



Analysis and Optimization Strategies of the Current Application of Environmental Facilities in Hangzhou's Waterfront Greenways

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Abstract. Urban waterfront greenways play a crucial role in enhancing urban environmental quality, ensuring ecological safety, and creating livable environments. Based on the natural resource characteristics and distribution features of Hangzhou's waterfront greenways, a survey was conducted on the current application status of environmental facilities across 10 representative greenways categorized into five types. The study found issues such as insufficient lighting and untimely maintenance in some lighting facilities, single content problems in some promotional facilities, a lack of aesthetic appeal and quantity in most rest facilities, absence of barrier-free facilities in some greenways, untimely cleaning of some sanitary facilities, and damage without timely repair in some fitness facilities. Among them, the facility issues of the Jing-Hang Grand Canal Greenway were particularly prominent. This paper discusses the corresponding optimization strategies for the problems found in the investigation, aiming to provide inspiration and reference for the quality improvement of environmental facilities of urban waterfront green road and the optimization of greenway planning.

Keywords: Environmental facilities, Waterfront Greenway, Current Status Survey, Optimization Strategy, Planning Insights, Hangzhou

1 INTRODUCTION

Urban waterfront greenways play an essential role in modern urban planning and development. They not only provide citizens with places for leisure, entertainment, and fitness^[1-3] but also have a positive impact on urban environmental quality^[4], ecological balance^[5-6], economic development, and cultural heritage^[7-8]. Environmental facilities, as a key component of urban waterfront greenway construction, inject new vitality into urbanization and are an indispensable part of urban-rural development. Paying attention to the reasonable arrangement of environmental facilities is the basic guarantee for improving the functionality of waterfront greenways and meeting the diverse needs of citizens^[9]. The "pan" planning and design research on waterfront greenways both domestically and internationally started early, with a considerable

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amount of accumulated research. The studies mainly focus on combining theoretical and practical research on greenway projects^[10-11], route network selection^[12], evaluation and optimization of greenways^[13,15-16], and the exploration of ecological and cultural-tourism values^[14,17-20], among others. For instance, Song and colleagues^[11] analyzed the user experience of High Line Park, one of New York's greenway parks, from the perspective of online comments between 2011-2018, summarizing the main reasons for its success (song Y et al,2023); Shoshany and colleagues^[12] proposed a new cellular automata simulation algorithm to evaluate the route network path selection of six green corridors in the northern part of Israel affected by development damage (Shoshany Y et al,2023); Meng Lu and colleagues^[13] used high-precision population grid data and park Points of Interest (POI) data to analyze the optimization direction of green open spaces represented by greenways in Haidian, Beijing (Meng Lu et al,2023); Fan and colleagues^[14] analyzed the relationship between greenway distribution and bodies of water such as lakes, further discussing the strategy for exploring the visual attraction value of greenway landscape resources in the Taihu Lake area (Fan R et al,2023). However, research on the in-depth survey, problem analysis, and optimization strategies for the application status of greenway environmental facilities after construction is relatively weak and needs further development. The optimization of urban waterfront greenway environmental facilities is of great importance to urban planning from multiple aspects. By optimizing facility design and management, it can enhance the city's ecological environment quality, cultural characteristics, spatial layout, sustainable development capability, and the quality of life for citizens, laying a solid foundation for the comprehensive, coordinated, and sustainable development of the city. Based on the characteristics and distribution features of Hangzhou's waterfront greenways, this study selects 10 representative greenways across five categories to conduct a current status survey and explore optimization strategies for lighting, promotional, barrier-free, rest, fitness, and sanitary facilities. The purpose is to provide inspiration and reference for the improvement of environmental facilities and the optimization of greenway layout in urban planning.

