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Systematic Review

Suitability Evaluation of Old Industrial Buildings Transformed into Stadiums

Lixin Jia [1,*], Cheng Sun [1], Wenhao Lv [1] and Wenlong Li [2]

[1] Physical Education Institute, Xi'an University of Architecture and Technology, Xi'an 710055, China; suncheng2022@xauat.edu.cn (C.S.); lvwenhao2022@xauat.edu.cn (W.L.)
[2] School of Urban Economics and Management, Beijing University of Civil Engineering and Architecture, Beijing 100044, China; liwenlong@xauat.edu.cn
* Correspondence: jialx@xauat.edu.cn; Tel.: +86-189-9184-7800

Abstract: The regeneration and utilization of idle, old industrial buildings in urban areas has become a focus of urban development, owing to urban renewal and industrial structural adjustment. At the same time, the increasing demand for sports space has highlighted the insufficient supply of sports facilities in cities. To solve this dilemma, the transformation of old industrial buildings into sports venues has become another mode of recycling and reuse in recent years. Due to the many specialties, complex contents, and numerous influencing factors involved in the transformation process, the suitability of these buildings is uncertain. To ensure the suitability of the transformation project, the theory of old industrial buildings recycling and sports building design specifications was used. An index system was established for the evaluating the suitability of transforming old industrial buildings into stadiums, which included five first-level and twenty second-level indices. Based on the matter–element extension theory, a suitability evaluation model was constructed to transform old industrial buildings into sports venues. The correlation function of each evaluation index was calculated, and the index weight was determined using the entropy weight method to obtain the suitability grade of the renovation project, which was verified by the renovation project case. The research shows that the suitability level of the renovation project is level II, which is consistent with the actual situation, indicating that the evaluation model—based on entropy weight method and matter–element extension method—for the transformation of old industrial buildings and stadiums has high reliability.

Keywords: old industrial building; recycling; matter–element extension method; entropy weight method; suitability evaluation

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Citation: Jia, L.; Sun, C.; Lv, W.; Li, W. Suitability Evaluation of Old Industrial Buildings Transformed into Stadiums. *Appl. Sci.* **2023**, *13*, 8065. https://doi.org/10.3390/app13148065

Academic Editors: Zhen Lei, Sungkon Moon, Joo-Sung Lee and Kyubyung Kang

Received: 28 April 2023
Revised: 22 June 2023
Accepted: 26 June 2023
Published: 10 July 2023

1. Introduction

Following the rapid development of China's national economy in recent years, the rates of urban renewal and development have increased. The development of urban spaces has shifted from production to consumption. In a wave of urban economic structural change, a number of traditional industrial buildings appeared in cities. In the process of urban development, there has been heated debate on the issues of "demolition and retention", "scrapping, and recycling" [1]. In recent years, the state has vigorously advocated for the transformation of existing buildings into green energy (saving) buildings. In particular, the new "14th Five-year Plan for Building Energy Conservation and Green Building Development" proposed by the Ministry of Housing and Urban–Rural Development clearly introduced important instructions to vigorously promote the development of energy-conserving buildings and green buildings during the "14th Five-year Plan" period. In the new era, the practice of large-scale demolition and the construction of traditional industrial buildings in the process of urban construction and development has gradually been eliminated, and the construction concept of "green sustainability" has gradually become the main trend for recycling old industrial buildings [2]. Recycling old industrial buildings is an important aspect of improving the quality of urban stock spaces. Better realization of the sustainable development of old industrial buildings is key to the current transformation work. With the continuous renewal of cities and the continuous improvement of people's material lives, sports, and health have become the focus of discussion. Owing to a surge in demand for fitness facilities, the supply of sports venues and fitness facilities has become unbalanced, investment in new sports venues has increased, and the return period has been prolonged. Consequently, cities cannot meet the needs of the masses on time, and social problems have arisen. The transformation of old industrial buildings into stadiums and sports facilities provides a good way for cities to use stock resources, and these buildings are both are highly suitable in terms of building structure and volume. There are also many successful transformation cases at home and abroad, which solve the problem of idle, old industrial buildings and alleviate the contradiction between fitness demand and the imbalance between the supply and demand of sports venues, in order to achieve a multiplier effect. At present, owing to the continuous impact of the new coronavirus epidemic, the global economy is weak, and growth rates are low; these factors have a significant impact on the accomplishment of the sustainable development goals of all countries in the world. In the case of a global resource shortage, the transformation of stock spaces into incremental spaces needed for urban development is an important factor to consider in the process of urban renewal and upgrading. Scholars have rarely studied either the suitability of transforming old industrial buildings into stadiums, or the application of entropy weight and matter–element extension methods to explore this issue. This study uses the "suitability of transformation" as the starting point—through the aspects of building structure, location advantages, and spatial conditions—of the early planning of the transformation of old industrial buildings into stadiums and gymnasiums, and evaluates it comprehensively. To a certain extent, it provides theoretical and methodological guidance for global urban renewal, the improvement of sports-supporting facilities, and application of old industrial buildings. This study is based on the concepts presented in Figure 1.

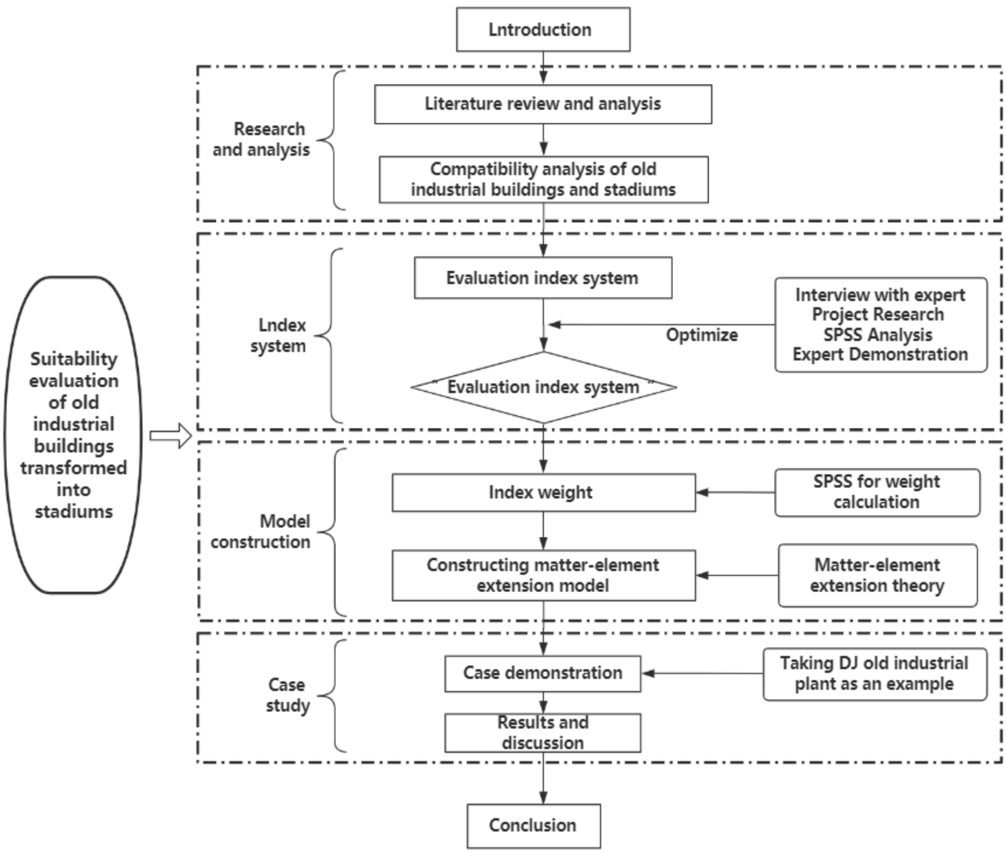


Figure 1. The study's research framework.

