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Assessment of the Adaptive Reuse Potentiality of Industrial Heritage Based on Improved Entropy TOPSIS Method from the Perspective of Urban Regeneration

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Abstract: In recent years, it has become critical to promote urban redevelopment and maximize the potentiality of industrial heritage through adaptive reuse. Research on the assessment of adaptive reuse potentiality helps to make scientific decisions in sustainable development and the strategy for utilizing industrial heritage. The purpose of this paper is to provide a comprehensive overview of the research on the potentiality of buildings or sites. It also constructs a system for the assessment of adaptive reuse potentiality in industrial heritage and describes the characteristics of different dimensions in the indicators of potentiality evaluation. Utilizing the Improved Entropy Technique for Ordering Preferences by Similarity to the Ideal Solution (Improved Entropy TOPSIS), the relative values of the reuse potentiality of each hierarchical evaluation index are calculated, and an adaptive reuse potentiality ranking of various industrial parks is determined. Through the calculation and analysis, it is demonstrated that the application of this quantitative method to the industrial heritage potentiality evaluation system is highly applicable. This paper's research framework for adaptive reuse potentiality and empirical findings provides targeted recommendations for determining the reuse potentiality and potential hierarchy of industrial heritage, identifying buildings with a high potential for reuse, and developing adaptive reuse strategies to better direct industrial heritage in urban regeneration.

Keywords: industrial heritage; adaptive reuse potentiality; improved entropy; technique for ordering preferences by similarity to the ideal solution; urban regeneration

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1. Introduction

As a significant component of cultural heritage, industrial heritage preserves the memories of regional and urban development as well as the historical fashions and traits of various nations and regions. Today, the adaptive reuse of industrial heritage has largely replaced demolition and reconstruction. How to maximize the value of industrial heritage while supporting regional and urban transformation and better integrating urban regeneration is a significant topic in the field of heritage conservation. Research on the adaptive reuse of industrial heritage has focused on the study of specific strategies for reuse [1] and heritage value assessment [2]. However, many cases have demonstrated that industrial heritage transformation and utilization strategies frequently rely on value assessment rather than adaptive reuse potential assessment, which does not lead to effective industrial heritage protection, full utilization, or the effective promotion of sustainable urban regeneration. Since more than ten years ago, Beijing has been preserving and reusing its industrial heritage. Numerous studies on actual instances of industrial heritage transformation have been conducted, and specific outcomes have been obtained in the fields of industrial heritage preservation and reuse, as well as value assessment. A thorough potentiality evaluation system that is pertinent, systematic, and useful is lacking in the field of research on the evaluation of reuse opportunities. The prerequisites of and keys to the adaptive reuse of industrial heritage now include how to construct a comprehensive evaluation index system to express the reuse potentiality of industrial heritage and how to thoroughly consider the current situation of industrial heritage.

Figure 1 depicts the research framework of this paper. Research on the potentiality of reusing industrial heritage clarifies the concept definition of reuse potentiality assessment, the selection of an evaluation index system, and quantitative methodologies. The rationale for selecting the indicators for the assessment of adaptive reuse potentiality is provided, and the industrial heritage value assessment system is constructed at various levels of autologous value, retrofitting value, and potential benefit value from the building dimension and urban dimension, respectively. In the literature review and material analysis, quantitative research methodologies for assessing the adaptive reuse potentiality of industrial heritage are included. To improve the scientific and unbiased results of the potentiality evaluation, the comprehensive weights of the evaluation indicators were calculated, and the technique for ordering preferences by similarity to the ideal solution (TOPSIS) was used to determine the relative size of the reuse potentialities of various industrial parks as well as the specific potentiality distribution values of each park, which were included in the method description. Ultimately, the applicability of the evaluation method is demonstrated by assessing the potentialities of eight industrial parks in Beijing, which are included in the evaluation results. The evaluation results provide robust, adaptive guidance for both decision making and the management of industrial heritage restoration. Predicting the timing, purpose, and focus of exploitation, as well as proposing reuse plans for the development of the area, are helpful for industrial heritage parks that have not yet been renovated; for those that have been renovated and are currently in use, the potential values and distribution are clarified, as are suggestions for optimizing the current renovation and operational management. This discussion and conclusion comprise this part.

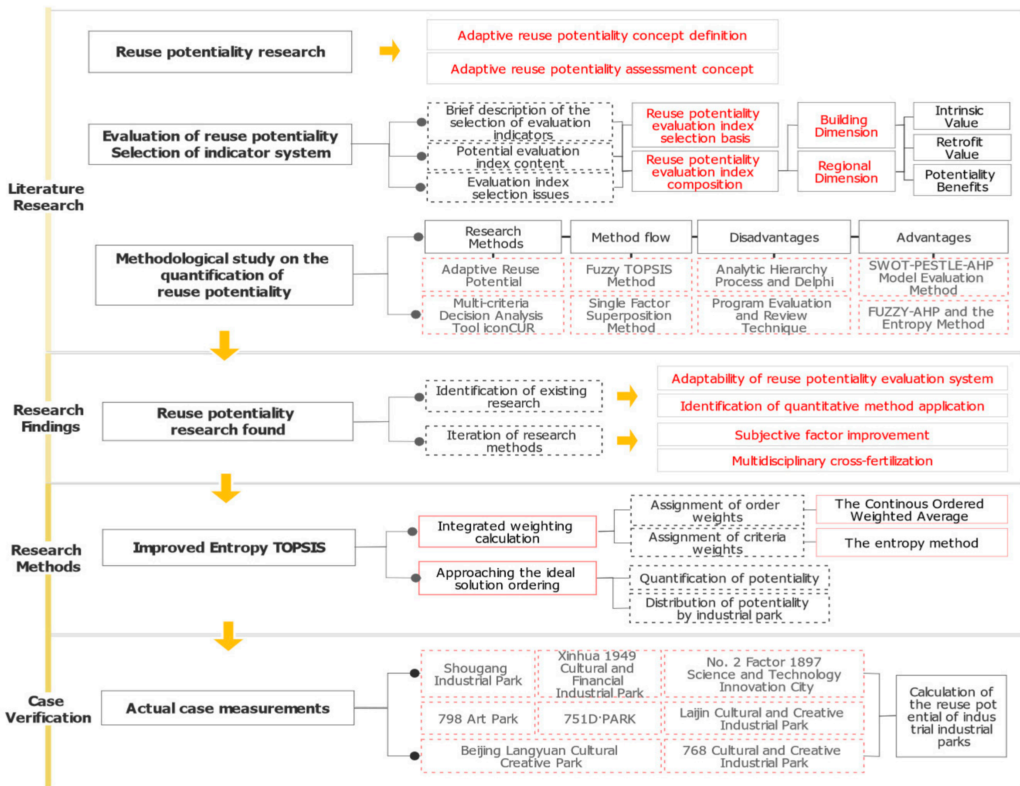


Figure 1. Diagram of the research framework.

2. Review of the Literature on the Potentiality for the Adaptive Reuse of Industrial Heritage

2.1. Research on Reuse Potentiality

Regarding the urban dimension of reuse potentiality, Gui Jin et al. conducted fundamental theoretical research on the design of spatial redevelopment and spatial conservation models for regional sustainable development, constructing an evaluation hierarchy based on spatial development and conservation [3]. Ana Martinovi et al. have developed a theoretical framework for the integration of social sustainability factors into urban regeneration processes in post-conflict areas, using a bottom-up approach to surveying and interviewing the social perceptions of all pertinent interests to obtain targeted influences on the socially sustainable heritage regeneration of industrial heritage. The importance and viability of including the social component of sustainability in strategies for regenerating cultural resources in post-conflict situations are emphasized [4]. This can be used as a trustworthy reference for identifying an indicator system for the growth of the urban dimension of reuse potentiality. Regarding the ontological dimension of reuse potentiality, Wang Jianguo and Jiang Nan categorized reuse potentiality into four categories, historical and cultural, industrial transformation, functional renewal, and economic benefits, and used this information to develop a reuse potential evaluation system based on the building base environment, building shape, structural equipment, internal space, and economic technology [5]. Vardopoulos, I., considers sustainable development potentiality, which implies the realization of benefits when adapting, including physical–economic, functional, environmental, political–social, and cultural potential, and adaptive reuse potential assessment, which focuses more on conservation and sustainable development strategies and provides recommendations on whether to engage in adaptive reuse and the priority of adaptive reuse for the target of the assessment [6]. Wijesiri, W.M.M., on the other hand, recently proposed the concept of the Green Adaptive Reuse (GAR) of buildings as an effective strategy to extend the life of facilities and reduce their carbon footprint, contributing to the preservation of an important heritage that determines cultural development [7] by following and extending Craig Langston's evaluation system and employing it to construct a GAR model to determine the potential for reuse of existing resources [8]. Regarding the potentiality for the reuse of industrial building heritage, Craig Langston predicts buildings' service lives based on the potential obsolescence of physical, economic, functional, technical, social, and legal criteria, guides design strategies by assessing the potentiality to enable building retrofitting to maximize adaptive reuse potential, and verifies the size and ranking of the adaptive reuse potential using the adapt STAR model [9]. This method combines the development of the adaptive reuse of old buildings with the objective of reducing the environmental impact of climate change and contributing to greater energy and resource efficiencies. Fan Shengjun summarized the potentiality evaluation system, which included architectural integrity, locational value, historical continuity, future profitability, and environmental friendliness, based on future value characteristics that reflect recycling potential [10].