2 MATERIALS AND METHODS

2.1 Selection of Research Subjects

To ensure the diversity and objectivity of the research plots, based on a comprehensive consideration of Hangzhou's natural geographical environment, the greenway development planning of Hangzhou City, the characteristics of the natural resources upon which the greenways rely, and the features and distribution of the greenways, 10 representative waterfront greenways across five categories were selected for the current status survey of environmental facilities application. These include the Zhijiang Greenway (Shangcheng section), Zhijiang Greenway (Binjiang section), Jinghang (Beijing-Hangzhou) Canal Greenway (Gongchen Bridge section), Shangtang River Greenway (Gongshu section), Yuhangtang River Greenway (Gongshu section), West Lake Greenway (Su Causeway), Jinsha Lake Greenway, West Creek Wetland Greenway, Fengshou Lake Park Greenway, and Peach Blossom Lake Park Greenway. The

basic overview of each greenway is presented in Table 1.

Table 1. Basic Situation of the Surveyed Greenways.

Number	Greenway	type	location
1	Zhijiang Greenway (Shangcheng section)	Riverside Greenway	Shangcheng District
2	Zhijiang Greenway (Binjiang section)	Riverside Greenway	Binjiang District
3	Beijing-Hangzhou Grand Canal Greenway (Gongchen Bridge section)	Riverside Greenway	Gongshu District
4	Shangtang River Greenway (Gongshu section)	Riverside Greenway	Gongshu District
5	Yuhangtang River Greenway (Gongshu section)	Riverside Greenway	Gongshu District
6	West Lake Surrounding Greenway (Su Causeway)	Lakeside Greenway	West Lake District
7	insha Lake Surrounding Greenway	Lakeside Greenway	Qiantang District
8	West Xi Wetland Greenway	Wetland Greenway	West Lake District, Yuhang District
9	Fengshou Lake Park Greenway	Park Greenway	Shangcheng District
10	Taohua (Peach Blossom) Lake Park Greenway	Park Greenway	Linping District

2.2 Survey Content and Research Methods

The main methods adopted for the survey on the current status of the application of lighting facilities, promotional facilities, barrier-free facilities, rest facilities, fitness facilities, and sanitary facilities on greenways include literature review, field survey, and data and information collection. The survey period was from June 2023 to December 2023.

The literature review method primarily involves systematically searching and analyzing existing literature on greenway environmental facilities, including books, journal articles, reports, and statistical data, to acquire knowledge and information in the research field. The field survey method entails visiting the geographical locations of the research subjects to collect on-site data and information about greenways through observations, interviews, and questionnaire surveys, thereby gaining a deep understanding of the essence of the issues and the underlying cause-and-effect relationships. The data and information collection method relies on various means and channels to gather data and information related to greenway environmental facilities, including statistical data, documentary materials, and online information.

3 RESULTS AND ANALYSIS

3.1 Analysis of the Current Application Status of Different Types of Waterfront Greenway Environmental Facilities

Riverside Greenway Environmental Facilities.

(1) Zhijiang Greenway (Shangcheng Section)

The Shangcheng section of the Zhijiang Greenway is a comprehensive greenway, incorporating functions such as fitness, socializing, and ecological protection. Due to the mature living circle it is located in, it serves a wide range of people, and the developed road network system also enhances the usage activity of the greenway. However, the construction of the greenway has poor maintenance levels in terms of greening and ancillary facilities. The landscape and plant varieties are monotonous, lacking aesthetic appeal. Ancillary facilities are rudimentary and vary in their degree of damage. Resting facilities lack shading equipment, making them virtually unused in summer; there are significant issues with the paving facilities, including severe damage to some paths and gaps in the road surface, which can easily lead to safety hazards during walking or cycling, as shown in Fig. 1. The signage facilities are severely faded, failing to effectively serve their guiding purpose; promotional facilities are severely worn; and the number of public toilets in sanitary facilities is limited and located far from the greenway (requiring departure from the greenway). Besides, this waterfront greenway lacks management, with some areas accumulating debris.



Fig. 1. Zhi Jiang Greenway (Shangcheng Section) Real Scene Picture.

