AG, Deutsche Post UPS and TNT etc.. Transporting parcels and mail by HSR began from 2012 in China. The dynamic inspecting train (a normal HSR passenger train which is run without passengers in advance of the first passenger train each day to test the tracks) and passenger Electric Multiple Units (EMUs, carrying parcels placed in luggage storage while carrying passengers) are the two main approaches for this new business. Currently, less than 5% of express parcels are transported by railway which means great potential for rail in the express delivery market (Gausemeier, etc., 2001; Gong, 2011; Lin and Yu, 2012). Transporting parcels and mail by HSR has received the attention of both the academic and industrial community. HSR freight in China is still at an initial stage and has lots of shortcomings in terms of transport vehicles, transportation organization and cooperation between different companies. Studying parcels and mail by HSR in Germany, France and China is thus of great theoretical and practical significance.

There are four reasons that explain why we choose Germany and France as comparison subjects. The first one is it has been over 30 years since France introduced TGV La Poste business and over 20 years since Germany introduced express freight trains, which could provide some lessons. The higher degree of liberalization of rail freight transport in Germany and France is another reason. According to the Rail Liberalization Index 2011, Germany ranked fourth in European countries in liberalization of rail freight transport (Rail Liberalization Index 2011). The liberalization index includes two sub-indices: Access index (practical market access barriers) and LEX index (legal requirements). Higher liberalization index means an easier access to the infrastructure in the rail freight market for shippers, third party operators etc.. The third reason is that Germany constructed HSR for the

purpose of serving both passenger and freight transport to offset the high investments in new infrastructure which is quite different from the Japanese and French models (Dunn and Perl, 1994; Ebeling, 2005; Campos and De Rus, 2009; Albalate and Bel, 2012). The China Railway Corporation obtained a large portion of its income (over 50%) from freight traffic too and also needs to offset the high investments in HSR by serving freight traffic as well. The fourth reason is that there was a business suspension both in Germany and France because of insufficient volume, which could provide useful lessons for countries practicing high speed freight business.

Before we start our research, we need firstly to define the concept of HSR freight to which category parcels and mail by HSR belongs and understand the different standards of Germany, France and China. Actually HSR freight is not clearly defined since high speed is primarily associated with passenger transport. But since 1980s, HSR freight began to attract the attention of scholars at home and abroad with the opening of TGV La Poste (Troche, 2005; Tan and Zhang, 2014). When defining HSR freight, all the factors including technology, operation and character of goods should be considered. Ellwanger and Wilckens（1994）believe that the speed should be over 200 km/h and trains should be operated on high speed railways. Troche then presented a general definition of HSR freight by considering different reference speeds for passenger and freight transport. He divided railway freight into three levels: HSR freight with speed over 200 km/h, semi HSR freight with speed from 140 km/h to 200 km/h and conventional rail freight with speed less than 140 km/h. The term HSR freight is normally understood in a broader sense and includes semi-HSR freight (Troche, 2005). In this paper, we adopt the broader sense. In the following, the term HSR freight includes semi-HSR. These trains for parcel intercity service with 160 km/h are the fastest freight trains in Germany and they run on the high speed railways. That is why we consider the freight train delivering parcels and mail with speed of 160 km/h in Germany as high speed freight.

The paper is organized as follows: section 2 explains the research methodology; section 3 and section 4 present the comparative analysis from business model and transportation organization aspects. Section 5 includes a performance comparison and discussion. Section 6 presents conclusions and policy implications.

2. Methodology

This paper researches parcels and mail by HSR in Germany, France and China from business model, transportation vehicle and transportation organization aspects. The choice among different research methods including the case study method depends on the kind of research question. Our research actually addresses a descriptive question-“what is happening” and an explanatory question-“how or why did something happen?” Therefore, we adopt the method of comparative analysis based on the case study of Germany, France and China. Case studies could be used to expand and generalize theories through a rigorous process of case selection and analysis. The findings of case studies can generate further inquiry to the existing theory and contribute to the accumulation of knowledge (Yin, 2008; Nostikasari, 2015). In addition, the approach of the case study is useful to test theoretical propositions and compare common sense with the observation of the case (Flyvbjerg, 2006).

In addition, we adopted the sensitivity analysis in section 4 when we discuss the market potential of dedicated freight train in China. We expect to understand in which case the dedicated freight train is feasible in China through this method.

2.1 Data

All data and information in this paper are from statistical yearbooks, corporate published or internal annual reports, corporate responsibility reports, news releases, related articles and open-ended interviews with key personnel from the railway company and parcels and mail delivery companies. The information on cities involved in the HSR freight business in China is gathered from the official website and news releases of China Railway Express. The cities involved in the route of HSR freight in Germany are acquired from the annual reports of DB AG and the official website of Deutsche Post. The performance of HSR freight in Germany related to the carbon emissions and the substitution rate to road are also from the annual reports of DB AG and corporate responsibility reports of DHL. Information about TGV La Poste business are gathered from related published articles and open-ended interviews with key personnel in SNCF. The volume and proportion of HSR freight in China are from the internal annual reports of SF-Express and interviews with key personnel of Beijing Railway Bureau. The parcel volume data of Beijing and Shanghai in section 4 are from the annual statistical bulletin of State Post Bureau. The information regarding participants and business model between railway and express delivery company and transportation organization in China are all acquired from interviews with key personnel from China Railway Corporation, China Railway Express, Beijing Railway Bureau and SF-Express.

2.2 Data Analysis

We firstly define the factors on which the comparative analysis is based. In order to achieve a comprehensive comparison and analysis, we choose six categories in total from participants to transport organization, see Table 1.

