

The Strategy for Optimizing the Living Environment of Xi 'an Xingqing Palace Park - Based on Vegetation Landscape and Cultural Facility Construction

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Abstract. As a Tang Dynasty imperial palace garden site, Xi'an Xingqing Palace Park possesses both profound historical and cultural significance while serving as a vital urban leisure and cultural tourism destination. This study examines the park's historical context and architectural features, followed by an evaluation of its current environmental conditions. Key issues identified include excessive vegetation density, insufficient natural lighting in shaded pathways, limited recreational facilities, and monotonous cultural exhibition formats. To address these challenges, the following improvement measures are proposed: First, adjusting tree heights and shrub density to enhance openness and lighting conditions; Second, adding benches, sun umbrellas, and leisure light poles to improve visitor comfort; Third, installing signage related to the Westward Migration Spirit to enrich cultural heritage; Fourth, strengthening cultural infrastructure development to enhance cultural ambiance. The research concludes that these measures will not only improve living environment quality but also facilitate the integration of cultural relics with modern lifestyles, providing valuable references for the development of other historical heritage parks.

Keywords: Xi'an Xingqing Palace Park, human settlement environment optimization, vegetation landscape, leisure facilities, spirit of westward migration

1. Introduction

Against the backdrop of rapid urbanization, heritage parks play a complex role in ecological conservation, cultural inheritance and public services. Xi 'an Xingqing Palace Park not only carries the historical memory of the ruins of the imperial gardens of the prosperous Tang Dynasty, but also serves as an important space for citizens' daily recreation and cultural experience. Existing studies have shown that after the renovation of parks, the public generally recognizes their ecological and cultural value, but their evaluation of the convenience and comfort of facilities remains relatively weak, suggesting that continuous optimization is needed in terms of service facilities and spatial quality [1]. Meanwhile, empirical analysis of the plant layer in Xingqing Palace Park indicates that structural problems such as high density of the tree layer and insufficient light under the forest still exist, directly affecting the lighting conditions and recreational experience of the tree-lined paths

[2]. Based on this, under the premise of respecting the integrity and historical features of the site, it is clearly necessary and feasible to promote the improvement of the living environment quality through the coordinated optimization of vegetation layers and the reinforcement of service facilities.

This study, based on the historical and architectural context of Xingqing Palace Park, conducts evaluations and optimization suggestions from four dimensions: vegetation landscape, lighting environment, recreational facilities, and cultural display. It improves the transparency under the forest through moderate thinning and "crown lifting" pruning, enhancing the accessibility and safety of the tree-shaded walkways. Supplement seats, sunshades and lighting facilities along the main tour routes and nodes to optimize the stopover and wayfinding experience. Under the premise of not damaging the appearance of the site, small exhibition stands and sign systems with themes such as "The Spirit of Westward Migration" are embedded to enhance the educational attribute and cultural literacy of the space. The above-mentioned goals and approaches are mutually corroborated with existing public perception research and plant structure evidence, providing a verifiable basis for the strategy selection of this paper [1,2].

2. Literature review

2.1. Relevant research

Domestic scholars have developed multi-dimensional discussions on the optimization of human settlements and urban public spaces, ranging from macro planning to micro sites. Dong Xin [3] integrated the improvement of human settlements into the overall urbanization strategy, emphasizing the coordinated development of county towns and cities as dual entities, which provides valuable insights for regional environmental governance. Tu Yanjie [4] advocates innovation in the integration of greenery forms and functions from the perspective of ecological garden architecture, aiming to enhance residents' experience.

The two jointly set the macro theoretical tone for the improvement of the living environment in site-type parks, but still focus more on policy guidance and landscape aesthetics, lacking empirical research on the coupling mechanism of micro-scale space - ecology - experience under the constraints of historical site protection. Therefore, in the future, it is urgently necessary to establish an indicator system that can be connected between macro strategies and site-scale renovations, providing an operational assessment framework for the renewal of heritage parks. In terms of the empirical research on Xingqing Palace Park, Chen Peiqiang, Wang Luhui, and Liu Linggui [1,5] investigated public satisfaction with cultural services after renovation through sentiment analysis. The findings revealed that while the public generally recognized the park's ecological and cultural value, there were still demands for improved facility accessibility and recreational comfort. Yu Xin, Tong Kailin, and Xu Yaoping [2] analyzed the structure of plant communities and demonstrated that excessive tree density in the canopy layer results in insufficient light in shaded areas, providing quantitative evidence for subsequent vegetation optimization. Guo Zhuo [2] analyzed the historical layout of Xingqing Palace through its garden design techniques, providing valuable references for preserving cultural landscapes and passing down design aesthetics.