(2) Zhi Jiang Greenway (Binjiang Section)

The Zhijiang Greenway (Binjiang Section) is one of Hangzhou's important recreational landscapes. Constructed later, the Binjiang section boasts a more comprehensive greenway construction system. It features a rich variety of activity spaces, including a small soccer field, skatepark, children's activity area, associated plazas, walking paths, cycling tracks, and running tracks. In terms of greenway landscape, it has a rich diversity of plant colors and types, with a plant landscape that provides a sense of layering, contributing to a high overall level of aesthetic appeal, as shown in Fig. 2. Regarding ancillary facilities, signage is clear, non-motorized vehicle parking areas are well-designed, public toilets are clean and tidy, and there is a diverse and comfortable selection of seating areas. Additionally, sound equipment is installed to enhance user experience. However, there is a lack of management in terms of maintenance. Due to the overabundance of functional areas and poor management, facilities in the soccer field and some children's interactive spaces are damaged, yet remain unrepaired.



Fig. 2. Zhi Jiang Greenway (Binjiang Section) Real Scene Picture.

Riverside Greenway Environmental Facilities.

(1) Jing-Hang Canal Greenway (Gongchen Bridge Section)

The Beijing-Hangzhou Grand Canal Greenway (Gongchen Bridge Section) is the public service hub of the Gongshu District and also the seat of the Gongshu District government in Hangzhou. In terms of plant landscape, the level of layering is average, with weak seasonal changes, but the landscape is highly harmonious. As for the ancillary facilities, due to the earlier construction year of the canal greenway, its related facilities are relatively old. The activity space is limited, with only fitness spaces and waterfront platforms available. Paving facilities are severely damaged, affecting walking comfort and safety; some areas lack directional signage; resting facilities are simple and uncomfortable; safety features are not high, posing a risk of falling into the river; there are few historical and cultural promotional facilities, unable to showcase canal culture. In terms of sanitary facilities, there is a shortage of trash cans and public toilets, which are also old and worn, as shown in Fig. 3. However, the number of accessible facilities and life-saving facilities is relatively complete.



Fig. 3. Jing-Hang Canal Greenway (Gongchen Bridge Section) Real Scene Picture.

(2) The Shangtang River Greenway (Gongshu Section)

Because the Shangtang River Greenway in the Gongshu section is located in the central development area of Hangzhou, it has formed a more mature living circle. The area features a dense road network and concentrated residential buildings, hence the construction and daily maintenance of this greenway are given special attention. The landscape of this waterfront greenway is richly layered, with well-arranged plantings and frequent appearances of birds, squirrels, and other animals; as shown in Fig. 4; in terms of ancillary facilities, the overall condition is relatively good, including signposts, ground markings, safety features, drainage facilities, accessible facilities, lighting, and paving, all of which are well-maintained. In addition, the greenway is equipped with smart screens and water bus stops, providing convenience for water transportation. The greenway has many secondary entrances but lacks reasonably accessible pathways, causing inconvenience for the elderly and others. Additionally, there are minor damages to fitness equipment, rest seats without shade, damaged pavilion seats, some trash cans not cleared in time, a scarcity of public toilets which are also concealed, severe damage to some side roads, and areas where plants are sparse.



Fig. 4. The Shangtang River Greenway (Gongshu Section) Actual Scene Picture.

(3) The Yuhang Tanghe River Greenway (Gongshu Section)

The Yuhangtang River Greenway (Gongshu Section) is one of the fitness centers for the northern citizens of Hangzhou, but due to its early construction year, there are significant issues with its environment. In terms of landscape plants, the overall color, variety, and planting layers are quite monotonous, but the greening rate is high, providing a cool refuge during the hot summer months, as shown in Fig. 5; in terms of activity spaces, due to the limited area, the activity space is relatively simple, with only basic pedestrian walkways and scattered pavilions as resting spaces. Regarding ancillary facilities, there are few guiding facilities, which do not effectively serve their guiding purpose; in terms of resting facilities, the benches are old and backless, made of concrete, which makes them uncomfortable; regarding fitness facilities, this greenway only has a ping-pong table set up in the space under a bridge, which is less used during the cold winter months. Additionally, in the summer, there is an issue with mosquitoes and flies breeding, and mosquito bites can be severe. Some waterfront platforms are used by citizens for fishing, but no related ancillary facilities for anglers have been set up nearby.