Table 1 Categories for comparative analysis of high speed express service

Category	**Details**	**Country**
Participant	Railway company and involved express delivery company	Germany, France and China
Business model	The way railway company and express delivery company cooperate with each other	
Transport vehicle	Vehicle parameters including speed, loading capacity and carriages	
Transportation organization	Shipping schedule-night train or day train; dedicated freight train or mixed train	
Transportation route	Route and involved cities	
Performance	Volume, carbon dioxide emissions and market share	

The descriptive analysis is conducted for participants, business model and transport vehicle after collecting related data and information. For the comparison analysis of transportation organization and transportation route, we draw them into graphs to find different patterns under different approaches as shown in figure 1.

In the sensitivity analysis, we chose Beijing (BJ) and Shanghai (SH), because both cities ranked in the top five in terms of the express parcels volume. We assume that there is potential to run the dedicated freight train if the route of Beijing to Shanghai has sufficient volume. The express parcel volume HSR will carry potentially is related to the total parcel volume between these two cities and the market share of HSR. Then different scenarios were set to see in which case the dedicated freight train between these two cities will be feasible. Since the average

annual growth rate of parcel volume of Beijing and Shanghai in the past five years is over 40%, the first scenario is to assume the same trend in the following several years. However, according to the experience from world leading express delivery companiesFedEx and UPS, the annual growth rate of express parcels has stabilised at around 10%. Therefore, the third scenario is to assume the decreasing trend from around 30% in 2016 to 10% in 2018. We also assumed one scenario in between as second scenario with 30% of annual growth rate in next three years. Meanwhile, we assumed different market share of HSR from 5% to 15% to see how much share the railway will need to meet the requirement of operating one freight train with at least 8 carriages. The conclusion was made through comparing the potential parcel weight between Beijing and Shanghai with the potential 120-ton loading capacity of one freight trainset, which is based on the international evaluation of loading capacity of high speed freight trains (Eurocarex, 2013). If the total parcel weight is less than 120 tons, then we conclude it is not the right time to start the express freight train service. Otherwise, it is possible to operate express freight on this route.

3. Comparison of business model

3.1 Participants

There are two kinds of participants involved in parcels and mail by HSR business- the railway company and post/express delivery company. In France, SNCF and La Poste launched the first HSR freight business-TGV La Poste in 1980s. The business in Germany dates back to 1994 and was operated by DB AG and a freight enterprise through commissioning operations (Liang and Tan, 2014). Then, DB AG began to cooperate with Deutsche Post in 2000. Although DHL was also involved in this business, we regard Deutsche Post as the main body when we discuss the participants, because Deutsche Post took over DHL from 2005.

In China, the number of participants in parcels and mail by HSR business is more than that in Germany and France. The involved railway company is discussed at railway bureau level. There are 18 railway bureaus in total in China affiliated with the China Railway Corporation. China Railway Corporation is in charge of train scheduling and network construction. The railway bureaus are responsible for the passenger and freight transport in their region. Normally, railway bureaus should turn over their transport revenue to the China Railway Corporation which will distribute benefits to different bureaus after liquidation. These railway bureaus granted permission from China Railway Corporation to run HSR freight business could expand the market by themselves. The number of participants in HSR freight in China is larger than in Germany and France. The involved express delivery companies are diverse, including a state-owned express delivery company (EMS), a private express delivery company (SF-Express), a foreign express delivery company (FedEx) and a railway express company (China Railway Express Co., Ltd.-CRE) etc.. A large number of participants means complex cooperation with each other and great challenge in negotiating when an emergency occurs.

3.2 Business model between different participants

The business models in Germany, France and China are different especially from the distribution of revenue risk. Although signing contract is the main method of cooperation between railway company and mail and parcels company in these countries, different participants bear different risks. In France, La Poste owned the

trainsets and bore the revenue risk. SNCF was a pure service provider and were paid for doing so. In China, different railway bureaus sell available spaces in inspecting trains to different express companies and bear revenue risk. Under the EMUs approach, it is CRE that bears the revenue risk for parcels and mail by EMUs. China Railway Corporation in this case is a pure service provider and gets paid. While, in Germany, although DB AG is responsible for marketing and bears the revenue risk, there are volume guarantee terms with Deutsche Post which will decrease this risk (see Table 2).

Table 2 Business model of parcels and mail by HSR in Germany, France and China

Country	**Germany**	**France**	**China**	
Start year	2000	1984	2012	2014
Approach	Freight train	Freight train	Dynamic inspecting train	EMUs
Train owner	DB AG	La Poste	China Railway Corporation	
Participant	DB AG & Deutsche Post	SNCF & La Poste	Railway Bureaus & Express delivery companies & Logistics Companies	China Railway Corporation & CRE
Business Model	Monopolized participants; contract; DB AG bear the revenue risk and is responsible for marketing, providing train service and purchasing capacity from DB Netz, Deutsche Post guarantee the volume to decrease DB AG's revenue risk and pay train service and access charges to DB AG	Monopolized participants; contract; La poste responsible for volume and marketing and bear revenue risk and also pay the access charge to RFF; SNCF responsible for providing maintenance service etc.	Open to all; contract; Railway Bureaus responsible for marketing, train and infrastructure service and bear revenue risk; Express and logistics companies pay for train service.	Monopolized participants; CRE get authorization from China Railway Corporation and responsible for marketing and bear revenue risk; China Railway Corporation get paid for train and infrastructure service.
Details of contract	Route and Scheduling, speed, guaranteed volume and capacity etc.	Related infrastructure construction, vehicle purchasing, division of work and benefit etc.	Scheduling, vehicle, rate, responsibility and operation body, document required, packaging etc.	

