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## Views & Comments

# Key Challenges and Countermeasures with Railway Accessibility along the Silk Road

Huawu He

Chief Engineer of China Railway Corporation; Member of Chinese Academy of Engineering

## 1. Overview

The Silk Road originated in Chang'an (Xi'an today) and linked the land routes of countries from Transoxiana, the Persian Gulf, and the Mediterranean Sea. It is the trunk road over which China historically carried out economic, trade, and cultural exchanges with Central Asia, West Asia, South Europe, and North Africa; the diligent and courageous people living in this region worked together with a friendship and cooperation that is still widely praised today.

Trade, investment, cooperation, and exchange have once again become active along the Silk Road. In order to rejuvenate the Silk Road, the Chinese Government has announced its vision and action to build the "Silk Road Economic Belt and the 21st Century Maritime Silk Road" (also known as the "Belt and Road" initiative) [1]. The announcement specifically points out that one of the focuses of the Silk Road economic belt construction is to unblock the road from China to Central Asia, West Asia, the Persian Gulf, and the Mediterranean Sea. This major strategic focus is to jointly build a China/Central Asia/West Asia international economic cooperation corridor by relying on major international corridors, using central cities along the route as underlying support, and using key economic and trade parks as the cooperation platform. The "Belt and Road" initiative will focus on the key corridors, key nodes, and key projects of the transportation infrastructure. It will complete missing segments, unblock bottleneck segments, provide sound road safety protection facilities and traffic management facilities, and improve the accessibility of the road. It will also establish a unified full-course transport coordination mechanism; promote organic linkages between international custom clearance, transshipments, and multi-model combined transportation; gradually develop a compatible and standardized transportation plan; and bring convenience to international transport. The strategic plan for the "Belt and Road" initiative has received broad recognition and an active response from the international community, and China will inevitably play an important role in promoting its construction.

Railway is an important infrastructure and a popular mode of public transport. Boasting merits such as robust transportation capacity, relatively low energy consumption, minor pollution, and low costs, railway holds a dominant position in the comprehensive

transportation system, making it an important tie connecting countries along the Silk Road and a critical contributor to economic growth and people's livelihood. To support and facilitate the joint construction of the China/Central Asia/West Asia international economic cooperation corridor, it is necessary to build a trunk railway along the Silk Road.

The current railway network along the Silk Road faces challenges such as being "open but blocked" in the eastern regions and missing segments in the western regions. Despite several rounds of research and negotiations, no progress has been made regarding the accessibility issue. Therefore, it is necessary and urgent for an in-depth study to be carried out on an accessibility solution for the Silk Road.

## 2. Key railway accessibility challenges along the Silk Road

The proposed railway along the Silk Road runs through many countries. Given the different technical standards and management systems involved, and considering factors such as economy, political systems, and railway development, we are currently faced with two major challenges. First, some areas are "open but blocked." Due to the different gauge standards, the Chinese railway cannot seamlessly connect with the railways in Central Asia and Iran, and the existing transport capacity and service quality are inadequate to meet the requirements of modern freight and passenger transport. Second, there are missing segments. In certain West Asian countries, there are not only dead-end rails, but also blank spaces without rail. These countries have not resolved the interconnection of railway infrastructures, not to mention the basic formation of a railway network. Thus, they cannot benefit from the driving effect of railway and its competitive advantage on the transportation market.

### 2.1. The "open but blocked" challenge: Non-uniform gauge standards

#### 2.1.1. Non-uniform gauge standards limit transport capacity and increase operating costs

(1) Bogie change stations limit the transport capacity of the railway. Bogie change stations currently exist at railway junctions between China, Iran, and Central Asia. China has two bogie change stations located at the ports of entry of Alashankou and

Khorgas. All five Central Asian countries employ the 1520 mm broad gauge, while China and Iran employ the 1435 mm standard gauge. Given such a gauge difference, the train must change its steering bogie or transship the cargos at the port-of-entry railway station—hence making the port-of-entry railway station into a bottleneck hampering the transport capacity of the railway. Taking the Alashankou–Dostyk port-of-entry railway station as an example, the freight volume transferred in 2014 was less than  $1.7 \times 10^7$  t, the bogie change capacity at the station is near saturation, and transit cargos are frequently delayed. Even though many measures have been taken, the limitations in technology and equipment mean that the transport capacity on both sides cannot be adequately coordinated and integrated to form a corridor with greater transport capacity.