The existing system of indicators for assessing reuse potentiality is proposed without providing a foundation for determining the indicators. The majority of value evaluation systems are carried forward from previous generations, resulting in insufficient adaptation to the specificity of industrial heritage for adaptive reuse. The interaction of the evaluation elements' opinions has not been considered. The reuse potentiality derived from the evaluation index system has a relatively limited scope of application and only applies to a specific area of a single industrial building, thereby lacking the relevance and generalizability necessary to guide the renovation strategy. In addition, research on reuse potentiality is more focused on heritage ontology, and the evaluation system does not completely account for the impact of adaptive reuse on the urban environment. To assess the adaptive potential of industrial heritage, the scope of the index system must be expanded to include not only individual industrial buildings but also their location, the surrounding area, and urban regeneration development.

2.2. Research on Quantitative Methods for Reuse Potentiality

The majority of existing studies on the preservation and reuse of industrial heritage adopt a qualitative approach. Due to the overuse of experience-based rules, subjective factors have a significant influence on outcomes and lack support from scientific theory. In recent years, the use of quantitative methods in industrial heritage research has increased due to the development of big data in the field of heritage conservation and the need for precise and scientific research. They are primarily used for assessing the reuse value of industrial heritage, risk analysis, and post-reuse evaluation, but quantitative research methods on reuse potentiality are scarce. The research on reuse potentiality should enhance the accuracy and applicability of predictions as well as build an adaptable potentiality evaluation system that can be utilized at various phases of industrial heritage preservation.

The most common quantitative methods for assessing the potentiality of industrial heritage are listed below. Although Adaptive Reuse Potential (ARP) is effective at estimating the remaining life of buildings and facilitating the analysis and comparison of various reuse objects, the physical life degradation of buildings cannot be precisely calculated, resulting in ambiguous potential evaluation results. The Single Factor Superposition Method simplifies the assessment factors based on quantification and operability principles, and the calculation procedure is more reproducible; however, it is more difficult to obtain assessment parameters and data [11]. Although the data obtained by aggregating and quantifying subjective and objective judgments using the Analytic Hierarchy Process (AHP) and Delphi method are more scientific, subjective factors also influence the variables and corresponding weights [12]. ELimination Et Choix Traduisant la REalité (ELECTRE) has a clearer concept of the superiority of decision options, which can improve decision accuracy, but the method for determining the weights does not take into account the influence of the interaction between the attributes of the indicators on the evaluation results [13]. It is difficult to assess multiple factors at various layers, making the decision outcome uncertain and making it difficult to implement complex decisions regarding reuse potentiality. The VIse Kriterijumski Optimizacioni Racun (VIKOR) ranking process compares group utility values and combined utility values to determine the merits of the evaluation options [14]. Individual high evaluation indicators, when applied to a system of evaluation indicators, can easily trump certain low evaluation indicators, which are also crucial for determining the potentiality of heritage reuse.

To minimize the influence of subjective factors on the evaluation system's results, it is necessary to determine the optimal ranking of the relative magnitudes of the reuse potentialities for multiple options. After combining several multi-attribute decision methods, the Technique for Ordering Preferences by Similarity to the Ideal Solution (TOPSIS) was finally used to determine the relative magnitudes and ranking of the reuse potentialities. The TOPSIS method is a sequential selection technique based on the similarity of ideal targets. The normalized data normalization matrix is used to identify the optimal and inferior targets among multiple targets. The proximity of each evaluation objective to the ideal is determined by separately calculating the distance between each objective and the positive and negative ideal solutions. The objectives are ranked by their magnitudes, and this is used as the basis for evaluating their superiority. The method is suitable for determining the magnitude of the reuse potential by comparing the ranking after calculating the weight of the multi-objective method, which enables a more objective assessment of the reuse potentialities of multiple options and provides decision-makers with targeted guidance. It is unaffected by the order of evaluation options, is suitable for the cross-sectional comparison of multiple evaluation options, is easier when handling fuzzy data, is simpler to calculate, and produces more objective quantitative results. Due to the indicator system's strong reliance on weight, it is easily influenced by the subjective factors of decision-makers, and different weighting schemes appear inconsistent for decision results, so it is more important for the calculation of indicator weights in use. In this paper, we calculate the comprehensive weight of the evaluation index system using the Continuous Ordered Weighted Averaging operator (C-OWA) and the Entropy Weight Method. C-OWA is appropriate for uncertain multi-attribute decisions for which the attribute weights are known with certainty and the attribute values are given as interval numbers in order to reduce the subjective factors of the evaluator and the extreme values of the evaluation data on the calculation errors of the indicator weights and to take into account the influence of the indicator factors in the order. The method was used to calculate the weight of the graded order of the evaluation indicators for reuse potentiality. The Entropy Weight Method is a quantitative method of objective weighting in which the entropy value is used to determine the dispersion of an indicator and the information entropy is used to calculate the weight of each indicator. The entropy weight is modified according to each indicator so as to obtain a more accurate and scientific weighting of the grading criteria indicators. Finally, the comprehensive weights are obtained by linear weighting. The calculation of the comprehensive weight contributes to the improvement of the scientific nature and accuracy of a multi-objective decision analysis, and the evaluation process is more operable and appropriate for the processing and analysis of quantitative data within a multi-layer potentiality evaluation system. Improved entropy TOPSIS enables an objective evaluation of the evaluation object and circumvents the issue in which the solution closest to the ideal solution is also clear to the negative ideal solution. The objective comprehensive assignment based on the determination of order and criterion weights increases the comparative analysis between evaluation indicators, and the combined use of the two methods can improve the scientific and rational nature of the evaluation results, significantly reducing the subjectivity of the results calculated by inviting experts to score the conventional TOPSIS method.

3. Materials and Methods

3.1. Analysis of Adaptive Reuse Potentiality of Industrial Heritage

Definition of Adaptive Reuse Potentiality and Its Assessment of Industrial Heritage

The former scholars defined architecture reuse potentiality as a capacity that needs to be stimulated externally and provides practical benefits [15], a capacity that contains the possibility of reuse hidden in itself and any intervention capacity to adapt to new conditions [16], which represents the potentiality for future transformation and the sustainability of the project after renovation. This paper defines the adaptive reuse potentiality of industrial heritage as the ability of the heritage to contribute to its own and to the city's sustainable development by providing practical benefits to subsequent development. This potentiality can be reflected in three dimensions: autologous value, retrofitting value, and potential benefit value. The first represents the potentiality for the industrial heritage to be reused, the second represents the potential ability for efficient use after reuse, and the third represents the potential ability for retrofitting to bring actual benefits to the region or city.

3.2. Selection of the Evaluation Index

3.2.1. Potentiality Evaluation Index Selection Basis

Previous assessments of reuse potentiality have focused predominantly on transformation potentiality based on heritage value indicators, with a greater emphasis on the value of industrial heritage ontology [17–19]. The future value-added effect and its impact on the city were not fully accounted for in the evaluation index system, and the existing potentiality assessment indexes do not differentiate the relationship between the heritage essence and urban redevelopment due to the indexes' lack of relevance and adaptability

[20,21], as well as an insufficient consideration for the complexity and diversity of industrial heritage transformation [22]. To emphasize the significance of urban indicators, the selected evaluation indicators emphasize the need to promote healthier and more efficient urban renewal [23,24]. Thus, this paper discusses adaptive reuse potentiality from three perspectives: autologous value, retrofitting value, and potential benefit value. Not only is the building itself discussed but the selection of urban dimension indicators also needs to be included.

This paper examines an index system for evaluating the reuse potentiality of industrial heritage, using industrial heritage as the research object and constructing three progressive relationship levels to address the existing problems of the potential evaluation system. The first dimension is autologous value, which represents an object's inherent value regardless of whether it has been renovated or not, and its own value, which exists objectively regardless of renovation or not and is used to determine whether renovation and reuse can be performed based on the evaluation results. The second dimension is retrofitting value, which represents the increase in use value resulting from renovation; the higher the rating, the greater the effect of subsequent renovation and use. The third dimension of future benefit represents the impact of the adaptive reuse of industrial heritage on surrounding areas and cities, which can help accelerate urban development.