From Table 2, the contract of delivering parcels and mail by HSR in Germany was signed by DB AG and Deutsche Post on 15th July 1999 (Li, 2000). They agreed to start the operation of parcel intercity train with the maximum speed of 160 km/h. The volume and capacity were also prescribed in detail. Although the business of delivering mail by railway was ended on 31st May 1997, railway still held a large share with 10% on weekdays and 50% at weekends in the parcel delivering market between major transfer centres[†]. Since the intercity parcels train is a high speed freight train, volume and capacity guarantees are necessary. Therefore, the agreement presented the clear requirements that Deutsche Post would transfer 10,000 loading units from road to railway guaranteeing the shipping volume increased by 20% and DB AG would receive 20,000 wagons from a third party guaranteeing the shipping capacity. Since DB AG owns the train and is responsible for marketing and bears the revenue risk, the guaranteed volume from Deutsche Post can reduce its revenue risk

[†] http://www.railwaygazette.com/news/single-view/view/postal-boost.html

and Deutsche Post will also pay train service and access charges to DB AG.

There were cooperation contracts between SNCF and La Poste as well. They have a clear division of work between each other. La Poste purchased the transport vehicle and was responsible for marketing, collection and delivery and also bore the revenue risk, while SNCF was responsible for train maintenance and negotiating the time slots with RFF. All revenues belonged to La Poste. La Poste paid SNCF service charges and RFF the access charges (Tan and Zhang, 2014). In this case, all revenue risks were on La Poste.

In order to take full advantage of the railway resource, the agreement put strong emphasis on the volume and capacity guarantee especially in Germany. There were no volume guarantee terms in France since La Poste owned the vehicle and were responsible for volume and revenue. However, because of more express delivery companies being involved and limited freight capacity in China, there were no volume guarantee terms in the contracts. Also the cooperation relationship is more complex than in Germany and France. Under the inspecting train approach, different railway bureaus sell the available spaces to different shippers and bear the revenue risk. Signing annual cooperation contracts is the main method between different participants. The rate, shipping schedule and packaging are prescribed in detail in the contract. Under the EMUs approach, China Railway Corporation authorized CRE as the sole body to operate parcels and mail by EMUs. CRE is responsible for marketing and volume and bears the revenue risk. The China Railway Corporation provides train and infrastructure service and is paid accordingly. However, other logistics companies still can cooperate with CRE to transport parcels on EMUs, which is viable in theory but no case in practice.

4. Transportation organization of parcels and mail

4.1 Rolling stock

The rolling stock is one of the most important elements in the operation of HSR freight. These three countries have adopted different types of rolling stock for this service. In China, parcels and mail by HSR mainly relies on passenger trains, while Germany and France use freight trains. Three trainsets of TGV La Poste were converted from former TGV passenger trains. Because the minimum speed of HSR freight in China is 200 km/h and it is operated only on the HSR, the requirements for HSR freight trains are higher than in Europe. Although the freight train is already under design, it will take a long time to come into service. HSR freight in China is still dependent principally on the inspecting train and EMUs, both of which are passenger trains.

The express freight train that Germany has adopted is with a speed of 160 km/h. The TGV La Poste in France ran with a speed of 270 km/h. HSR freight in China runs over 200 km/h. However, the real HSR freight network will need a long time to develop. Currently, China Railway Corporation and express delivery companies are relying on the express freight train with the speed of 160 km/h and 140 km/h on the conventional lines in addition to the inspecting train and EMUs to meet the increasing demand.

The differences in rolling stock that Germany, France and China use for HSR freight service include vehicle type, speed and loading capacity and number of carriages (see Table 3).

Table 3 Rolling stock comparison of HSR Freight in China, Germany and France

Parameter	China	Germany	France
Train type	Passenger train	Freight train	Freight train
Vehicle type	Inspecting train /EMUs	DB Sgss-y	Series 923000
Speed	Over 200 km/h	160 km/h	270 km/h
Carriage	8 or 16 carriages	20 containers	8 carriages
Loading capacity of one trainset	17t	500t	61t
Lines	HSR	HSR or conventional lines	HSR

Note: The loading capacity for parcel transport in Chinese case is the actual available capacity of one dynamic inspecting train with 8 carriages and with all passenger seats in it.

Table 3 shows that there are great differences in the parameters of rolling stock these three countries use for HSR freight. Except for the speed, the most obvious difference is the loading capacity, which is because of the different approaches. China takes the unmodified passenger train to carry express parcels, while Germany takes the modified freight train. The payload is up to 500 tons for a freight train with 20 containers (Liang and Tan, 2014). In addition to the Sgss-y series train that DB AG used, they brought in another six trainsets of Sdggmrs739 in 2001 with a speed of 140 km/h. In contrast, the inspecting train with 8 carriages in China could carry a maximum weight of 17 tons because most space is taken by passenger seats. The extra capacity of passenger EMUs for freight is less. To guarantee the service quality of passenger transport, China Railway Corporation regulated the maximum weight one EMU could carry. The freight trains converted from passenger trainsets in France have an 87 tons tare mass and the loading capacity is 61t (Troche, 2005; Tan and Zhang, 2014).

The different rolling stock types these three countries have adopted are also related to the freight volume. Guaranteed volume from parcels and mail delivery company in French and German case required the operation of freight trains and the economies of scale can be achieved through this approach. The unit transport cost can be decreased accordingly. In contrast, the development of HSR freight in China is just at the early stage. The limited transport capacity of trains and lack of supporting facility limit its development. In addition, parcels and mail delivery companies in China are conservative in guaranteeing mode transfer in the early development of this business. It is also risky for railway company to run the dedicated high speed freight trains under current conditions.