Based on the above research, it can be seen that the existing achievements have initially revealed the key influencing factors in the renewal of heritage parks from three dimensions: tourists' subjective perception, ecological structure and garden-making techniques. However, these achievements operate independently. They have not yet integrated "plant structure - light environment - cultural experience - facility convenience" into a unified assessment model, nor do they lack a mechanism-based explanation of how each factor works together on the overall human

settlement experience. Therefore, this study needs to establish a cross-dimensional quantitative indicator and path analysis framework based on the integration of existing evidence, in order to better guide subsequent landscape optimization and cultural inheritance. In terms of public facilities and spatial carrying capacity, Chen Yuchao, Qiu Hualong, and Lin Weihua [6] developed an evaluation system for assessing the utilization of recreational facilities in forest parks, providing a systematic tool to determine the rationality of facility allocation. Xing Weiming et al. [7] found in their study on urban park carrying capacity that inadequate facilities and uneven tourist distribution could diminish residents' leisure experience and even disrupt overall environmental order. Both jointly emphasized the significance of facility quantity, layout and carrying capacity management for the public space experience, providing a fundamental reference for the optimization of seats, sunshade facilities and path nodes in Xingqing Palace Park.

However, such studies mostly focus on general urban or forest park scenarios, lacking a dedicated exploration of the relationship between facility deployment and visitor carrying capacity in heritage parks under the constraints of historical style protection. At the same time, the assessment of carrying capacity generally adopts static thresholds, which fail to reflect the dynamic pressure brought about by holidays, time period changes and behavioral aggregation. Therefore, this study will combine the red line for site protection and the time-varying characteristics of tourist flow to explore the zoned and time-segmented carrying management and facility layout optimization strategies suitable for Xingqing Palace Park.

In terms of cultural values and wayfinding interpretation, Qin Maosheng and Zhao Wenjuan [8] examine the dissemination pathways of publications centered on the 'Spirit of Westward Relocation,' highlighting their crucial role in promoting university ethos, strengthening cultural identity, and advancing social responsibility education in the new era. Yang Yaping and Nan Yajuan [9] further noted that the 'Spirit of Westward Relocation,' as a regional cultural symbol, holds unique value in enhancing public historical identity and fostering ideals and beliefs among youth. He Jinyu and Zhao Xinping [10] conducted a survey on the signage system at Xingqing Palace and other heritage parks, concluding that improving the signage system could enhance visitors' cultural literacy and enhance their touring experience. The existing achievements have laid a theoretical foundation for the cultural display and narrative creation of Xingqing Palace Park. However, they generally remain at the level of communication significance and concept interpretation, lacking empirical tests on the readability of the wayfinding system, the effect of behavioral guidance, and learning outcomes. Moreover, an evaluation framework for the integrated design of cultural narrative and spatial wayfinding has not been formed. Therefore, this study will take the "spirit of westward Migration" as the core cultural thread, and combine the behavioral paths of tourists and the interactive feedback of wayfinding to explore the strategies and evaluation indicators for the integration of cultural narrative and spatial navigation in heritage parks. Lopez et al. [10] employed mobile laser scanning (MLS) and the Barrios-4D method to conduct high-precision quantification of settlement and neighborhood spatial morphology. This approach enables detailed characterization of alley closure, sightlines, and green space distribution, offering new perspectives for structural dimension diagnosis of urban living environments. However, the methodology primarily focuses on geometric structures, lacking explanatory power regarding micro-environmental and experiential dimensions such as understory lighting, shade comfort, and signage readability. Additionally, the high instrument costs and limited coverage restrict its application in daily evaluation and management of heritage park sites.

