High Speed Railways
-Case of China
A Symbol of China

China’s One Belt, One Road initiative and Asian Infrastructure Investment Bank, both highlight and also facilitate a high-speed interconnectivity among nations and regions. It seeks a high-speed development on a specialized track where China has demonstrated expertise. An influential symbol of China’s fast development, interconnectivity and technical prowess is high-speed rail.

China had built at least 34 lines of the high-speed rail globally, a network exceeding 20,000km and covered 160 cities.

China built 5,000km Pan-Asian HSR that connects Kunming in China to Singapore and other OBOR countries.

Asia needs to spend USD 40 trillion on infrastructure by 2030 and HSR is the crown jewel of China’s infrastructure export.

Source: Xinhua News Agency
1. High speed development of HSR

**How does China achieve the deed?**

- **Chinese Government Support**
  High-speed rail developed rapidly in China over the past 15 years thanks to generous funding from the Chinese government, especially the economic stimulus program during the Great Recession.

- **Foreign Technology Transfer**
  Chinese engineers, after receiving transferred foreign technology, have been able to develop indigenous capability to produce key parts and improving upon foreign designs.

- **Spillover Effects**
  Technological and socio-economic spillover effects brought about wide benefits and further scale-up high-speed rail.
Huge investments

When the 2008 financial crisis hit the U.S. and Europe and led to many countries there to adopt austerity measures, China made use of the opportunity to do the opposite by investing heavily in infrastructure building in order to stimulate the economy and to create jobs.

In November 2018, the Chinese government announced a package worth 4 trillion yuan (US$586 billion) to stimulate the economy, a large part of which went into the development of high-speed railway.

Investments in rail projects soared from $49 billion to $88 billion within one year. Since 2010, China has been spending about $100 billion a year on rail development.

In 2014 it invested 809 billion yuan and in 2015, 823.8 billion yuan (or $125.6 billion) in railway construction.

Source: (Mark Cranshaw, 2014)
Joint Effort

China is able to benefit from the economy of scale and the economy of standardisation in railway construction. The fine division of labour and the mass production have cut down the costs of many items of technology giving China an added advantage to developing HSR.

The strong political will of Chinese leaders to do things on a grand scale and to complete projects quickly is a major contributing factor. This institutional factor speeds up China’s HSR development.

Scale

Leadership

To develop its HSR technology almost from scratch with the introduction of foreign technology, China has been able to mobilise the resources of 25 leading universities, 11 science academies, 51 national laboratories, 500 companies and 40 government research institutes. Over 10,000 engineers, researchers and technicians took part, including 68 fellows from the Chinese academies of sciences and engineering and 500 university professors.

Resources

The unit cost of China’s HSR infrastructure is about $17-21 million per km, while the comparable cost in Europe is $25-39 million per km. As to the costs of building railway tunnels, it is about $10-15 million per km in China. It is $50 million per km in the U.S. and $60 million per km in Australia.

Workforce

Source CNN
Technology Transfer & Spillover

In 2004, Four major international technology providers – Alstom, Siemens, Bombardier and Kawasaki Heavy Industries – signed technology transfer contracts with the two major train manufacturing conglomerates in China: China Southern Railway Corp (CSR) and China Northern Railway Corp (CNR) for market access.

By 2015, over 90 Chinese cities were connected by the HSR system. CSR and CNR are now able to build ‘next generation’ HSR trains by developing indigenous capability and improving on imported foreign designs.

The top speed of indigenous-designed Beijing-Shanghai HSR trains reaches 380km/h, faster than any other HSR trains in the world.

Nowadays, Chinese government has been actively promoting the export of HSR technology to other countries and partnering or competing with the established manufacturers in overseas markets.

A 42% increase in patent applications in the cities and technology classes with HSR technology transfer after 2004. The number drops to 20% after excluding patents that were applied for directly by CSR or CNR affiliates and HSR suppliers, but it remains significant.

Source: CentrePiece Autumn 2016 Yatang Lin
The first intercity train between Beijing and Tianjin. The new train service would cut the 120-km journey from the current 70 minutes to about 30 minutes.