(2) Bogie change operations significantly prolong the arrival time. Bogie change operations require changing the steering bogie (including the wheelset), transshipping cargos, using an expensive variable-gauge, or transferring the passengers. Such operations increase not only the transportation time but also the operating costs. In particular, transshipment operations at the port of entry may take as long as 10 days due to the different types of train and cargos to be handled, and given the detention of cargos at the port of entry. Taking the time-sensitive China–Europe block train as an example, on November 18, 2014, with a full journey stretching 13 052 km, the Yiwu–Xinjiang–Europe route (82 twenty-foot equivalent unit (TEU)) initiated operation, passed through eight countries, underwent three bogie change operations, and took 21 days to reach its destination. Clearly, bogie change operations significantly impair the advantage and competitiveness of railway transport.

### 2.1.2. Solutions to international railway lines with different gauges

According to the International Union of Railways (UIC), broad gauges are above 1520 mm (inclusive), standard gauge is 1435 mm, and narrow gauges are below 1067 mm (inclusive). Different gauge systems have led to drawbacks such as low efficiency and high operating costs. Various solutions exist for international railway lines.

(1) Normal-speed railways can maintain the existing gauge status and newly constructed railways such as high-speed railway can employ the standard gauge. Japan used to employ the 1067 mm gauge for its normal-speed railways. When constructing the Tokaido Main Line, which was put into operation in October 1964, Japan selected the standard gauge without hesitation, and continued to use the standard gauge for the construction of subsequent main lines. Railways with two different gauges are geared to different but explicit purposes, and the passenger transfer facilities are reasonable in arrangement and satisfactory in operation.

Taiwan of China employs narrow gauge for its normal-speed railways but standard gauge for high-speed railways, such as the Taipei–Kaohsiung Line and the high-speed rails constructed in Taipei, Taoyuan, and Kaohsiung.

Thailand, Malaysia, and Indonesia all employ narrow gauge for their normal-speed railways and standard gauge for the high-speed railways constructed in Bangkok and Kuala Lumpur. All three countries chose standard gauge for the future construction of high-speed railways.

(2) Railway networks can unify the gauge in order to achieve unblocked interconnection. Spain, Portugal, Lithuania, Latvia, and Estonia employ broad gauge for their normal-speed railways, and are planning to change the broad gauge into standard gauge in order to achieve interconnection with European Union (EU) railways, so as to enable cross-line operations and reduce operating costs. Spain has developed a variable-gauge train that

can automatically shift to another gauge at an operating speed of  $15 \text{ km}\cdot\text{h}^{-1}$ ; however, the technologies involved are complex, the manufacturing costs are high, and the operation will not be cost-effective. During the construction of its high-speed railways, Spain chose the standard gauge, and its total length of high-speed rail tracks now ranks second in the world.

The historic gauge systems in Canada, the US, and Mexico were disorderly, making interconnection and combined transport impossible. Since February 1886, the US has uniformed the rail track to standard gauge gradually, rail tracks exceeding 20 000 km have been rebuilt. After the gauge was unified across North America, remarkable progress was made in straight-through combined transport, freight transport efficiency, and freighter satisfaction.

Standard-, broad-, and narrow-gauge tracks all existed in the mainland of China in the past. During the construction of the Tangshan–Xugezhuang Railway and the Beijing–Zhangjiakou Railway, respectively, both Mr. Da Jin and Mr. Tianyou Zhan insisted on using standard gauge. Today, standard gauge has become a uniform gauge on the railway network.

(3) Newly built high-speed railways can employ the same gauge as existing railways. In Russia and the member states of Commonwealth of Independent States (CIS), the rail gauge is 1520 mm. This gauge standard has been widely applied on the gigantic railway network across Europe and Asia, which ranks as the second largest railway network in the world. In order to take full advantage of existing resources (except for specific railway lines intended for specific purposes), newly built railway lines will employ the same gauge as existing railways. The Moscow–Kazan High-speed Railway, to be constructed in Russia, will also employ the 1520 mm gauge.

