Research Paper

Suitability assessment of industrial heritage tourism of the towns along Chinese Eastern Railway in Heilongjiang Province

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Abstract

Tourism utilization of industrial heritage is a meaningful way to balance heritage conservation and economic development. As a linear cultural heritage that runs through northeast China, Chinese Eastern Railway (CER) carries the historical and cultural memory of all places along the line, so it is of great significance to evaluate its suitability for tourism development. This study takes 24 towns along CER in Heilongjiang Province as research samples. Based on the theory of sustainable tourism and heritage protection, it constructs a suitability evaluation system of industrial heritage tourism development that includes five categories of 20 indicators such as heritage resources, natural environment, social environment, transportation accessibility, and tourism service facilities. Group Decision and Entropy Weight method give the weight of each index to calculate the total score. Then the score results are input into SPSS for cluster analysis. According to the classification results, the "Region-Town" industrial heritage tourism development framework of towns along CER in Heilongjiang Province is proposed: Implement district development to form complementary advantages; Make proper strategic positioning of town development to enhance the competitiveness of the towns in heritage tourism.

Keywords

Industrial Heritage, Chinese Eastern Railway, Tourism Development, Suitability Evaluation, Analytic Hierarchy Process

1. Introduction

1.1. Background

Industrial heritage records the history of industry and regional development, carries the collective memory of residents in a specific period. It is of great significance to protect and use it. Heritage tourism is a meaningful way to protect industrial heritage: through heritage tourism, heritage forms consumption capital in a particular space and time, which can transform the value of industrial heritage into economic benefits when tourists visit the heritage site. The income can be used for the daily maintenance and management of the industrial heritage, realize the sustainable use of industrial heritage resources, and drive the regional economy's comprehensive development. In addition, visitors can have a deeper understanding of the heritage sites' historical events and technological development processes through the display and interpretation functions. Then, the historical context of the industry and the significant lessons of the past will be passed on.

From colonial to high-speed, railways have played an important role in the different historical periods of China. Especially in Northeast China, there are many railway industry heritages due to the construction of Chinese Eastern Railway (CER). However, except for individual heritage resources that have been effectively protected and utilized, most industrial heritages remain idle, facing the risk of protective decline and constructive destruction. Therefore, a systematic evaluation of the suitability of tourism development on the industrial heritages of the towns along CER has specific practical significance.

1.2. Review

In evaluating the utilization of industrial heritage tourism, scholars' researches mainly focus on the character description, reconstruction feasibility, and post-use evaluation of individual heritage or heritage sites. Hou (1992) carried out descriptive research on the historical background, cultural characteristics, and landscape elements of CER industrial heritages. Eros (2018) introduced the development history of the Hershey Sugar Factory in Cuba and its significance to the local area. He also discussed the evaluation results of the incremental tourism development of the sugar factory as an industrial heritage tourist destination on the local employment promotion potential. Philip et al. (2020) investigated residents' attitudes towards tourism development and reconstruction of abandoned shipyards in Macao. Based on grounded theory, they discussed that residents' cognition and attitude towards tourism projects proposed by local governments play a crucial role in shaping urban revitalization.

In recent years, as the concept of heritage protection has become integrated and systematic, scholars have begun to focus the overall protection of heritage with similar characteristics and use information technology for quantitative evaluation. According to the characteristics of historical and cultural blocks, Shen (2014) used indicators such as historical and cultural value, recreational value, and architectural environment to construct an evaluation system for the eight main historical blocks in Nanjing. Fang et al. (2014) used GIS technology to evaluate the Yangtze River Delta's spatial calculation and development suitability based on the acquired remote sensing data and obtained suitable towns for tourism development based on the evaluation results.

Based on this, this paper uses AHP combined with subjective and objective weighting methods to construct an evaluation system for the suitability of industrial heritage tourism development in the towns along CER. Take the Heilongjiang section of CER as an example, use quantitative methods to analyse industrial heritage protection status quo in the towns, and propose targeted industrial heritage protection and sustainable use measures.

2. Research area and methodology

2.1. Research area

CER is a railway line proposed by Tsarist Russia between 1897 and 1903. It connects Northeast China with a T-shaped route, starting from Manzhouli in Inner Mongolia in the west, Suifenhe in Heilongjiang in the east, and Dalian in Liaoning in the south, covering a total of about 2,489 kilometers. The Heilongjiang section starts from Nianzishan in Qiqihar in the west and ends at Suifenhe in Mudanjiang in the east. The line connects, Daqing, Suihua, Harbin, and Mudanjiang from west to east. According to the research needs of this article, the research objects are determined to be the 24 towns with the industrial heritages of CER among the above five cities (Figure 1).