"Harmony" trains stop at a high-speed railway maintenance base in Wuhan, one of the four such maintenance bases.

China increased the maximum speed of bullet trains on the Beijing-Shanghai high-speed railway to 350 kph, cutting the journey to 4 hours and 28 minutes.

Next generation bullet train "Fuxing" at Beijing South Railway Station also known as electric multiple units (EMU) has top speeds of 400 kilometers an hour.

Harmony bullet trains sit on the tracks at a high-speed train maintenance base in Wuhan.

Beijing South Railway Station, northern terminal of the Beijing-Shanghai high-speed railway in Beijing.

Source: Xinhua net
Types of High-speed Rail Services

**G-class** trains run at higher speed at top speeds of at least \(250 \text{ km/h}\). The G7 train from Beijing South to Shanghai Hongqiao averages \(300 \text{ km/h}\). G-class trains run on the high speed tracks and typically serve long distance trips.

**D-class** train runs at lower speeds and can vary widely in actual trip speed. D-class trains have distributed power system and run on regular tracks between major cities. The earlier generation D-class trains have a maximum speed of \(200-250 \text{ km/h}\).

**C-class** ("intercity" between two nearby cities) train also operate on high-speed track at speeds above \(250 \text{ km/h}\). C-class trains on the Beijing–Tianjin ICR reach top speeds of \(330 \text{ km/h}\) and average \(226 \text{ km/h}\) for the trip.
The Shanghai Maglev is currently the world’s fastest commercially operational train, routinely zipping back and forth between the city and Pudong International Airport at \(430 \text{ km/h}\). The 30-km journey takes less than eight minutes.

China’s first medium-low-speed maglev line with maximum speed of \(100 \text{ km/h}\) started operations in May 2016 in Changsha.

Some maglev train line costs ran beyond budget. The commercial viability of maglev is in question. The price tag of the Shanghai Maglev was believed to be \$1.3 \text{ billion}\) and was partially financed by the German government.

**Maglev**

The maglev hovers several centimeters above the tracks. It is propelled by electrically charged magnets, and uses specially designed tracks to keep the trains from overturning or derailing.
Milestones

- **Aug. 1, 2008**: The first HSR (Beijing–Tianjin route) opened.
- **Dec. 26, 2009**: The longest and most complicated Wuhan–Guangzhou line (part of the Beijing–Guangzhou–Shenzhen–Hong Kong route) opened.
- **Feb. 6, 2010**: The first HSR built on a collapsible loess area (Zhengzhou–Xi’an route) opened.
- **Nov. 25, 2015**: 17 leaders from 17 countries took an HSR train from Suzhou to Shanghai.
- **Dec. 1, 2012**: The first HSR built on a high latitude area (Harbin–Dalian route) opened.
What are the effects of developing high-speed rail?

➔ Urban Agglomeration
➔ Regional Network
➔ Changing Travel Mode
➔ Western Development
➔ Silk Road
➔ Oversea Exports
Urban Agglomerations

China has approved a $36 billion railway plan to improve transport links between the capital Beijing, the port city of Tianjin, and the neighboring province of Hebei.

Yangtze river delta is well-connected with the famed high-speed rail Beijing–Shanghai and Shanghai–Hangzhou part of the Hangzhou–Fuzhou–Shenzhen high-speed railway.

Pearl river delta, which was the earliest test field of reform and opening-up, is connected by its 140-kilometer Guangzhou-Shenzhen-Hong Kong express rail link.

Three major urban agglomerations in China’s south, east and north has emerged in socioeconomic development. These are Jing-jin-ji in the north, Yangtze river delta in the east, and Pearl river delta in the south. As early as 2014, these three urban agglomerations made up for 40% of China’s GDP, which showed their significance in China’s development. Recent spotlight has been on Jing-Jin-Ji, the national capital region of China. It is the biggest urbanized region in Northern China that includes an economic region surrounding Beijing, Tianjin, and Hebei, along the coast of the Bohai Sea.
The advent of high-speed rail in China has greatly **reduced travel time** and has **transformed** Chinese society and economy. The network's rapid expansion means that **29** of China's **31** provinces and regions are today connected by bullet trains.
More Chinese are choosing to **ride rather than fly**. This is because train terminals tend to be located closer to city centres, and, unlike at airports, security screenings and check-ins are much speedier. High-speed rail is almost like a “scaled-up subway” system serving the whole country. **500k** passengers take China's busiest HSR route from Beijing to Shanghai per day.
Western Development

The high-speed train industry comprises several sectors and has a spillover effect on China's industrial upgrading and economic restructuring.

