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Satisfaction Evaluation of Civil Air Defense Engineering Renovated into Cooling Place from the Perspective of Public Experience

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Abstract: Scientific and reasonable satisfaction evaluation is an excellent way to understand the effects of building (structure) renovation and public satisfaction. This study presents a satisfaction evaluation of civil air defense engineering renovated into cooling place from the perspective of public experience. First, a satisfaction evaluation indicator system was constructed for civil air defense engineering renovated into cooling place from the perspective of public experience, focusing on 5 first-level indicators—location condition, spatial status, physical environment, service management, and emotional experience—and 27 second-level indicators. Second, the matter-element extension and combined weighting method were introduced to establish a satisfaction evaluation model for civil air defense engineering renovated into cooling place from the perspective of public experience. Finally, the rationality of the index system and feasibility of the evaluation model were verified by considering civil air defense cooling centers as examples. This research can provide a basis for the further optimization of such projects and the development and management of cities, as well as new ideas or methods for the satisfaction evaluation of similar old buildings (structures) after renovation.

Keywords: civil air defense engineering; cooling place; renovation; satisfaction evaluation; public experience; matter-element extension

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Citation: Li, W.; Li, Q.; Liu, Y.; Jia, L.; Pei, X.; Cui, J. Satisfaction Evaluation of Civil Air Defense Engineering Renovated into Cooling Place from the Perspective of Public Experience. *Buildings* **2024**, *14*, 3301. https://doi.org/10.3390/buildings14103301

Academic Editor: Rafik Belarbi

Received: 7 September 2024
Revised: 11 October 2024
Accepted: 14 October 2024
Published: 18 October 2024

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1. Introduction

Civil air defense engineering is a special type of underground engineering with an important strategic position [1]. During wars, people use them to protect their lives; during periods of peace, they are mostly idle. Nowadays, with the vertical development of urban spaces and social progress, people use the spatial resources resulting from civil air defense engineering to carry out diversified developments, which achieves good economic benefits and has positive social effects. According to incomplete statistics, presently, there are numerous projects renovated from civil air defense engineering around China, including more than 14,700 underground hotels; 11,200 underground shopping malls, shops, and restaurants; 6600 underground cultural, recreational, and sports venues; 9500 underground production workshops; 13,300 underground warehouses; and 7300 underground car parks [2].

Recently, with the gradual deepening and extension of the cognition of sustainable development, there have been more and more renovation projects of old buildings (structures). These abandoned old buildings (structures) have been given a new lease of life, which has injected new vitality into urban sustainable development and urban renewal [3,4] and

provided new ideas for the construction of resilient cities [5]. Civil air defense engineering are characterized by their solid structures and wide spaces, which has led to the increased exploration of transformation and renovation possibilities [6]. The underground sports ground, scientific research center, and underground water treatment plant in Oslo, the capital of Norway, in Northern Europe, are famous examples of the renovation of underground civil air defense engineering that can be rated as world-class. In China, the Jixuting bar in Shanghai, Gulangyu Shell Museum in Xiamen, Transoceanic Book City in Fuzhou, and Jiuyao Air Raid Shelter Noodle Shop in Xi'an are typical examples of the renovation of civil air defense engineering.

However, through numerous investigations, it was found that the renovation of civil air defense engineering into cooling place is widespread. A cooling place refers to a public space that can provide heat relief for residents affected by high temperature, where they can take shelter and cool off in high-temperature weather and heatwaves. In hot summers, civil air defense engineering are underground and can act as "natural cold storage", providing a good place for residents to relax and escape from the heat. Through the summary, the advantages of civil air defense engineering being renovated into cooling place, which can be split into six aspects, are outlined in Table 1 [7,8].

Table 1. Advantages of civil air defense engineering renovated into cooling place.

Serial Number	Advantage	Explanation
1	Good location condition	Civil air defense engineering is mostly built in densely populated areas, so they have a good location, are suitable for renovation and utilization, and are able to radiate and serve the surrounding communities.
2	Adequate distribution space	Generally, the exterior of civil air defense engineering is usually equipped with corresponding buffer space, which can achieve certain distribution functions to meet the needs of crowd distribution when an emergency occurs.
3	Robust structural condition	The importance and significance of building civil air defense engineering are self-evident. Their structural quality is solid and reliable, providing a good material basis suitable for the renovation of civil air defense engineering.
4	Suitable and controllable internal physical environment	The interior micro-environment of civil air defense engineering is relatively stable and suitable. Especially in hot summers, they can be kept cool and comfortable. While there will be poor ventilation and lighting and individual areas of dampness, these problems can be reasonably and properly solved given the successful development of underground spaces such as subways and underground shopping malls.
5	Lower cost input	Compared with the renovation into commercial or scientific research infrastructures, the cost of renovation into a cooling place is relatively low. This is mainly reflected in the relatively low investment, short reconstruction period, and low maintenance cost during use.
6	Flexible utilization possibilities	Due to the characteristics of the internal space and the need for the combination of peacetime and wartime, it is very appropriate to renovate civil air defense engineering into cooling place, which also increases the possibility of flexible utilization in the future. Should it become necessary to utilize and renovate the space again or change its function in the future, this can be quickly adjusted at any time.