In order to make the potentiality evaluation results more scientific for guiding the renovation and adaptive reuse strategies, the potentiality assessment results are presented as weighted scores of the three dimensions, and the corresponding reuse strategy cannot determine the reuse potentiality of industrial heritage solely based on the final score but should consider the weights of different levels and further clarify the tendency and trend of reuse based on the specific score. To develop a targeted redevelopment plan, we should consider the weighting of various indicators and elucidate the reuse tendency and trend based on the specific score and weight distribution of each dimension.

3.2.2. Reuse Potentiality Evaluation Index Composition

Figure 2 illustrates how the assessment indexes of the adaptive reuse potentiality of industrial heritage are calculated, as well as how the evaluation content is separated into autologous value, retrofitting value, and potential benefit value. There are two components to the assessment of industrial heritage: the building dimension and the urban dimension. The evaluation index of the autologous value comprises the landscape integrity, structural reliability, heritage authenticity, safety in the autologous dimension and location, the surrounding environment, external space, planning restrictions, and infrastructure in the regional dimension. The evaluation indexes of the retrofitting value include the functional variability, architectural sustainability, user attitude, and construction technology implementation. The evaluation indexes of the retrofitting value include the expected effect, functional variability, architectural sustainability, user attitude, construction technology implementation, and expected effect. In the urban dimension, the evaluation indexes of the retrofitting value include the economic conditions, political context, participants' attitudes, and legal policies. The potential effect evaluation indexes include the humanistic value, artistic value, expected impact, scientific and technological value, the representativeness and scarcity of the building ontology dimension, the historical continuity, the cultural evaluation parameters of the indicators, and data acquisition that is challenging, resulting in the variables and weights being influenced by subjective factors.

The evaluation of the adaptive reuse potentiality of industrial heritage is a complicated process that depends on many factors. Using a singular evaluation index to evaluate the reuse potentiality of various options could result in less precise evaluation results. Due to the fact that the three-dimensional indicators for various industrial heritage need to be modified in a targeted manner, they are only partially enumerated in the examples, and the specific contents of the indicators need to be modified for various research topics.

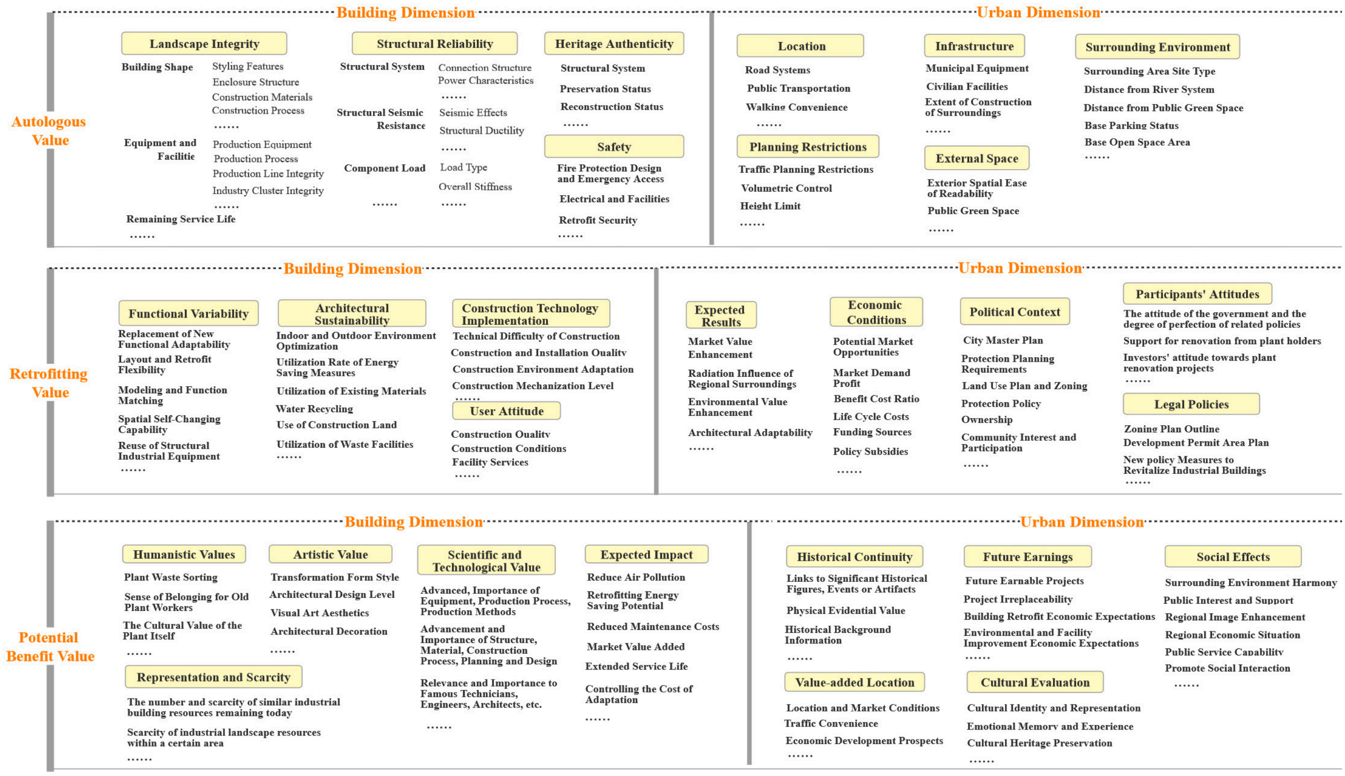


Figure 2. Industrial heritage reuse evaluation system indicators.

3.2.3. Overview Section of the Research Area

In China, the city of Beijing was early in carrying out practices of industrial heritage conservation and reuse, and it has taken the lead in conducting a census and academic research on industrial heritage. From the announcement of 30 existing industrial heritage sites in Beijing by the Architectural Society of China's Academic Committee on Industrial Architectural Heritage in 2010 to the first batch of China's Industrial Heritage Protection List in 2019, 9 industrial heritage sites in Beijing were selected [25]. The preservation and reuse of Beijing's industrial heritage are becoming more important. Beijing's existing urban industrial heritage can be divided into nine national, six municipal, and several general industrial heritage sites, totaling 2500 hectares and generally possessing multiple groups of architectural monuments.

Although Beijing has made some progress in the preservation of industrial heritage, a large number of industrial buildings and structures are still inevitably demolished and severely damaged during urban construction. Due to their advantageous location and low demolition costs, a large number of industrial buildings and structures in Beijing's older urban areas have been demolished [26]. In addition, there is a lack of rational and scientific development and utilization of industrial heritage, as well as a lack of policy guidance for the reuse of individual industrial heritage properties, resulting in a uniform pattern of reuse and imitation. The reuse of industrial heritage must be developed appropriately, taking into consideration its own potential for adaptive reuse and the actual urban development situation [27].

This paper selects the first group of eight representative and typical parks, including Shougang Industrial Heritage Park and 798 Art Park, which Beijing announced in January 2019 as cultural and creative industrial parks transformed from industrial architecture heritage. They have multiple building clusters, are close in scale, contribute significantly to the development of Beijing's cultural industries through adaptive reuse, and best represent Beijing's industrial architecture heritage conservation in its current state. Figure 3 illustrates the distribution of the parks' locations. They are currently employed as evaluation objects for measuring and verifying the potential for reuse of industrial architecture heritage.