2. Literature Review

The reuse of old industrial buildings has become an important part of urban renewal, and scholars at home and abroad have conducted relevant studies on this issue. For example, Li et al. [3]. proposed the execution of vulnerability analyses of examples of old industrial building regeneration based on a normal cloud model, in view of the existing security ambiguity problems in the reconstruction process of old industrial buildings. In this study, a vulnerability evaluation index system of old industrial buildings was constructed concerning the aspects of structure and environment, and evaluation criteria were set up to compensate for the ambiguity of the previous safety evaluation process. Aranđelović and others studied the impact of reuse and new facilities on the potential display of industrial monuments [4]. Chen considered the optimized design of an indoor lighting strategy for the transformation of old industrial buildings from the perspective of physical environment improvements. The authors comprehensively evaluated lighting factors from three aspects: lighting coefficients, dynamic lighting hours, and lighting standards in the inner area. The results showed that optimizing the atrium size is important in transforming the indoor lighting environments of large-scale, old industrial buildings [5]. Zheng et al. [6]. believed that the renovation design of old industrial buildings should meet the needs of the public. Owing to the different needs of the public, this study applies Maslow's demand theory to the renovation process of old industrial buildings, and develops corresponding evaluation models. Finally, it is concluded that the basic needs of contemporary architecture are high quality, the challenging needs are the unique and attractive driving forces of the project, and the advanced needs are the easiest to ignore. Wu et al. [7]. studied the vulnerability of a reinforcement safety system of old industrial buildings. Through the improvement of the vulnerability coping diagram model, this study not only considers the influence of external changes in the system, but also compensates for the buffering effect induced by adaptability, and improves the vulnerability theory model system [7]. Li et al. constructed a political enterprise evolutionary game model for the reuse of old industrial buildings, based on evolutionary game theory, to analyze the stability and optimal strategies of both sides of the game [8]. Guo et al. [9]. constructed a dynamic health risk assessment model to study the dust hazards in industrial building reuse from the perspective of dust management. This study considers the time-varying nature of construction dust in risk assessments from a dynamic perspective, expands the connotations of the United States Environmental Protection Agency model, and compensates for previous static and quantitative research. Lu explored strategies for retrofitting old industrial buildings [10]. M. Pszczółkowski addressed the adaptation challenges of the adaptive reuse of old industrial buildings in a culturally oriented manner [11]. Zhang et al. analyzed the factors that influenced the green regeneration of old industrial buildings using SEM during the development stage, and provided a theoretical basis for the evaluation criteria of the green development of these buildings. However, this study only considered the influences of various factors on the transformation of old industrial buildings in the decision-making stage of project development, and did not analyze the influences of various factors on the project from the perspective of the entire life cycle of project transformation [12]. Li et al. [13]. evaluated the status quo of China's old industrial areas from the perspective of sustainable development. Based on unknown measurement theory and the combination weighting method, they established a usability evaluation model for the status quo of old industrial areas. This study improved research on the status quo of old industrial areas before protection and regeneration, and the status quo of roads, pipelines, and the environment in old industrial areas. Chen et al. studied the distribution of benefits in the renovation process of old industrial buildings based on Nash equilibrium [14]. Carol Berenset et al. discussed the adaptive renovation of old industrial buildings from the perspective of property development in the "Redevelopment and utilization of industrial sites" [15]. Ding et al. [16]. discussed the transformation of old industrial buildings into university parks based on the perspective of the adaptive transformation of existing buildings, using the transformation of the coastal campus of Deakin University in Australia as the research object. This article summarizes the transformation principles of the project, discusses the transformation and reuse strategies, and analyzes the project after transformation. Perfetto [17] conducted a cultural industry management study on the renovation of old industrial buildings and cultural tourism. Frank et al. [18]. discussed the adaptive use of old industrial buildings from an architectural design perspective. The adaptive process of the regeneration of old industrial buildings was described based on architectural design. The entropy weight and matter–element extension methods have yielded specific results in the reconstruction and reuse of old industrial buildings [19–22]. Based on the three factors of environment–economy–society and the matter–element extension method, Xiao et al. [23]. studied the reuse of abandoned coal mine industrial land in Beijing. This study considered eight state-owned abandoned coal mine industrial sites (ACMIS) located in the suburbs of Beijing as the research object. According to relevant planning documents, policies and regulations, research interviews, and other factors, four ACMIS reuse modes were explored: residential areas, parks, scientific research parks, and business districts. Based on the EES model, four types of adaptive evaluation index systems were constructed. Using the ACMIS in Daanshan as an example, a suitability evaluation of residential area reuse was conducted using the matter–element extension model. The calculation results showed that the initial reuse targets of all the objects were consistent with the decision-making results obtained in this study. Thus, the feasibility of the evaluation model was verified. The aforementioned scholars are more focused on research related to the renovation of old industrial buildings, and do not consider the factors influencing their conversions to stadiums or sports facilities.

Following the continuous improvements in people's living standards in recent years, sports and health have gradually attracted the public's attention. National enthusiasm for fitness is increasing in conjunction with a shortage of sports venues and facilities. In the process of urban transformation, there are many similarities between old industrial buildings and sports venues in their use of space. Several researchers have conducted studies in this field. For example, based on the study of the ontology of old industrial buildings, Qin et al. [24]. discussed the development of functional spaces for sports and old industrial buildings. Based on field investigations and a literature review, the author collected and recorded 396 cases of old industrial building renovations. It was found that there are a few functional sports projects, and the simplification and homogenization of renovation projects is significant. This study analyzed problems in the regeneration and development of old industrial buildings in China, and proposed relevant optimization measures [25]. Sun studied the renovation design of old industrial building spaces from the perspective of national fitness. Jia et al. [26]. conducted a study on the application of old industrial building renovations to sports stadiums, and presented an analysis method. The author studied the advantages and disadvantages of the transformation of old industrial buildings into sports venues and provided countermeasures to improve the success rate of project transformation, but did not analyze the importance of the factors that affected this transformation. Yan [27] used industrial relics in Shenyang as the object of study to explore the feasibility of transforming old industrial buildings into leisure and sports spaces. Aiming to counteract the problems of the low utilization rate and poor accessibility of sports buildings, Chen and others [28] explored the multifunctional transformation mode of "sports + X" (this refers to the relationship between sports and other specific areas or themes; for example, "sports + tourism" is the combination of sports and tourism that provides a diverse, rich, and interesting travel experience) of old industrial buildings from the perspective of the building stock. This study examined the possibility, significance, advantages, and strategies of the organic combination of old industrial buildings with sports, entertainment, culture, and commerce. Based on the goal of sports function transformation, we explored the advantages and challenges of old industrial building renovation projects, and the possibility of transformation from the perspective of macro positioning in combination with the current social background. A design strategy for space transformation was proposed through analyzing domestic and foreign cases [29]. Lu et al. [30]. studied the spatial activation and renewal of old metallurgical industrial buildings in the context of national fitness. In this study, the mechanical performance of the case was analyzed using ABAQUS finite element software, and an optimization strategy for the building structure, which affected the reconstruction, was proposed. The research results showed that the improvement scheme promoted the activation of the project and the utilization of the original building space. As mentioned above, scholars have conducted research on the relevant issues involved in the transformation of old industrial buildings into stadiums or sports facilities. However, only a few studies exist on the suitability of the transformation of old industrial buildings during the design and planning stages. In summary, this study focuses on the evaluation of suitability, and on solutions to the rationality problem of the transformation of old industrial buildings into stadiums. This has important theoretical significance and practical value for conducting in-depth research.