Therefore, the renovation of civil air defense engineering into cooling place is a good initiative for society and the public. This is in line with the concepts of recycling and regenerating old buildings (structures), green development, and sustainable development. However, it is worth studying how well renovation has been carried out and whether it has met public demand and experience. Only by evaluating the effect of civil air defense engineering renovated into cooling place from the perspective of public experience can we truly understand the renovation effect and further optimize it accordingly. Based on this,

this study conducted a satisfaction evaluation of civil air defense engineering renovated into cooling place from the perspective of public experience. The research flowchart of this paper is shown in Figure 1.

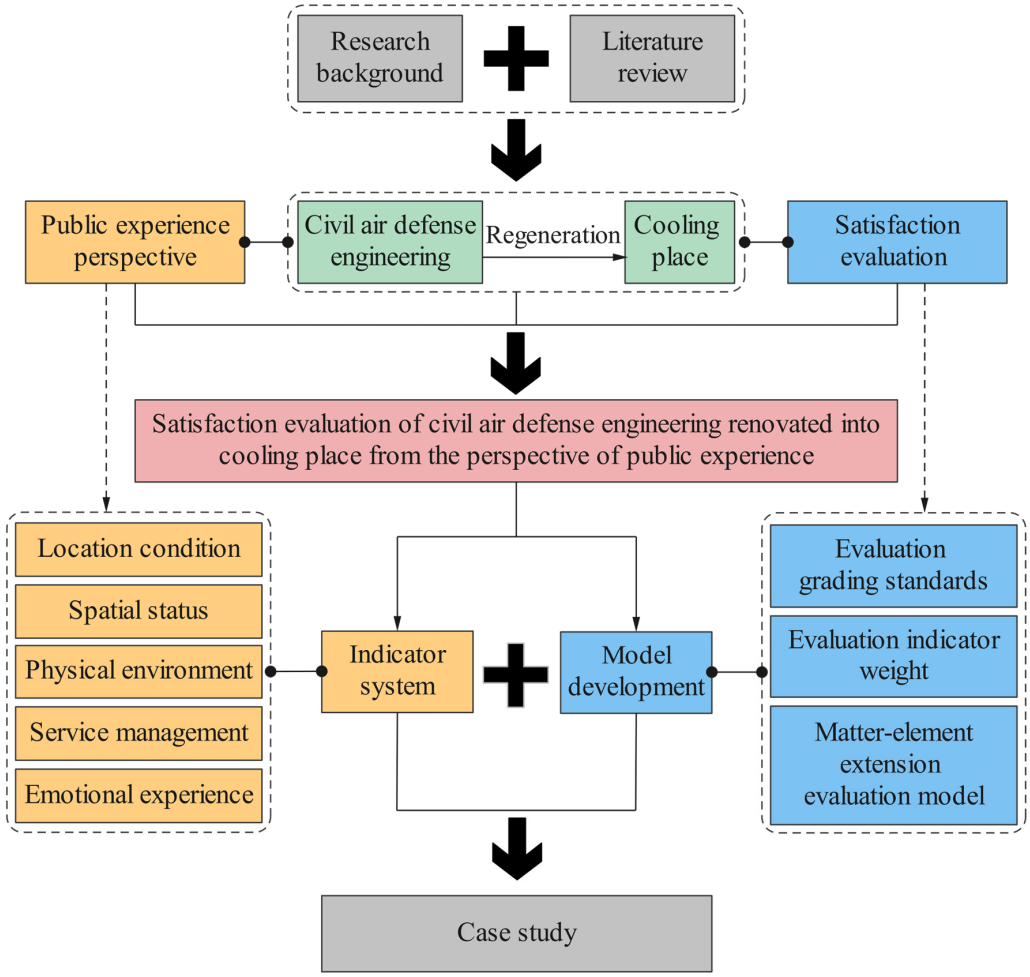


Figure 1. Research flowchart.

2. Literature Review

Research has indicated that renovation is presently a common treatment method for old buildings (structures) [9]. Not only does it make full use of the self-value of existing resources and highlights new functions, but it also plays a role in improving the environment and inheriting culture [10]. National and international research on the renovation of old buildings (structures) has been relatively mature and in depth, mainly including the renovation of civil buildings, industrial buildings, historical buildings, rural residential buildings, special structures, etc. Ferretti et al. [11] used the multi-attribute value theory to assess the sustainability of a reuse project for historical buildings, aiming to achieve the reasonable protection and renovation of historical buildings. Campagnol [12] mentioned an adaptive reuse strategy and discussed the role of architects and planners in determining urban industrial heritage. Vardopoulos [13] took the transformation of a distillery into an art museum as an example and analyzed the key factors of adaptive reuse to inject vitality into local, sustainable development. Glumac and Islam [14] proposed reusing a silo as a residential building that could meet the needs of certain people and verified its feasibility and sustainability through research. Liu et al. [15] conducted a value evaluation of industrial heritage, providing a reference for future development decisions on protection and renovation. Zhang et al. [16] proposed an extended theory of the planning behavior model, providing a new idea for the future regeneration and sustainable

development of abandoned buildings. Li and Li [17] studied the current availability of old industrial areas, providing a basis for their reuse and renovation.

