Optimization Evaluation of Public Environmental Facilities at Zaoyuan Historical Landmark

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Abstract: The Zaoyuan Historical Landmark, as a witness to history, carries profound cultural and historical significance. It is not only a historical relic but also a national treasure, representing a spirit and belief. However, over time, the public environmental facilities at the Zaoyuan Historical Landmark have gradually revealed various issues that require optimization and renewal. This article aims to explore the current state of public environmental facility services at the Zaoyuan Historical Landmark, analyze optimization strategies using factor analysis, and propose corresponding improvement strategies and suggestions. The goal is to enhance the visitor experience and better protect and pass on these precious historical and cultural heritages.

Keywords: Public Environmental Facilities; Zaoyuan Historical Landmark; Factor analysis; Optimization evaluation

1. Introduction

The Zaoyuan Historical Landmark is classified as an important modern historical site and representative building among cultural heritage protection units. In 2023, the National Cultural Heritage Administration issued the "Guidelines for the Display of Historical Sites (2023)," [1] which states that the construction of public facilities at revolutionary sites should be accurate, standardized, and comply with national standards. These facilities should meet environmental, economic, aesthetic, and durability requirements, and should complement the revolutionary site. In Europe, "Street Furniture," known as "urban public facilities" or "street furniture" in China, aims to serve the general public in public spaces. In recent years, with the rise of red tourism, the Zaoyuan Historical Landmark, [2] as an important venue for red culture, offers visitors a unique tourism experience. However, with the increase in visitors, the public environmental facilities at the Zaoyuan site have gradually exposed issues such as a lack of overall planning and insufficient integration of red culture and interactivity. Therefore, optimizing the public environmental facilities at the Zaoyuan Historical Landmark has become an urgent issue. This article uses factor analysis to analyze and summarize the public environmental facilities at the Zaoyuan Historical Landmark, providing a set of methods to solve current problems and offering a reference for optimizing public environmental facilities at revolutionary sites. Given the current situation, we should optimize the design of public environmental facilities at the Zaoyuan Historical Landmark according to the season, meeting the unique needs of red tourism while effectively passing on and promoting red culture.

2. Current Status and Evaluation of Public Environmental Facilities at Zaoyuan Historical Landmark

2.1 Current Status of Public Environmental Facilities at Zaoyuan Historical Landmark

The design of public facilities at the Zaoyuan Historical Landmark covers five aspects: landscape facilities, service facilities, sanitary facilities, lighting facilities, and transportation facilities. Public landscape facilities play a key guiding role in the site's environment. Their design should extract color and shape elements from the site's architecture, primarily using metal materials to enhance durability and coordinate with the historical and cultural atmosphere [3]. Public service facilities, such as seating, are not only functional but also cultural carriers. Their design should reflect simplicity and solemnity, using materials like wood, stone, or concrete to further convey the weight of revolutionary history along with the

natural environment and architecture. Public sanitary facilities, such as trash bins, are functional but monotonous in design. They can be enhanced by incorporating elements of Zaoyuan culture to improve visual appeal and cultural expression. Public lighting facilities are limited in number and lack distinctive features of the site. While durable, they do not resonate with the historical atmosphere. Future designs could integrate elements from the revolutionary era to strengthen cultural expression. Public transportation facilities, such as bus shelters, are simple in function and lack cultural characteristics and modern technological support. Their design is ordinary and fails to showcase the spirit of Zaoyuan (*e.g.*, Figure 1. Trash Bin of Zaoyuan).

Figure 1. Trash Bin of Zaoyuan
(Source Own Photography)

2.2 Evaluation of Public Environmental Facilities at Zaoyuan Historical Landmark

(1) Lack of Overall Planning for Public Environmental Facilities

The design of public environmental facilities at the Zaoyuan Historical Landmark lacks overall and systematic planning, making it difficult to meet the diverse needs of visitors. Although facilities such as trash bins, streetlights, signage, and public seating serve their basic functions [4], their styles, colors, and shapes do not deeply align with the historical and cultural connotations of the site, resulting in a lack of visual coherence and distinctiveness. For example, trash bins and streetlights adopt standardized industrial designs, lacking revolutionary cultural elements; signage does not harmonize with the architectural style in form and color; and public seating is rigid in design, neither comfortable nor reflective of the cultural atmosphere. Future designs should focus on overall planning, deeply integrating culture and environment to make public facilities an extension of revolutionary history, enhancing the visitor experience and cultural perception.