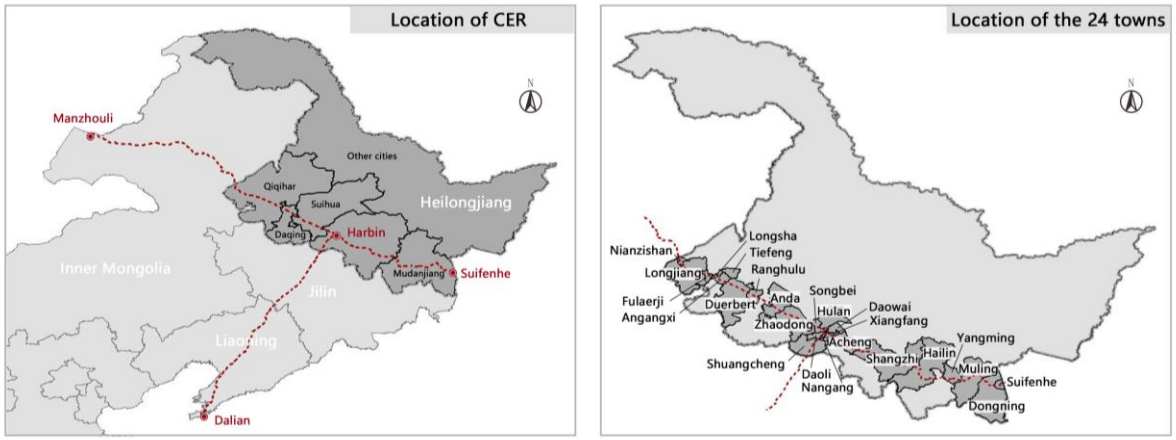

Figure 1. Location of CER and the 24 towns in Heilongjiang section. Source: Author.

2.2. Methodology and technical route

2.2.1 Research method

The suitability for tourism development of CER industrial heritages is affected by many internal and external factors. It is necessary to operate and enable a straightforward reading of the relationship among indicators, making a horizontal comparison and a vertical analysis. Therefore, this paper chooses to use the AHP method to construct the evaluation model. After that, group decision-making and entropy method are used to determine the index weight comprehensively. On the one hand, it can reflect the characteristics of the essential elements of the heritage site. On the other hand, it can also comprehensively consider the needs of tourists. Finally, this paper uses K-means clustering to analyse. K-means clustering is an intuitive and fast clustering analysis method, and the results are detailed and easy to understand, so it has been widely used.

2.2.2 Technical path

This study firstly selects evaluation indicators and designs quantitative calculation method based on relevant theories, statutory documents, and existing literature, and then adjusts the indicator framework through consultation of experts to obtain a formal evaluation indicator framework: The first step is to calculate and score indicators for 24 towns along CER; The second step is to integrate group decision and entropy weight method to determine the weight of each indicator and calculate the total score of each town; The third step is to classify the evaluation results, use K-means clustering to analyse the score results, and divide towns into different categories according to the results of cluster analysis; The fourth step is to propose corresponding industrial heritage protection and tourism utilization enhancement measures based on the evaluation results (Figure 2).

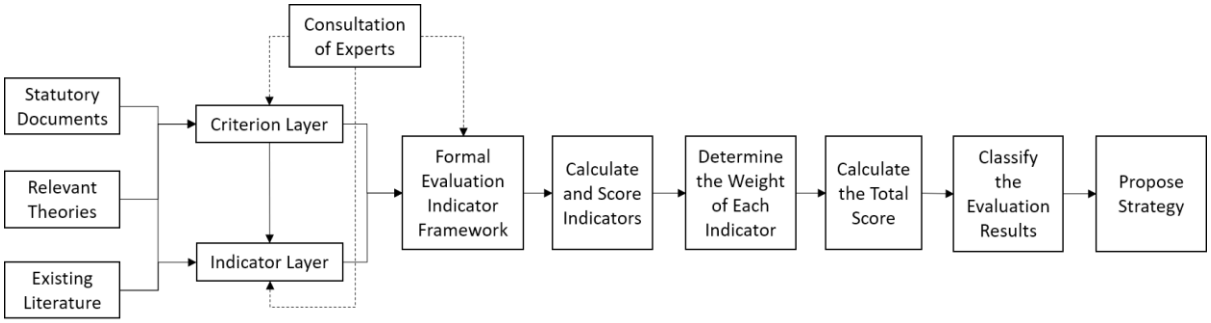

Figure 2. Technical path of this research. Source: Author.