Among the numerous studies on protection and renovation, there have been relatively few studies on the renovation of civil air defense engineering. Collado Lozano [18] studied air-raid shelters in Valencia as displays of the urban cultural landscape. Broseta Palanca [19] noted that air-raid shelters and other war buildings constructed during the Spanish Civil War were listed on the municipal heritage list. Furthermore, Luo [20] proposed the renovation and repair of air-raid shelters to explore their diversified utilization and give play to their public service function. Sun [21] studied the maintenance and reinforcement of underground air-raid shelters to transform them into utility tunnels, which could reduce the cost and difficulty of constructing new utility tunnels while utilizing existing resources. Matacz and Świątek [6] combed the German underground air-raid shelter heritage and sought more sustainable and active development activities to enhance the regeneration feasibility of underground spaces with the participation of neighborhood communities. Guardiola-Villora et al. [22] re-evaluated the six air-raid shelters designed by the Valencian architect Joaquín Rieta and examined their value. Wu [23] studied commonweal, commercialization, functional, and integrated renovation of air-raid shelters to serve society. Chen and Liu [24] used a case study method to explore the ambiguous transformation of air-raid shelters in Chongqing to study the positive significance of the ambiguous transformation of negative building spaces for the renewal of urban public spaces. Zhu [25] and Zhou [26], respectively, took Changchun City and Qingdao City as examples to carry out relevant research on the space renovation of underground civil air defense engineering, which presented new ideas for promoting the development and utilization of urban underground space.

From the above research, it can be seen that although the current research on the renovation of old buildings (structures) is relatively rich and in depth, studies on the renovation of civil air defense engineering are relatively few and shallow. They mainly focus on the relevant theoretical or strategic research or take a certain engineering project as an example to illustrate. So, there are many aspects worth our attention and research. In this regard, it is still important to study renovation status and whether the renovation effect is satisfactory to the public. Satisfaction evaluation is an important means to judge the renovation effect; thus, it is of great practical significance to evaluate the satisfaction of civil air defense engineering renovated into cooling place.

3. Methodology

3.1. Construction of Evaluation Indicator System

An indicator system is the basis of a satisfaction evaluation. Based on the above literature review and related project field research, this study summarized the key factors that influence the satisfaction of civil air defense engineering renovated into cooling place from the perspective of public experience in terms of five aspects: location condition, spatial status, physical environment, service management, and emotional experience. Based on this, the satisfaction evaluation indicator system for civil air defense engineering renovated into cooling place was determined (Figure 2).

Location condition mainly refers to the added value brought about by geographical location and traffic conditions to the project. For the civil air defense engineering renovated into cooling place in this study, it is mainly reflected in the degree of convenience to public transport station, surrounding shopping place, living or working place, etc., so as to judge whether it plays a convenient role for the public, and this is also an important aspect of determining public satisfaction.

Space status is an important material carrier to carry the renovation project and accommodate the public, so its quality is the basic condition to measure public satisfaction. On the one hand, the structure reliability, internal space layout, functional partition, decoration and furnishing are the prerequisites for the normal use of the internal space. On the other hand, internal traffic streamlining and evacuation and fire-fighting facilities provide a strong guarantee to ensure safety of use.