(2) Lack of Culture in Public Environmental Facilities

The design of public environmental facilities at the Zaoyuan Historical Landmark insufficiently incorporates historical and cultural elements, tending towards modernization and simplicity without closely integrating with the revolutionary historical background and cultural atmosphere. Signage lacks thematic elements or iconic symbols, focusing more on functional design and lacking situational expression, failing to showcase the unique spirit of the historical site.

(3) Lack of Interactivity in Public Environmental Facility Design

The current design of public environmental facilities at the Zaoyuan Historical Landmark lacks interactivity and appeal, failing to fully engage visitors' interest and participation [5]. Future designs should consider visitor behavior habits, incorporating interactive screens, touch query devices, and dynamic display technologies. Gamified designs of revolutionary stories can combine fun and education, enhancing the experience and engagement. Additionally, facility design should balance functionality and spatial rationality, avoiding interference with core functions or visiting order. For example, multimedia interactive devices could be set up in walkways or open areas to innovatively recreate historical scenes. Future designs should consider incorporating interactive screens and gamified designs of historical narratives, combining fun and education.

3. Verification and Results of Factors Affecting Public Environmental Facilities at Zaoyuan Historical Landmark

3.1 Summary of Influencing Factors

This article summarizes 25 influencing factors for the design of public facilities at the Zaoyuan Historical Landmark and compiles them into a detailed survey questionnaire. The questionnaire uses a quantitative scoring method to evaluate and screen each factor, allowing for a more accurate understanding of the needs and expectations of visitors and residents regarding various aspects of public environmental facilities

(*e.g.*, Table 1 Influencing Factors for Public Environmental Facilities at Zaoyuan Historical Landmark).

Table 1. Influencing Factors for Public Environmental Facilities at Zaoyuan Historical Landmark

(Source: Author's creation)

No.	Factor	Factor Explanation
1	Regional Culture	Regional Culture - Yan'an's Unique Culture
2	Historical Heritage	Historical Heritage - Historical Spirit Inheritance
3	Emotional Resonance	Emotional Resonance - Historical Sentiment Resonance
4	Story Association	Story Association - Historical Story Reminiscence
5	Material Culture	Material Culture - Tangible Cultural Heritage
6	Intangible Culture	Intangible Culture - Spiritual Cultural Heritage
7	Functional Use	Functional Use - Basic Usage Needs
8	Ancillary Functions	Ancillary Functions - Educational Display, Cultural Creativity
9	Interactive Functions	Interactive Functions - Space Sharing and Interaction
10	Guidance Functions	Guidance Functions - Signage and Direction
11	Landscape Environment	Landscape Environment - Natural and Cultural Environment
12	Design Style	Design Style - Harmonizing with the Overall Style of Historical Sites
13	Design Symbols	Design Symbols - Elements Reflecting Historical Spirit and Historical Symbols
14	Design Consistency	Design Consistency - Maintaining Uniformity
15	Design Decoration	Design Decoration - Edge, Texture Carving
16	Color Diversity	Color Diversity - Diverse and Solemn Color Usage
17	Color Typicality	Color Typicality - Red, Gray, Earth Yellow
18	Color Atmosphere	Color Atmosphere - Conveying the Seriousness of Historical History
19	Color Harmony	Color Harmony - Maintaining Visual Harmony
20	Color Timeliness	Color Timeliness - Reflecting Historical and Contemporary Characteristics
21	Material Diversity	Material Diversity - Stone, Wood, Metal
22	Material Safety	Material Safety - Non-toxic, Eco-friendly Materials
23	Material Expression	Material Expression - Texture, Hardness
24	Material Durability	Material Durability - Withstanding Long-term Use
25	Material Culturality	Material Culturality - Materials Reflecting the Cultural Characteristics of the Site

3.2 Data Sources

To study the key factors affecting the optimization of public environmental facilities at the Zaoyuan Historical Landmark, a survey questionnaire was designed to collect relevant data. The core content of the questionnaire is the 25 identified influencing factors, and respondents are required to rate the impact of each factor on a scale of 1 to 5, with higher scores indicating a more significant impact on the optimization of public environmental facilities at the Zaoyuan Historical Landmark**.** The questionnaire was distributed both on-site and online. The survey targeted local residents and visitors to the Zaoyuan Historical Landmark, with a total of 380 questionnaires distributed and 357 valid responses collected, yielding an effective rate of 93.94%. The questionnaire content was designed based on the 25 influencing factors identified earlier, ensuring the survey's relevance and scientific rigor.

The entire questionnaire survey was conducted over a continuous period, with equal distribution between weekdays and weekends, ensuring the randomness and representativeness of the data sample. The results of the questionnaire distribution are shown in Figure (*e.g.*, Figure 2. Gender statistics，Figure 3. Age statistics，Figure 4. Educational background statistics).