In conclusion, regarding the solution to international railway lines with different gauges: The gauge system is generally a historical and cultural heritage of the railway development in respective countries, and different gauges will remain for quite a long time. Applying old standards to old lines and new standards to new lines is the best strategy, and can be worked out based on the social and economic development needs and the technological and economic level of respective countries.

### 2.2. Addressing missing segments

Accelerating the construction of the “Belt and Road” undertaking will contribute to economic prosperity and regional economic cooperation along the Silk Road, strengthening exchanges and mutual learning between different civilizations and promoting peaceful global development. It is a great cause, benefiting billions of people.

The interconnection of the Silk Road is a top priority for the “Belt and Road” initiative. On the basis of respecting the sovereignty and security concerns of relevant countries, countries along the Silk Road are expected to strengthen their infrastructure construction and planning, and the linkage of their technical standards and systems; to jointly push ahead the construction of international trunk corridors; and to gradually shape the infrastructure network connecting Asian regions and connecting Asia with Europe and Africa. These visions have drawn high levels of concern and broad recognition from the international community, and relevant actions have been taken. The Gulf Cooperation Council plans to construct a railway network connecting six member states, with an anticipated total length exceeding 2000 km. Turkey, Iran, and Iraq will speed up the implementation of their respective national railway network development plans, and are actively working on railway interconnection with neighboring countries, marking a preliminary accomplishment in the goal to connect the missing segments.

Therefore, the key to an unblocked railway along the Silk Road is to complete the missing segments in Central Asia.

### 3. Valuable solutions to completing missing segments in Central Asia

Given the geographic limitations posed by the Tian Shan and Kunlun Mountains, we have studied the natural, traffic, and economic characteristics of the China–Central Asia–Iran Railway, as well as the multilateral relations and the interest concerns of the relevant countries. We have proposed three valuable solutions for expanding or constructing railway lines through Khorgas, Torugart, or Irkeshtam.

#### 3.1. Through Khorgas

To mitigate the transportation pressure at Alashankou, the Jinghe–Khorgas Railway has been interconnected with Kazakhstan railways, and its role in promoting regional economic cooperation and cultural exchanges between China and Central Asian countries is becoming increasingly evident. Despite its current issues, the Khorgas port-of-entry railway station has great potential and is bound to develop into an international logistics hub, integrating passenger and freight transport, warehousing, and e-commerce. It will play a vital role in the construction of the Silk Road economic belt. However, in order to build a cross-line, unblocked, and high-throughput railway, we must address the bottleneck of the Khorgas bogie change station.

#### 3.2. Through Torugart

The China–Kyrgyzstan–Uzbekistan Railway stretches over 500 km and passes through Kashgar, Torugart, and Andijan. The construction of this railway allows interconnection between China, Kyrgyzstan, and Uzbekistan, and adds one more option to the international railway network. It also helps to avoid the detour of cargo and passenger transport between China and Central/West Asia, and even changes the transportation landscape in Southern Kyrgyzstan. Given the different gauge standards, bogie change stations must be set up at the port of entry between China and Kyrgyzstan. In order to build a cross-line, unblocked, and high-throughput railway, the bottleneck caused by the bogie change station must be addressed.

#### 3.3. Through Irkeshtam

In December 2014, the China–Kyrgyzstan–Tajikistan–Afghanistan–Iran Railway was proposed at a railway conference held in Dushanbe. The preliminary route will pass through Kashgar, Irkeshtam, Karamyk, Dushanbe, Mazari Sharif, Maimana, Herat, and Taybad; then, at an appropriate node, it will split into a south line reaching the Persian Gulf directly and a west line reaching Turkey and the Middle East. The proposed railway stretches more than 2300 km and will run through mountainous areas characterized by complex geological conditions and posing notable engineering challenges. Having perceived its importance and potential, Iran has been an active promoter of this project. From the perspective of Kyrgyzstan, Tajikistan, and Afghanistan, this project can help to construct a regional railway transport platform that will facilitate international commodity exchanges and prosper the regional economy through constant transit shipment. For China, this project will create a new international railway and make direct transport more convenient. This project almost fills all the railway gaps within the region. If it is built using the expected standard gauge, a cross-line, unblocked, and high-throughput corridor will

take shape.