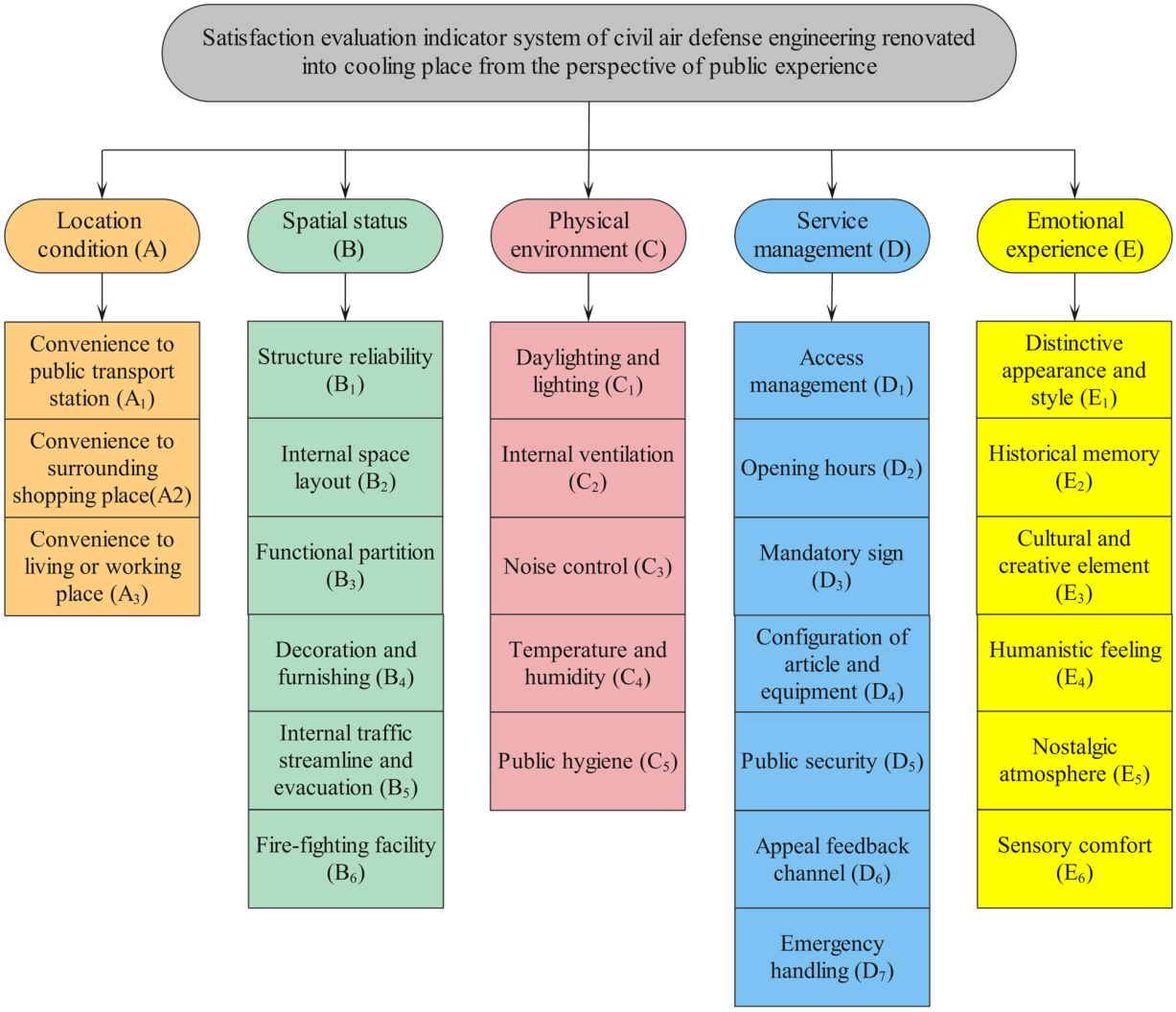


Figure 2. Satisfaction evaluation indicator system for civil air defense engineering renovated into cooling place from the perspective of public experience.

The physical environment is primarily concerned with the use situation of internal space. As the civil air defense engineering is set up underground, when they are renovated for civilian use functions, whether it is lighting, ventilation, noise control, temperature, humidity, public hygiene, etc., they are all aspects that need to be paid close attention.

Service management is a key indicator that affects public satisfaction, and the quality of service management is related to the direct experience and satisfaction of the public. Among them, access management, opening hours, mandatory signs, configurations of articles and equipment belong to the routine service management contents; on-site public security, appeal feedback channels, and emergency handling are among the work contents that can better demonstrate the effect of service management.

Emotional experience is distinguished from other aspects that pay more attention to the actual feelings of the public heart. Apart from sensory comfort, other important factors for many members of the public to choose are that this place gives them a refreshing and different experience because of its distinctive appearance and style, historical memory, cultural and creative element, humanistic feeling and nostalgic atmosphere.

3.2. Determination of Evaluation Grading Standards

According to the grading standard quantification and other research achievements [27,28], and combined with the actual situation of this research, the satisfaction evaluation of civil

air defense engineering renovated into cooling place was divided into four grades. The evaluation grading standards for each indicator are listed in Table 2.

Table 2. Evaluation grading standards of each indicator.

Grading	Description	Grading Standards
I	The result of satisfaction evaluation is poor.	(0, 60]
II	The result of satisfaction evaluation is moderate.	(60, 75]
III	The result of satisfaction evaluation is good.	(75, 90)
IV	The result of satisfaction evaluation is excellent.	(90, 100]

3.3. Calculation of Evaluation Indicator Weight

The combined weighting method can consider both subjective and objective weight information, making the weight determination more reasonable. Based on this, we used the combined weighting method to determine the weight of each evaluation indicator.

3.3.1. Subjective Weight

This study used the analytic hierarchy process (AHP) to calculate the subjective weights [29]. The following main steps were applied [15,30]:

Step 1: Constructing the judgment matrix A by using a 1~9 scale method:

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{21} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \quad (1)$$

Step 2: Calculating the weight. According to judgement matrix A, the maximum eigenvalue $\lambda_{\max}$ and its corresponding normalized eigenvector $w' = (w'_1, w'_1, \cdots, w'_n)$ were calculated, and the relationship $Aw = \lambda_{\max} w$ was satisfied.