3. Index System

In the environment of urban renewal and development, the sustainable development of old factories is highly valued by the government. The state encourages the transformation of old factories into stadiums to achieve multi-industry integration and give full play to their own individual value. In the exploration of the transformation of old industrial buildings into sports venues, some progress has been achieved. The regeneration and integration of sports venues and old industrial buildings have also been extensively recognized by the industry, and there is also a high degree of fit between the two (the specific content of which is outlined in Appendix A). Old industrial buildings are affected by many factors during their transformations into sports venues. Compared with ordinary construction projects, the transformation of old industrial buildings involves many considerations, such as location, structure, and space. Therefore, it is very important to comprehensively analyze the influencing factors in the process of transformation, and construct an evaluation index system.

3.1. Construction of Index System

(1) Construction method:

An analytic hierarchical process (AHP) was proposed by American operations researcher Thomas Saaty in the 1970s [31]. The AHP is not only scientific and reasonable in theory, but also simple and easy to apply. It can comprehensively analyze qualitative and quantitative problems. It is a decision-making method suitable for multi-objective decision-making. Its purpose is to address the complexity and subjectivity of decision problems.

(2) Construction steps

Using the transformation of old industrial buildings into sports venues as the research object and adhering to the relevant principles (such as scientificity, systematicness, operability, and mutual exclusion) to establish evaluation index systems, system construction was completed by referring to the guidelines on the recycling of old industrial buildings, the design specifications of sports buildings, and the relevant standards for the recycling of old industrial buildings [32–36]. The specific steps are as follows:

Step 1: Establishing the initial hierarchical structural model

Based on field research, expert guidance, and a literature analysis [37–39], the structure initially established 5 dimensions for first-level indicators, and 28 for second-level indicators.

Index analysis:

The primary considerations when converting an old industrial building into a stadium are safety and structural stability. The stadium needs to be able to withstand the load of a large number of spectators and participants, so the building structure must be strong and stable enough. The feasibility of the site layout and other facilities is inseparable from the structure of the building, and some old industrial buildings may have outdated structural designs with which it is difficult to meet the requirements of modern sustainable architecture. Therefore, evaluation of the structural condition of old industrial buildings helps to determine the technical options, budget, feasibility, and environmental impact of the renovation process, and ensure the successful implementation of the renovation project. The importance of location advantage for the transformation of old industrial buildings into stadiums lies in the provision of good accessibility and the convenience of surrounding facilities and services. A good location has a high degree of commercial activity and will attract more consumers and business cooperation. The right location is the key to ensure the successful operation and sustainable development of the project.

Reasonable planning and design can make full use of existing resources to reduce the cost of projects and reduce the impact on the environment. The efficient use of this resource is a key factor in economic efficiency, alongside assessing renovation costs and construction periods, determining the feasibility and cost budget of the project, and determining whether there is an economic advantage to transformation compared to the construction of a new stadium. During the renovation process, meeting the needs of people for cultural and sporting activities and improving the living environment can help to achieve the sustainable development goals, protect the historical value of the building, and promote the development of creative industries. It is a social element that needs comprehensive consideration. To summarize, reasonable index evaluation can improve the suitability of old industrial buildings to be transformed into sports venues.

Step 2: Consistency check

To ensure the feasibility of each index, the importance, correlation, and discreteness of the indices are analyzed based on the statistical analysis software Statistical Product and Service Solutions (IBM SPSS Statistics 26) (As shown in Tables 1 and 2). After the expert demonstration, 20 secondary indices were retained, and the suitability evaluation index system of transforming old industrial buildings into stadiums and gymnasiums was constructed, as shown in Figure 2.

Table 1. Linear regression analysis results.

	Nonnormalized Coefficient		Standardization Coefficient	t	p	Collinearity Diagnostics	
	B	Standard Error	*Beta*			VIF	Tolerability
Constant	−0.197	0.074	-	−2.675	0.015 *	-	-
Secondary index	0.098	0.002	0.996	48.857	0.000 **	1.000	1.000
R^2				0.993			
Adjust R^2				0.992			
F				F (1,18) = 2387.001, p = 0.000			
D-W value				1.611			

Dependent variable: suitability. * $p < 0.05$ ** $p < 0.01$.

The regression coefficient value of the secondary index is 0.098 (t = 48.857, $p = 0.000 < 0.01$), which means that the secondary index will have a significant positive influence on the suitability.

It can be seen from the above table that different indicator samples present significant differences in suitability ($p < 0.05$).

Table 2. Chi-square test analysis results.

Topic	**Name**	**Index**																				**Total**	χ^2	p
		D11	**D12**	**D13**	**D14**	**D21**	**D22**	**D23**	**D31**	**D32**	**D33**	**D34**	**D35**	**D41**	**D42**	**D43**	**D51**	**D52**	**D53**	**D54**	**D55**			
Suitability	Very suitable	0	4	0	6	5	8	0	3	3	0	5	2	3	0	0	1	4	0	0	1	45	170.896	0.000 **
	Suitable	0	2	2	0	4	5	7	5	0	5	3	3	7	5	2	5	0	5	3	5	68		
	General suitable	0	1	1	3	0	1	2	1	3	1	2	8	0	0	1	0	1	3	4	3	35		
	Poor suitable	3	0	4	2	2	0	0	4	8	2	0	2	1	3	0	1	2	0	1	0	35		
	Unsuitable	1	1	0	6	0	3	1	0	3	0	1	0	0	1	4	3	0	3	0	0	27		
	Total	4	8	7	17	11	17	10	13	17	8	11	15	11	9	7	10	7	11	8	9	210		

** $p < 0.01$.

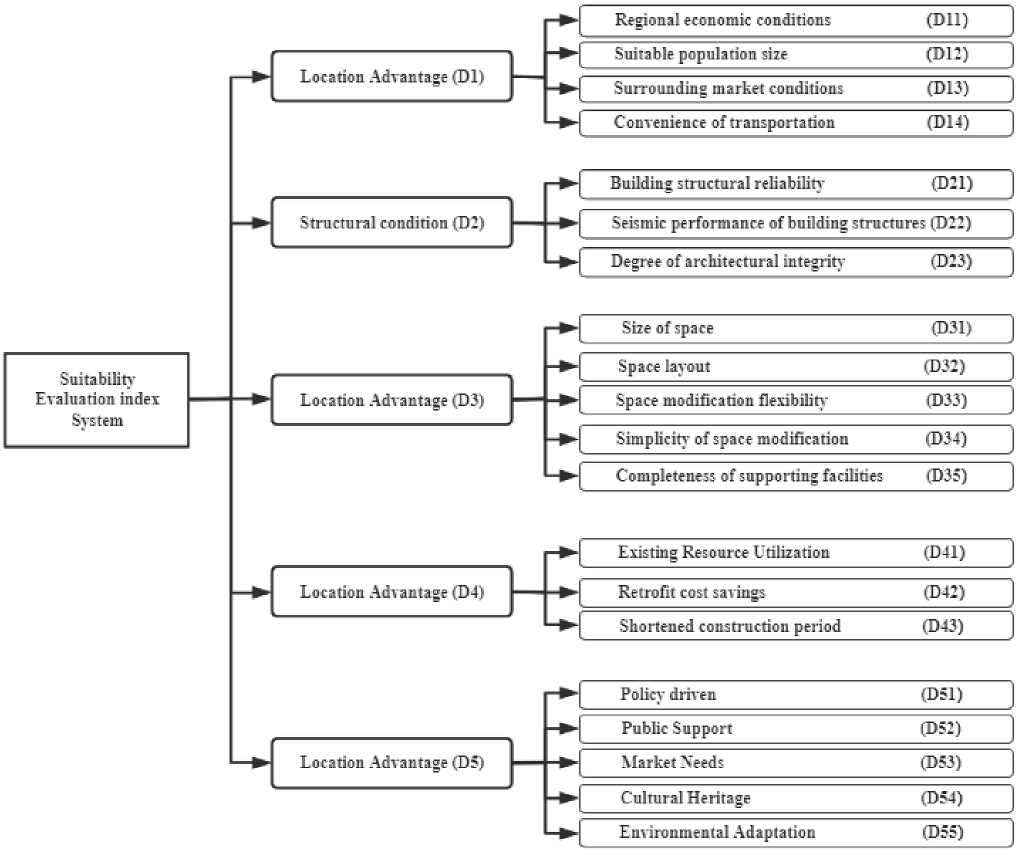


Figure 2. Suitability evaluation index system used for the transformation of old industrial buildings into sports stadiums.