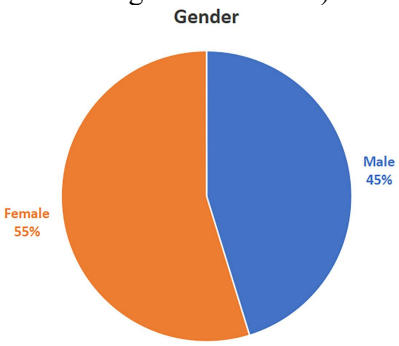

Figure 2. Gender Statistics.

(Source: Author's creation)

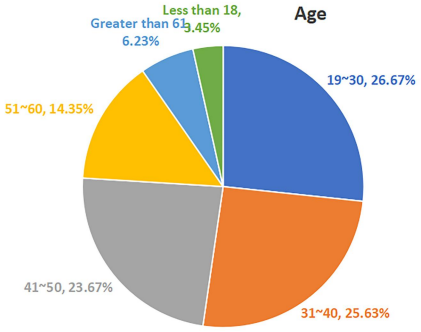

Figure 3. Age Statistics.

(Source: Author's creation)

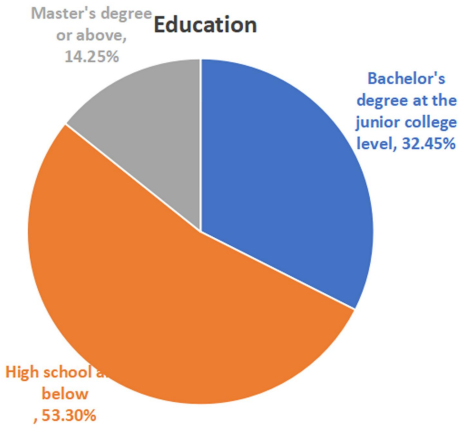

Figure 4. Educational Background Statistics.
(Source: Author's creation)

3.3 Reliability and Validity Analysis

(1) Reliability Analysis:

Generally, a Cronbach's alpha coefficient between 0.7 and 0.8 indicates good reliability; between 0.8 and 0.9 indicates very good reliability; and above 0.9 indicates excellent reliability. If the Cronbach's alpha coefficient is below 0.7, the data's reliability is poor, and the scale needs to be revised. After importing the survey data into IBM SPSS Statistics 27 and running the analysis, the reliability analysis results for multiple variables are shown in Table 2. The analysis tool calculated the Cronbach's alpha coefficient for the survey questionnaire, which was 0.898, indicating that the survey results are reliable and have good internal consistency (*e.g.*, Table 2 Reliability Test).

Table 2 Reliability Test
(Source: Author's creation)

Cronbach's Alpha	Number of Items	Sample Size
0.898	25	357

(2) Validity Analysis:

This study uses the KMO value and Bartlett's sphericity test to analyze the validity of the questionnaire scale. The KMO value ranges from 0 to 1, with higher values indicating that the data is more suitable for factor analysis. According to the standard, a KMO value greater than 0.9 indicates that the data is very suitable; between 0.8 and 0.9 indicates suitability; between 0.7 and 0.8 indicates moderate suitability; between 0.6 and 0.7 indicates marginal suitability; between 0.5 and 0.6 indicates barely suitable; and below 0.5 indicates unsuitability for factor analysis.

This study used SPSS 25.0 software for validity testing. The results showed a KMO value of 0.875, falling within the "very suitable" range. Bartlett's sphericity test yielded an approximate chi-square value of 2551.638, with 120 degrees of freedom and a p-value of 0.000, indicating a significance level of less than 0.05, suggesting the presence of common factors in the correlation matrix. Based on these two test results, the data in this study is confirmed to be suitable for factor analysis (*e.g.*, Table 3 Validity Test).

Table 3. Validity Test
(Source: Author's creation)

KMO Value	0.875	
Bartlett's Sphericity Test	Approximate Chi-Square	2551.638
Degrees of Freedom	120	
p-value	0.000	

3.4 Factor Commonality Monitoring

Commonality can be used to test the impact of each influencing factor. The higher the commonality, the greater the dependency of the influencing factor on the common factor, and the more effective the common factor is in explaining the influencing factor [6]. Generally, when the commonality is greater than 0.5, the common factor can effectively explain the influencing factor. Based on the commonality analysis results, nine factors that did not meet the criteria were excluded: emotional resonance, story association, interactive functions, environmental landscape, design consistency, color diversity, color typicality, material expression, and material culture. The remaining 16 factors in the questionnaire all have commonalities above 0.5 and can be used for subsequent factor analysis (*e.g.*, Table 4 Commonality Test (After Exclusion).