4.2 Market Potential for Dedicated Trains

Since the main partner of HSR freight business is express delivery companies, the future developing trend of express delivery industry and the potential market share of HSR determine whether to operate dedicated high speed freight trains in China. Based on the fact of average growth rate from world leading express delivery companies FedEx and UPS, the annual growth rate of express parcels is around 10%. According to French Les Echos and La vie du rail, TGV La Poste achieved 15.5% of market share in Southeast of France in next-day delivery service of La Poste and about 5% in the whole France[‡]. Therefore, we set three scenarios about the market

‡
http://www.lesechos.fr/19/06/2014/lesechos.fr/0203579790369_la-poste-arrete-les-tgv-pour-transporter-le-courrier--mais-reste-fidele-au-rail.htm
http://laviedurail.com/011-16283-les-tgv-de-la-poste-seront-remplaces-par-des-wagons-en-2015.html

share of HSR-5%, 10% and 15%. Even if the Chinese express delivery industry will keep increasing at an annual growth rate of 40% in the following three years, a high level of parcel transfer from other transport modes is essential for the operation of freight train even on Beijing-Shanghai route (see Table 4).

We set 2015 as the base year and the total parcel volume of Beijing in 2015 is 1.41 billion pcs and volume of Shanghai in 2015 is 1.71 billion pcs according to the statistical bulletin of State Post Bureau on the 2015 post industry development. Also, based on the statistical data of express mail service between BJ-SH from State Post Bureau in 2014, we assumed the same percentage exist in the next three years ie 8% of parcels from Beijing are sent to Shanghai, 10% of parcels from Shanghai are sent to Beijing. Then, we examine the market potential of one dedicated freight train through comparing the possible parcel weight between Beijing and Shanghai with the 120-ton loading capacity of one high speed freight trainset.

Table 4 Sensitivity analysis of parcel volume and market share of HSR on BJ-SH route

Scenario	Year	Growth rate	Market share of HSR	BJ-SH HSR(ton/day)	No. of carriages	SH-BJ HSR ton/day	No. of carriages
Scenario1	2016	40%	5%	32.6	2.2	49.1	3.3
			10%	65.1	4.3	98.3	6.6
			15%	97.7	6.5	147.4	9.8
	2017	40%	5%	45.6	3.0	68.8	4.6
			10%	91.1	6.1	137.6	9.2
			15%	136.7	9.1	206.3	13.8
	2018	40%	5%	63.8	4.3	96.3	6.4
			10%	127.6	8.5	192.6	12.8
			15%	191.4	12.8	288.9	19.3
Scenario2	2016	30%	5%	30.2	2.0	45.6	3.0
			10%	60.5	4.0	91.2	6.1
			15%	90.7	6.0	136.9	9.1
	2017	30%	5%	39.3	2.6	59.3	4.0
			10%	78.6	5.2	118.6	7.9
			15%	117.9	7.9	177.9	11.9
	2018	30%	5%	51.1	3.4	77.1	5.1
			10%	102.2	6.8	154.2	10.3
			15%	153.3	10.2	231.3	15.4
Scenario3	2016	30%	5%	30.2	2.0	45.6	3.0
			10%	60.5	4.0	91.2	6.1
			15%	90.7	6.0	136.9	9.1
	2017	20%	5%	36.3	2.4	54.7	3.6
			10%	72.5	4.8	109.5	7.3
			15%	108.8	7.3	164.2	10.9
	2018	10%	5%	39.9	2.7	60.2	4.0
			10%	79.8	5.3	120.4	8.0
			15%	119.7	8.0	180.7	12.0

Note:(a) each parcel weights 1.5kg on average obtained by total weight over toal pcs according to SF-Express. (b) the HSR ton per day is calculated through the total weights per year divided by 365 days. (c)one carriage of HSR freight train can load 15 tons on average.

Table 4 shows the sensitivity analysis result about the number of HSR carriages needed between Beijing and Shanghai under different scenarios. The actual base figures are extrapolated forward to future years based on market shares and growth rates assumed under each scenario. The results tell us even if the future annual growth rate keeps at 40%, 10% market share of HSR is essential for the operation of one dedicated freight train with 8 carriages in 2018. With decreasing annual growth rate from 30% to 10%, over 10% of market share should be guaranteed for the freight train to be viable. However, this is based on the forecasting data of Beijing and Shanghai, which are both in the top five cities in terms of parcel volume. For such developed cities with higher parcel volumes in East and South of China, the necessary market share of HSR will be lower and for cities with lower parcel volumes in less developed Southwest of China, such as Chengdu and Changsha, it will be higher accordingly. The parcel volume comparison of different cities in China is listed in Table 5.

Table 5 Parcel volume comparison of major Chinese cities in 2015

Rank	City	Parcel volume(10000pcs)	Rank	City	Parcel volume(10000pcs)
1	Guangzhou(GZ)	195207.7	7	Dongguan	75121.9
2	Shanghai(SH)	170778	8	Suzhou	56383
3	Beijing(BJ)	141447.3	9	Nanjing	50251.9
4	Shenzhen	140134.9	10	Chengdu(CD)	38179.7
5	Hangzhou	125707.3	24	Changsha(CS)	18675.8
6	Jinhua(Yiwu)	97095			

Data source: the annual statistical bulletin of State Post Bureau, 2015

From Table 5, Guangzhou has the highest parcel volume of all cities in 2015. However, even on Guangzhou-Shanghai route, under the assumption of 40% annual growth rate in next three years and 10% of parcels sent from Guangzhou to Shanghai and 10% from Shanghai back to Guangzhou, over 5% of parcels transported by HSR between the two cities is still needed to make one dedicated train viable. While about 30% of parcels transported by HSR from Chengdu to Changsha will make the one-way transport of the dedicated trainset feasible under the same assumption. Higher market share for the two-way transport will be necessary on Chengdu-Changsha route because the parcel volume of Changsha is less than half the volume of Chengdu. In summary, compared with higher market share essential for one dedicated high speed freight train on less busy routes, relatively lower market share on busy routes connecting cities with higher parcel volume is necessary. In three years, it will be feasible for busy routes like Beijing-Shanghai and Guangzhou-Shanghai to operate the dedicated freight train even with only 5% of market share of HSR.