Step 3: Consistency check according to the Equation (2):

$$CI = \frac{\lambda_{\max} - n}{n - 1} \quad (2)$$

$$CR = \frac{CI}{RI} \quad (3)$$

where CI is the consistency index; RI is the random index; and CR is the consistency ratio. If $CR < 0.1$, the judgment matrix satisfies the consistency check, indicating that the weight results were reasonable and effective.

3.3.2. Objective Weight

The entropy weight method avoids the influence of many subjective factors on the weight results [31,32], but it also has certain drawbacks. There are special rules for $\mu_{ijk} = 0$ and $\mu_{ijk} \ln \mu_{ijk} = 0$; however, $\mu_{ijk} = 0$ or $\mu_{ijk} = 1$ and $\mu_{ijk} \ln \mu_{ijk} = 0$. Therefore, this study used an improved entropy weight method to calculate the objective weights adhering to the following main steps [17]:

Step 1: Defining entropy. The entropy of the j-th indicator was expressed as follows:

$$E_j = -t \sum_{k=1}^{p} f_{ijk} \ln f_{ijk} \quad (4)$$

where $E_j > 0$; $f_{ijk} = (\mu_{ijk} + 0.1) / \sum_{k=1}^{p} (\mu_{ijk} + 0.1)$; t is a coefficient; and $t = 1/\ln p$.

Step 2: Calculating entropy weight. The entropy weight of the j-th indicator was expressed as follows:

$$w'' = \frac{D_j}{\sum_{j=1}^{m} D_j} = \frac{1 - E_j}{m - \sum_{j=1}^{m} E_j} \tag{5}$$

3.3.3. Combined Weight

Based on subjective weight w_j' and objective weight w_j'', the combined weight set is

$$w_j = \alpha \times w_j' + \beta \times w_j'' \tag{6}$$

where $\alpha + \beta = 1$; $\alpha = 0.5$; and $\beta = 0.5$.

3.4. Establishment of the Matter-Element Extension Evaluation Model

The matter-element extension method is based on extension mathematics and matter-element theory and is a combination of qualitative and quantitative analysis methods [33–35]. Presently, it has been widely used in many fields, such as quality evaluation [36], safety evaluation [37,38], risk evaluation [39], contamination evaluation [40], durability evaluation [41], stability evaluation [42], and suitability evaluation [43].

The matter element is an ordered triplet composed of the name, feature, and measure of the value of matter. Given matter S, the measure value of the corresponding feature F is R, and the ordered triplet $H = (S, F, R)$ is taken as the basic element to describe the matter, which is called a matter element. Matter often has multiple characteristics, assuming that matter S has m features (i.e., indicators), which are described by $F_1, F_2, \cdots, F_m$ and the corresponding measure value $R_1, R_2, \cdots, R_m$. The satisfaction evaluation model in this study can be expressed as [27]

$$H = (S, F, R) = \begin{bmatrix} S & F_1 & R_1 \\ & F_2 & R_2 \\ & \vdots & \vdots \\ & F_m & R_m \end{bmatrix} \tag{7}$$

where H is the matter element; S is the evaluation grade; F is the evaluation indicator; and R is the corresponding measure value.

3.4.1. Determination of Classical Domain and Joint Domain

(1) Classical domain. Suppose that the satisfaction evaluation model has m evaluation indicators and is divided into n evaluation grades. The classical-domain matter element of satisfaction evaluation determined by the j-th evaluation grade can be expressed as

$$H_j = (S_j, F_i, R_{ij}) = \begin{bmatrix} S_j & F_1 & R_{1j} \\ & F_2 & R_{2j} \\ & \vdots & \vdots \\ & F_m & R_{mj} \end{bmatrix} = \begin{bmatrix} S_j & F_1 & (a_{1j}, b_{1j}) \\ & F_2 & (a_{2j}, b_{2j}) \\ & \vdots & \vdots \\ & F_m & (a_{mj}, b_{mj}) \end{bmatrix} \tag{8}$$

where H_j is the classical-domain matter element; S_j is the j-th evaluation grade; $j = 1, 2, \cdots, n$; F_i is the i-th evaluation indicator; $i = 1, 2, \cdots, m$; R_{ij} is the measure value range of the i-th evaluation indicator concerning the j-th evaluation grade; a_{ij} is the lower limit of the value range; b_{ij} is the upper limit of the value range; and $R_{ij} = (a_{ij}, b_{ij})$.