Fig. 5. The Yuhang Tanghe River Greenway (Gongshu Section) Actual Scene Picture.

Lakeside Greenway Environmental Facilities.

(1) The West Lake Greenway (Sudi Section)

The West Lake Surrounding Greenway, located within a national 5A scenic area, is equipped with very comprehensive infrastructure and a mature road system. The ancillary facilities are complete, including resting facilities, waterfront platforms, viewing platforms, temporary pedestrian stopping spaces, walkways, driveways, and sanitary facilities, as shown in Fig. 6. However, there are still issues such as an insufficient number of toilets and a lack of measures to separate pedestrians from vehicles. Moreover, due to the high volume of visitors to the West Lake scenic area, some side roads are severely damaged, and the problem of insufficient number of resting chairs is also quite evident.



Fig. 6. The West Lake Greenway (Sudi Section) Actual Scene Picture

(2) The Jinsha Lakeside Greenway

The Jinsha Lake Surrounding Greenway offers a rich variety of activity spaces, including a children's beach, wake surfing, a children's activity area, viewing platforms, activity plazas, and lakeside walkways. In terms of ancillary facilities, the signage system is relatively complete, providing park maps and directional signs, as shown in Fig. 7. However, there are serious damages to the road pavement, safety warning signs have faded, some resting facilities are rudimentary with low comfort and lack weather protection, and there is also damage to the facilities in the children's activity area.



Fig. 7. The Jinsha Lakeside Greenway Actual Scene Picture.

Wetland Greenway Environmental Facilities.

(1) The Xixi Wetland Greenway

The West Xi Wetland Greenway features a complete slow traffic system, with walkways, running tracks, and driveways set up in different areas to separate pedestrians from vehicles, providing convenience for different user groups while enhancing the safety of pedestrians, as shown in Fig. 8. In terms of ancillary facilities, it has clear and abundant directional signs; multiple greenway entrances and exits have been established, improving the greenway's accessibility; and service stations are available for fitness enthusiasts to rest temporarily. In addition, the West Xi Greenway includes 4 smart display screens, allowing active individuals to clearly see their movement paths and average speed. To meet the needs of active users, the smart screens also incorporate seven functions: lighting, 5G signal towers, IP audio broadcasting, USB charging, and emergency SOS. However, there is a shortage of sanitary facilities, with too few toilets available.



Fig. 8. The Xixi Wetland Greenway Actual Scene Picture.

Park Greenway Environmental Facilities.

(1) The Harvest Lake Park Greenway

The Fengshou Lake Park Greenway integrates the park's beautiful garden landscape and topography, arranged in a circular layout around Fengshou Lake, connecting distinctive attractions such as the "Urban Station," "Waterfront Platform," "Children's Fun Park," and "Cedar Embankment Proud Moon" on the outside. The design of the park paths has a clear functional zoning, with one side featuring tiled roads for

walking and the other side having a blue plastic track for jogging. However, some areas within the greenway lack warning signs, some regions have sparse plant landscapes, and there are issues with timely daily sanitation maintenance, as shown in Fig. 9.



Fig. 9. The Harvest Lake Park Greenway Actual Scene Picture

(2) The Peach Blossom Lake Park Greenway

The Peach Blossom Lake Park Greenway was constructed later, hence it features a more comprehensive greenway system internally. Within the Peach Blossom Lake Park Greenway, there is a variety of activity spaces, including large areas for children's activities, waterfront platforms, galleries, pavilions, and open spaces for events, as shown in Fig. 10. In terms of ancillary facilities, there are landscape introduction signs, and the paving of the park paths is diverse. However, the children's activity spaces lack management and maintenance, leading to some sanitation issues. Moreover, due to the strong sunlight in summer, issues such as fading greenway signs, lack of resting areas for parents in children's activity spaces, and insufficient number of toilets still need to be addressed.



Fig. 10. The Peach Blossom Lake Park Greenway Actual Scene Picture.