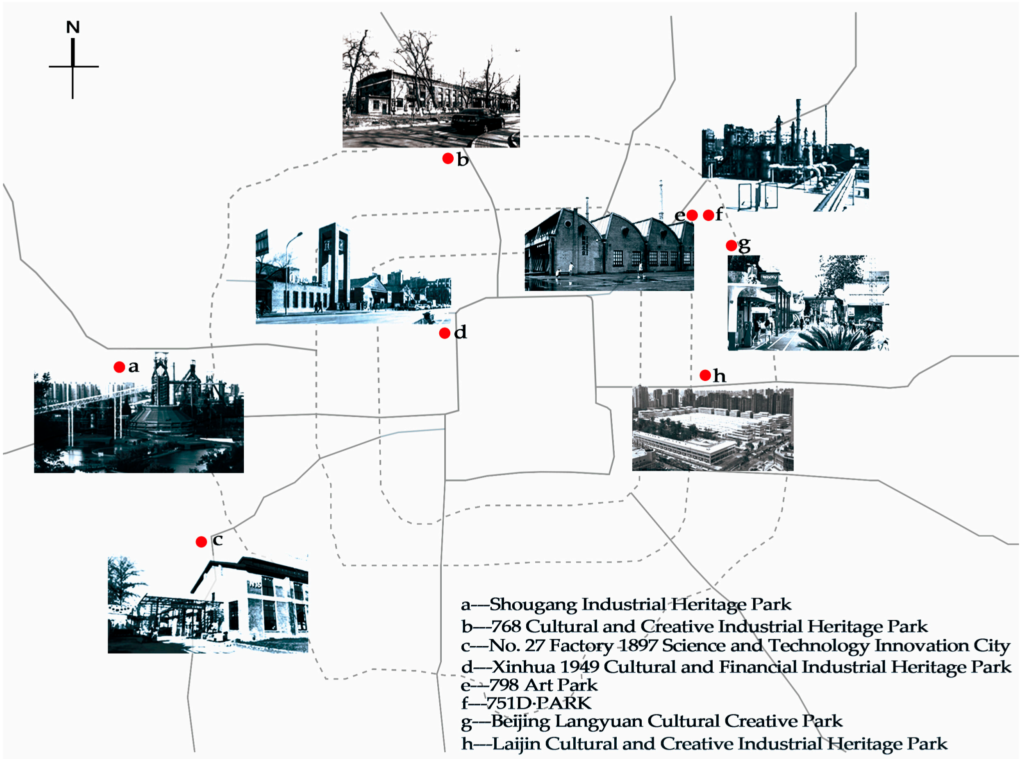


Figure 3. Distribution of industrial parks' locations.

3.3. Calculation of Reuse Potentiality Based on Improved Entropy TOPSIS

The quantitative measurement of reuse potential usually begins by assigning weights to the evaluation indicator system, including criteria weights and order weights. Based on the linearly weighted composite weights, the reuse potential size is compared via ranking after the composite potential evaluation value is calculated based on the indicator weights using Improved Entropy TOPSIS [28].

3.3.1. Combined Weighting of Indicators

Assignment of Order Weights

The C-OWA method was used to calculate the order weights of the reuse potential evaluation indicators. The specific calculation steps are as follows:

1. A number of expert groups were invited to score the importance of the indicators according to the existing evaluation system. Scoring set A for the original indicators of the re-evaluation program was obtained.

$$A = (a_1, a_2, \ldots, a_n)$$

2. The new importance scores were obtained by arranging the scored data from the largest to the smallest to obtain the evaluation set B:

$$B = (b_0, b_1, \ldots, b_{n-1}) \quad (b_0 \geq b_1 \geq \ldots \geq b_{n-1})$$

3. The weighting vector φ_{m+1} for each value in the evaluation index was determined based on the combination number C_{n-1}^{m}:

$$\varphi_{m+1} = \frac{C_{n-1}^{m}}{\sum_{m=0}^{n-1} C_{n-1}^{m}} = \frac{C_{n-1}^{m}}{2^{n-1}}, \tag{1}$$

$$m = 0, 1, \ldots, l-1 \quad \sum_{m=0}^{n-1} \varphi_{m+1} = 1.$$

4. Set B of the importance scores of the evaluation indicators was weighted to obtain the absolute weight $\overline{\vartheta_j}$:

$$\overline{\vartheta_j} = \sum_{m=0}^{n-1} \varphi_{m+1} b_m \, (j = 1, 2, \ldots, n) \tag{2}$$

5. The relative weights of the evaluation indicators ϑ_j were calculated:

$$\vartheta_j = \frac{\overline{\vartheta_j}}{\sum_{j=0}^{p} \overline{\vartheta_j}} \, (j = 1, 2, \ldots, n) \tag{3}$$

Assignment of Criteria Weights

The Entropy Weight Method was used to calculate the criteria weights of the reuse potential evaluation indicators. The specific calculation steps are as follows:

1. The corresponding values of different program indicators a_{ij} were determined, and they were homogenized according to the available expert importance evaluation scoring data to avoid the influence of different levels of evaluation indicators:

$$a'_{ij} = \frac{a_{ij} - \min(a_{ij}, \ldots, a_{mj})}{\max\{a_{ij}, \ldots, a_{mj}\} - \min\{a_{ij}, \ldots, a_{mj}\}} \, (i = 1, \ldots, m \; j = 1, \ldots, n) \tag{4}$$

2. The weight of the different evaluation values of each indicator in the total value δ_{ij} were calculated:

$$\delta_{ij} = \frac{a'_{ij}}{\sum_{i=1}^{m} a'_{ij}} \, (i = 1, \ldots, m \; j = 1, \ldots, n) \tag{5}$$

3. The entropy of each indicator e_j was calculated:

$$e_j = -\mathrm{k} \sum_{i=1}^{m} \delta_{ij} \ln(\delta_{ij}) \, (i = 1, \ldots, m \; j = 1, \ldots, n) \tag{6}$$

4. The information entropy redundancy of each indicator d_j was calculated:

$$d_j = 1 - e_j \tag{7}$$

5. The weights of the graded indicators μ_j were calculated:

$$\mu_j = \frac{d_j}{\sum_{i=1}^{n} d_j} \, (j = 1, \ldots, n) \tag{8}$$

Determination of Comprehensive Weights

In order to avoid the negative influence of a single weight on the calculation of the evaluation indexes, the comprehensive weights must consider both the relative importance of the indexes and the influence of the index factors in the order of the evaluation results. The criteria weights and the order weights must be linearly weighted to obtain the comprehensive weights ω_j.

$$\omega_j = \alpha\mu_j + (1-\alpha)\vartheta_j \quad \alpha \in [0,1], \tag{9}$$

$$\omega_j \geq 0 \quad \sum_{j=1}^{n} \omega_j = 1. \tag{10}$$

3.3.2. Determination of the Reuse Adaptive Potentiality Using TOPSIS Method

The exact calculation procedure is as follows:

1. The standardization of the indicator data was determined according to the development of the evaluation indicators' scoring level criteria, the actual observation to obtain the quantitative indicator value, the expert scoring to achieve the quantitative qualitative indicators, and the evaluation value of x_{ij}. Then the attributes of each indicator are uniformly varied to the range of (0, 1), using the normalization process of the function mat2gray in matble data processing software, which is more convenient for obtaining the normalized evaluation value x'_{ij}.
2. A weighted decision matrix Z was constructed based on the normalized evaluation values:

$$z_{ij} = \omega_{ij} x'_{ij},$$

$$Z = \begin{bmatrix} z_{11} & \cdots & z_{1j} \\ \vdots & \ddots & \vdots \\ z_{i1} & \cdots & z_{ij} \end{bmatrix}. \tag{11}$$

3. The optimal evaluation value for each evaluation scenario was determined as a positive ideal solution z^+, and the worst evaluation value was determined as a negative ideal solution z^-:

$$z^+ = [z_{i1}^+, z_{i2}^+, \ldots, z_{ij}^+](j = 1,2,\ldots,n),$$

$$z^- = [z_{i1}^-, z_{i2}^-, \ldots, z_{ij}^-](j = 1,2,\ldots,n).$$

4. the Euclidean distance, the distance to the optimal solution D_i^+, and the distance to the worst value D_i^- were calculated:

$$D_i^+ = \sqrt{\sum_{j=1}^{n} \left(z_{ij}^+ - z_{ij}\right)^2} \ (i = 1,2,\ldots,m \ \ j = 1,2,\ldots,n), \tag{12}$$

$$D_i^- = \sqrt{\sum_{j=1}^{n} \left(z_{ij}^- - z_{ij}\right)^2} \ (i = 1,2,\ldots,m \ \ j = 1,2,\ldots,n). \tag{13}$$

5. The relative proximities C_i^* of each evaluation option to the optimum value and rank were calculated and compared to determine the size of the recycling potentiality;

$$C_i^* = \frac{D_i^-}{D_i^+ + D_i^-} \quad 0 \leq C_i^* \leq 1(i = 1,2,\ldots,m) \tag{14}$$

The closer the value of the relative proximity C_i^* is to 1, the more effective the corresponding solution is and the greater the reuse potentiality is.

4. Calculation

The specific reuse potential calculations have been omitted due to space limitations, and the results are presented in table form. The building evaluation process is as follows:

1. The evaluation criteria were developed using empirical data and industry norms, as well as the specific indicator content of the reuse potential evaluation system, and experts scored the importance using the evaluation criteria, as shown in Table 1.

Table 1. Evaluation index importance scoring basis.