Dong et al. [11] employed remote sensing (RS) sequence imagery to compare vegetation landscape patterns before and after ecological water diversion, demonstrating RS technology's advantages in

evaluating ecological restoration effectiveness and landscape pattern changes. However, the macro-level pattern indicators failed to adequately reflect key human experience variables at the trail scale, such as light environment and recreational comfort.

Wang et al. [12] developed a comprehensive evaluation model for the spatial quality of traditional village landscapes by integrating the Semantic Difference Method (SD) with entropy weighting. This innovative approach effectively combines tourists' subjective perceptions with objective weighting, offering a novel methodology for assessing the environmental quality of historical and cultural landscapes. However, the results of this model are easily influenced by the scale design and sample structure. If it is directly applied to the scene of a site-type park, objective micro-environment indicators such as illuminance, ventilation, and shading rate need to be supplemented to enhance the robustness and explanatory power of the model. Huo et al. [13] proposed policy-oriented improvement strategies for mountainous urban villages through in-depth research and comprehensive evaluation. Their approach effectively bridges vulnerable scenarios with governance tools, yet the study's framework shows limited applicability to heritage park environments due to unique topographical and social characteristics. Overall, these two studies have demonstrated the policy value of a comprehensive evaluation model and governance tools that combine subjective and objective aspects. However, there are still issues such as the insufficient integration of subjective indicators and objective environmental data, and the lack of a refined indicator system for park micro-updates. In the future, subjective perception models can be linked with on-site micro-environment monitoring and visitor behavior data. Form a comprehensive assessment system for human settlement experience and a verification system for the effectiveness of intervention that can be extended to heritage parks.

Chu and Zhang [14] employed the spatial-temporal difference-in-differences (spatio-temporal DID) method to evaluate the net impact of wetland park development on habitat quality, establishing a crucial framework for understanding the 'project intervention—ecological outcome' relationship. However, this method relies on the assumption of parallel trends and the control of spatial spillover effects. If it is applied to the micro-updates of site parks (such as thinning and crown lifting, adding seats and shading facilities, and optimizing wayfinding, etc.), it is necessary to design more fine-grained intervention Windows and control areas to ensure the recognition effectiveness. Zhao et al. [15] analyzed the spatial distribution and driving factors of public cultural facilities from 2012 to 2020 using POI and statistical data. While their study revealed key macro-level characteristics of facility layout and accessibility, it failed to capture micro-level indicators closely tied to user experience, such as the readability of site-level signage systems, path guidance efficiency, and visitor dwell behavior. Although such research provides valuable experience for the assessment of spatial equity and ecological intervention effects of cultural facilities, there is still a lack of an integrated evaluation framework for cultural display and wayfinding systems in heritage parks. In the future, it will be necessary to combine quasi-experimental strategies such as DID with behavioral monitoring methods to incorporate the readability, path compliance and visitor learning benefits of cultural narrative guidance into the micro-scale evaluation system, so as to promote the collaborative optimization of heritage parks in the three dimensions of ecology, facilities and culture.

2.2. The historical and architectural background of Xingqing Palace Park in Xi'an

Xingqing Palace originated from the Longchi Villa during the Kaiyuan period of Emperor Xuanzong of Tang. Later, it was expanded into a grand imperial garden and became an important political and cultural exchange center in the Tang Dynasty. As a symbolic existence of the "Kaiyuan Golden Age" of the Tang Dynasty, Xingqing Palace was not only the place where Emperor Xuanzong handled

state affairs and held large banquets, but also a concentrated manifestation of Tang Dynasty garden art and royal life. Its existence carries the historical memory of the prosperous Tang Dynasty society and also holds an important position in the development history of ancient Chinese palaces and gardens.

From the perspective of architectural layout and garden style, Xingqing Palace adopts the traditional symmetrical form along the central axis. Palaces, pavilions and gardens are distributed in a staggered manner, demonstrating the grand and magnificent, naturally formed artistic style of the imperial gardens of the Tang Dynasty. Buildings within the palace, such as the Chenxiang Pavilion and the Qinzhi Tower, not only serve political purposes but also have recreational value. The combination of water pools and flowers and plants embodies the idea of a "harmony between man and nature" garden. Due to the rise and fall of the Tang and Song dynasties and frequent wars, most of the architectural remains were destroyed. However, in archaeological discoveries and the exploration of garden construction techniques, the unique charm of the architecture and gardens of Xingqing Palace in those days can still be found. This has significant academic value for contemporary site protection and garden restoration.