It will have a far-reaching impact on the economic development of the economically backward western part of the country.

It takes about 5½ hours to travel from Beijing to Xi’an in Shaanxi province by a high-speed train, compared with more than 11 hours by normal-speed trains.

Over the past 30 years, China has adopted a progressive development strategy with priority to the eastern coastal region, because their proximity to the sea makes import of raw materials and export of finished products easier.

With the world’s major economies facing economic difficulties, China cannot sustain its export-oriented economic growth and instead focuses on boosting domestic consumption.

China has concrete plans of developing its vast western region. The idea of western development was put forward 14 years ago, but progress was unsatisfactory, partly because of lack of infrastructure. High-speed rail is a jumpstart to change.
Thailand has agreed to build a $12.2-billion railway line connecting to China. It is to be extended through Malaysia to reach Singapore.

China is building a high-speed rail network through Central Asian countries such as Kazakhstan, Uzbekistan, Turkmenistan, and Middle East nations like Iran and Turkey.

In the north, China is negotiating with Moscow to build a line stretching from Heilongjiang province to Russia’s northern regions. Besides, some African countries could get China’s help to build more railways.

As the economic links among the countries in the region strengthen, the regional economy will consolidate and become more stable to the benefit of all the countries involved.

China’s high-speed railway program is crossing borders. The expansion of the high-speed rail network will provide the boost to the development plans for West China because it will connect the region not only with the developed eastern provinces but also with the vast markets in Central Asia, Russia and Europe. This will facilitate the extension of China’s economic links with its northern and western neighbors and create an alternative regional market that can offset the impact of the recession or downturn in the big trading powers of America and Europe.
Oversea Exports

China’s high-speed railway exports

<table>
<thead>
<tr>
<th>Country</th>
<th>Route</th>
<th>Distance (km)</th>
<th>Estimated cost (US$b)</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turkey</td>
<td>Ankara-Istanbul</td>
<td>533</td>
<td>1.3</td>
<td>Completed in 2014</td>
</tr>
<tr>
<td>Thailand</td>
<td>Bangkok-Nakhon Ratchasima</td>
<td>250</td>
<td>5</td>
<td>Construction to begin in Dec</td>
</tr>
<tr>
<td>Indonesia</td>
<td>Jakarta-Bandung</td>
<td>150</td>
<td>5</td>
<td>Awarded in Sep 2015</td>
</tr>
<tr>
<td>Russia</td>
<td>Moscow-Kazan</td>
<td>770</td>
<td>20</td>
<td>Chosen; now in design stage</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>Dhaka-Jessore</td>
<td>169</td>
<td>3.1</td>
<td>Awarded</td>
</tr>
<tr>
<td>Hungary</td>
<td>Budapest-Belgrade</td>
<td>350</td>
<td>1.6</td>
<td>Awarded the Hungarian section</td>
</tr>
<tr>
<td>Laos</td>
<td>Vientiane-Yunnan</td>
<td>427</td>
<td>6</td>
<td>Broke ground</td>
</tr>
</tbody>
</table>

Bidding war continues

<table>
<thead>
<tr>
<th>Country</th>
<th>Route</th>
<th>Distance (km)</th>
<th>Estimated cost (US$b)</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>India</td>
<td>Mumbai-Ahmedabad</td>
<td>500</td>
<td>14.7</td>
<td>India signed agreement for technical and financial assistance from Japan</td>
</tr>
<tr>
<td>Malaysia</td>
<td>Kuala Lumpur-Singapore</td>
<td>350</td>
<td>10.5</td>
<td>Planning/Bidding stage</td>
</tr>
<tr>
<td>US</td>
<td>Los Angeles-San Francisco</td>
<td>558</td>
<td>68</td>
<td>Broke ground; selecting builder</td>
</tr>
</tbody>
</table>

Countries that have either already signed contracts or are negotiating with Chinese Infrastructure Complex

China’s high-speed trains have been sold to 102 countries and regions. **US$18 billion** worth of HSR-related agreements were signed in 2016, a 40 per cent increase from 2015. In 2015, China outbid Japan to win a **US$5.5 billion** project in Indonesia.