Evaluation Index importance Level Classification and Corresponding Score					
Level Classification	Absolutely Important	Very Important	More Important	Important	Normal
Corresponding Score	10.0–8.0	8.0–6.0	6.0–4.0	4.0–2.0	2.0–0.0

2. The Continuous Ordered Weighted Average (C-OWA) operator and entropy weighting method were used to calculate the order weights and criteria weights of the secondary indexes, respectively, and the comprehensive weight is determined via linear weighting, as shown in Table 2 and Figure 4;

Table 2. Combined weighting calculation results.

Evaluation Indicator System		Weighting Calculation							
Primary Indicators	Secondary Indicator	Importance Scoring					Order Weights ϑ_j	Criteria Weights μ_j	Integrated Weights ω_j
		Expert 1	Expert 2	Expert 3	Expert 4	Expert 5			
Intrinsic Value (Building Dimension)	Landscape Integrity	8.5	8.0	9.0	8.5	8.0	0.0377	0.019	0.0284
	Structural Reliability	9.0	8.5	9.5	8.5	7.5	0.0388	0.044	0.0414
	Heritage Authenticity	8.5	6.5	7.5	7.0	8.0	0.0338	0.025	0.0294
	Safety	9.5	9.0	8.5	8.0	9.0	0.0398	0.043	0.0414
Intrinsic Value (Regional Dimension)	Location	8.2	8.0	7.5	6.5	7.8	0.0348	0.041	0.0379
	Surrounding Environment	7.0	7.3	8.5	6.5	8.0	0.0334	0.019	0.0262
	External Space	6.5	6.0	7.5	7.0	8.5	0.0317	0.044	0.0379
	Planning Restrictions	8.5	8.0	7.5	7.0	9.0	0.0360	0.025	0.0305
	Infrastructure	7.5	8.5	8.0	7.5	9.0	0.0362	0.043	0.0396
Retrofit Value (Building Dimension)	Functional Variability	6.5	7.5	8.0	8.5	8.0	0.0352	0.021	0.0281
	Architectural Sustainability	5.5	6.5	7.0	6.5	7.0	0.0297	0.021	0.0254
	User Attitude	7.8	7.5	6.5	4.5	8.0	0.0323	0.041	0.0367
	Construction Technology Implementation	7.0	8.5	9.0	7.5	7.5	0.0352	0.042	0.0386
Retrofit Value (Regional Dimension)	Expected Results	8.5	8.0	7.5	8.5	9.0	0.0376	0.046	0.0418
	Economic Conditions	9.5	9.0	8.0	8.5	7.5	0.0383	0.025	0.0317
	Political Context	7.0	6.5	7.5	8.0	8.5	0.0338	0.040	0.0369
	Participants' Attitudes	7.0	7.5	8.5	7,0	7.5	0.0334	0.021	0.0272
	Legal Policies	8.5	8.0	9.0	9.5	8.5	0.0390	0.021	0.0300
Potential Benefits (Building Dimension)	Humanistic Values	7.5	7.0	7.5	8.5	8.0	0.0345	0.041	0.0400
	Artistic Value	7.5	7.0	8.0	8.5	8.5	0.0359	0.042	0.0390
	Expected Impact	9.0	9.5	8.5	8.0	8.5	0.0390	0.046	0.0425
	Scientific and Technological Value	7.5	7.0	6.5	7.5	8.0	0.0331	0.051	0.0421
	Representation and Scarcity	8.0	8.5	9.0	8.5	9.5	0.0390	0.041	0.0400
Potential Benefits (Regional Dimension)	History Continuity	5.5	6.5	7.0	7.5	7.5	0.0312	0.040	0.0356
	Cultural Evaluation	9.5	9.0	8.5	8.0	9.0	0.0398	0.031	0.0354
	Social Effects	8.0	8.5	7.5	7.0	8.0	0.0353	0.058	0.0467
	Value-added Location	7.5	8.5	8.0	8.5	7.0	0.0359	0.031	0.0335
	Future Earnings	9.5	9.0	8.5	9.0	8.0	0.0398	0.034	0.0369

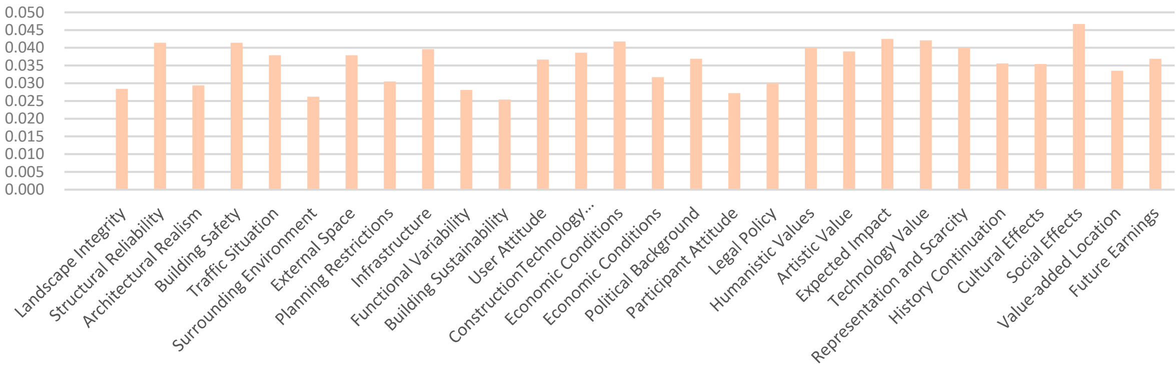


Figure 4. Graphical representation of the integrated weight calculation results.

3. The scoring was based on the characteristics and actual conditions of the different industrial heritage parks, and the indicator data was standardized, as shown in Table 3a,b;

Table 3. Standardization of indicator evaluation data.

(a)

Evaluation Indicator System		**Campus Case Measurement**							
Primary Indicators	**Secondary Indicator**	**Shougang Industrial Park**		**751D·PARK**		**No. 27 Factory 1897 Science and Technology Innovation City**		**Laijin Cultural and Creative Industrial Park**	
		Weighted Data		**Weighted Data**		**Weighted Data**		**Weighted Data**	
Intrinsic Value (Building Dimension)	Landscape Integrity	0.0248	0.1215	0.0195	0.1050	0.0178	0.0808	0.0244	0.1056
	Structural Reliability	0.0362		0.0349		0.0107		0.0287	
	Heritage Authenticity	0.0294		0.0156		0.0185		0.0180	
	Safety	0.0311		0.0349		0.0337		0.0345	
Intrinsic Value (Regional Dimension)	Location	0.0142	0.0614	0.0332	0.1049	0.0140	0.1115	0.0242	0.1194
	Surrounding Environment	0.0000		0.0066		0.0116		0.0160	
	External Space	0.0095		0.0308		0.0336		0.0273	
	Planning Restrictions	0.0229		0.0172		0.0169		0.0254	
	Infrastructure	0.0149		0.0173		0.0352		0.0264	
Retrofit Value (Building Dimension)	Functional Variability	0.0246	0.1015	0.0237	0.0951	0.0187	0.0700	0.0250	0.0609
	Architectural Sustainability	0.0158		0.0143		0.0066		0.0183	
	User Attitude	0.0321		0.0367		0.0190		0.0112	
	Construction Technology Implementation	0.0290		0.0205		0.0257		0.0064	
Retrofit Value (Regional Dimension)	Expected Results	0.0334	0.1322	0.0209	0.0657	0.0248	0.1069	0.0000	0.1007
	Economic Conditions	0.0198		0.0000		0.0117		0.0167	
	Political Context	0.0351		0.0115		0.0232		0.0318	
	Participants' Attitudes	0.0177		0.0051		0.0272		0.0272	
	Legal Policies	0.0263		0.0281		0.0200		0.0250	
Potential Benefits	Humanistic Values	0.0300	0.1683	0.0100	0.1241	0.0207	0.0933	0.0267	0.1113
	Artistic Value	0.0243		0.0195		0.0231		0.0303	
	Expected Impact	0.0372		0.0345		0.0346		0.0319	

(Building Dimension)	Scientific and Technological Value	0.0368		0.0276		0.0000		0.0058	
	Representation and Scarcity	0.0400		0.0325		0.0148		0.0167	
Potential Benefits (Regional Dimension)	History Continuity	0.0356	0.1718	0.0189	0.1228	0.0211	0.1279	0.0040	0.0682
	Cultural Evaluation	0.0257		0.0277		0.0328		0.0197	
	Social Effects	0.0420		0.0262		0.0380		0.0233	
	Value-added Location	0.0335		0.0293		0.0223		0.0130	
	Future Earnings	0.0351		0.0208		0.0137		0.0082	

(b)