After the founding of the People's Republic of China, the Xi 'an Municipal People's Government established Xingqing Palace Park on the basis of the Xingqing Palace ruins, which was opened to tourists in 1958. During the construction and operation phases, not only was the protection of the site emphasized, but also extensive use of landscaping and modern horticulture was made, gradually turning this place into a venue for daily leisure and cultural activities for urban residents. In recent years, Yu Xin [2] et al. conducted an in-depth analysis of the plant configuration in the park and found that although the existing layers of trees, shrubs and herbs could form a good greening effect, there were still problems such as insufficient light under the forest and closed space. As the core area of the Tang Dynasty ruins landscape, Xingqing Palace Park serves not only as a vital showcase of historical and cultural heritage but also as a pivotal hub for urban living environment enhancement. This dual value provides a solid foundation for future research on optimizing living environments [5].

2.3. Current environmental conditions and public evaluations

The green coverage rate of the entire Xingqing Palace Park is quite high, with a rich variety of trees and herbaceous plants, which belong to the category of trees, shrubs and grasses, forming a typical multi-layered green vegetation landscape. However, there are certain problems with the current plant arrangement. The density of tree planting is too high, and the branches and leaves are luxuriant. Many tree-lined paths are occupied by branches, and there is insufficient ventilation and sunlight. Although such excessive shading can bring coolness in summer, it can also make some roads darker during the day and make the space under the forest less comfortable.

In terms of public facilities, the park has set up corresponding seats, pavilions, corridors and other places for people to rest, but generally speaking, the number is small and the distribution is uneven. Some of the main walking paths, squares and lakesides do not have reasonable rest areas, nor do they have many facilities such as sunshades and pergolas. It's not cool on hot days. The night lighting and wayfinding systems are also not perfect. In some areas, there is not enough lighting at night, and the signs are unclear, all of which make it difficult to understand the spatial information well. These problems became quite prominent after being fed back by tourists and also affected their visiting experience.

From the public's overall evaluation, Xingqing Palace Park has unique advantages in both ecological landscape and historical culture. Tourists generally recognize its cultural atmosphere and

green environment. However, the park still has shortcomings in facilities, shade, and cultural display forms. The former is reflected in the lack of rest facilities such as seats and shade. The latter is closely related to the insufficient light under the forest caused by the excessively high density of the tree layer. Research indicates that Xi'an's urban development must balance ecological conservation with public service infrastructure enhancement, with Xingqing Palace Park serving as a prime example of this challenge. The park's strategy to preserve its ecological and cultural heritage while upgrading facilities and creating livable spaces has become a key approach to elevating its overall quality.

3. Improvement methods

3.1. Vegetation landscape optimization and lighting improvement

The first step is to adjust the height and quantity of vegetation. Xingqing Palace Park has a rich variety of plant layers, with dense trees and luxuriant branches and leaves, creating a scene where the tree-lined paths are relatively narrow and oppressive. To change this situation, scientific pruning and moderate thinning can be carried out. For trees, the "crown lifting" treatment can be implemented to raise the layers of branches and leaves and increase the transparency of the space under the forest. Additionally, adjust the plants in the shrub layer by removing branches that are too tall and dense, and replacing them with shorter shrubs or flowers to enhance the sense of openness in the space and highlight the changing seasons. This approach not only ensures ecological functions but also enhances the aesthetic appeal of the landscape. The second is the improvement of lighting and the enhancement of spatial experience. On the basis of vegetation optimization, it is also necessary to solve the problem of poor light transmission on tree-lined paths. Due to the overly dense branches in some areas, light cannot penetrate, causing the road to become dim. Tourists walking inside may feel uneasy and panicked. By using appropriate thinning intervals and planting methods, the transparency of the canopy can be improved, allowing sunlight to spread out evenly and creating an alternating effect of light and shade. At the same time, at the intersections of roads, the nodes of squares and places near water, they should be moderately open to create sunny Spaces, known as "open pockets", providing tourists with places to rest and communicate. These measures can enhance the spatial perception and create conditions for the subsequent placement of facilities and the living environment.