3.2. Index Grading Standards

(1) Establishment method:

This paper refers to the components of a Likert scale, the grade division, form, score, and other elements, and through the literature review and analysis [40,41], the final design of the evaluation scale of the adaptability of old industrial buildings to be transformed into the gymnasiums.

The score of the index was obtained using the expert scoring method. The members of the expert group participating in this study are three university teachers (Professors), two research staff (with doctoral degrees), four sports building practitioners (Master's degrees), and three construction managers (undergraduates).

(2) Establishment of the indicator grade:

To ensure the rationality, scientificity, and accuracy of the suitability grade classification of old industrial buildings to be transformed into stadiums, this study combined relevant policies, regulations, theories, and technical documents, and designed an adaptability evaluation scale for old industrial buildings transformed into stadiums, based on the Likert scale, after the transformation of old industrial buildings and the guidance and feedback of sports construction experts and practitioners. The corresponding value range was 0–10 points, which was divided into I (very suitable), II (suitable), III (generally suitable), IV (poorly suitable), and V (unsuitable) parts according to the degree of suitability from high to low. The specific contents are listed in Table 3 time.

Table 3. Classification of suitability.

Grade	Suitability	Suitability Description	Score Range
I	Very suitable	The index plays a great role in promoting the reconstruction and reuse	(8–10]
II	Suitable	The index can promote the reconstruction and reuse obviously	(6–8]
III	Average adaptability	The promoting effect of index on reconstruction and reuse	(4–6]
IV	Poor adaptability	The index neither promotes nor hinders reconstruction and reuse	(2–4]
V	Unsuitable	Indicators are not conducive to retrofitting for reuse	(0–2]

4. Model Development

The matter–element extension method [42] is a system engineering and decision analysis method used to evaluate and optimize the performance of complex systems. Its core idea is to establish a mathematical model and evaluation system by decomposing the elements of the system into materials and expanding them. It has been extensively used in different fields. However, only a few studies exist in the field of suitability research on the transformation of old industrial buildings into stadiums and gymnasiums. In this study, the AHP was used to construct a suitability evaluation index system for the transformation of old industrial buildings into stadiums, and the entropy weight method was used to determine the weight of each index. Based on the entropy weight and matter–element extension methods, a suitability evaluation model was constructed and applied to the transformation of old industrial buildings into stadiums, and the suitability of the transformation project was analyzed as a whole. The specific process for implementing the model is shown in Figure 3.

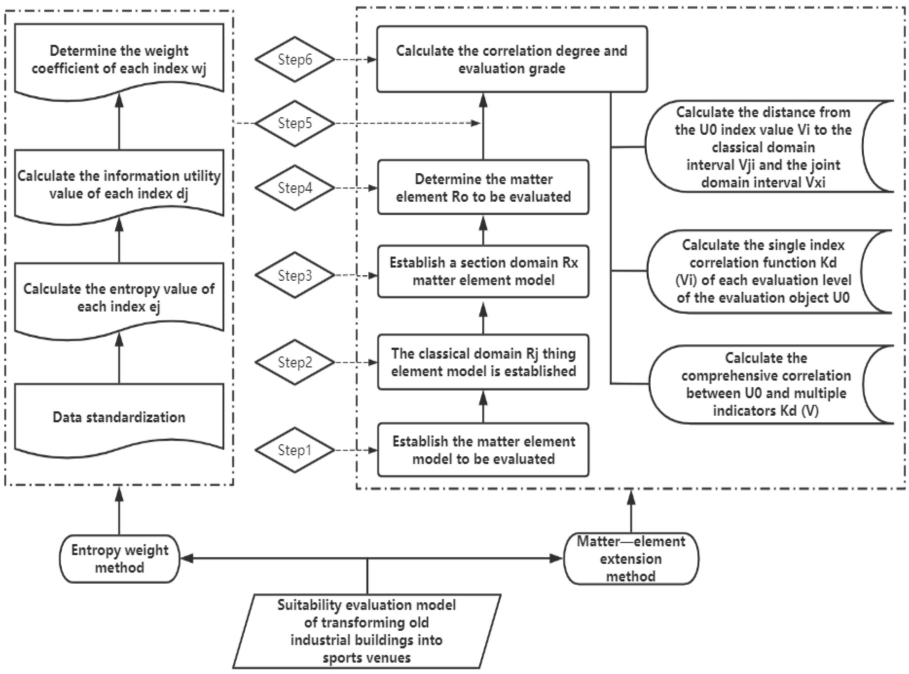


Figure 3. Model implementation flow chart.

4.1. Entropy Weight Method

Commonly used methods for determining index weights include subjective and objective weighting. However, because of the great uncertainty in the suitability of transforming old industrial buildings into stadiums, changes occur in the transformation process due to the influence of multiple factors such as location and structure. In this study, the entropy weighting method [43,44] was used for objective weighting to determine the weight of each index. The weight was first standardized in the calculation process, and the entropy value e_j of each index was calculated, followed by the calculation of the information utility value

d_j of each index. Finally, the weight w_j of each index was determined. The coefficient w_j Appendix B) avoids the subjectivity and limitations of traditional weight determination methods.

Relevant data on the 20 secondary evaluation indicators were collected using expert questionnaires. According to the calculation steps in Appendix A, 11 project data points were used as samples (data from expert questionnaires: 12 were issued, and 11 were recovered). SPSS software was used to calculate the weight coefficients of the 20 indictors. w = [0.0690, 0.0056, 0.0161, 0.1783, 0.0266, 0.0100, 0.0293, 0.0857, 0.0620, 0.0340, 0.0036, 0.0176, 0.0857, 0.1092, 0.1092, 0.0228, 0.0032, 0.0161, 0.0645, 0.0516].

4.2. Matter–Element Extension Method

Establishing the Matter Element Model to Be Evaluated

The matter–element method is an ordered triple composed of the evaluation object U, the feature T, and the value V about T [45]. R = (U, T, V) is the basic element of the description, referred to as the matter element. It is assumed that the suitability evaluation grade U has n characteristics, with $T_1, T_2, \ldots, T_n$ and specific values $V_1, V_2, \ldots, V_n$ to describe them; the suitability evaluation model can be expressed as follows.

$$R = (U,\ T,\ V) = \begin{bmatrix} U\ T_1\ V_1 \\ T_2\ V_2 \\ \vdots\ \vdots \\ T_n\ V_n \end{bmatrix} \tag{1}$$

where R is the evaluation matter element; U is divided into K suitability grades; T_n is the adaptability evaluation index; V_n is the value range of evaluation grade about each evaluation index; and V = [a, b].