Source: South China Morning Post
"Four Vertical and Four Horizontal" network: The centerpiece of China’s Ministry of Railways’ expansion into high-speed rail is a national high-speed rail grid that is overlaid onto the existing railway network. The grid is composed of eight high-speed rail corridors, four running north-south and four east-west, and has a total of 12,000 km.

**Four North-South HSR Corridors**

<table>
<thead>
<tr>
<th>Corridor</th>
<th>Speed (km/h)</th>
<th>Length (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing–Harbin High-Speed Railway</td>
<td>350</td>
<td>1,700</td>
</tr>
<tr>
<td>Beijing–Shanghai High-Speed Railway</td>
<td>350</td>
<td>1,433</td>
</tr>
<tr>
<td>Beijing–Guangzhou–Shenzhen–Hong Kong High-Speed Railway</td>
<td>350</td>
<td>2,229</td>
</tr>
<tr>
<td>Hangzhou–Fuzhou–Shenzhen High-Speed Railway</td>
<td>350–250</td>
<td>1,495</td>
</tr>
</tbody>
</table>

**Four East-West HSR Corridors**

<table>
<thead>
<tr>
<th>Corridor</th>
<th>Speed (km/h)</th>
<th>Length (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qingdao–Taiyuan High-Speed Railway</td>
<td>250</td>
<td>873</td>
</tr>
<tr>
<td>Xuzhou–Lanzhou High-Speed Railway</td>
<td>350</td>
<td>1,363</td>
</tr>
<tr>
<td>Shanghai–Wuhan–Chengdu High-Speed Railway</td>
<td>350–200</td>
<td>2,078</td>
</tr>
<tr>
<td>Shanghai–Kunming High-Speed Railway</td>
<td>350</td>
<td>2,066</td>
</tr>
</tbody>
</table>
Four North-South HSR Corridors

- **Name:** Beijing–Harbin Passenger Dedicated Line (PDL)
- **Length:** 1,300 km
- **Design speed:** 350 kph
- **Main stops:** Beijing Nan, Tianjin West, Qinhuangdao, Shenyang North, Changchun West, Harbin West

It connects Northeast China with the national capital, Beijing and cuts the journey time from 12 hours to 6 hours between Beijing and Harbin.

- **Name:** Beijing–Shanghai HSR
- **Length:** 1,318 km
- **Design speed:** 350 kph
- **Main stops:** Beijing Nan, Jinan West, Nanjing South, Suzhou North, Shanghai Hongqiao

It connects two popular cities and reduces the journey time from 12 hours to 5 hours (2 hours by air).
**Hangzhou–Shenzhen HSR**
- **Name:** Hangzhou–Shenzhen HSR
- **Length:** 1,600 km
- **Design speed:** 250–350 kph
- **Main stops:** Hangzhou West, Ningbo, Fuzhou South, Shenzhen North

It connects the Yangtze River Delta and the Pearl River Delta. There are only D-trains (running at 180–250 kph) in operation, and the journey takes about 10½ hours.

**Beijing–Guangzhou–Shenzhen–Hong Kong HSR**
- **Name:** Beijing–Guangzhou–Shenzhen–Hong Kong HSR
- **Length:** 2,240 km
- **Design speed:** 350 kph
- **Main stops:** Beijing West, Shijiazhuang, Zhengzhou East, Wuhan, Changsha South, Hengyang East, Guangzhou South, Shenzhen North, Hong Kong

It is the longest passenger dedicated high-speed rail line in the world and connects North China, Central China, and South China.
Four East-West HSR Corridors

**Qingdao–Taiyuan Passenger Dedicated Line (PDL)**
- **Name**: Qingdao–Taiyuan Passenger Dedicated Line (PDL)
- **Length**: 770 km
- **Design speed**: 200–250 kph
- **Main stops**: Qingdao, Jinan, Shijiazhuang, Taiyuan South

It takes less than 3 hours to travel from Qingdao and 1½ hours from Shijiazhuang to Taiyuan.

