Organizational Optimization Study on Western Outbound Transportation for China Railway Express

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Abstract. At present, China Railway Express are developing faster and faster. Many scholars believe that the transfer assembly is the general trend of the future development of the China Railway Express, and Urumqi is a good choice as a centre of assembly because of its geographical advantage. This paper builds a mathematical model for quantitative analysis and explores the domestic container class. The effect of the average travel speed of the column on the transport organization.

1. Introduction
The steady development of the “the Belt and Road” has made the social and economic activities between China and Europe and the countries along the line more active. From the development of China Railway Express to 2017, the scope and depth of benefits have become wider and wider. The overall transportation cost has dropped by about 40%. The Asia-Europe Land Logistics Trade Channel has got rid of the traditional mechanism and formed an efficient connection between supply and demand. Not only has its potential been released, but also the economic and trade cooperation between China and Europe has been greatly promoted.

There are three major channels in China, including the East, Central and West. These three channels are not only railway passages, but also multimodal transport corridors for aviation and water transport, connecting 38 domestic sources. And 36 destinations in Europe. 61 operating lines are connected to countries along China and Europe, as well as East Asia, Southeast Asia and other regions. The transportation cost is only one-fifth of the air, and the time is shorter than the sea by more than half. It serves China's foreign trade and economic cooperation and penetrates the China and European continent. Road trade channel to achieve smooth roads and smooth logistics between China and Europe. The circuit diagram of the China Railway Express is shown in Figure 1.

2. Literature review
The representatives of the various operating companies of China Railway Express signed the Declaration on the Alliance of China Railway Express on the “the Belt and Road” on April 15, 2016. Urumqi was selected as the assembly center of the China and European Intercontinental Passage, and the China Railway Express will carry out the reorganization and marshalling operations in Xinjiang.

Zhao Qingsong [1] (2016) analyzed the favorable conditions for the construction of the Xinjiang assembly center on the basis of the overall goal of the construction of the Silk Road Economic Belt and the positioning of each city. Cao Yanfang [2] (2017) based on the strategic position of Xinjiang in history, pointed out that Xinjiang has the advantage to be assembly center of China Railway Express. Huang Li [3] (2016) analyzed the main Continental Bridge and the China and European line, and proposed effective strategies such as accelerating the construction of transit stations and setting up...
logistics distribution centers in Europe. Zhao Qingsong [4] (2017) demonstrated that it is feasible and extremely necessary to build an international logistics center in Xinjiang. Wang et al. [5] analyzed the current status and problems of the operation of the China Railway Express, and proposed to adopt the axle-and-spoke transportation organization model, and selected three hub cities of Lanzhou, Zhengzhou and Harbin through comprehensive consideration.

China Railway Express is of great significance for realizing the great strategy of “the Belt and Road”. At present, a few studies on the location of the assembly center, mostly under the guidance of relevant documents, choosing Urumqi, rarely use mathematical models and actual data for quantitative analysis, the lack of assembly site selection Certain theoretical and data support. In this paper, through the mathematical model, the frequency of the China and European trains based on the set conditions is obtained, and the better outbound transportation organization scheme is obtained. The better assembly center is obtained, verifying the rationality of the policy.

![Figure 1. Operation Route Map of China Railway Express.](image)

### 3. Organizational Optimization Model

According to the research of scholars in previous years, for the Western Corridor Western Corridor, Lanzhou and Urumqi have the same infrastructure conditions and geographical location advantages. At the same time, Lanzhou also has the connectivity of the railway network in comparison with Urumqi. Therefore, based on the above-mentioned two modes of direct and aggregate, we will consider the two assembly points of Lanzhou and Urumqi at the same time, and construct a transportation organization optimization model with the minimum transportation cost as the final optimization goal. The frequency of the container freight trains is based on the selection of the direct or assembled transport organization optimization scheme, and the better assembly point is selected.

We propose a hybrid non-integer linear programming model to optimize the transportation organization of China Railway Express.

#### 3.1. Assumptions

We adopt the following reasonable assumptions.

1. Assume that the number of container relays in this paper is at most one time.
2. It is assumed that the technical operation of the trains at the starting point and the assembly point can be completed within the waiting time of the collection, and the speed of the train used in the model is its average travel speed, and the time spent on the work on the way has been considered.
3. Assume that the container trains studied in this paper are only divided into two types: domestic container trains and China Railway Express. The cost parameters of the two different types of trains are different except for the running sections, but the same type of train cost parameters are the same.
4. Assume that the time value of the goods is proportional to the value of the goods.
5. Assuming that the time consumed by the batch of goods in this article at the departure point is equal to the uniform distribution, the average collection waiting time at the departure point is $1/2f$ days.
3.2. **Objective function**

The transportation cost in this model mainly includes four types of costs, namely, train operation cost, container operation cost, cargo time value cost and port station exchange cost. The running cost of the train is mainly composed of two parts, namely fixed cost and variable cost. The maintenance of the train, rail and various equipment is required for the operation of the container train, which is a fixed travel cost. There is also a series of artificial labor costs, etc.; variable costs involve many influencing factors. This paper mainly considers the cost of fuel consumed by container trains. The cost of container operations consists of three parts. This includes the cost of loading the container at the point of origin, the cost of unloading at the end point, and the cost of reloading at the assembly point. We express the product of the assembly waiting time of the goods at the originating station or the central station and the time value coefficient as the time value cost of the goods.