Evaluation Indicator System		Campus Case Measurement							
Primary Indicators	**Secondary Indicator**	**Xinhua 1949 Cultural and Financial Industrial Park**		**768 Cultural and Creative Industrial Park**		**798 Art Park**		**Beijing Langyuan Cultural Creative Park**	
		Weighted Data		**Weighted Data**		**Weighted Data**		**Weighted Data**	
Intrinsic Value (Building Dimension)	Landscape Integrity	0.0230	0.1009	0.0182	0.0969	0.0258	0.1028	0.0158	0.0814
	Structural Reliability	0.0311		0.0340		0.0113		0.0199	
	Heritage Authenticity	0.0184		0.0210		0.0281		0.0120	
	Safety	0.0285		0.0237		0.0376		0.0337	
Intrinsic Value (Regional Dimension)	Location	0.0237	0.0754	0.0379	0.1149	0.0190	0.1401	0.0182	0.1095
	Surrounding Environment	0.0164		0.0262		0.0250		0.0213	
	External Space	0.0201		0.0162		0.0379		0.0364	
	Planning Restrictions	0.0153		0.0120		0.0277		0.0158	
	Infrastructure	0.0000		0.0226		0.0306		0.0176	
Retrofit Value (Building Dimension)	Functional Variability	0.0176	0.0798	0.0030	0.0444	0.0141	0.0942	0.0219	0.0433
	Architectural Sustainability	0.0174		0.0000		0.0115		0.0038	
	User Attitude	0.0195		0.0262		0.0300		0.0163	
	Construction Technology Implementation	0.0253		0.0152		0.0386		0.0014	
Retrofit Value (Regional Dimension)	Expected Results	0.0340	0.0978	0.0090	0.0599	0.0380	0.1081	0.0046	0.0371
	Economic Conditions	0.0198		0.0181		0.0058		0.0047	
	Political Context	0.0196		0.0171		0.0185		0.0014	
	Participants' Attitudes	0.0170		0.0029		0.0173		0.0131	
	Legal Policies	0.0075		0.0129		0.0286		0.0133	
Potential Benefits (Building Dimension)	Humanistic Values	0.0263	0.0526	0.0171	0.0701	0.0273	0.1200	0.0059	0.0805
	Artistic Value	0.0122		0.0042		0.0159		0.0159	
	Expected Impact	0.0080		0.0121		0.0367		0.0000	
	Scientific and Technological Value	0.0000		0.0195		0.0401		0.0187	
	Representation and Scarcity	0.0063		0.0171		0.0000		0.0400	
Potential Benefits (Regional Dimension)	History Continuity	0.0200	0.1095	0.0203	0.1411	0.0178	0.1293	0.0158	0.1041
	Cultural Evaluation	0.0354		0.0278		0.0338		0.0170	
	Social Effects	0.0379		0.0467		0.0424		0.0415	
	Value-added Location	0.0105		0.0239		0.0152		0.0161	
	Future Earnings	0.0058		0.0224		0.0201		0.0137	

4. The relative size of the reuse potential was obtained by calculating the relative proximity C_i^* according to the TOPSIS method, and the final potentiality ranking is shown in Table 4.

Table 4. TOPSIS evaluation calculation results.

Item	Positive Ideal Solution Distance D_i^+	Negative Ideal Solution Distance D_i^-	Relative Proximity C_i^*	Sort Results
Shougang Industrial Heritage Park	0.294	0.627	0.681	1
798 Art Park	0.347	0.573	0.623	2
751D·PARK	0.375	0.483	0.563	3
No. 27 Factory 1897 Science and Technology Innovation City	0.404	0.466	0.536	4
Laijin Cultural and Creative Industrial Heritage Park	0.471	0.465	0.497	5
768 Cultural and Creative Industrial Heritage Park	0.464	0.401	0.464	6
Xinhua 1949 Cultural and Financial Industrial Heritage Park	0.494	0.397	0.446	7
Beijing Langyuan Cultural Creative Park	0.534	0.368	0.408	8

The potentiality validation step was a continuation of the reuse potential evaluation system, with the combined weights obtained via the linear weighting of the order weights and the criteria weights. Step 3.invited park users to score the secondary evaluation indicators for which the standardization is shown in Tables A1 and A2 in the Appendix A. The TOPSIS method was used to quantify the magnitude of the reuse potential of the eight parks as per the users, as shown in Table A3.

5. Results and Discussion

The calculation results of the relative size ranking of the potential of the eight parks are as follows: Shougang Industrial Heritage Park > 798 Art Park > 751D·PARK > No. 27 Factory 1897 Science and Technology Innovation City > Laijin Cultural and Creative Industry Heritage Park > 768 Cultural and Creative Industry Heritage Park > Xinhua 1949 Cultural and Financial Industry Heritage Park > Beijing Langyuan Cultural Creative Park. The calculation results with respect to the reuse potential from the user's perspective are as follows: Shougang Industrial Heritage Park > 798 Art Park > 751D-PARK > No. 27 Factory 1897 Science and Technology Innovation City > Laijin Cultural and Creative Industrial Park > Xinhua 1949 Cultural and Financial Industrial Heritage Park > 768 Cultural and Creative Industrial Heritage Park > Beijing Langyuan Cultural Creative Park.

According to the radar map derived from the potentiality measurements and evaluation data of the eight parks, the results of the actual measurements and user evaluations in six dimensions, such as building ontology and the urban dimension, for measuring the potential distribution do not differ significantly. The final ranking results of the relative value of the potential size remain unchanged, indicating that the potentiality evaluation system and quantitative measurement procedure are feasible.

The evaluation results indicate that: (1) the potentiality of the regional dimension needs to be taken into account. With the exception of Shougang Industrial Park and 798 Industrial Park, the urban dimension has a greater potential for utilization than the building dimension in the remaining parks. The scarcity of both Shougang Industrial Heritage Park and 798 Art Park increases the value of the building ontology because their distinct designs represent the characteristics of their respective industries. According to the findings, the potentiality value of the regional dimension largely determines the ranking of the final reuse potentialities of industrial parks with less distinct shapes, and the higher the actual measured potential value, the higher the ranking of the industrial park's reuse potentiality. Due to insufficient utilization of the potentiality of the urban dimension, the current paradigm of transformation is rather homogeneous. In order to promote sustainable urban development, it is necessary to devise a targeted industrial heritage reuse strategy that takes the urban dimension into account. (2) These eight successful reuse cases of industrial parks demonstrate that an important prerequisite for the reuse of industrial heritage is that the buildings are objectively adaptable, so structural reliability and architectural safety provide significant advantages in terms of intrinsic value assessment. Furthermore, the expected impact of the building and the social utility of the urban dimension highlight its potentiality value. As the location of industrial heritage will be the new environment for functional use after renewal, the location's potential has a significant impact on the future development of the reuse project. The added-value conditions of the location, such as the anticipated increased impact and the social benefit of the industrial heritage prior to use, are essential in determining the reuse strategy.

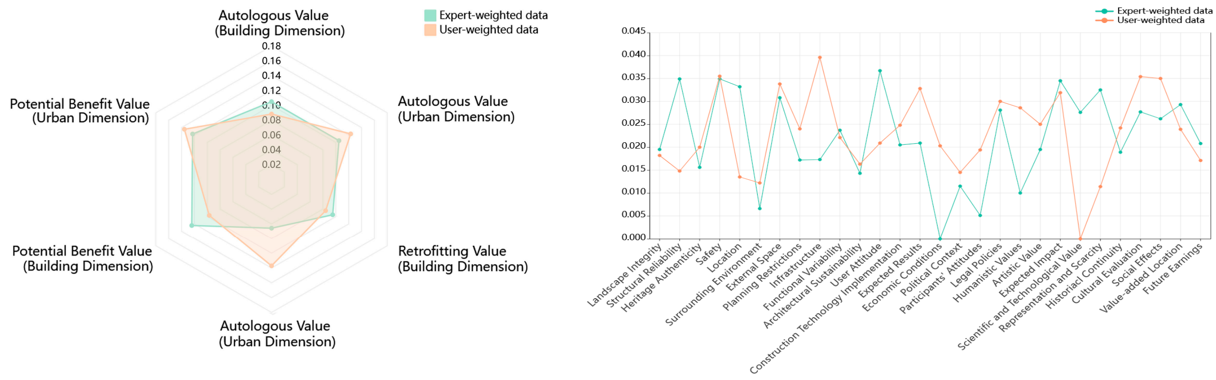
798 Art Park was the first industrial heritage park in China to be redeveloped spontaneously without planning; 751 D·PARK was redeveloped through planning; and Shougang Industrial Heritage Park was the largest industrial heritage park to be redeveloped through planning. Due to space limitations, we will briefly discuss the assessment results using the three industrial heritage parks with the greatest potential for reuse and the most representative examples.