Establishing the Classical Domain R_j Thing Element Model

$$R_j = (U_j, T_i,\ V_{ji}) = \begin{bmatrix} U_j\ T_1\ \langle a_{j1},\ b_{j1} \rangle \\ T_2\ \langle a_{j2},\ b_{j2} \rangle \\ \vdots\ \ \vdots \\ T_n\ \langle a_{jn},\ b_{jn} \rangle \end{bmatrix} \tag{2}$$

where R_j is the classical domain matter element [46]; U_j is the Kth evaluation grade, j = 1, 2, 3, . . . , n; T_i is the i th evaluation index, i = 1, 2, 3, . . . , n; V_{ji} is the value range of the jth evaluation grade about the ith evaluation index; b_{ji} is the upper limit of the value; a_{ji} is the lower limit of the value; and $V = [a_{ji}, b_{ji}]$.

Establishing a Section Domain R_x Matter Element Model

$$R_x = (U_x,\ T_i,\ V_{xi}) = \begin{bmatrix} U_X\ \ T_1\ \langle a_{x1}, b_{x1} \rangle \\ T_2\ \langle a_{x2}, b_{x2} \rangle \\ \vdots\ \ \vdots \\ T\ \ _n\ \langle a_{xn}, b_{xn} \rangle \end{bmatrix} \tag{3}$$

Among them, R_x is a section domain matter element [46]; U_X is the overall rating; V_{xi} is the value range of all evaluation grades about the ith evaluation index; a_{xn} is the lower limit of the value in all the evaluation grades; b_{xn} is the upper limit of the value of the value in all the evaluation grades; and $V_{xi} = [a_{xn}, b_{xn}]$.

Determining the Matter Element R_o to Be Evaluated

$$R_o = (U_0,\ T_i,\ V_i) = \begin{bmatrix} U_0 & T_1 & V_1 \\ & T_2 & V_2 \\ & \vdots & \vdots \\ & T_n & V_n \end{bmatrix} \tag{4}$$

Among them, U_0 is the object to be treated; V_i is the value of U_0 with respect to T_i, which is the specific value of the object to be evaluated.

Calculating the Correlation Degree and Evaluation Grade

Step 1: Calculate the distance from the U_0 index value V_i to the classical domain interval V_{ji} and the section domain interval V_{xi} [46]:

$$\mathrm{P}\ (V_i,\ V_{ji}) = \left| V_i - \frac{1}{2}(a_{ji} + b_{ji}) \right| - \frac{1}{2}(b_{ji} - a_{ji}) \tag{5}$$

$$\mathrm{P}\ (V_i,\ V_{xi}) = \left| V_i - \frac{1}{2}(a_{xi} + b_{xi}) \right| - \frac{1}{2}(b_{xi} - a_{xi}) \tag{6}$$

where $p\ (V_i, V_{ji})$ is the distance from the index value V_i to the classical domain interval V_{ji}, and $p\ (V_i, V_{xi})$ is the distance from the index value V_i to the section domain interval V_{xi}.

Step 2: Calculate the single index correlation function $K_d(V_i)$ of each evaluation level of the evaluation object U_0 [46].

$$K_d(V_i) = \begin{cases} -\frac{p(V_i,\ V_{ji})}{|V_{ji}|}, V_i \in V_{ji} \\ \frac{p(V_i, V_{ji})}{p(V_i,\ V_{xi}) - p(V_i,\ V_{ji})}, V_i \notin V_{ji} \end{cases} \tag{7}$$

If $K_s\ (V_i) = \max K_d(V_i)$, $s \in \{1, 2, \ldots, t\}$, it is judged that V_i belongs to grade N_s in the object U_0 to be evaluated. If $K_s(V_i) \leq 0$, it means that V_i does not belong to grade N_s.

Step 3: Calculate the comprehensive correlation between U_0 and multiple indicators [46] $K_d(\mathrm{V})$:

$$K_d(\mathrm{V}) = \sum_j W_j K_j\ (V_i) \tag{8}$$

If $K_s\ (\mathrm{V}) = \max K_d(\mathrm{V})$, $d \in \{1, 2, \ldots, t\}$, $s \in \{1, 2, \ldots, t\}$, then the object U_0 belongs to the evaluation level U_j.

5. Example Application

5.1. Project Overview

The old DJ (Refers to a specific plant) industrial plant renovation project is located in the annex of the Qinglong Temple subway station in Yanta District, Xi'an City, Shaanxi Province, China. The geographical location was superior, and the building conditions were good. The plant was a single-story, single-span, bent structure with a length of 55 m, width of 20 m, and height of 9.5 m. The construction area was approximately 1100 m^2. Owing to the relocation of enterprises, the plant was idle. The current situation of the project (recycling existing plant resources and their transformation into sports venues) is represented in Figure 4.

(**a**) Building's south facade (**b**) Building's interior

Figure 4. Old DJ industrial plant(created by the authors).

5.2. Project Analysis

We conducted an overall analysis of the surrounding environment of the project (as shown in Table 4), and the generated results are as follows:

(1) Location advantage

There are many residential areas around the project, with large-scale, high-quality real estate under construction, multiple commercial complexes, and high urban vitality. The project is conveniently located near the subway station, and the reachable range includes multiple residential areas, business circles, and campuses. The cultural atmosphere is strong, and there are many service objects.

(2) Structure and space conditions

Based on an actual investigation of the project, it was found that the building had high integrity, a strong main structure, and good seismic performance. The internal space was large, its layout was regular, its form was open, and the transformation was convenient and adaptable.

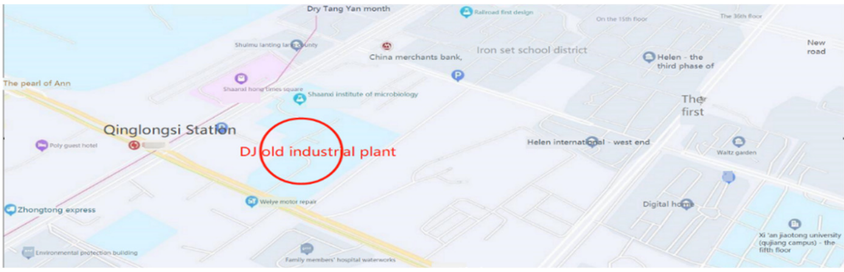
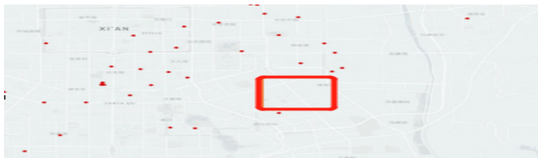
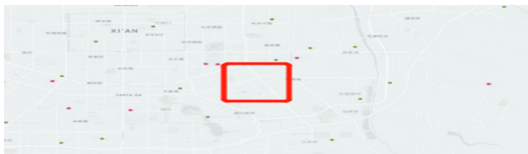
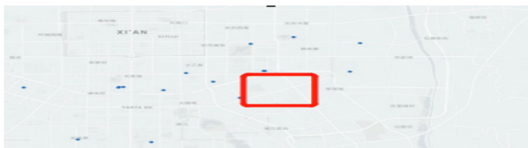
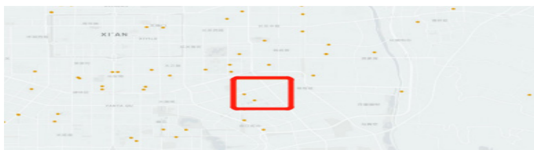
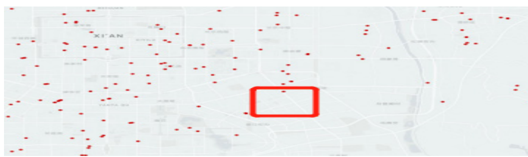
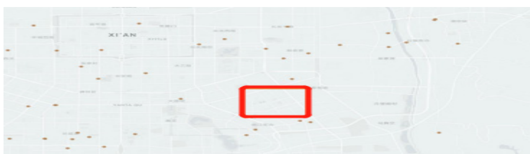
(3) Economic benefits

The overall situation of the project was good, and existing building resources could be fully reused, thus reducing the consumption of materials and energy, shortening the construction period to a certain extent, reducing the cost of renovation, and improving the economic benefits of the project.