**Xuzhou–Lanzhou Passenger Dedicated Line (PDL)**
- **Name**: Xuzhou–Lanzhou Passenger Dedicated Line (PDL)
- **Length**: 1,400 km
- **Design speed**: 250–350 kph
- **Main stops**: Xuzhou East, Lianyungang, Zhengzhou, Xi’an North, Baoji, Lanzhou

It takes 2 hours to travel from Zhengzhou to Xi’an on the fastest train, G97 and The other G and D trains take 2 to 3 hours due to more stops on the journey.
**Shanghai–Kunming HSR**
- **Name:** Shanghai–Kunming HSR
- **Length:** 2,266 km
- **Design speed:** 350 kph
- **Main stops:** Shanghai Hongqiao, Hangzhou East, Nanchang Xi, Changsha South, Guiyang North, Kunming South

It connects East China and Central China with Southwest China.

**Shanghai–Wuhan–Chengdu HSR**
- **Name:** Shanghai–Wuhan–Chengdu HSR
- **Length:** 1,600 km
- **Design speed:** 160–350 kph
- **Main stops:** Shanghai Hongqiao, Nanjing South, Hefei South, Hankou, Yichang East, Chongqing North, Chengdu East

It is built alongside the Yangtze River. The high-speed trains on most of the route have an average speed of 200 to 250 kph, except from Shanghai to Nanjing (350 kph), and from Yichang to Wanzhou (160 kph) because of the curves in the track that were designed to get around the area’s landforms.
In 2016, the National Development and Reform Commission (NDRC) announced the plans to extend the almost completed "Four Vertical and Four Horizontal" network to a new "Eight Vertical and Eight Horizontal" network. The new network comprises eight north-south ("vertical") corridors and eight east-west ("horizontal") ones, almost doubling the route length.
5. High-speed intercity railways

Intercity railways are designed to provide regional high-speed rail service between large cities and metropolitan areas that are generally within the same province. They are built with the approval of the central government but are financed and operated largely by local governments with limited investment and oversight from the China Rail Corporation.

<table>
<thead>
<tr>
<th>HSR Line</th>
<th>Distance (km)</th>
<th>Design Speed (km/h)</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing-Tianjin Intercity Railway</td>
<td>115</td>
<td>250</td>
<td>25–57min</td>
</tr>
<tr>
<td>Shanghai-Nanjing Intercity Railway</td>
<td>301</td>
<td>250</td>
<td>1h–1h 20min</td>
</tr>
<tr>
<td>Nanchang-Jiujiang Intercity Railway</td>
<td>131</td>
<td>250</td>
<td>1h–1h 10min</td>
</tr>
<tr>
<td>Shanghai-Hangzhou Intercity Railway</td>
<td>169</td>
<td>350</td>
<td>1h</td>
</tr>
<tr>
<td>Chengdu-Qujiang Intercity Railway</td>
<td>65</td>
<td>220</td>
<td>1h–1h 30min</td>
</tr>
<tr>
<td>Changchun-Jilin Intercity Railway</td>
<td>111</td>
<td>250</td>
<td>40–50min</td>
</tr>
<tr>
<td>Guangzhou-Zhuhai Intercity Railway</td>
<td>117</td>
<td>200</td>
<td>50min–1h 24min</td>
</tr>
<tr>
<td>Guiyang-Kaixiang Intercity Railway</td>
<td>62</td>
<td>200</td>
<td>48 min–1h 7min</td>
</tr>
</tbody>
</table>
Thank you!

“Cities require connectivity rather than territory in order to drive their economic stability and growth.”

- James Scott, Institute for Critical Infrastructure Technology