Figure 5 depicts the measured results of Shougang Industrial Heritage Park, and the actual measurement is essentially consistent with the results of the user evaluation potential; its reuse potential primarily emphasizes the potentiality value in the building and urban dimension, and the renovation strategy indicates the potential ability to bring actual benefits to the region and the city following adaptive reuse. Most of the buildings and structures in the park have strong industrial characteristics, and their distinctive forms and volumes are highly representative and scarce for the regional and urban environments [29]. To preserve its scientific and technological value, Shougang Industrial Heritage Park must retain a greater number of heritage categories and quantities, as well as several significant process nodes and a large number of surviving muscles, and contribute to the preservation of collective memory [30]. Because it is not in a central location with well-developed urban functions or a commercial environment, the urban dimension's inherent value prior to adaptive use is low.

(**a**) (**b**)

Figure 5. Comparison of potential evaluation distribution in Shougang Industrial Heritage Park. (**a**) Distribution of reuse potential of primary indicators; (**b**) distribution of reuse potential for secondary indicators.

Figure 6 depicts the results of 798 Art Park's evaluation potential. The user evaluation of the urban dimension's autologous value and retrofitting value is less than the actual potential measured potential benefit value, indicating that its renovation brings expectations to the urban area that fall short of the actual predicted potential value. The urban dimension of the park's autologous value is more prominent.

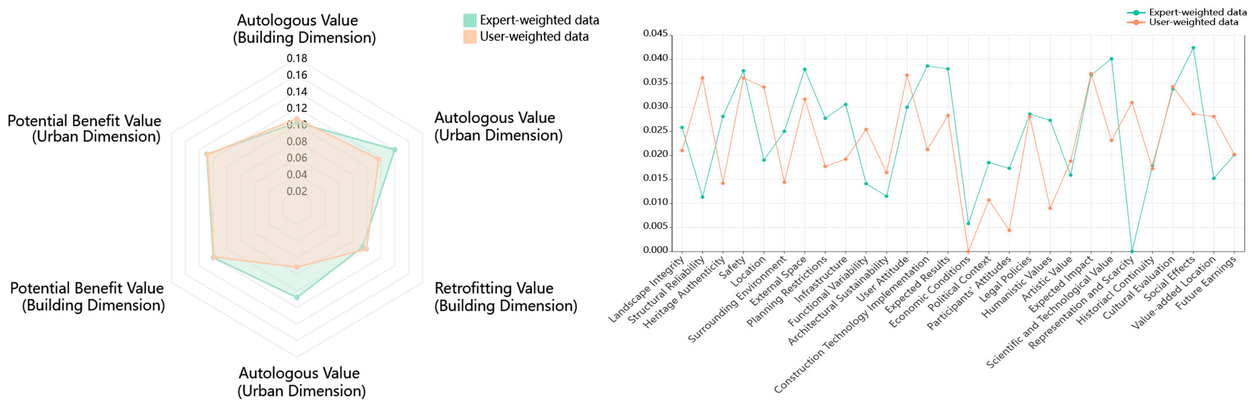


(**a**) (**b**)

Figure 6. Comparison of potential evaluation distribution in 798 Art Park. (**a**) Distribution of reuse potential of primary indicators; (**b**) distribution of reuse potential for secondary indicators.

798 Art Park epitomizes the value of art and its driving force. As its adaptive reuse adds new artistic and cultural values to its industrial heritage, it presents rich and diverse cultural values to visitors and provides better artistic experiences through the atmosphere of the art district, resulting in economic value for the area in which it is located [31]. The interior and outdoor space characteristics of the old building are utilized rationally in the building space, and emphasis is placed on the transformation of space. The indoor and outdoor spaces and flow lines are reorganized so that the spaces form various levels and depths. Nevertheless, according to feedback from actual users, the park's building environment and sanitation facilities are less satisfactory, and the sanitary conditions are more concerning. In addition, because some functions overlap and business introductions are comparable [32], the users' evaluation of the transformation value of the urban dimension is lower than anticipated.

Figure 7 depicts the potential measurement results for 751D-PARK. The user evaluation has a higher value than the actual measurement potential among the autologous and retrofitting values of the urban dimension, indicating that its renovation has a larger impact on the urban area than the actual predicted potential size. The potential benefits of the urban dimension and the building itself stand out more.



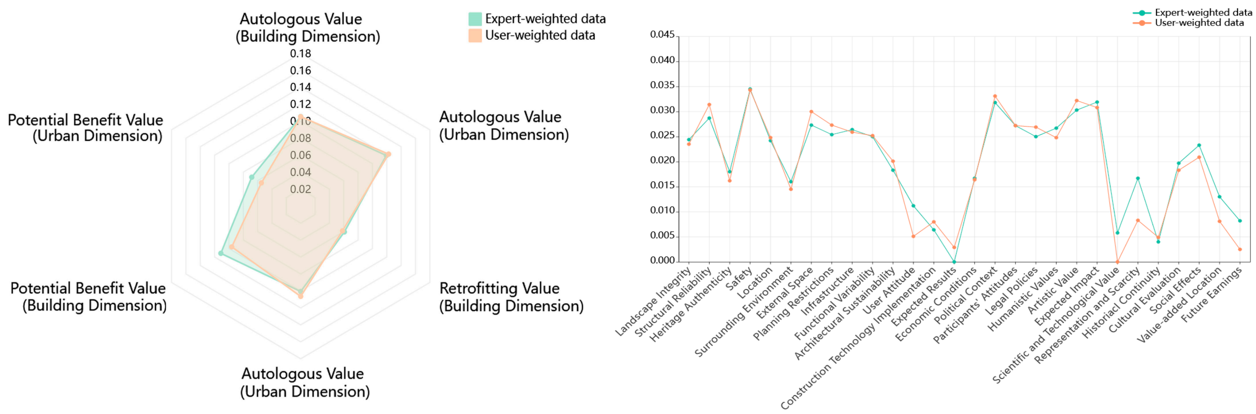
(**a**) (**b**)

Figure 7. Comparison of potential evaluation distribution in 751 D·PARK. (**a**) Distribution of reuse potential of primary indicators; (**b**) distribution of reuse potential for secondary indicators.

The primary function of 751D-PARK was to ensure the supply of living and production energy for the construction and development of the electronic city. Later, it was transformed into an international cultural and creative park with a fashion design theme, establishing a trading platform for the design industry in the original factory compound and serving as a cultural gathering place for numerous domestic and foreign fashion design groups and well-known companies. The transformed industrial space resources serve as a venue for high-end brand launches and original design exhibitions, and the brand's activities have a far-reaching influence, culminating in an anticipated impact on the urban area that exceeds its actual predicted potential size. The retention of iconic and representative buildings and structures reflects the potential value response for the building proper, and the renovation preserves the original environment, develops new functions, and transforms old industrial equipment into new art spaces, making it an important area for the fusion of fashion and art [33].

The potentiality measurements for the remaining parks are shown in Figure 8.

(**a**)



(**b**)

(**c**)

(**d**)

(**e**)

Figure 8. Comparison of the radar map of the distribution of potential of the remaining industrial heritage parks. (**a**) Distribution of indicators of reuse potential in No. 27 Factory 1897 Science and Technology Innovation City; (**b**) distribution of indicators of reuse potential in Laijin Cultural and Creative Industry Heritage Park; (**c**) distribution of indicators of reuse potential in Xinhua 1949 Cultural and Financial Industrial Heritage Park; (**d**) distribution of indicators of reuse potential in 768 Cultural and Creative Industry Heritage Park; (**e**) distribution of indicators of reuse potential in Beijing Langyuan Cultural Creative Park.

Its evaluation method is more compatible than a conventional reuse potentiality evaluation, and the evaluation process is applicable not only to measuring the adaptive reuse potential of the entire industrial heritage park but also to determining the development timing of individual industrial architecture heritage and the relative sizes of their respective reuse potentials within a park. To increase the compatibility of the evaluation methods, the system of evaluation of reuse potential proposed in this paper includes the evaluation of the potential of renovated and reused industrial architecture heritage, determining the advantages and disadvantages of their potential and defining the possibility of future adjustment.