3.2 Comprehensive Comparative Analysis of the Current Application Status of Environmental Facilities

By comprehensively analyzing the current application status of environmental facilities along urban waterfront greenways in Hangzhou, the results show that the environmental facilities of urban waterfront greenways are influenced by factors such as the construction time, whether they are located in the central development area of Hangzhou, the accessibility of related road networks, the degree of completeness of the living area, and the level of greenway activity. According to the survey results, waterfront greenways constructed later usually have a more mature and comprehensive system of environmental facilities, while those completed earlier tend to have more usage issues. Therefore, there are significant differences in the current situation of landscape, ancillary facilities, activity spaces, and surrounding environment among various urban waterfront greenways. Below is a specific analysis of the advantages and disadvantages of the survey sites, as shown in Table 2.

Table 2. Hangzhou waterfront green road environmental facilities research advantages and disadvantages summary.

Number	Greenway	type	advantages	disadvantages
1	Zhijiang Greenway (Shangcheng section)	Riverside Greenway	The accessibility level of greenway facilities is relatively high; the service scope and user groups are extensive.	The rest seats are rudimentary, worn-out, randomly placed, without shading facilities. The pavement is single and severely damaged. Greenway signs are heavily faded, and there are few public toilets, which are distant from the greenway (requiring leaving the greenway). The signboards are severely damaged, and promotional facilities are heavily worn. Some areas have accumulated debris.
2	Zhijiang Greenway (Binjiang section)	Riverside Greenway	Rich in functional zones; diverse range of ancillary facilities; well-developed greenway system.	Lack of regular maintenance, with some facilities in certain areas damaged and left unrepaired.
3	Beijing-Hangzhou Grand Canal Greenway (Gongchen Bridge section)	Riverside Greenway	Accessible facilities are well-equipped, with anti-slip and anti-collision signs, and life-saving facilities are available.	Some areas lack signage, the ground is severely damaged, there are few public toilets, the seating is rudimentary and lacks shelter, leading to low usage rates, there are few historical and cultural promotional facilities, and the fitness equipment is rudimentary and dilapidated.
4	Shangtang River Greenway (Gongshu section)	Riverside Greenway	The signage, lighting, safety facilities, accessibility facilities, drainage facilities, and pavement facilities are relatively complete. There is a rich landscape hierarchy and good ecology. There are water bus docking points and smart screens along the greenway.	The entrances and exits lack accessible pathways. Some fitness and leisure facilities are slightly damaged. Trash bins are not cleaned in a timely manner, and public toilets are few and hidden.

5	Yuhangtang River Greenway (Gongshu section)	Riverside Greenway	Has historical and cultural significance.	The landscape is relatively simple, and the functionality is rather limited. The rest facilities are run-down.
6	West Lake Surrounding Greenway (Su Causeway)	Lakeside Greenway	Beautiful scenery; the accessibility facilities are relatively well-developed; strong historical and cultural significance.	Some branch roads have severe pavement damage, and the seating areas are dilapidated with low comfort levels.
7	insha Lake Surrounding Greenway	Lakeside Greenway	The activity spaces are diverse and distinctive.	The pavement is severely damaged, the warning signs are faded, the seating facilities are damaged.
8	West Xi Wetland Greenway	Wetland Greenway	The greenway system is well-developed.	The road signs are not clear in their instructions.
9	Fengshou Lake Park Greenway	Park Greenway	The overall landscape is rich in layers, and there is a variety of activity spaces available.	Some areas lack signage for guidance.
10	Taohua (Peach Blossom) Lake Park Greenway	Park Greenway	Accessibility facilities, promotional infrastructure, pavement facilities, and service amenities are well-established; the landscape features diverse layers.	The greenway signage is faded, some roads are damaged or poorly designed, and there is no designated area for parents to rest in the children's activity space.