(4) Social benefits

In recent years, the state has attached great importance to the sports industry, and local governments have issued relevant laws and regulations. At the same time, the successful holding of sports events, such as the "14th National Games", allowed the local sports industry to develop rapidly. Government guidance, social support, and mass participation strengthened the local sports culture. In the context of "industry–city integration", the sports industry has also ushered in new development opportunities.

Table 4. Overall situation of project location.

<table>
<tr><td rowspan="4">Analysis of the overall situation of the project location</td><td colspan="3">
</td></tr>
<tr><td colspan="3">Project location map</td></tr>
<tr><td colspan="3">
</td></tr>
<tr><td colspan="3">The positional relationship between the project and the surrounding large-scale sports complex</td></tr>
<tr><td></td><td rowspan="6">Sports facilities around the project</td><td>Table</td><td></td></tr>
<tr><td></td><td>Football</td><td></td></tr>
<tr><td></td><td>Badminton</td><td></td></tr>
<tr><td></td><td>Basketball</td><td></td></tr>
<tr><td></td><td>Billiards</td><td></td></tr>
<tr><td></td><td>Taekwondo</td><td></td></tr>
</table>

5.3. Demonstration Process

5.3.1. Establishment of Matter Element to Be Evaluated

Data collection and simulation analyses were performed for plant reconstruction project No. 2. According to the scoring criteria in Table 1, 20 secondary indicators were scored by colleges and universities, research institutes, and sports and construction-related professionals. The maximum and minimum values were removed, and the original values of the indicators to be evaluated were used to establish the matter element to be evaluated. The original values were [6.7, 6.7, 7.7, 6.3, 8.2, 7.5, 5.7, 7.3, 7.8, 8.5, 8.7, 5.5, 7.3, 7.2, 7.2, 7.2, 8.5, 7.5, 7.7, 7.6, 7.8].

5.3.2. Establishment of the Correlation Matrix

Combined with the established classical domain matter element and the matter element to be evaluated, the degree of correlation of each evaluation index corresponding to the suitability grade was calculated according to the correlation function. Using D_{11} as an example, the evaluation value was 6.7, and the single index correlation degree between the sample and each evaluation grade was calculated using Equation (5):

$$\mathrm{p}(V_i,\ V_{1i}) = 1.3$$
$$\mathrm{p}(V_i,\ V_{2i}) = -0.7$$
$$\mathrm{p}(V_i,\ V_{3i}) = 0.7$$
$$\mathrm{p}(V_i,\ V_{4i}) = 2.7$$
$$\mathrm{p}(V_i,\ V_{5i}) = 4.7$$

According to Equation (6) $\mathrm{p}(V_i,V_{xi}) = -3.3$

When $V_i \in V_{ji}$, according to Formula (7), we calculate that

$$K_2(V_i) = -\frac{p(V_i,\ V_{2i})}{|V_{2i}|} = 0.350$$

When $V_i \notin V_{ji}$, according to Formula (7), we calculate that

$$K_1(V_i) = \frac{p(V_i,V_{1i})}{p(V_i,\ V_{xi}) - p(V_i,\ V_{1i})} = -0.283$$
$$K_3(V_i) = \frac{p(V_i,V_{3i})}{p(V_i,\ V_{xi}) - p(V_i,\ V_{3i})} = -0.175$$
$$K_4(V_i) = \frac{p(V_i,V_{4i})}{p(V_i,\ V_{xi}) - p(V_i,\ V_{4i})} = -0.450$$
$$K_5(V_i) = \frac{p(V_i,V_{5i})}{p(V_i,\ V_{xi}) - p(V_i,\ V_{5i})} = -0.588$$

Similarly, the correlation matrix R_0 of other evaluation indexes about each grade is shown in Table 5:

Table 5. Correlation matrix R_0.

		I	II	III	IV	V
$R_0 =$	D11	−0.283	0.350	−0.175	−0.450	−0.588
	D12	−0.283	0.350	−0.175	−0.450	−0.588
	D13	−0.115	0.150	−0.425	−0.617	−0.713
	D14	−0.315	0.150	−0.075	−0.383	−0.538
	D21	0.100	−0.100	−0.550	−0.700	−0.775
	D22	−0.167	0.250	−0.375	−0.583	−0.688
	D23	−0.348	−0.065	0.150	−0.283	−0.463
	D31	−0.206	0.350	−0.325	−0.550	−0.663
	D32	−0.083	0.100	−0.450	−0.633	−0.725

Table 5. *Cont.*

	I	II	III	IV	V
D33	0.250	−0.250	−0.625	−0.750	−0.813
D34	0.350	−0.350	−0.675	−0.783	−0.838
D35	−0.357	−0.100	0.250	−0.250	−0.438
D41	−0.206	0.350	−0.325	−0.550	−0.663
D42	−0.222	0.400	−0.300	−0.533	−0.650
D43	−0.222	0.400	−0.300	−0.533	−0.650
D51	0.250	−0.250	−0.625	−0.750	−0.813
D52	−0.167	0.250	−0.375	−0.583	−0.688
D53	−0.115	0.150	−0.425	−0.617	−0.713
D54	−0.143	0.200	−0.400	−0.600	−0.700
D55	−0.083	0.100	−0.450	−0.633	−0.725

5.3.3. Comprehensive Evaluation of Matter–Element Extension

From the correlation matrix R_0, it can be inferred that the correlation degrees of each index to be evaluated for grades I, II, III, IV, and V (using D11 as an example), are $K_1(V_i) = -0.283$, $K_2(V_i) = 0.350$, $K_3(V_i) = -0.175$, $K_4(V_i) = -0.450$, and $K_5(V_i) = -0.588$, respectively. According to Equation (7), the maximum value is $K_2(V_i) = 0.350$; thus, the evaluation grade is grade II, and the single-factor suitability grade of the other indicators can be obtained.

According to Equation (8), $K_1(\text{v}) = -0.184$; similarly, $K_2(\text{v}) = 0.211$, $K_3(\text{v}) = -0.287$, $K_4(v) = -0.527$, and $K_5(\text{v}) = -0.646$. The calculation results are listed in Table 6.

Table 6. Project evaluation results.

Correlation Degree	$K_1(v)$	$K_2(v)$	$K_3(v)$	$K_4(v)$	$K_5(v)$	Grade
Numerical value	−0.184	0.211	−0.287	−0.527	−0.646	II

As shown in Equation (8), $\max[(K_d(v))] = 0.211$; moreover, the suitability evaluation grade of the renovation project was grade II.

5.4. Results and Discussion

5.4.1. Analysis of the Causes of the Influence of Single Index

According to Equation (8), there are four single indicators belonging to grade I, accounting for 20% of the total; there are 14 grade II indicators, accounting for 70% of the total; and there are two grade III indicators, accounting for 10% of the total. Therefore, the constructed index system was found to be more reasonable.

5.4.2. Suitability Analysis of Multi-Index Coupling Effect

As shown in Table 3, $K_2(v) = 0.211$. From the analysis of the suitability degree based on the coupling of multiple indicators, the suitability grade of the transformation project was grade II.