Table 4. Commonality Test (After Exclusion)
(Source: Author's creation)

Name	Commonality (Common Factor Variance)
Regional Culture	0.725
Historical Heritage	0.676
Material Culture	0.704
Intangible Culture	0.716
Functional Use	0.761
Ancillary Functions	0.715
Guiding Functions	0.717
Design Style	0.758
Design Symbols	0.735
Design Decoration	0.780
Color Typicality	0.740
Color Atmosphere	0.746
Color Consistency	0.725
Material Diversity	0.749
Material Safety	0.617
Material Durability	0.700

3.5 Factor Analysis

Based on the principle of eigenvalues greater than or equal to 1, the first five common factors were extracted. According to the table,

the cumulative variance explained by the first five common factors is 72.294%, meaning that these five factors explain 72.294% of the information from the original 16 factors, achieving an ideal level of explanatory power (*e.g.*, Table 5 Variance Explanation Rate Table).

Table 5. Variance Explanation Rate Table

(Source: Author's creation)

Factor No	Characteristic root			Rotational front difference interpretation rate			Rate of interpretation of variance after rotation		
	Eigenvalue	Variance explanation rate %	Accumulate %	Characteristic root	Variance Explanation Rate %	Accumulate %	Characteristic root	Variance explanation rate %	Accumulate%
1	6.01	37.565	37.565	6.01	37.565	37.565	2.859	17.867	17.867
2	1.749	10.93	48.495	1.749	10.93	48.495	2.291	14.318	32.185
3	1.422	8.890	57.385	1.422	8.89	57.385	2.209	13.808	45.993
4	1.285	8.029	65.414	1.285	8.029	65.414	2.205	13.782	59.776
5	1.101	6.880	72.294	1.101	6.88	72.294	2.003	12.518	72.294
6	0.638	3.987	76.281	-	-	-	-	-	-
7	0.488	3.049	79.33	-	-	-	-	-	-
8	0.467	2.922	82.252	-	-	-	-	-	-
9	0.449	2.806	85.058	-	-	-	-	-	-
10	0.41	2.565	87.623	-	-	-	-	-	-
11	0.389	2.433	90.057	-	-	-	-	-	-
12	0.364	2.277	92.334	-	-	-	-	-	-
13	0.344	2.151	94.485	-	-	-	-	-	-
14	0.321	2.005	96.489	-	-	-	-	-	-
15	0.307	1.919	98.409	-	-	-	-	-	-
16	0.255	1.591	100	-	-	-	-	-	-

3.6 Factor Analysis Results

The data analysis revealed the impact of 16 factors on the design of public environmental facilities at the Zaoyuan Historical Landmark, categorizing them into five aspects: cultural elements, functional elements, design elements, color elements, and material elements. In the first common factor, the four factors with factor loadings above 0.778 are regional culture, historical heritage, material culture, and intangible culture, with "regional culture" having the highest value (0.812), reflecting design elements at the cultural level, named cultural elements. In the second common factor, the three factors with factor loadings above 0.798 are functional use, ancillary functions, and guiding functions, with "functional use" having the highest value (0.822), reflecting design elements at the functional level, named functional elements. In the third common factor, the three factors with factor loadings above 0.802 are design style, design symbols, and design decoration, with "detail treatment" having the highest value (0.835), reflecting design elements at the design level, named design elements. In the fourth common factor, the three factors with factor loadings above 0.794 are color typicality, color atmosphere, and color consistency, with "color representation" having the highest value (0.821), reflecting design elements at the color level, named color elements. In the fifth common factor, the three factors with factor loadings above 0.743 are material diversity, material safety, and material durability, with "material selection" having the highest value (0.767), reflecting design elements at the material level, named material elements (*e.g.*, Table 6 Rotated Factor Loadings)

Table 6. Rotated Factor Loadings

(Source: Author's creation)

Factor Group	Evaluation Item	Factor Loading				
ICultural Elements	Regional Culture	0.812	0.059	0.111	0.212	0.064
	Historical Heritage	0.778	0.148	0.138	0.117	0.129
	Material Culture	0.798	0.146	0.070	0.114	0.167
	Intangible Culture	0.802	0.091	0.121	0.117	0.192
IIFunctional Elements	Functional Use	0.155	0.143	0.140	0.822	0.146
	Ancillary Functions	0.173	0.132	0.110	0.801	0.121
	Guiding Functions	0.164	0.105	0.182	0.798	0.097
IIIDesign Elements	Design Style	0.218	0.815	0.164	0.129	0.051
	Design Symbols	0.091	0.802	0.152	0.157	0.189
	Design Decoration	0.094	0.835	0.152	0.106	0.201
IVColor Elements	Color Typicality	0.179	0.164	0.794	0.127	0.186
	Color Atmosphere	0.100	0.144	0.821	0.141	0.147
	Color Consistency	0.119	0.160	0.795	0.175	0.153
VMaterial Elements	Material Diversity	0.212	0.247	0.184	0.144	0.767
	Material Safety	0.086	0.038	0.141	0.127	0.757
	Material Durability	0.245	0.216	0.174	0.104	0.743