6. Conclusions

This paper takes as its research object the existing successfully reused industrial parks in Beijing, combines the current reuse statuses and potentiality characteristics of the urban dimension, breaks through the traditional emphasis on the value assessment of the heritage itself, introduces potential evaluation factors that promote urban renewal, and forms a multi-faceted and multi-level comprehensive reuse potentiality evaluation system. Through a comprehensive comparison of various evaluation methods and by taking into account the fuzzy nature of the indicators of the evaluation object of potential, linearly weighted comprehensive weights are used to determine the parameters of each indicator, and Improved Entropy TOPSIS is used to quantify the ranking and relative value of industrial park reuse potentiality. Finally, the scientific validity and feasibility of the research framework for revealing the reuse advantages and potential distribution of established industrial heritage sites are validated through the application of actual cases in industrial parks. The industrial heritage reuse potentiality evaluation study enhances the accuracy and effectiveness of proprietors and practitioners in formulating reuse strategies at the implementation level, thereby maximizing the sustainable use of scarce resources. The revitalization of industrial heritage through adaptive reuse continues historical lineage and contributes to urban development.

The assessment of the reuse potentiality of industrial heritage involves many evaluation index factors, and this paper only calculates the relative value of potentiality for the primary and secondary evaluation index systems because the scoring basis and index composition of the three-tier index system may change due to the different evaluations of industrial heritage parks. It is necessary to further quantify the potentiality of the evaluation content and score after a specific analysis of the evaluation objects. The focus of this paper is to propose the content of graded indicators and the calculation of the relative potential size for the evaluation of industrial heritage in utilization potentiality in the urban dimension with insufficient research on optimization and improvement after the evaluation. The next stage will be to scientifically analyze the potentiality distribution of each park based on the research findings, clarify the advantages and disadvantages of transformation, and then enhance the reuse potential evaluation index system.

The evaluation system contains more indicators to obtain more comprehensive evaluation data, and it is difficult to determine the evaluation parameters and obtain the corresponding data, so the scientific quantification of the indicator data and the simplification of the evaluation system are future directions for research improvement. To broaden the compatibility of the evaluation methods and adapt them to various phases of reuse, such as preliminary research, design, construction, and operation, it is necessary to strengthen and improve the potentiality evaluation system by supporting cross-disciplinary and actual research.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Standardized processing of user indicator evaluation data.

Evaluation Indicator System		Campus Case Measurement							
Primary Indicators	**Secondary Indicator**	**Shougang Industrial Park**		**751D·PARK**		**No. 27 Factory 1897 Science and Technology Innovation City**		**Laijin Cultural and Creative Industrial Park**	
		Weighted Data		**Weighted Data**		**Weighted Data**		**Weighted Data**	
Intrinsic Value (Building Dimension)	Landscape Integrity	0.0241	0.1106	0.0182	0.0884	0.0252	0.1013	0.0235	0.1054
	Structural Reliability	0.0326		0.0148		0.0138		0.0314	
	Heritage Authenticity	0.0276		0.0200		0.0278		0.0162	
	Safety	0.0263		0.0355		0.0345		0.0343	
Intrinsic Value (Regional Dimension)	Location	0.0080	0.0351	0.0135	0.1231	0.0105	0.1215	0.0248	0.1226
	Surrounding Environment	0.0032		0.0122		0.0233		0.0145	
	External Space	0.0000		0.0338		0.0336		0.0300	
	Planning Restrictions	0.0166		0.0240		0.0254		0.0273	
	Infrastructure	0.0072		0.0396		0.0286		0.0259	
Retrofit Value (Building Dimension)	Functional Variability	0.0238	0.0927	0.0221	0.0841	0.0156	0.0912	0.0252	0.0583
	Architectural Sustainability	0.0131		0.0163		0.0084		0.0201	
	User Attitude	0.0289		0.0209		0.0285		0.0051	
	Construction Technology Implementation	0.0269		0.0248		0.0386		0.0080	
Retrofit Value (Regional Dimension)	Expected Results	0.0393	0.1289	0.0328	0.1171	0.0372	0.0986	0.0029	0.1064
	Economic Conditions	0.0153		0.0203		0.0053		0.0164	
	Political Context	0.0358		0.0145		0.0144		0.0331	
	Participants' Attitudes	0.0148		0.0194		0.0151		0.0272	
	Legal Policies	0.0236		0.0300		0.0267		0.0269	
Potential Benefits (Building Dimension)	Humanistic Values	0.0267	0.1584	0.0286	0.0969	0.0267	0.1103	0.0248	0.0961
	Artistic Value	0.0224		0.0250		0.0108		0.0322	
	Expected Impact	0.0335		0.0319		0.0378		0.0308	
	Scientific and Technological Value	0.0382		0.0000		0.0350		0.0000	
	Representation and Scarcity	0.0376		0.0114		0.0000		0.0083	
Potential Benefits (Regional Dimension)	History Continuity	0.0280	0.1576	0.0242	0.1356	0.0119	0.1125	0.0049	0.0548
	Cultural Evaluation	0.0193		0.0354		0.0334		0.0183	
	Social Effects	0.0410		0.0350		0.0415		0.0209	
	Value-added Location	0.0335		0.0239		0.0093		0.0081	
	Future Earnings	0.0358		0.0171		0.0164		0.0025	

Table A2. Standardized processing of user indicator evaluation data.

Evaluation Indicator System		Campus Case Measurement							
Primary Indicators	**Secondary Indicator**	**Xinhua 1949 Cultural and Financial Industrial Park**		**768 Cultural and Creative Industrial Park**		**798 Art Park**		**Beijing Langyuan Cultural Creative Park**	
		Weighted Data		**Weighted Data**		**Weighted Data**		**Weighted Data**	
Intrinsic Value (Building Dimension)	Landscape Integrity	0.0230	0.0921	0.0172	0.0948	0.0210	0.1074	0.0153	0.0775
	Structural Reliability	0.0285		0.0311		0.0361		0.0175	
	Heritage Authenticity	0.0147		0.0200		0.0142		0.0113	
	Safety	0.0259		0.0266		0.0361		0.0334	
Intrinsic Value (Regional Dimension)	Location	0.0190	0.0790	0.0365	0.1149	0.0342	0.1172	0.0219	0.1070
	Surrounding Environment	0.0147		0.0234		0.0144		0.0212	
	External Space	0.0260		0.0149		0.0317		0.0335	
	Planning Restrictions	0.0143		0.0109		0.0177		0.0153	
	Infrastructure	0.0050		0.0212		0.0192		0.0152	
Retrofit Value (Building Dimension)	Functional Variability	0.0158	0.0730	0.0050	0.0478	0.0254	0.0996	0.0119	0.0303
	Architectural Sustainability	0.0158		0.0027		0.0164		0.0029	
	User Attitude	0.0172		0.0249		0.0367		0.0155	
	Construction Technology Implementation	0.0241		0.0152		0.0212		0.0000	
Retrofit Value (Regional Dimension)	Expected Results	0.0340	0.0944	0.0045	0.0455	0.0283	0.0715	0.0080	0.0360
	Economic Conditions	0.0178		0.0136		0.0000		0.0049	
	Political Context	0.0173		0.0158		0.0107		0.0000	
	Participants' Attitudes	0.0178		0.0010		0.0044		0.0115	
	Legal Policies	0.0075		0.0107		0.0281		0.0115	
Potential Benefits (Building Dimension)	Humanistic Values	0.0250	0.0514	0.0045	0.0571	0.0090	0.1189	0.0046	0.0835
	Artistic Value	0.0097		0.0136		0.0188		0.0195	
	Expected Impact	0.0066		0.0158		0.0370		0.0033	
	Scientific and Technological Value	0.0000		0.0010		0.0231		0.0162	
	Representation and Scarcity	0.0100		0.0107		0.0310		0.0400	
Potential Benefits (Regional Dimension)	History Continuity	0.0200	0.1180	0.0178	0.1399	0.0172	0.1284	0.0192	0.1009
	Cultural Evaluation	0.0354		0.0266		0.0343		0.0150	
	Social Effects	0.0364		0.0467		0.0286		0.0413	
	Value-added Location	0.0146		0.0239		0.0281		0.0142	
	Future Earnings	0.0115		0.0250		0.0202		0.0114	

Table A3. User TOPSIS evaluation calculation results.

Item	Positive Ideal Solution Distance D_i^+	Negative Ideal Solution Distance D_i^-	Relative Proximity C_i^*	Sort Results
Shougang Industrial Heritage Park	0.355	0.593	0.626	1
798 Art Park	0.352	0.525	0.599	2
751D·PARK	0.367	0.527	0.589	3
No. 27 Factory 1897 Science and	0.396	0.540	0.577	4

Technology Innovation City				
Laijin Cultural and Creative Industrial Heritage Park	0.499	0.479	0.49	5
Xinhua 1949 Cultural and Financial Industrial Heritage Park	0.482	0.398	0.452	6
768 Cultural and Creative Industrial Heritage Park	0.495	0.387	0.439	7
Beijing Langyuan Cultural Creative Park	0.549	0.369	0.402	8

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