2.2.3 Data sources

The data sources of this paper mainly include the following categories:

1) CER Heilongjiang Section Database: Data of CER industrial heritages in Heilongjiang Section such as texts, images, videos, architectural surveying and mappings, geographic coordinates, and three-dimensional models (Figure 3).

2) Statistical Yearbook and Annual Statistical Bulletin of National Economic and Social Development: This paper mainly referred to the 2018 Statistical Yearbooks and Annual Statistical Bulletin of National Economic and Social Development of Heilongjiang Province, Qiqihar City, Daqing City, Suihua City, Harbin City, and Mudanjiang City.

3) Official websites of government departments and agencies: Public query and download data provided by the official websites of the National Meteorological Information Center, Heilongjiang Provincial Bureau of Culture and Tourism, 12306, AQI China, and other agencies.

4) Remote sensing image and DEM data: Digital elevation model data of the National Geographic Information Resource Directory Service System and Landsat8 remote sensing image data of GSCloud.

5) POI data related to the number, quality, and type of tourist reception facilities on Baidu Maps.

6) Questionnaire survey data: 203 valid questionnaires were distributed to tourists around the main industrial heritages to obtain their opinions on the development of industrial heritage tourism in CER towns.

Figure 3. CER Heilongjiang section database. Source: Author.

3. Evaluation System Construction

3.1. Selection of indicators

In the evaluation process, the evaluation index system constructed must comprehensively, objectively, scientifically, and accurately reflect the various elements in the development of industrial heritage tourism. This paper strictly followed the following four principles when constructing the evaluation indicators for the suitability of the industrial heritage tourism development of CER towns:

Table 1. Indicator system. Source: Author.

Target layer	Criterion layer	Indicator layer
Suitability of industrial heritage tourism development in CER towns	Heritage resource A	Heritage cultural protection level - A1
		Amount of heritage - A2
		Existing state of heritage - A3
		Heritage age - A4
		Richness of heritage species - A5
	Social environment B	Other surrounding tourism resources - B1
		Current situation of local tourism market - B2
		Economic basis of population - B3
		Type of town where heritage is located - B4
		Heritage awareness - B5
	Natural environment C	Air quality - C1
		Vegetation coverage - C2
		Proportion of land suitable for construction - C3
		Appropriate tour period of tourism resources - C4
	Transportation accessibility D	Degree of heritage aggregation - D1
		Heritage accessibility - D2
		Travel time cost - D3
	Tourist service facilities E	Number of tourist reception facilities - E1
		Quality of tourism reception facilities - E2
		Types of tourist reception facilities - E3

1) Ensure the authenticity of heritage. Research on heritage protection emphasizes that authenticity is the measure of heritage value and the key to heritage protection. Therefore, the process of selecting indicators needs to consider the authenticity value of heritage fully.

2) Consider the needs of tourists. Tourists' request for the authentic experience of heritage is the driving force for heritage tourism development. At the same time, tourists will also have various transportation, accommodation, catering, and entertainment when visiting recreational areas. Therefore, when evaluating the suitability of tourism development of heritage sites, factors such as traffic conditions and supporting service facilities also need to be considered.

3) The systematic construction of the evaluation system. The evaluation indicator system constructed can reflect the overall status of the evaluation system. During the construction process, the systemic principles must be observed. The evaluation indicator system shall be regarded as a system as a whole, and the suitability of tourism development shall be the goal. Thoroughly consider the organic connection and internal logic among the evaluation indicators and construct a comprehensive evaluation indicator system.

4) The evaluation indicators are easy to quantify. It is necessary to comprehensively consider the actual investigation of CER industrial heritages and the accessibility and operability of data acquisition to ensure the accuracy and authenticity of evaluation results. Indicators that are difficult to count, define, measure, and have weak evaluation significance should be removed or replaced, and indexes with strong

correlation, availability, and great evaluation significance should be selected to construct the evaluation system.

This paper is based on the above principles, combined with the description of the "Classification, Investigation and Evaluation of Tourism Resources" (GB/T 18972-2017) and the status quo of the development of CER industrial heritages, regarding the suggestions of relevant experts, to construct an evaluation indicator system with five categories and 20 indicators (Table 1).