(2) Joint domain. Based on the overall evaluation grades and measure value ranges, the joint-domain matter element of the satisfaction evaluation can be expressed as

$$H_p = (S_p, F_i, R_{ip}) = \begin{bmatrix} S_p & F_1 & R_{1p} \\ & F_2 & R_{2p} \\ & \vdots & \vdots \\ & F_m & R_{mp} \end{bmatrix} = \begin{bmatrix} S_p & F_1 & (a_{1p}, b_{1p}) \\ & F_2 & (a_{2p}, b_{2p}) \\ & \vdots & \vdots \\ & F_m & (a_{mp}, b_{mp}) \end{bmatrix} \quad (9)$$

where H_p is the joint-domain matter element; S_p is the overall evaluation grade; F_i is the i-th evaluation indicator, $i = 1, 2, \cdots, m$; R_{ip} is the measure value range of the i-th evaluation indicator for the overall evaluation grade; a_{ip} is the lower limit of the value range; b_{ip} is the upper limit of the value range; and $R_{ip} = (a_{ip}, b_{ip})$.

3.4.2. Determination of the Matter Element to Be Evaluated

The matter element composed of the basic information of the object to be evaluated is called the matter element to be evaluated and can be expressed as

$$H_o = (S_o, F_i, R_{io}) = \begin{bmatrix} S_o & F_1 & R_{1o} \\ & F_2 & R_{2o} \\ & \vdots & \vdots \\ & F_m & R_{mo} \end{bmatrix} \quad (10)$$

where H_o is the matter element to be evaluated; S_o is the evaluation grade of the object to be evaluated; F_i is the i-th evaluation indicator of the object to be evaluated, $i = 1, 2, \cdots, m$; and R_{io} is the actual measured value of the i-th evaluation indicator of the object to be evaluated.

3.4.3. Establishment of the Correlation Function and Calculation of Correlation Degree

The correlation function of the i-th evaluation indicator concerning the j-th evaluation grade is defined as follows [44]:

$$K_j(V_{io}) = \begin{cases} -\frac{\rho(R_{io}, R_{ij})}{|R_{ij}|} & R_{io} \in R_{ij} \\ \frac{\rho(R_{io}, R_{ij})}{\rho(R_{io}, R_{ip}) - \rho(R_{io}, R_{ij})} & R_{io} \notin R_{ij} \end{cases} \quad (11)$$

$$\rho(R_{io}, R_{ij}) = \left| R_{io} - \frac{a_{ij} + b_{ij}}{2} \right| - \frac{b_{ij} - a_{ij}}{2} \quad (12)$$

$$\rho(R_{io}, R_{ip}) = \left| R_{io} - \frac{a_{ip} + b_{ip}}{2} \right| - \frac{b_{ip} - a_{ip}}{2} \quad (13)$$

where $\rho(R_{io}, R_{ij})$ is the distance between R_{io} and R_{ij} and $\rho(R_{io}, R_{ip})$ is the distance between R_{io} and R_{ip}.

3.4.4. Determination of Evaluation Grades

Using the indicator weight and correlation degree obtained above, the correlation degree K_j between the evaluation indicator and the object to be evaluated (overall objective) concerning the j-th evaluation grade can be calculated as follows [45]:

$$K_j = \sum_{i=1}^{m} w_i \times K_j(V_{io}) \quad (14)$$

where w_i is the weight of the i-th indicator. Then, the following calculation was performed:

$$K_j' = \max_{1 \le j \le n} K_j \quad (15)$$

According to the principle of maximum affiliation, the evaluation grade of each evaluation indicator and the object to be evaluated (overall objective) belongs to grade

j'. To more accurately reflect the evaluation grade, the more accurate affiliation grade is obtained by calculating the grade variable eigenvalue. The expressions are as follows:

$$\overline{K_j} = \frac{K_j - \min K_j}{\max K_j - \min K_j} \tag{16}$$

$$j^* = \frac{\sum_{j=1}^{m} j \times \overline{K_j}}{\sum_{j=1}^{m} \overline{K_j}} \tag{17}$$

where j^* is grade variable eigenvalue of the object to be evaluated.

4. Case Study

4.1. Project Introduction

To verify the effectiveness and feasibility of the model, this study used two air defense cooling centers in Xi'an as examples to conduct an empirical analysis of the established satisfaction evaluation model. The two air defense cooling centers, herein abbreviated as the YT project and the BL project, are located near Yanta West Road in Xi'an and near Anton Street in Xi'an, respectively. Both air defense cooling centers are open annually from mid-June to mid-September. Presently, they have become ideal and popular places for residents to enjoy a cool environment and relaxation. The scenes of these two air defense cooling centers are shown in Figures 3 and 4.



(**a**) Exterior scene



(**b**) Interior scene

Figure 3. Scene of the YT project.



(**a**) Exterior scene



(**b**) Interior scene

Figure 4. Scene of the BL project.

4.2. Evaluation Process

Owing to space limitations, only the YT project was used as an example to introduce the evaluation process in detail. It included the following calculation steps:

(1) Determining classical domain and joint domain.