In fact, China Railway Corporation started developing a freight bullet train in 2014. The HSR freight train is modelled on existing passenger trains that can run at up to 350 km/h to haul higher-value cargo such as E-commerce deliveries and express parcels at speeds of up to 250 km/h. The first carriage will roll off the assembly line in the first half of 2016[§]. Because there will be fewer components and less trim inside, the cost of freight train will be lower than for passenger trains and the loading capacity will be higher than inspecting trains and passenger EMUs. The freight train will run on HSR which will make the dedicated passenger rail lines to freight-passenger mixed ones. However, due to lack of supporting facilities around railway stations and the uncertainty of cooperation with the railway company, high level of parcel transfer from parcels and mail delivery companies to support the operation of HSR freight train is unrealistic for now. Therefore, the inspecting train and EMUs are the compelling choice under this situation.

4.3 Transport route

The network design and transport route of parcels and mail by HSR in Germany, France and China are different too, which is also relevant to different transport approach these three countries adopt. The German and French cases are more centralized and the Chinese case is more discrete.

Since Germany and France adopt the freight train with high capacity, a limited intercity network with trunk lines is a better choice. The German network consists of

§ http://companies.caixin.com/2015-12-17/100889222.html?utm_source=xueqiu&utm_medium=PCweb&utm_campaign=HeZuo

the East-West line and North-South line. The North-South line connecting Hamburg and Munich firstly came into service in 2000. Then, the East-West line connecting Berlin and Cologne went into service in 2001.After one-year's operation, the service on East-West line stopped in September 2002 because of the insufficient volume and poor performance. The freight had to be transported by road. But with the increasing tolls for heavy trucks in Germany, the transport cost of road increased accordingly. Deutsche Post began to reconsider the possibility of transporting express freight by railway. The negotiation between DB AG and Deutsche Post was then restarted and Deutsche Post needed to increase the freight volume to ensure the economic benefit of this project. In early 2004, the East-West line went into service again. The volume guarantee from Deutsche Post and competitive price from DB AG were the basis of the reopening of the East-West line.

The French network mainly includes one line-the North to South line. In this way, the trunk line could concentrate the freight from nearby cities and take advantage of the railways' high speed, long distance and high capacity into full effect. After 31 years operation, TGV postal services ended in mid-2015 because of increasing access charges and decreasing volume. It became cost inefficient for La Poste to transport parcels and mail through high speed railway.

There are no fixed transport routes in China because of the lack of high speed freight trains. There is point-to-point transport between different cities rather than a hub and spoke network. The cities currently involved in HSR freight business are shown in Table 6. Most of them are relying on EMUs to transport parcels.

Table 6 Cities involved in parcels and mail by HSR network in China

Order	No. of cities	Cities included	Start time
1st batch	23	Changsha, Beijing, Shanghai, Zhengzhou, etc.	1st Apr.,2014
2nd batch	22	Dalian, Qingdao, Chengdu, Chongqing, Xuzhou, etc.	1st Sep.,2014
3rd batch	56	Baoding, Wuhai, Linhe, Dongsheng, etc.	1st Nov.,2014
4th batch	50	Baotou, Nanyang, Shangqiu, Taian, Liaocheng,etc.	30th Dec.,2014

Data Source: From the official website of CRH

Table 6 shows that since the parcels and mail by HSR business launched on 1st April 2014, there are 151 cities in total involved in this new business (as of end of 2014) in China. The passenger EMUs is the main approach. The first batch of cities involved mainly large cities with dense populations such as Beijing, Shanghai and Guangzhou etc. The second city batch involved mainly large and medium size cities such as Dalian, Tsingtao and Chongqing etc.. In order to extend the coverage of this business, the 3rd city batch launched from 1 November 2014 and included another 56 cities. The provincial capital cities of Tibet, Gansu and Qinghai were also involved in this batch. On 30 December 2014, China Railway Corporation together with CRE designated another 50 small and medium-sized cities to promote the high speed rail freight business. Among the 151 cities, most of them are concentrated in eastern coastal areas and well-developed areas. As of the end of November 2015, there are 224 cities that have been involved in this business. They plan to start this business in a further 300 cities with over 400 HSR stations in 2016 and will expand it to 1000 cities in 2018 involving all HSR stations in their blueprint. But the HSR freight network in China is still characterized by point-to-point and discontinuous transport. It is still hard to reach large scale transport between different cities. The hub and spoke

network of HSR freight needs not only proper nodes but also proper route design. Routes with distance of over 1000km in China will make HSR more competitive than air and road.

4.4 Shipping schedule

Another difference in transportation organization of parcels and mail by HSR in Germany, France and China is the shipping schedule. The high speed freight train in Germany and France operates during the night with a fixed schedule, while the time of HSR freight service in China is more flexible. There are both night trains and day trains for different transport distances.