In summary, the overall construction of environmental facilities along waterfront greenways in Hangzhou is relatively mature, capable of meeting the daily leisure needs of urban residents to a certain extent and significantly enriching the urban landscape. However, there are also certain issues. Most greenway environmental facilities suffer from inadequate management and missing functionalities, which could lead to low usage efficiency of the greenways, negatively impact the greenway environment, and even affect residents' user experience.

4 EXISTING PROBLEMS AND OPTIMIZATION STRATEGIES

4.1 Existing Problems

Rest Facilities.

The waterfront greenway rest facilities are frequently used by the public and are essential spaces for rest and relaxation. An analysis of survey results reveals that the current greenway rest facilities primarily face issues such as uneven spatial distribution, low accessibility, poor aesthetic appeal, insufficient quantity of facilities, poor

management, and low comfort level. Among these, a lack of facilities is a common problem across seven greenways, as illustrated in Figure 11. For example, the West Creek Wetland Greenway suffers from an insufficient number of seats or lacks shelter and rain protection facilities, which to some extent affects people's user experience.

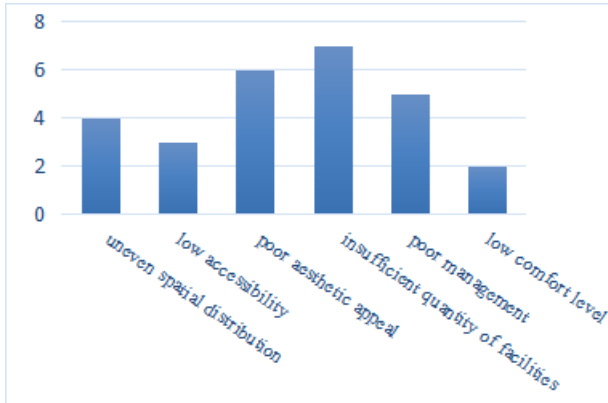


Fig. 11. Occurrence frequency statistics of waterfront greenway leisure facilities.

Lighting Facilities.

Waterfront greenway lighting facilities can provide illumination for citizens' nighttime activities and enhance the overall aesthetic appeal of the greenway. However, a survey of 10 waterfront greenways reveals issues with the lighting facilities, including a lack of aesthetic appeal, poor environmental integration, weak lighting function, prominent safety hazards, high energy consumption, and poor management, as shown in Figure 12. Among these, safety hazards are a common issue in 8 of the waterfront greenways, manifested as exposed electrical wires and lights flickering due to poor contact.

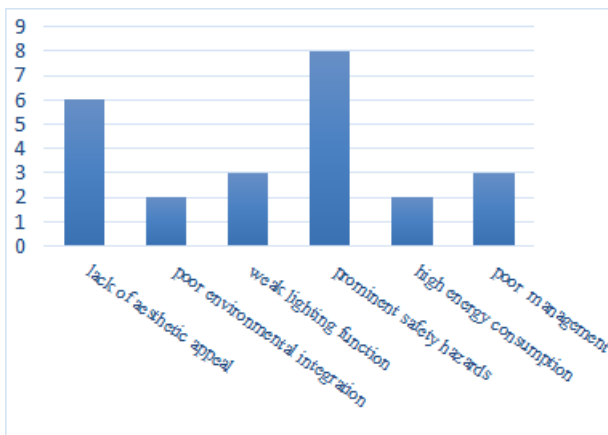


Fig. 12. Occurrence frequency statistics of waterfront greenway lighting facilities.

Accessibility Facilitie.

The accessibility facilities of the waterfront greenways are directly related to the social participation of special groups in society. The survey of 10 waterfront greenways shows that the main issues are low accessibility, poor management, unclear guidance, insufficient quantity of facilities, difficulty of use, and non-compliance with standards, as illustrated in Figure 13. For example, the West Creek Wetland Greenway lacks accessible toilets, which may affect the normal use by special groups.