3.3. **Constraints**

The container freight volume between the stations is equal to the sum of the container freight volume of all road sections. The number of container trains at the starting point of any container train in China is greater than or equal to 1. The weekly freight volume of the container train between the stations is not greater than the product of the train line frequency and the marked load. In this paper, we stipulate that the domestic container train can only run between the domestic origin station and the assembly transfer station (that is, on the domestic line segment); the Central European container train can not only run on the domestic line segment. It can also be run on foreign line segments. It can be divided into two types according to the different stations: the first one is the “point-to-point” direct train from the domestic origin station to Europe, and the second is from the assembly. Stations that drive to foreign stops.

Since the model is applied to the actual transportation process, the decision variables have their corresponding actual value ranges.

We can solve this model using a nonlinear programming solver such as LINGO.

4. **Numerical example**

In this section, we provide a numerical example to illustrate the validity of the model. On a 2.4 GHz dual-core PC, the solution was implemented using LINGO in a Windows 8.1 environment using a dual-core PC with 4 GB of RAM.

Among China Railway Express, the “Yu Xinou”, “Chengdu-Europe Express Railway”, “Zheng Xinou” and “Han Xinou” have relatively large volume and relatively mature development. Therefore, examples include Chongqing. In Chengdu, Zhengzhou and Wuhan, in order to simplify the example, we set the destination as Hamburg, Germany, and the assembly center will consider Lanzhou and Urumqi at the same time, but the trains issued at each station will only be assembled at most once. In addition, domestic container trains can only be operated on domestic line segments; China Railway Express can be operated on domestic and foreign line segments. The circuit diagram is shown in Figure 2.

![Figure 2. Assembly mode diagram.](image-url)
The above four types of trains have only one destination. The length of the route from the Urumqi Container Center Station to the foreign cities is the average distance from Urumqi, Rongou Express, Zheng Xinou and Hanxin Europe from Urumqi to the destination.

The data obtained from the survey is brought into the model and solved by the mathematical software lingo11. Each China Railway Express has three paths to choose from. The first one is in Lanzhou, the second is in Urumqi, and the third is direct. Mode, the results are shown in Table 1.

Table 1. The Solution of Lingo.

| Origin | Destination | Frequency |
|--------|-------------|-----------|
|        |             | Domestic train | China Railway Express |
| 1      | 5           | 0          | -              |
| 2      | 5           | 0          | -              |
| 3      | 5           | 0          | -              |
| 4      | 5           | 0          | -              |
| 1      | 6           | 0          | -              |
| 2      | 6           | 0          | -              |
| 3      | 6           | 0          | -              |
| 4      | 6           | 0          | -              |
| 1      | 7           | 0          | 4              |
| 2      | 7           | 0          | 3              |
| 3      | 7           | 0          | 9              |
| 4      | 7           | 0          | 7              |
| 5      | 7           | -          | 0              |
| 6      | 7           | -          | 0              |

A detailed analysis of the above results shows that because the average travel speed of domestic container trains is very low compared to the China Railway Express, it is only 500km/d, and the mode of assembly and operation needs to add additional fixed travel costs, medium conversion equipment, etc. The cost of operations requires an increase in assembly waiting time, resulting in an increase in the time value of the goods. On the contrary, the average travel speed of the China Railway Express is fast. The direct travel can not only shorten the transit time of the goods, but also save the cost of loading and unloading operations of the goods at the assembly center station. Therefore, the optimized transportation organization mode is the direct mode.

Based on the above examples, we discuss the impact of the average travel speed of the train on the organization mode of the train. The sensitivity analysis table can be shown in Table 2.

Table 2. The Sensitivity analysis table.

| Average travel speed (km/day) | China Railway Express | Domestic train | Transport organization model |
|--------------------------------|-----------------------|----------------|------------------------------|
|                                | Direct               | Direct + Aggregation | Aggregation |
| 1000                           | 500-884              | √               |                             |
|                                | 885-1154             |                 |                             |
|                                | >1154                |                 |                             |
| 1300                           | 500-945              | √               |                             |
|                                | 946-1320             |                 |                             |
|                                | >1320                |                 |                             |

5. Conclusion
Based on the data obtained from the survey, this paper uses the mathematical optimization model to calculate the freight volume optimization model based on several well-developed and large-capacity container freight center stations, and calculates the matching outbound transportation organization
optimization plan. The average travel speed of the train is used for sensitivity analysis, and the following conclusions are obtained.

(1) Under the actual circumstances of China, if the China Railway Express want to completely abandon the transportation organization mode of peer-to-peer direct flights, all of them should be assembled. The average travel speed of domestic trains should be higher than the average travel speed of China Railway Express.

(2) To achieve the lowest transportation cost, the speed of the domestic container train will not only affect the transportation organization mode, but also affect the selection of the assembly center station. As far as the actual situation is concerned, increasing the average travel speed of the domestic trains will make the trains show a tendency to gather in Urumqi. Therefore, the assembly center of the Western Corridor has chosen Urumqi to have certain rationality.

(3) When the speed changes within a certain range, only the container trains issued by Zhengzhou first appeared in the trend of assembly in Lanzhou, and then appeared in the trend of assembly in Urumqi.

(4) Under the existing conditions of running 1000 km of China Railway Express, when the average travel speed of domestic container trains reaches 1155 km/d, the transportation organization mode in Urumqi is better.

(5) In the future, when the average speed of the domestic container trains reaches 1,525 km/d, the transport organization mode in Urumqi is better.

Acknowledgments
This work was supported by the National Key R&D Program of China [grant number 2018YFB1201403].

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