6. Conclusions

(1) A suitability evaluation system was constructed for the transformation of old industrial buildings into stadiums based on references to the relevant standards and guidelines in conjunction with the characteristics of old industrial building renovation projects, including 5 first-level indicators of location advantages, structural conditions, spatial conditions, and economic and social benefits, and 20 second-level indicators.

(2) Using of the entropy weight method to determine the weight, we were able to avoid the influences of human factors, and an objective analysis was able to improve the reliability of the data and ensure the accuracy of the evaluation.

(3) The matter–element extension method was used to establish a suitability evaluation model for the transformation of old industrial buildings into stadiums, and the model was applied to actual projects. The results showed that the model can reasonably evaluate transformation projects.

Author Contributions: Conceptualization, L.J.; methodology, C.S. and W.L. (Wenlong Li); investigation, W.L. (Wenhao Lv); data curation, C.S. and W.L. (Wenlong Li); writing—original draft preparation, C.S.; writing—review and editing, C.S., L.J. and W.L. (Wenhao Lv); funding acquisition, L.J. All authors have read and agreed to the published version of the manuscript.

Funding: This study was funded by the Youth Science Foundation project, grant number 51908452; the General Projects of National Natural Science Foundation of China, grant number 51178386; and the Annual Project of Major Theoretical Discoveries and Practical Problems of Philosophy and Social Sciences in Shaanxi Province, grant number 2022ND0459.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Acknowledgments: We would like to thank Fang Qiao for English language editing support.

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

Appendix A. Compatibility Analysis

(1) Policy promotion

The action plan to further promote participation in sports, issued by the General Administration of Sport of the State, clearly points out that it is necessary to create a variety of sports complexes, strengthen the construction of convenient sports facilities, and implement other measures to grow the extent of participation in sports. To this end. We must encourage and guide the recycling of old factories and existing facilities to transform them into sports complexes that combine fitness, leisure, and commercial services [47].

(2) Infrastructure

Old industrial buildings are buildings with complete structures, but they cannot carry out normal industrial production. Old industrial buildings in good overall condition have good structural performance and strong seismic capacity. It is due to the existence of these advantages that old industrial buildings have the possibility of transformation. In the process of transformation, old industrial buildings can be put to use by strengthening and repairing the places that need to be repaired, according to the individual situation. In addition, old industrial buildings are also relatively perfect in terms of basic supporting facilities. Transformation can be carried out on the basis of the original water supply and drainage, HVAC, electricity, communication, and other facilities, and finally, the facilities of the transformation project can be upgraded; therefore, the transformation of old industrial buildings not only saves costs and resources, but also provides convenience for the sports venues to be transformed.

(3) Layout Planning

In the process of transforming old industrial buildings into sports venues, using the characteristics of old industrial buildings with large spans and high roofs, the functions of these buildings can dedicated to the reconstruction of sports venues, which can not only provide multiple combination spaces for the repositioning of new project functions, but can also adapt to the requirements of sports venues for tall spaces, using measures such as increasing partitions and enclosures to divide functional spaces, which can be planned for a variety of sports projects; old industrial buildings have large external spaces in their preliminary planning and design, and these spaces can be fully utilized in the transformation process to produce a reasonable layout of sports activity venues and facilities [28]. In addition, before large-scale urbanization, old industrial buildings were mostly located vicinity of convenient transportation, which is another innate advantage of these renovation projects.

(4) Aesthetic features

The process of transforming old industrial buildings into stadiums is affected by many factors. Compared with ordinary building projects, the transformation of old industrial buildings involves many considerations such as location, structure and space. Therefore, it is crucial to comprehensively analyze the influencing factors in the transformation process and construct an evaluation index system. The special construction method of old industrial buildings gives them a distinct sense of hierarchy and integrity [48], while the construction method and spatial layout of sports stadiums have something in common with old industrial buildings, and the aesthetic characteristics of both are very similar.

Appendix B. The Calculation Steps of Index Weight

Step 1: Data standardization. Different index dimensions will cause different data to affect the result in the calculation process. In order to eliminate the influence of different index dimensions, the initial data are first processed by forward (MMS), and the proportion of the i-th sample value of the j-th index is calculated p_{ij};

$$p_{ij} = \frac{y_{ij}}{\sum_{i=1}^{n} y_{ij}} \tag{A1}$$

Step 2: Calculate the entropy value of each index e_j;

$$e_j = -k \sum_{i=1}^{n} p_{ij} \ln(p_{ij}) \tag{A2}$$

where k is the correction factor, $k = \frac{1}{\ln n}$, $k > 0$, and guarantees $0 \ll e_j \gg 1$;

Step 3: Calculate the information utility value of each index d_j;

$$d_j = 1 - e_j \tag{A3}$$

Step 4: Determine the weight coefficient of each index w_j;

$$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j} \tag{A4}$$

References

1. Yu, B.; Shen, C. Industrial Structure, Spatial Structure and Urbanization Efficiency. *Stat. Res.* **2020**, *37*, 65–79.
2. Tian, W.; Wang, A.; Guo, X.; Guo, P.; Chen, X. Study on Satisfaction Evaluation of Green Regeneration Decision of Old Industrial Buildings. *J. Saf. Environ.* **2022**, *22*, 371–378.
3. Li, H.; Zhong, X.; Tian, W. On the Analysis and Assessment of the Vulnerability of the Reuse of the Old Industrial Buildings Based on the Normal Cloud Model. *J. Saf. Environ.* **2020**, *20*, 1221–1228.
4. Aranđelović, M.; Videnović, A.; Gadžić, N.; Tomanović, D. Repurposing and the Impact of New Facilities on the Potential Presentation of Industrial Heritage. *Sustainability* **2022**, *14*, 5915. [CrossRef]
5. Chen, W.; Li, Y.; Cao, D.; Bi, X. Research on Indoor Daylighting Optimization Strategy for Renovated Old Industrial Building with Large Spans. *Ind. Constr.* **2022**, *52*, 139–145.
6. Zheng, X.; Heath, T.; Guo, S. From Maslow to Architectural Spaces: The Assessment of Reusing Old Industrial Buildings. *Buildings* **2022**, *12*, 2033. [CrossRef]
7. Wu, Q.; Geng, J.; Wang, L.; Sun, M.; Li, Y. Research on the Structural Reinforcement Safety system of Old Industrial Building Reconstruction. *J. Saf. Environ.* **2022**, *22*, 1701–1708.
8. Li, L.; Wu, Q.; Zhang, X. Evolutionary game analysis between governments and enterprise in the regeneration of old industrial buildings. *Oper. Res. Manag. Sci.* **2022**, *31*, 69–74.