In Germany, high speed rail lines are mainly used for passenger transport during the day time. High speed freight trains normally operate during the night, which was similar with the French case. Therefore the parcels and mail can be collected during the day and transported during the night, which could just meet the demand of parcels and mail delivery companies to deliver the parcels and mail in the morning. On the North-South line in Germany, the departure time from Hamburg station toward Munich is 20:25. The train is separated into two sets at Wurzburg station. They will arrive at Kornwestheim station at around 03:17 and at Munich station at around 04:11 next morning respectively. The departure time from Munich and Kornwestheim station towards Hamburg station is 20:15 and 21:09 respectively. These two trainsets are marshalled into one train at Wurzburg station and arrive at Hamburg station at 04:10 next morning. The average time the train takes between Hamburg and Munich is 8 hours (Troche, 2005). The train in the East-West line connecting Cologne and Berlin departs at 20:30 from Unna station and arrives at Berlin station at 02:59 the next morning. While the train from Berlin towards Unna departs at 20:48 from Berlin station and arrives at Unna station at 02:46 the next morning. The average time the train takes between Berlin and Unna is 6 hours. The shipping schedule of the East-West and North-South lines is shown in Figure 1.

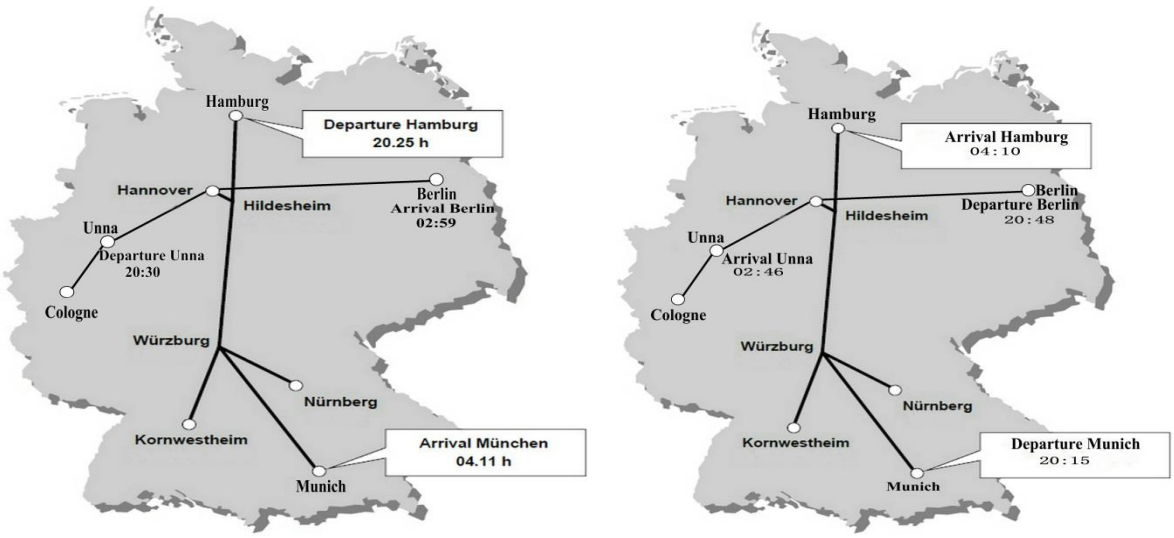

Figure 1 the shipping schedule of East-West line and North-South line in Germany

In France, SNCF mainly considered the passenger train operation and the maintenance window at night when designing the freight train schedule. The freight train operating between Paris and Marseille normally departed late at night and arrived in the morning. For example, the train departed from Paris at 19.11pm heading

for Lyon and returned to Paris at 02:25am the next day (Tan and Zhang, 2014). This schedule did not disturb the operation of passenger trains and the mail collection of La Poste as well.

There are more time choices of HSR freight in China under the inspecting train and EMUs approach. Since the inspecting train could only run in a restricted region, the range of it is limited. Generally, it will depart from one station and arrive at another in the early morning. This schedule will not delay the delivery time for express companies. Take the Wuhan-Guangzhou line for example, the inspecting train will leave the Guangzhou station at 04:45, then make a short stop at Shenzhen station and arrive at Changsha station at 08:32 (see Figure 2), which could meet the timing requirement of express delivery companies without disturbing the first passenger train's operation in the morning.