According to the evaluation grading standards of each indicator, the classical domain was determined using Equations (18)–(21), and the joint domain was determined using Equation (22):

$$H_1 = \begin{bmatrix} S_1 & A_1 & [0, 6.0) \\ & A_2 & [0, 6.0) \\ & \vdots & \vdots \\ & E_6 & [0, 6.0) \end{bmatrix} \tag{18}$$

$$H_2 = \begin{bmatrix} S_2 & A_1 & [6.0, 7.5) \\ & A_2 & [6.0, 7.5) \\ & \vdots & \vdots \\ & E_6 & [6.0, 7.5) \end{bmatrix} \tag{19}$$

$$H_3 = \begin{bmatrix} S_3 & A_1 & [7.5, 9.0) \\ & A_2 & [7.5, 9.0) \\ & \vdots & \vdots \\ & E_6 & [7.5, 9.0) \end{bmatrix} \tag{20}$$

$$H_4 = \begin{bmatrix} S_4 & A_1 & [9.0, 10.0] \\ & A_2 & [9.0, 10.0] \\ & \vdots & \vdots \\ & E_6 & [9.0, 10.0] \end{bmatrix} \tag{21}$$

$$H_p = \begin{bmatrix} S_p & A_1 & [0, 10.0] \\ & A_2 & [0, 10.0] \\ & \vdots & \vdots \\ & E_6 & [0, 10.0] \end{bmatrix} \tag{22}$$

(2) Determining the relevant basic data for the evaluation model.

First, 60 related personnel (including 10 experts and 50 citizens) were invited to score the evaluation indicators according to the grading standards listed in Table 2. Among them, the 10 experts include those engaged in the design, construction, operation and scientific research in the field of old building renovation. In addition, the data of 50 citizens were obtained through the form of questionnaires. Questionnaires were distributed to the citizens who took a rest in the air defense cooling centers, and then 50 valid questionnaires were recovered.

Then, the final indicator values were obtained by eliminating the highest and lowest scores and calculating the average value, as shown in Table 2. Second, the indicator weights were calculated using the combined weighting method, as shown in Table 3.

Table 3. Basic data and calculation results of the YT project.

First-Level Indicator		Second-Level Indicator		Value	Correlation Degree			
Code	**Weight**	**Code**	**Weight**		**I**	**II**	**III**	**IV**
A	0.089	A1	0.381	7.02	−0.255	0.068	−0.139	−0.399
		A2	0.254	7.11	−0.278	0.055	−0.119	−0.395
		A3	0.365	8.13	−0.533	−0.252	0.077	−0.318

Table 3. *Cont.*

First-Level Indicator		Second-Level Indicator		Value	Correlation Degree			
Code	Weight	Code	Weight		I	II	III	IV
B	0.245	B1	0.302	9.35	−0.838	−0.740	−0.350	0.037
		B2	0.151	8.68	−0.670	−0.472	0.037	−0.195
		B3	0.124	8.83	−0.708	−0.532	0.019	−0.127
		B4	0.108	9.19	−0.798	−0.676	−0.190	0.021
		B5	0.112	8.54	−0.635	−0.416	0.054	−0.240
		B6	0.203	8.67	−0.668	−0.468	0.038	−0.199
C	0.287	C1	0.218	7.83	−0.458	−0.132	0.042	−0.350
		C2	0.235	7.46	−0.365	0.005	−0.016	−0.377
		C3	0.197	7.38	−0.345	0.016	−0.044	−0.382
		C4	0.183	7.85	−0.463	−0.140	0.045	−0.348
		C5	0.167	8.64	−0.660	−0.456	0.042	−0.209
D	0.211	D1	0.139	7.95	−0.488	−0.180	0.057	−0.339
		D2	0.127	8.11	−0.528	−0.244	0.075	−0.320
		D3	0.153	7.87	−0.468	−0.148	0.047	−0.347
		D4	0.164	9.26	−0.815	−0.704	−0.260	0.028
		D5	0.162	7.31	−0.328	0.026	−0.066	−0.386
		D6	0.117	7.14	−0.285	0.050	−0.112	−0.394
		D7	0.138	7.65	−0.413	−0.060	0.020	−0.365
E	0.168	E1	0.176	7.92	−0.480	−0.168	0.053	−0.342
		E2	0.168	8.17	−0.543	−0.268	0.082	−0.312
		E3	0.147	7.55	−0.388	−0.020	0.007	−0.372
		E4	0.135	7.24	−0.310	0.036	−0.086	−0.389
		E5	0.131	7.15	−0.288	0.049	−0.109	−0.394
		E6	0.243	8.86	−0.715	−0.544	0.016	−0.109

(3) Calculating the correlation degree and determining evaluation grades.

Based on the above basic data, the correlation degree of each second-level evaluation indicator concerning the four evaluation grades was calculated according to Equations (11)–(13), as shown in Table 3. Then, based on the weights and correlation degree of the second-level evaluation indicators, the correlation degree of each first-level evaluation indicator and the overall target of the four evaluation grades were calculated according to Equation (14), as shown in Table 4. Accordingly, based on the correlation degree results, the evaluation grades were calculated according to Equation (15), as shown in Table 4.

Table 4. Evaluation results of YT project.