9. Guo, P.; Tian, W.; Li, H. Dynamic health risk assessment model for construction dust hazards in the reuse of industrial buildings. *Build. Environ.* **2022**, *210*, 108736. [CrossRef]
10. Lu, Y. Discussion on the strategy of old industrial building renovation design. *Ind. Constr.* **2022**, *52*, 230.
11. Pszczókowski, M. Adaptation problems of the post industrial heritage on the example of selected objects of bydgoszcz. *Civ. Environ.* **2016**, *22*, 145–156. [CrossRef]
12. Zhang, Y.; Li, H. Analysis of the influencing factors on the green transformation of old industrial buildings based on the SEM. *J. Xi'an Univ. Archit. Technol. Nat. Sci. Ed.* **2015**, *47*, 689–693.
13. Li, Q.; Li, W. Availability evaluation for current status of old industrial area in China: From the perspective of sustainable development. *Environ. Technol. Innov.* **2021**, *23*, 101743. [CrossRef]
14. Chen, X.; Gu, Y.; Tian, W.; Gao, M. Benefit distribution of old industrial building reconstruction based on Nash equilibrium. *J. Civ. Eng. Manag.* **2019**, *36*, 86–91.
15. Berens, C. *The Development and Utilization of Industrial Sites—A Practical Guide for Architects, Planners, Developers and Decision Makers*; Electronic Industry Press: Beijing, China, 2012.
16. Ding, D.; Wang, C. Existing industrial buildings reformed to a university campus: Deakin University Waterfront Campus, Australia. *Ind. Constr.* **2017**, *47*, 194–198 + 20.
17. Perfetto, M.C.; Sanchez, A.V.; Presenza, A. Managing a complex adaptive ecosystem: Towards a smart management of industrial heritage tourism. *J. Spat. Organ. Dyn.* **2016**, *4*, 243–264.
18. Yeager, F.P. *Old and New-Existing Building Renovation Design Manual*; China Building Industry Press: Beijing, China, 2017.
19. Meng, F.; Zhi, Y.; Pang, Y. Assessment of the Adaptive Reuse Potentiality of Industrial Heritage Based on Improved Entropy TOPSIS Method from the Perspective of Urban Regeneration. *Sustainability* **2023**, *15*, 7735. [CrossRef]
20. Li, W.; Li, Q.; Liu, Y.; Li, H.; Pei, X. Construction Safety Risk Assessment for Existing Building Renovation Project Based on Entropy-Unascertained Measure Theory. *Appl. Sci.* **2020**, *10*, 2893. [CrossRef]
21. Zhou, T.; Zhou, Y. Fuzzy Comprehensive Evaluation of Urban Regeneration Decision-making Based on Entropy Weight Method: Case Study of Yuzhong Peninsula, China. *J. Intell. Fuzzy Syst.* **2015**, *29*, 2661–2668. [CrossRef]
22. Liu, J.; Li, G. Comprehensive benefit evaluation on urban village micro-transformation based on extension matter-element model. *Int. J. Constr. Manag.* **2021**, *21*, 524–537. [CrossRef]
23. Xiao, L.; Chen, Z.; Liu, Z.; Yang, H. Decision-Making on Reuse Modes of Abandoned Coal Mine Industrial Sites in Beijing Based on Environment-Economy-Society Matter-Element Models. *Math. Probl. Eng.* **2021**, *2021*, 9941182.
24. Li, Q.; Yin, Z.; Tian, W.; Di, W. Research on the design strategy of sports functional regeneration space of large span old industrial buildings requirements. *J. Xi'an Univ. Archit. Technol. Nat. Sci. Ed.* **2020**, *52*, 709–716.
25. Sun, Z. *Research on Space Reconstruction Design of Old Industrial Buildings Refurbishment under the Needs of Mass Sports Fitness*; Harbin University of Technology: Harbin, China, 2019.
26. Jia, L.; Li, H.; Yan, R.; Chen, X. Application of SWOT analysis method in reform engineering of an old industrial building. *Ind. Build.* **2013**, *43*, 33–37.
27. Yan, P. The feasibility study of using old industrial buildings to transform leisure sports space in Shenyang. *Yangtze River Ser.* **2018**, *415*, 168.
28. Chen, B.; Li, L.; Yu, S. An exploration of multi-functional transformation model of old s "sports + X" of old industrial building. *Ind. Build.* **2022**, *52*, 60–66.
29. Lu, S.; Li, L.; Ma, X. On the design strategy of renovation of old industrial buildings with the objective of sports function conversion. *Urban. Archit.* **2018**, *2018*, 18–22.
30. Lu, Y.; Liu, J.; Lv, J. Research on activation and renewal of old metallurgy industrial building space under background of national fitness. *J. Archit. Sci. Eng.* **2022**, *39*, 183–192.
31. Saaty, T.L. How to make a decision: The analytic hierarchy process. *Eur. J. Oper. Res.* **1990**, *48*, 1. [CrossRef]
32. Li, H.; Li, W.; Li, Q.; Xingwang, P. *Project Construction for the Regeneration of Old Industrial Buildings*; China Construction Industry Press: Beijing, China, 2019; pp. 1–15.
33. *T/CMCCA4002-2017*; Technical Standard for Recycling of Old Industrial Buildings. National Assembly of the PRC: Beijing, China, 2017.
34. *T/CMCCA4002-2018*; Acceptance Standard for Demonstration Base of Old Industrial Building Recycling. National Assembly of the PRC: Beijing, China, 2018.
35. *T/CMCCA4002-2019*; Operation and Maintenance Standards for Recycling of Old Industrial Buildings. National Assembly of the PRC: Beijing, China, 2019.
36. *JGJ-2003*; Sports Building Design Code. National Assembly of the PRC: Beijing, China, 2003.
37. Sun, M.; Chen, C. Renovation of industrial heritage sites and sustainable urban regeneration in post-industrial Shanghai. *J. Urban Aff.* **2023**, *4*, 729–752. [CrossRef]
38. Huang, W.; Xiong, G.; Zhong, L.; Li, K.; Li, H.; Skitmore, M.; Talebian, N. Research into Satisfaction with Industrial Heritage Renewal Based on the SEM-IPA Model: A Case Study of the Dongguan Jianyuzhou Park. *Land* **2022**, *11*, 403. [CrossRef]
39. Loures, L.; Panagopoulos, T. From derelict industrial areas towards multifunctional landscapes and urban renaissance. *WSEAS Trans. Environ. Dev.* **2007**, *3*, 181–188.

40. Li, Q.; Zhou, H.; Zhang, H. Durability evaluation of highway tunnel lining structure based on matter element extension-simple correlation function method-cloud model: A case study. *Math. Biosci. Eng.* **2021**, *18*, 4027–4054. [CrossRef] [PubMed]
41. Li, H.; Guo, S. External Economies Evaluation of Wind Power Engineering Project Based on Analytic Hierarchy Process and Matter-Element Extension Model. *Math. Probl. Eng.* **2013**, *1*, 11. [CrossRef]
42. Nie, X.; Zhang, J. Risk assessment for the safety production in the open –pit mines based on the improved matter-element extension theory. *J. Saf. Environ.* **2019**, *19*, 1140–1148.
43. Sahoo, M.; Patra, K.; Swain, J.; Khatua, K. Evaluation of Water Quality with Application of Bayes' rule and Entropy Weight Method. *Eur. J. Environ. Civ. Eng.* **2016**, *21*, 1–23. [CrossRef]
44. Zhao, G.; Wang, D. Comprehensive Evaluation of AC/DC Hybrid Microgrid Planning Based on Analytic Hierarchy Process and Entropy Weight Method. *Appl. Sci.* **2019**, *9*, 3843. [CrossRef]
45. Chen, J.; Wang, Y.; Li, Y.; Zhao, X.; Ye, S.; Yue, W. Evaluation of rock slope stability based on analytic hierarchy process-extension theory. *Subgrade Eng.* **2022**, *225*, 12–18.
46. Gao, J.; Liu, Y.; Zheng, H. Land use multifunctional diagnosis based on entropy weight and matter-element model. *Chin. J. Agric. Resour. Reg. Plan.* **2021**, *42*, 52–61.
47. National Development and Reform Commission. *Action Plan to Further Promote Sports Consumption (2019–2020)*; National Development and Reform Commission: Beijing, China, 2019.
48. Dai, Y. Analysis of space transformation strategy of old industrial buildings from the perspective of structural aesthetics. *Ind. Build.* **2022**, *52*, 224–225.