3.2. Indicators calculation method

Considering that different evaluation indicators often have different meanings and dimensions, making them dimensionless before evaluation is necessary. According to the data characteristics of the indicators, this paper divides them into qualitative indicators and quantitative indicators for assignment and calculation (Table 2):

1) Assignment and calculation of qualitative indicators. In systematic evaluation, qualitative indicators are those that are described qualitatively by written comments. For this kind of indicator, it is necessary to establish the corresponding score table for evaluation. In this paper, the 5-point scale is used as the scoring scale to determine the assignment scale.

2) Assignment and calculation of quantitative indicators. Traditionally, quantitative indicators can be divided into benefit type, cost type, fixed type, and interval type. According to the meaning of each indicator, quantitative indicators in this paper can be divided into benefit type and cost type. Benefit-type indicators refer to the better, the larger the indicator's value; Cost-type indicators refer to the better, the smaller the indicator's value; The formulas are:

$$d_{ij} = \frac{a_{ij} - a_{j,min}}{a_{j,max} - a_{j,min}} \quad \text{(Benefit type)}$$

$$d_{ij} = \frac{a_{j,max} - a_{ij}}{a_{j,max} - a_{j,min}} \quad \text{(Cost type)}$$

In the formula: i=1,2,⋯,m; j=1,2,⋯,n; $a_{j,max}$——The maximum value of the indicator u_j; $a_{j,min}$——The minimum value of the indicator u_j.

In order to ensure that all indicators can be compared with each other, the numerical interval of each indicator is uniformly converted into [0-5].

Table 2. Classification of index calculation methods. Source: Author.

Type	qualitative indicators	quantitative indicators	
		Benefit type	Cost type
Indicator	A1; A3; A4; B1; B2; B4; B5; C1; C3; C4; D2	A2; A5; B3; C2; D1; E1; E2; E3	D3

3.3. Determination of the weights of indicators

Firstly, eight experts and scholars of CER and tourism development were invited to independently compare all factors at the same level in pairs according to Saaty's 1-9 scale method. Secondly, according to the questionnaire results, group decision-making judgment matrixes were constructed in Yaahp software to calculate the indicator weights of the expert group decision-making. Then, entropy method

was used to analyse the collected 203 tourist questionnaires. This paper standardizes the original evaluation data, calculates the entropy value and difference coefficient of each indicator, and finally obtains the weight vector of the evaluation indicator.

Since the group decision-making method uses the expert's experience and knowledge to determine the weights subject to heavier subjectivity. While entropy method entirely relies on the size of the difference between the evaluation indicator data and obtains the weights by calculating the entropy value without considering the subjective importance of the index.

Therefore, this paper uses the principle of minimum relative information entropy to combine and optimize the two, getting more reasonable and scientific weights. The weights obtained through the combination optimization method can solve the emotional problem of the analytic hierarchy process in determining the weights. On the other hand, it can also make up for the lack of the entropy method to determine the weights relying on indicator data. The final index weights are shown in Table 3.

Table 3. Weight calculation results. Source: Author.

Indicator layer	Group decision weight	Entropy method weight	The total weight
A1	0.15	0.06	0.11
A2	0.09	0.05	0.07
A3	0.06	0.03	0.05
A4	0.04	0.07	0.06
A5	0.07	0.04	0.06
B1	0.05	0.04	0.05
B2	0.03	0.05	0.04
B3	0.02	0.09	0.05
B4	0.01	0.10	0.03
B5	0.04	0.05	0.05
C1	0.05	0.03	0.04
C2	0.03	0.04	0.04
C3	0.01	0.13	0.04
C4	0.06	0.03	0.05
D1	0.08	0.05	0.07
D2	0.05	0.02	0.04
D3	0.04	0.02	0.03
E1	0.02	0.04	0.03
E2	0.06	0.04	0.05
E3	0.04	0.02	0.03

4. Results and analysis

4.1. Suitability evaluation result

According to the indicator scores and weights obtained above, the final evaluation scores of the 24 towns are shown in Table 4.

Table 4. Final evaluation score. Source: Author.