In view of the railway interconnection between China and its neighboring countries and the need for railway-oriented territorial development, the China–Kyrgyzstan–Uzbekistan Railway and the China–Kyrgyzstan–Tajikistan–Afghanistan–Iran Railway are both necessary and cannot replace each other. Given the complex geographic conditions, natural characteristics, market demands, economic characteristics, security considerations, interest concerns, and political situations involved, the possibility, feasibility, and urgency of project implementation remain in some doubt. In response to these major and key challenges, and abiding by the vision of the “Belt and Road” initiative as well as the principle of joint construction and cooperation, we have proposed a solution based on analysis and preliminary study. This solution is to construct a high-speed railway over the Central Asia section of the Silk Road, while simultaneously considering container lines. We suggest that a cooperative feasibility study be launched, through which we can carry out multi-level and multi-channel communication and consultation in order to consider the interests and concerns of all parties and seek common ground for cooperation.

### 4. Design of the Silk Road high-speed railway

#### 4.1. Basis of design

The Silk Road high-speed railway is based on the following premises:

(1) It will be differentiated from the existing Central Asian railway transport market, which is dominated by the 1520 mm gauge system. The two railways will complement each other's advantages.

(2) Given the northwest-southeast trend of most existing railways in Central Asia, the proposed high-speed railway will improve the railway network by adding a northeast-southwest trend.

(3) It is expected to attract most of the population (60 million people) from five Central Asian countries, as well as international tourists.

(4) Incremental container cargos and transferred container cargos from sea transport will ensure the cargo supply for international container lines.

(5) It will contribute to the formation of a brand-new and efficient comprehensive transport system.

(6) It will contribute to the formation of a railway-driven economic belt, along which investment will be attracted to railway stations, cities will be built upon investment, people will accumulate wealth in the cities, and comprehensive developments will be rolled out.

#### 4.2. Route design

The proposed route will pass through Urumqi, Yining, Almaty, Bishkek, Tashkent, Samarkand (Dushanbe), Ashkhabad, and Teheran. This route not only covers major cities in Central Asia, but also stands apart from the existing railway trends and other proposed railways with a north-south trend in the region. In addition, the proposed route avoids complex mountainous areas and geological conditions.

#### 4.3. Functional positioning

Carrying massive quantities of passengers and cargo, the existing 1520 mm gauge railways are important parts of the infrastructure of Central Asian countries. The Silk Road high-speed railway will be an important part of the modern comprehensive communication and transport system in Central Asia. Upon com-

pletion, it will effectively complement the existing normal-speed railway transport, road transport, and air transport. It will not only significantly boost the travel efficiency of passengers, but also greatly expand their travel options. The Silk Road high-speed passenger trains and international container lines will run on the same track. This model is different from that of the normal-speed railways on the railway transport market, and permits complementary advantages, thus promoting and serving socioeconomic development and a higher quality of life.

#### 4.4. Research focus on technical and economic conditions

Apart from the existing feasibility studies on the high-speed railway, the study on the Silk Road high-speed railway will have the following focuses:

- Convenient transfer between the standard-gauge Silk Road high-speed railway and the existing passenger transport system, and seamless linkage of container transport;
- A highest running speed of 250–300 km·h<sup>-1</sup>;
- A highest running speed for international container lines of 120 km·h<sup>-1</sup>, or an appropriate speed;
- One deck or two decks for the containers' carriage;
- A selection of sleeper carriages or a running plan;

- A transport-oriented development (TOD) model and a development plan;
- Project implementation and a comparison of valuable business models.

#### 5. Conclusions

The Silk Road high-speed railway is an important solution to the construction of a high-throughput railway corridor along the Silk Road in Central Asia and railway interconnection between China, Central Asia, and West Asia. Taking this high-speed railway as the “axle” and treating city stops along the route as the “points,” the “point-axle” theory indicates that this initiative will help to develop an economic belt of co-prosperity within Central Asia, catering to economic development, the improvement of people's livelihood, and future trends. As long as we hold to the principle of joint construction, focus on the “five links,” and make persistent efforts, this great vision will be achieved.

#### Reference

- [1] National Development and Reform Commission, Ministry of Foreign Affairs, Ministry of Commerce. Vision and actions on jointly building Silk Road Economic Belt and 21st Century Maritime Silk Road. 2015 Mar 28. Chinese.