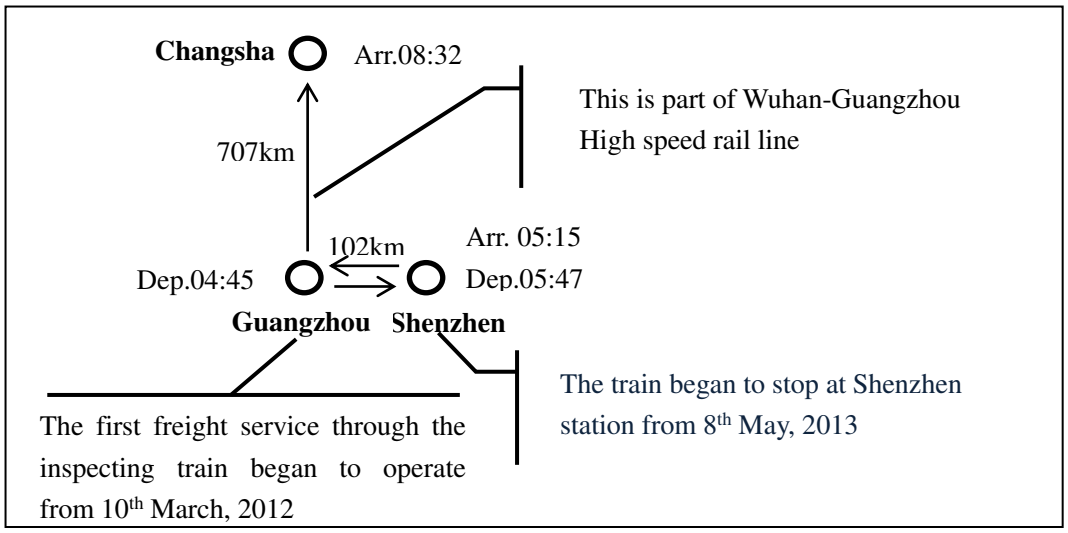

Figure 2 Schedule of inspecting freight train on Wuhan-Guangzhou HSR

However, the EMUs only operate in the day time. The arrival time depends on the transport distance. Express delivery companies normally collect and deliver parcels in the day time but transport them at night. In order to harmonize this working time, the night train is best for express delivery companies. But the existence of a maintenance window for high speed railways will impede the operation of high speed trains in the night. How to optimize the train working diagram to meet demands from both sides needs further research.

5. Performance of parcels and mail by HSR

5.1 Performance

As a result of the difference in shipping schedule, business model and transportation organization of parcels and mail by HSR in Germany, France and China, there is much difference in performance especially in the mode transfer aspect.

Although HSR freight has been operated in Germany for a long time, there was insufficient volume initially and consequently there was an interruption of this service. But with the agreement of the volume guarantee and preferential price policy, the HSR freight service achieved much higher volumes in the later period. For example, the capacity utilization was up to 75% in the South-North line in the end of 2002, which is the decisive cause for DB AG agreeing to reopen the East-West line. Parcels

and mail from Deutsche Post accounted for 80% of freight in the parcels intercity business and others are from IKEA, Danzas Euronet and Otto-Versand. Since 2000, freight transferred to railway from road numbered more than 100,000 trucks every year. Green transportation is realized through delivering parcels and mail by railway. The noise from road transport is decreased. The road congestion is eased and the carbon dioxide emissions are reduced as well**.

The environmental benefit of the intercity parcels train is very obvious in Germany, such as less traffic noise, less congestions on the roads, fewer emissions of CO_2 and other airborne pollutants According to the sustainability report and environment report of Deutsche Post World Net and DHL, Parcel InterCity transports 280,000 tons of goods per year along South-North and East-West routes, shifting 70 truckloads off the roads and onto the railway system each day. Transporting one parcel over 850 km by rail generated 410g of CO_2 emissions with 0.48g/km, which is lower than 1.45g/km by road. This result accorded with the original intention of cooperation between DB AG and Deutsche Post. Delivering express parcels and packages by rail could not only reduce the transport cost but also improve the transport performance. Therefore, the subsidiary of Deutsche Post-DHL chose rail as the main transport mode in transnational parcel delivery, such as the high value-added transport from Sweden to Germany via Denmark.

In France, after the launch of TGV La Poste in 1984, all traditional mail services on conventional freight trains with speed of 80 km/h were transferred to the high speed freight train in the end of 1990s. In terms of the load capacity, one TGV trainset could load 61 tons which is more than 4 times what one postal airplane could carry. Meanwhile, the energy consumption is only 1/6 that of a postal airplane (Tan and Zhang, 2014). Under the fierce competition from other express delivery companies and the increasing cost of HSR freight, La Poste reduced this service from 8 to 6 daily round trips in 2009. In mid-2015, La Poste ended TGV postal services, deciding to shift mail services to swap bodies instead as part of an investment in its logistics network. A new rail hub at Bonneuil-sur-Marne south of Paris is due to open later in 2016, which will replace the TGV terminal at Charolais. The hub will link Paris with freight terminals across France and will consolidate operations from two road terminals, reducing lorry movements by around 638,000 km per year.

However, parcels and mail by HSR in China is new and relies on the passenger train. The capacity is quite limited. Taking the Guangzhou Railway Group Corporation for example, they operate the inspecting train delivering parcels and mail from Guangzhou to Changsha via Shenzhen. During the period from March in 2012 to June 2013, this train transported 13 tons express parcels on average every day, which is actually less than the weight one carriage could load in the case of dedicated freight train. Since the EMUs need to consider the service quality for passengers, China Railways Corporation set limits on the maximum kg and pieces of parcels one EMU could carry. According to interviews with key staff from Beijing Railway Bureau, the income of HSR freight through EMUs is only around 1400 CNY. In Ha'erbin, the volume of HSR freight was only 200 pieces from April to May in 2014 with 8 pieces on average every day.

In addition, HSR still has low market share in the express delivery industry. Taking SF-Express for example, the proportion of HSR during January to June in 2013 was only 0.24%, whilst road transport had the highest proportion and then full-cargo aircrafts. According to the estimation of China Railway Express, the

** Corporate responsibility report of DHL, 2010

substitutability of railway to air transport will be increased once the high speed freight trains come into service. The market share of railways in express delivery industry will increase accordingly.

5.2 Discussion

According to the results of comparative analysis between Germany, France and China, we found that the performance of parcels and mail by HSR in Germany and France in terms of mode transfer, stable cooperation and network design is better than in China. The long history of high speed freight in Germany and France is one reason. Other reasons are also decisive. First of all, the network design with several trunk lines like in Germany could contribute to enough freight being collected from parcels and mail delivery companies or other shippers to exploit economies of scale. Also, the penalty imposed on the railway company for punctuality can assure the express delivery company the timeliness for parcels delivery, which has a positive effect on the mode transfer. In addition, the number of participants influences the cooperation complexity. For example, the cooperation between numerous express delivery companies and 18 railway bureaus in China is much more complex than between DB AG and Deutsche Post in Germany, SNCF and La Poste in France. It is time consuming to come to an agreement and negotiate with each other. The mechanism of penalties and responsibility allocation for different participants in China is not advanced yet, which in turn has an adverse effect on volume guarantee and network development.