Type	Correlation Degree				Evaluation Grade
	I	II	III	VI	
Location condition	−0.362	−0.052	−0.055	−0.368	2
Spatial status	−0.735	−0.575	−0.105	−0.099	4
Physical environment	−0.448	−0.126	0.012	−0.339	3
Service management	−0.483	−0.192	−0.039	−0.295	3
Emotional experience	−0.486	−0.198	0.002	−0.298	3
Overall evaluation	−0.524	−0.256	−0.035	−0.267	3

4.3. Results and Discussion

Table 4 presents the satisfaction evaluation results for the YT project. The overall satisfaction evaluation was Grade III, and the satisfaction evaluation grades for the five first-level indicators were as follows: location condition—Grade II, spatial status—Grade VI, physical environment—Grade III, service management—Grade III, and emotional experience—Grade III. The results showed that the overall satisfaction of the YT project

from the perspective of public experience after the renovation of the air-raid shelter into a cooling place was good, satisfying the basic needs of the public and achieving a largely satisfactory result. It can be seen from the satisfaction evaluation results of the five first-level indicators that the spatial status was excellent because the project has just been put into use this year and is in a brand-new state; the location condition was moderate, mainly determined by the geographical location of the project; the physical environment, service management, and emotional experience were good, but there is room for improvement. It can be enhanced and optimized according to the specific situation to obtain a more satisfactory public experience.

Moreover, this study also evaluated the satisfaction of the BL project. The overall satisfaction evaluation grade was Grade II, and the satisfaction evaluation grades for the five first-level indicators were as follows: location—Grade III, spatial status—Grade II, physical environment—Grade II, service management—Grade II, and emotional experience—Grade II. The results showed that the overall satisfaction of the BL project from the perspective of public experience after the renovation of the air-raid shelter into a cooling place was moderate and requires more in-depth, multifaceted, targeted adjustments and adaptation optimizations.

Finally, after obtaining the satisfaction evaluation grades of the two projects, the site conditions of the project were analyzed and compared with the evaluation results of the model. It was found that the evaluation results matched the site conditions, indicating that the evaluation results were reasonable and accurate. The evaluation results can provide a basis for the optimization and improvement of air defense cooling centers and promote the construction and development of a resilient and livable city. In general, the evaluation model created in this study can be used to judge the overall satisfaction status of the project and the satisfaction status of five first-level indicators. In reality, relevant managers can undertake corresponding improvement strategies according to the satisfaction of the five aspects, so as to achieve the purpose of improving the satisfaction of each aspect and the overall satisfaction.

5. Conclusions

The renovation of civil air defense engineering into cooling place is a positive exploration of the reuse of underground civil air defense engineering during periods of peace. By giving full play to the advantages of civil air defense engineering, it is possible to add a strong color to urban renewal and sustainable development, which can also offer highly beneficial life experiences to the public. It is important to conduct the satisfaction evaluation of civil air defense engineering renovated into cooling place from the perspective of public experience. The main conclusions drawn from this study are as follows:

(1) Constructing the satisfaction evaluation indicator system. Through literature analysis and related project field research, focusing on five aspects—location condition, spatial status, physical environment, service management, and emotional experience—a satisfaction evaluation indicator system for civil air defense engineering renovated into cooling place from the perspective of public experience was constructed.
(2) Establishing the satisfaction evaluation model. By introducing the matter-element extension and combined weighting methods, a satisfaction evaluation model for civil air defense engineering renovated into cooling place from the perspective of public experience was established.
(3) Verifying the rationality of the indicator system and feasibility of the model. The evaluation model was applied to two actual projects, and analysis showed that the results of the evaluation model were reliable and could accurately reflect the actual situation of the project.

In conclusion, this research clarifies the public satisfaction and real-world effect of civil air defense engineering renovated into cooling place, which can provide a basis for in-depth enhancement and optimization; serve as a reference for urban management and healthy development; and aid in the development of new ideas or methods for the

satisfaction evaluation of similar old buildings (structures) after renovation. Specific improvement and optimization suggestions on various aspects will be the direction and goal of further research.

Author Contributions: W.L.: Conceptualization, Methodology, Data curation, Writing—original draft preparation, Writing—review and editing. Q.L.: Conceptualization, Writing—review and editing. Y.L.: Methodology, Investigation. L.J.: Investigation, Data curation. X.P.: Investigation, Project administration. J.C.: Investigation. All authors have read and agreed to the published version of the manuscript.

Funding: This research was supported by the Project of Beijing Social Science Foundation (Grant No. 18YTC020), the Project of Beijing Municipal Educational Science "13th Five-Year Plan" (Grant No. CDDB19167), the Project of China Association of Construction Education (Grant No. 2019061), the subject of Beijing Association of Higher Education (Grant No. MS2022276), and the Scientific Research Cultivation project of BUCEA (Grant No. X24003).

Data Availability Statement: All data generated or analyzed during this study are included in the manuscript.

Conflicts of Interest: Author Xingwang Pei was employed by the company Zhongtian Northwest Construction Investment Group Co., Ltd. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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