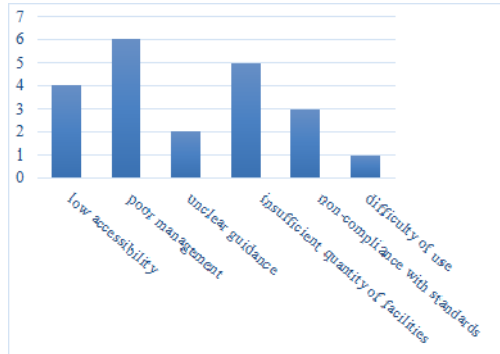


Fig. 13. Occurrence frequency statistics of waterfront greenway accessibility facilities

Fitness Facilities.

The fitness facilities along the waterfront greenways provide citizens with places to exercise and improve their physical fitness. Currently, the 10 surveyed waterfront greenways face issues such as aging facilities, poor management, limited variety, high usage difficulty, low accessibility, and prominent safety hazards. Among these, aging facilities are a common problem across 8 greenways, as shown in Figure 14. For example, the fitness facilities along the Beijing-Hangzhou Grand Canal greenway have significantly aged and damaged due to exposure to sun and rain, and high frequency of use.

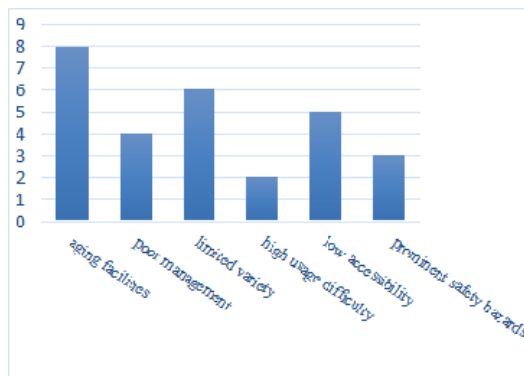


Fig. 14. Occurrence frequency statistics of waterfront greenway fitness facilities.

Sanitary Facilities.

The sanitary facilities along the waterfront greenways significantly affect the surrounding ecological environment and the comfort experience of users. However, the current survey of waterfront greenways reveals issues such as irrational layout, improper management, low aesthetic appeal, insufficient quantity, poor accessibility, and aging facilities in some greenways, as illustrated in Figure 15. For example, the Zhijiang Greenway in the Shangcheng district suffers from an insufficient number of sanitary facilities, causing users to be unable to find toilets, washbasins, and other basic sanitary facilities in a timely manner.

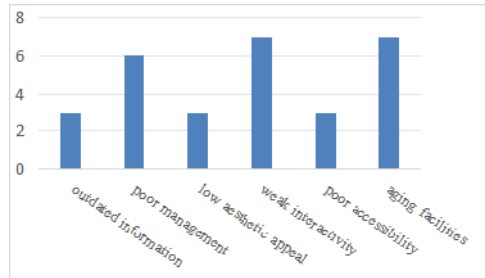


Fig. 15. Occurrence frequency statistics of waterfront greenway Sanitary facilities.

Publicity Facilities.

Waterfront greenway promotional facilities are key channels for disseminating cultural, educational, and policy information. The current survey of 10 waterfront greenways identified a range of issues with these facilities in practical use, such as outdated information, poor management, low aesthetic appeal, weak interactivity, poor accessibility, and aging facilities. Among these, promotional facilities in 7 greenways were found to lack aesthetic appeal, as shown in Figure 16. For example, the promotional facilities along the Beijing-Hangzhou Grand Canal greenway may suffer from a lack of management personnel and maintenance funds, leading to delays in updating facility information and, to some extent, affecting the effectiveness of the promotions.

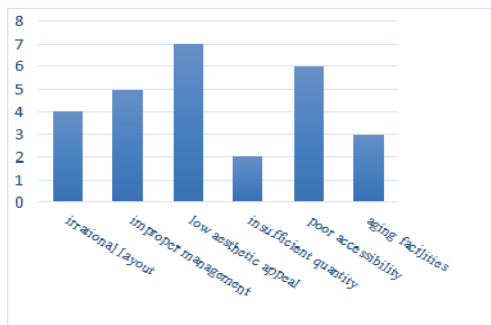


Fig. 16. Occurrence frequency statistics of waterfront greenway Publicity facilities.