Towns	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E	Total score
Nangang	1.23	0.73	0.58	0.62	0.53	3.70
Daoli	1.20	0.59	0.61	0.64	0.49	3.54
Shangzhi	1.19	0.51	0.69	0.60	0.31	3.30
Angangxi	1.52	0.32	0.63	0.58	0.19	3.23
Hailin	1.16	0.53	0.63	0.61	0.27	3.20
Songbei	0.80	0.69	0.62	0.66	0.35	3.13
Daowai	0.95	0.50	0.61	0.59	0.41	3.07
Acheng	0.66	0.54	0.67	0.63	0.34	2.84
Xiangfang	0.60	0.64	0.58	0.61	0.41	2.84
Hulan	0.62	0.45	0.63	0.70	0.36	2.75
Suifenhe	0.84	0.48	0.66	0.52	0.19	2.69
Shuangcheng	0.66	0.38	0.66	0.57	0.30	2.57
Anda	0.69	0.29	0.69	0.62	0.26	2.55
Muling	0.76	0.38	0.64	0.52	0.22	2.53
Zhaodong	0.66	0.24	0.71	0.60	0.29	2.50
Fulaerki	0.67	0.30	0.68	0.56	0.25	2.47
Yangming	0.74	0.26	0.61	0.55	0.24	2.40
Longsha	0.47	0.39	0.62	0.57	0.34	2.39
Duerbert	0.58	0.42	0.70	0.43	0.24	2.37
Dongning	0.60	0.36	0.67	0.48	0.21	2.33
Longjiang	0.68	0.21	0.63	0.51	0.25	2.28
Tiefeng	0.46	0.42	0.62	0.35	0.29	2.14
Ranghulu	0.42	0.30	0.70	0.36	0.35	2.13
Nianzishan	0.50	0.28	0.63	0.35	0.24	2.00

4.2. Cluster analysis result

K-mean cluster analysis is performed on the evaluation results in SPSS software, and 24 cities and towns are divided into four categories according to the analysis results (Table 5):

The first type is high development suitability. It is mainly located in the central area of Harbin and along the Harbin-Mu section of Binsui Line. This type is at a high level in all dimensions except the natural environment dimension, especially in terms of related indicators under the heritage resource dimension, which is significantly different from other types.

The second type is moderate development suitability. The spatial distribution is mainly located in the suburbs of Harbin and Suifenhe. This type is at a high level in terms of social environment and traffic accessibility but is at a medium level in heritage resources, natural environment, and tourist service facilities.

The third type is low development suitability. The spatial distribution is mainly located along the Binzhou Line, the Mu-Sui section of the Bin-Sui Line, and the Shuangcheng section of the Harbin-Dalian Line. This type of town only reaches a high level in the dimension of the natural environment, the dimension of tourism service facilities is at a general level, and the other three dimensions are all at a low level.

The fourth type is high overall development suitability but extremely unbalanced indicators in various dimensions, namely, Angangxi District. The town is at a very high level in the dimension of heritage resources but an average or low level in the other four indicator dimensions.

Table 5. Cluster analysis results. Source: Author.

Type	Towns	Average score	Criterion A	Criterion B	Criterion C	Criterion D	Criterion E
First	Nangang; Daoli; Shangzhi; Hailin; Daowai	3.36	1.15 (High)	0.57 (High)	0.63 (General)	0.61 (High)	0.40 (High)
Second	Songbei; Acheng; Xiangfang; Hulan; Suifenhe	2.85	0.70 (General)	0.56 (High)	0.63 (General)	0.62 (High)	0.33 (General)
Third	Shuangcheng; Anda; Muling; Zhaodong; Fulaerji; Yangming; Longsha; Duerbert; Dongning; Longjiang; Tiefeng; Ranghulu; Nianzishan	2.36	0.61 (Low)	0.33 (Low)	0.66 (High)	0.50 (Low)	0.27 (General)
Fourth	Angangxi	3.23	1.52 (Very high)	0.32 (Low)	0.63 (General)	0.58 (General)	0.19 (Low)

4.3. Strategy

4.3.1 Implement district development

Most of the cultural heritage resources in the high-suitability region have high heritage resource value and resource combination. Convenient transportation and a suitable recreation environment make this region's industrial heritage resources highly attractive to tourists, so it is appropriate to vigorously carry out tourism development and utilization activities in this region.