4. Optimization Strategies

4.1 Integrating History and Culture

Yan'an, as a revolutionary holy site, has a revolutionary culture that intertwines with regional culture, forming a unique cultural system that enriches historical connotations [7]. Material culture, through buildings (such as the site and leaders' former residences) and artifacts (such as documents and office furniture), vividly recreates historical scenes of revolutionary struggles, carrying important historical memories and spirit.

4.2 Improving Facility Functions

To optimize the public environmental facilities at the Zaoyuan Historical Landmark, functionality and service levels can be enhanced in various ways. By reasonably arranging seating and trash bins, strengthening the environmental performance of waste disposal facilities, and ensuring that the design is consistent with the scenic area's style; upgrading the visitor service center, adding services such as souvenir sales, item storage, and emergency medical care, and introducing digital facilities like QR codes or NFC to enrich the visitor experience; improving the signage system, designing flexible crowd control plans, and adding regional maps at key nodes to ensure smooth and clear visitor flow; integrating revolutionary symbols and classic quotes into facility designs, using interactive devices and audio guides to showcase revolutionary history and figures, enhancing educational functions; and selecting environmentally friendly and durable materials to ensure that the facility style harmonizes with the site's environment, reflecting green and sustainable development concepts [8].

4.3 Shaping Classic Designs

In the design of public facilities at the Zaoyuan Historical Landmark, historical architectural elements should be fully extracted, combining the characteristics of cave dwellings, traditional window structures, and pavilion roof designs to highlight regional and historical cultural traits [9]. Symbolic elements, such as the flowing lines of water features and red ribbons, can be cleverly integrated into facility designs to reflect revolutionary spirit and cultural depth. At the same time, innovative designs that combine traditional elements with modern facilities can create public environments with both local characteristics and cultural depth, enhancing visitors' cultural experience and historical emotional connection.

4.4 Highlight Cultural Colors

In the design of public environmental facilities at the Zaoyuan Historical Landmark, cultural elements should be extracted, drawing representative colors such as red and yellow from the Five-Starred Red Flag, the Central Military Commission's former site, and the statues of the Five Great Secretaries, combined with deep gray and brown to showcase the historical weight of revolutionary struggles [10].

4.5 Selecting Facility Materials

In the design of public environmental facilities at the Zaoyuan Historical Landmark, diverse materials should be fully utilized, combining metal and wood for walkway railings and trash bins, transparent materials and stainless steel for information displays, and anti-corrosion wood or stone for seating, balancing concealment and aesthetics. Environmentally friendly and harmless materials, such as anti-corrosion wood and anti-slip metal, should be selected, and facility edges should be optimized, especially using anti-slip materials for walkway railings and steps to ensure visitor safety. To enhance durability, corrosion-resistant stainless steel, synthetic wood, and high-strength stone should be used, with anti-pollution coatings added to surfaces to extend facility life and reduce maintenance costs. At the same time, traditional materials such as red bricks and imitation stone can be used in pavilions, railings, and seating to showcase the material characteristics of the revolutionary period, enhancing cultural expression and historical weight, making the facilities both practical and durable, and rich in cultural connotation.

5. Conclusion

With the promotion of national policies and the increasing emphasis on historical culture, the protection and development of the Zaoyuan Historical Landmark have received more attention. The optimization of public environmental facilities not only enhances the

visitor experience but also better passes onhistorical historical culture. In future research on public environmental facilities at the Zaoyuan Historical Landmark, on one hand, more quantitative and qualitative analysis methods can be combined to further improve design plans, enhance the functionality and cultural aspects of facilities, and ensure the organic integration of historical spirit and modern design. On the other hand, the research results of this article can also be applied to the design of public facilities at other historical cultural sites historical landmarks, promoting the cultural inheritance and visitor experience enhancement of more. By continuously optimizing the public environmental facilities at the Zaoyuan Historical Landmark, we can not only better protect and utilize this but also promote the dissemination and inheritance of historical culture, providing visitors with a richer cultural experience and further leveraging the important role of historical landmarks in social education and cultural inheritance.

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