3.2. Improvement of leisure facilities and cultural exhibitions

First of all, the improvement of seats and sunshade facilities. Xingqing Palace Park, as a very important public space in the city, currently lacks sufficient leisure facilities in terms of both quantity and distribution. Some major roads and activity nodes lack reasonable seating arrangements, leaving tourists without places to rest after a long time of sightseeing. Meanwhile, the number of sun protection facilities such as sunshades and pergolas is very small. During the hot summer season, the comfort level of tourists drops significantly. A well-developed strategy should be to set up different types of seats along the main tourist routes and at scenic spots, distributed in places such as squares, lake shores, and tree-lined open Spaces. In addition, lightweight sunshades or semi-open pergolas can be introduced in combination with the vegetation space, allowing tourists to have a better rest experience under different climatic conditions and in different seasons. This not only enhances the favorability of the living environment but also prolongs the time tourists stay.

Secondly, the design of the exhibition stand and signboards for the spirit of the westward migration. Xingqing Palace Park is a park of the Tang Dynasty ruins type, and the importance of its cultural display function cannot be ignored. Nowadays, cultural interpretations are mostly confined to historical sites, and there is very little content that combines with contemporary spirit. To make up for such shortcomings, small "Westward Migration Spirit" exhibition stands and sign systems can be set up in appropriate locations within the park, integrating historical fragments and the core spirit of Jiaotong University's relocation. Exhibition stands will display information, and QR codes will provide extended details through pictures, creating an intuitive form of cultural communication. And at important entrances, tree-lined paths and other places, set up indication signs in both Chinese and English to enable tourists to understand and experience the spiritual connotations during their visit. This approach not only enhances people's sense of cultural identity but also boosts the educational value and cultural connotation of the park.

3.3. The enrichment of entertainment facilities

Apart from the most basic ecological and cultural functions, the entertainment facilities are rather monotonous and cannot meet the needs of people of different social strata. The direction of optimization can be set as adding parent-child play areas and light sports and leisure facilities in some relatively open Spaces, such as children's playgrounds, fitness trails, and temporary exhibition and performance areas, to meet the activity needs of visitors of different age groups. At the same time, various activities can be held according to the four seasons and festivals. For instance, people can enjoy flowers in spring, escape the heat in summer, take photos in autumn and tell stories in winter. This will increase the frequency of visitors to the park and make it more interesting. The enrichment of these recreational contents can make the park more interesting, further enhance the improvement of the living environment, and turn it into a complex where ecological environment, cultural environment and recreational environment coexist

4. Conclusion

Through the analysis of the historical background, architectural features and current situation evaluation of Xi 'an Xingqing Palace Park, it can be seen that as a park of the Tang Dynasty site type, Xingqing Palace not only carries profound historical and cultural memories, but also plays an important role in improving the living environment and providing public leisure space in the present. However, in the current environment, there still exist problems such as overly dense vegetation, insufficient lighting, lack of facilities, and monotonous cultural displays.

These deficiencies have restricted the overall value of the park from being fully realized. In response to these issues, this paper proposes optimization strategies such as adjusting the height and quantity of vegetation, improving the lighting conditions of tree-lined paths, adding seats and shading facilities, introducing "westward Migration spirit" exhibition stands and signs, and enriching entertainment functions. These measures not only enhance the comfort of recreation and spatial experience, but also strengthen the function of cultural dissemination, thereby promoting the organic integration of ecological environment and cultural heritage protection.

Looking ahead, the optimization of the living environment in Xingqing Palace Park should adhere to the principle of "equal emphasis on ecology and culture". Under the premise of maintaining the integrity of the site and its historical and cultural value, modern means such as smart navigation and digital display should be gradually introduced to expand the depth and breadth of cultural dissemination. At the same time, the maintenance and management mechanism of facilities

should be further improved to ensure that vegetation pruning, facility renewal and cultural display content remain dynamically adaptable. Through continuous optimization and innovation, Xingqing Palace Park is expected to become a model urban public space that showcases the cultural heritage of Tang Dynasty sites, carries forward the spirit of westward migration, and meets the diverse needs of modern citizens.

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