4.2 Optimization Strategies

Carry out Routine Maintenance of Facilities.

Establish regular maintenance schedules for environmental facilities, including regular inspections and repairs of aging and damaged facilities, to ensure their functionality and safety. For severely aged or damaged environmental facilities, timely upgrades should be made using durable materials and modern designs to extend their lifespan. Additionally, it is essential to strengthen management and supervision, enhance daily management and supervision of waterfront greenway environmental facilities, ensure their normal use, improve management and maintenance standards, and ensure the long-term sustainable operation of environmental facilities^[21]. Furthermore, by encouraging community residents, volunteers, and others to participate in the management and maintenance of greenway facilities, social governance awareness can be enhanced, creating favorable conditions for the sustainable use of greenway environmental facilities.

Optimize Facility Layout and Quantity.

Reasonable considerations regarding the distribution, quantity, types, and density of facilities^[22] are beneficial to ensure that environmental facilities can meet the needs of different groups, including leisure, fitness, and recreation functions, thereby enhancing the diversity and sustainable utilization of greenways. Additionally, considerations should be given to the comfort and accessibility of visitors, optimizing the usage process of environmental facilities to make them easy to understand and operate. After the implementation of environmental facilities along waterfront greenways, regular maintenance and upkeep should be conducted, and the layout and quantity of facilities should be optimized and improved based on user feedback and new requirements. In summary, regular optimization of facility layout is of great significance in improving safety, reducing costs, and promoting the sustainable development of waterfront greenways.

Enhance the Regional Characteristics of Facilities.

Expressing regional characteristics of facilities is one of the important strategies for beautifying waterfront greenway facilities. It is necessary to fully understand the environment and cultural background of each waterfront greenway, clarify its unique features and advantages, and combine environmental facilities with natural landscapes and historical culture to highlight the unique regional charm^[23]. For example, for waterfront greenways like the Jing-Hang Grand Canal Greenway (Gongchen Bridge Section), which have significant historical and cultural significance, the landscape design along the canal can incorporate cultural heritage elements, setting up sculptures, signs, or exhibition areas with cultural connotations to showcase the historical stories and cultural heritage of the Jing-Hang Grand Canal. At the same time, utilizing the resources and characteristic industries around the greenway, developing cultural activities and distinctive experiential projects can attract more tourists and residents to participate, creating a waterfront greenway system with local characteristics and at-

tractiveness. In summary, highlighting the regional characteristics of waterfront greenways is one of the key strategies for optimizing greenway facilities, which can enhance their visibility and attractiveness, and promote urban tourism and cultural development.

5 CONCLUSION

With the acceleration of urbanization, people are paying increasing attention to the quality and sustainability of urban built environments. The planning and construction of urban greenway environmental facilities cover a vast and complex system, playing an important role on the stage of urban renewal and development^[24]. Based on factors such as the general situation of the natural environment in Hangzhou and the distribution of the greenway system in the city, 10 urban waterfront greenways were selected from 5 categories. The current application status of internal lighting facilities, promotional facilities, accessibility facilities, rest facilities, fitness facilities, and recreational facilities were evaluated for their merits and demerits. It was found that there are common problems such as severe aging, unreasonable distribution, and insufficient aesthetic appeal. Suggestions were made to address these issues by improving daily maintenance of facilities, optimizing layout and quantity of facilities, and enhancing the regional characteristics of facilities. These recommendations provide valuable reference for the construction and development of future urban waterfront greenway environmental facilities.

The planning and construction of urban greenway environmental facilities constitute a vast and complex system. However, this study only focuses on the current application status of some facilities in the waterfront environment of Hangzhou, and the sample selection is not comprehensive enough. To some extent, the results of this study are only applicable to Hangzhou and cities with similar natural geographical environments. For other cities, the accuracy and reliability of the research data still need to be improved. Nevertheless, by analyzing the current status of specific urban waterfront greenway environmental facility issues, this study partially reveals common problems existing in greenway systems, providing some reference for improving the planning of urban waterfront greenway environmental facilities in China.

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