Also, a competitive price of HSR freight is important for mail and parcel delivery companies when deciding whether to transfer parcels and mail to rail. In the German case, the infrastructure manager and the main railway operator are two branches of one holding company which could lead the price to favor the main operator (Link, 2003; Crozet, 2004). DB AG as the main operator can offer competitive price to Deutsche Post to promote mode transfer. In the French case, the infrastructure manager and railway operators were totally independent from each other which would lead to conflict on the field of infrastructure charges and slot allocation (Beria etc., 2012). Also the access charges on high speed lines in France have increased substantially and exceed the marginal infrastructure cost level (Crozet, 2004; Crozet, 2007; Nash, 2009). Since La Poste owns the train, the price was set by La Poste based on the access and service charges by SNCF. With the high access charges from SNCF, the transport cost for La Poste is high accordingly which directly weakened the competitiveness of high speed rail freight. In China, the price of HSR freight is much higher than road and only a little lower than air in the inspecting train case which appears not competitive enough for those potential partners.

Meanwhile, the night train in Germany and France meets the requirements of shippers well. The express delivery company could collect enough parcels before the train's departure and the distribution would not be delayed with the train's arrival in the morning. Although the inspecting train in China could arrive at the destination in the early morning, the shipping distance is still limited to cities belonging to the same railway bureau. In spite of the flexible timetable and transport distance in the case of EMUs, they can only carry business or urgent letters and a small amount of fresh vegetables or flowers because of the restricted transport capacity. Shipping schedule and transport distance are two crucial factors for HSR freight. The unreasonable layout of either of them would affect the enthusiasm of express delivery companies.

In addition to the limitation in available capacity, shipping schedule and transport distance of current rolling stocks that the high speed parcel transport business has adopted in China, there are some other obstacles that have a significant impact on the feasibility of this business. Firstly, platforms and passageways in Chinese HSR stations are passenger dedicated. There are no freight access and transshipment facilities on existing platforms. Most loading and unloading processes are carried out manually which is time consuming and inefficient. Potential loading and unloading technique depends on the type of wagons or containers to handle. Secondly, there are no freight yards at existing terminal stations. All stations were constructed for passenger transport purpose without freight yards. Specialized freight yards with extra space for parcel storage and sorting will be necessary as demands increase. They could be either newly constructed and situated nearby the high speed lines or renovated from conventional freight yards and connect with the high speed lines through a branch line. Different solutions depend on different budgets and planning purposes. The long distance between HSR station and parcel distribution centre is another weakness. It requires extra time to transfer parcels and mail from local distribution center to railway stations. This can be improved when multimodal terminals are constructed. Since the above improvements will need a lot of investments in train design, transshipment facilities, construction of yards and terminals, the technical and economic feasibility of this business should be considered before introducing it to the market.

6. Conclusions

Given the different national conditions, economic structure and cultural traditions, we did not expect the same approach and business model in these three countries. Although the approach of railway heavy cargo transport may be similar for different countries, the approach of parcels and mail by HSR which targets the door to door transport of high value goods with higher timeliness requirements and flexible shipping distance can be quite different. The objective of this article was to explore the common and different grounds of HSR freight business in Germany, France and China and try to find the applicability and performance of different approaches, then to investigate what lessons can be learned from the case studies in order to deal with the transport organization issues that characterize today's high speed freight development.

Various lessons are learned through the comparative analysis. Firstly, it seems that the high speed freight train is better than the mixed train at exploiting the advantages of HSRs and achieving economies of scale. Also it will promote mode transfer. However, the volume guarantee from the mail and parcel delivery company or other shippers is essential under this approach. For example, over 5% of parcels transferred to HSR in China are essential to make the freight train viable even on busy routes like Beijing-Shanghai and Guangzhou-Shanghai. Higher levels of mode transfer will be essential on less busy routes. Otherwise, there will be capacity waste and cost increase. The mixed train like EMUs in China could be applied to routes with extra capacity when there is less passenger transport demand, which could improve the train utilization rate with only a small increase in the marginal operational cost. Under the approach of a dedicated freight train, the price of HSR freight has to be competitive compared with road and air transport in order to attract enough freight transfer from them. The route design is also important to attract enough volume forming the hub and spoke network. In addition, a reasonable shipping time is crucial

for express delivery companies, so they can collect enough parcels before the train's departure and distribute them in time after the train's arrival. Overnight trains suit express delivery companies and are adopted by all three countries, because normally parcels are collected in the afternoon and distributed in the morning. An inconvenient shipping schedule means insufficient freight volume, which will adversely affect the economics of high speed freight trains. Consequently, we might expect that high speed freight trains in China could run successfully under volume guarantees from express delivery companies with an HSR freight network set up with a reasonable route design and shipping time exploiting the advantages of HSR to the full.

The lack of quantitative analysis in this article is caused by the lack of data in the China case from just 3 years of operation. Therefore, although we compared the performance between different approaches in Germany, France and China, there is no supporting quantitative evidence to show which approach between high speed freight trains and mixed passenger-freight transport is better. In terms of scope for future work, studies related to other countries would be helpful in finding different approaches to HSR freight and the applicability of them. The cost and benefit analysis of HSR freight train is also decisive upon whether to adopt this approach. The comparison through the quantitative approach would be helpful to evaluate the efficiency of different approaches. Also, the assessment of different cooperation mechanisms among numerous participants aiming to decrease the transaction cost requires more research since the management factors normally weigh more highly than technical issues in determining the success of HSR freight business. The optimization of high speed train working graphs for both passenger and freight transport is another research focus.

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