In terms of the spatial layout of tourist attractions, the scale of tourist nodes and the humanistic connotation of the railway industrial heritage are highlighted. The resource core area is the growth pole of the industrial heritage tourism belt, radiating the surrounding secondary suitable areas for tourism development. The adjacent heritage resource points in the region are connected with the cultural tourism pedestrian street as the axis. To build commercial forms with regional cultural characteristics, introduce commercial projects providing food, accommodation, transportation, tourism, shopping, and entertainment, and improve the quality of tourism service supply in heritage sites. Furthermore, pay attention to the activation and utilization of intangible cultural heritage elements in tourism development, develop related tourism products, show railway cultural characteristics, enable tourists to have a better recreational experience, and promote the tourism image of CER. For the architectural heritage in the core resource utilization area, the authenticity of the architecture should be maintained, and the surrounding architectural style should be controlled to create a unique tourist atmosphere through facade reconstruction. Finally, carry out the calculation of the environmental capacity of scenic spots with cultural heritage scenes as the core scenic spots, implement a tourism capacity monitoring system for popular attractions, and adopt current limiting measures for scenic spots to prevent overloaded visits from causing damage to core heritage resources.

Due to the relatively insufficient overall development and utilization conditions for low-suitability areas, protection should be the priority, and appropriate development should be maintained. From the unit of heritage resources to the overall protection of the region, it is the evolutionary path for the development of industrial heritage protection. The development and utilization of regional heritage as a tourism resource will usher in opportunities in the future. Although the overall development suitability of heritage resources in low-suitability areas is not as good as those in high-suitability areas, there are still individual resources with higher suitability evaluations. Therefore, it is possible to choose a single heritage resource with regional representativeness to develop and utilize high-quality goods. One is to undertake the overflow of tourists in the highly suitable area, and the other is to become a significant small-scale growth through the planning and construction of characteristic heritage cultural tourist attractions, driving regional economic development.

4.3.2 Make proper strategic positioning of town development

Inferior factors in evaluating the suitability of tourism development will limit the overall evaluation of regional heritage resources. Based on the positioning of the evaluation of towns, the development strategies are proposed from five evaluation dimensions.

1) Heritage resources. The general repair of the damaged buildings is carried out to prevent the heritage from being destroyed by natural forces and manufactured damage, maintain the value of the authenticity, and let some idle industrial heritage play its maximum value.

2) Natural environment. For towns whose natural environment is not suitable for outdoor activities, they can try to improve the micro-climate around the heritage sites and install some winter cold and wind protection facilities or plan indoor themed activities on the premise of not damaging the heritage features, to improve the comfort level of the human body during heritage tourism.

3) Social environment. Make full use of the local existing characteristic tourism resources and carry out heritage tourism activities by local conditions. Publicizing the historical, science education, aesthetic, and recreation value of the resource points to highlight heritage resources' cultural charm. Moreover, use new technical media means to promote and expand the brand reputation.

4) Traffic accessibility. Improve transportation links between heritage sites and surrounding areas. Make full use of the existing railway resources and open the CER tourism special train during the peak tourist season to reduce the time cost of tourists to travel destinations and provide a stable source of tourists for heritage sites with inconvenient road transport conditions.

5) Tourist service facilities. Improve infrastructure such as environmental sanitation and create a high-quality recreational environment. Besides, improve the conditions of tourism supporting facilities, build or renovate existing tourism service facilities, and improve the supply of tourism elements in heritage sites. Moreover, encourage the participation of the residents and communities to promote the reasonable allocation of local human, material, and financial resources and build the heritage site into a tourist site to provide better services.

5. Conclusion

This paper comprehensively uses the AHP, Group Decision-making, and entropy method to construct the industrial heritage tourism development suitable evaluation model for CER towns from five dimensions: heritage resources, natural environment, social environment, transportation accessibility, and tourism service facilities. Based on geographic information technology and multi-source data, it conducts qualitative and quantitative research on the suitability of industrial heritage tourism development in towns along the route. Taking the Heilongjiang section as a case study, it is found that the suitability of industrial heritage tourism development in the study region presents a phenomenon of uneven spatial distribution through multivariate data calculation and cluster analysis. Most of the towns suitable for development are concentrated around metropolitan areas. However, towns with high suitability usually have poor natural environment attributes. At the same time, in the evaluation process, it is found that the indicator of the dimension of heritage resources has a significant weight. Based on this, this paper puts forward the overall development strategy of coordinating the high and low suitability areas from a macro perspective and puts forward the strategy of character development and optimal resource allocation according to the development shortcomings and limiting factors of different types of towns. In the future, other towns along CER can be evaluated to realize the overall protection and scientific development of CER industrial heritage.

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