Research on Renovation and Design of Urban Block Public Toilets Based on Service Design

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Abstract: This study focuses on urban block public toilets and explores their renovation and design through literature review, field research, and questionnaire surveys. Taking the block near Daming Lake Scenic Area in Lixia District, Jinan City as an example, this study applies service design concepts to analyze touchpoints, stakeholders' needs, and service processes of public toilets. It proposes renovation design principles and strategies aiming to enhance the service experience of public toilets and meet the diverse needs of different user groups.

Keywords: urban block, public toilets, service design, spatial renovation

1. Introduction

Public toilets are closely tied to urban services and serve as important indicators of a city's level of civilization and public service. However, the construction of public toilets has long been neglected in urban development, leading to the common sight of foul-smelling facilities that inconvenience urban residents. City block public toilets are an indispensable part of urban infrastructure and hold significant importance for residents and tourists. However, many current city block public toilets suffer from issues such as aging facilities and inconvenient services, which hinder the improvement of the quality of life for residents and visitors. Therefore, this study aims to utilize the concept of service design to transform and redesign city block public toilets, enhancing the service experience and meeting the needs of different user groups.

Extensive research on public toilet design has been conducted in Japan since the 19th century. In recent years, the "Tokyo Toilet" project, initiated by a Japanese charity organization, aimed to renovate and design the interior and exterior environments of public toilets in 17 locations in Shibuya, Tokyo. Renowned designers such as Shigeru Ban, Tadao Ando, and Kengo Kuma were invited to create innovative and aesthetically pleasing designs. [1] The facilities were equipped with user-friendly and accessible features, including multifunctional toilets, sound devices, emergency assistance devices, child-friendly toilets, and baby changing stations, catering to the needs of various user groups. The project also incorporated touchless toilets to challenge the common perception of public toilets being dirty and poorly maintained. This initiative provides
valuable insights and references for the transformation and design of public toilets in China. Research on public toilets has also been conducted in Western countries. Clara Greed explored the significance of public toilets as an integral part of urban design in her book "Inclusive Urban Design: Public Toilets," addressing existing problems and emphasizing the importance of improving public toilets while proposing strategies and approaches for improvement.[2] Julie Hollen documented diverse toilet cultures in different regions during her travels, presenting the history of toilets in an entertaining manner and offering references for studying different toilet cultures. [3] The World Toilet Organization (WTO), founded in Singapore in 2001, is an international non-profit organization dedicated to promoting toilet and sanitation issues worldwide. They designated November 19th as World Toilet Day.

In recent years, Scholars in China have also paid attention to public toilets. Various works have been published, rigorously discussing toilet culture, psychological and physiological aspects of defecation, and the correlation between Eastern and Western civilizations.[4] These works humorously record anecdotes and highlight the necessity of a toilet revolution in China. They comprehensively discuss the design process and key points of public toilets and analyze the current status of domestic and international urban public toilets, providing detailed design methods from various perspectives.[5] Some researchers have focused on the problems of urban public toilet design, emphasizing the need to meet people's needs in the design of urban public toilets.[6] Others have analyzed the existing issues and proposed that solving the contradiction in urban environments requires scientific and effective strategies, as well as the participation and collective efforts of society as a whole. Research on urban public toilets covers various aspects such as hygiene, user satisfaction, environmental characteristics, technological innovation, and intelligent systems. These studies highlight the importance of cleanliness, accessibility, and user experience in public toilets, as well as the need for proper maintenance and management.[7] They also emphasize the role of technology in improving toilet facilities and addressing challenges related to pathogen transmission, odor control, and water usage. The research provides insights into improving hygiene, user satisfaction, and environmental conditions through innovative approaches and technologies, contributing to the understanding of the current challenges and potential solutions in providing clean, accessible, and user-friendly public toilets.

2. Application of Service Design Principles in City Block Public Toilets

The application of service design principles in city block public toilets includes touchpoint analysis, stakeholder needs analysis, and service process optimization. Touchpoint analysis involves analyzing and evaluating various touchpoints and interactions between users and public toilets. This can include the process of entering the toilet, the experience of using the facilities, and the perception after leaving the toilet. By understanding user needs and experiences at different touchpoints, targeted improvements and optimizations can be made to enhance user satisfaction.[8]

Stakeholder needs analysis focuses on understanding the needs of stakeholders related to public toilets, such as residents, tourists, and government departments. Different stakeholders may have different needs and expectations. For example, residents may prioritize the quantity and convenience of nearby public toilets, while government departments may focus on hygiene management and facility
maintenance.[9] By comprehensively analyzing the needs of different stakeholders, more targeted and comprehensive strategies for public toilet services can be developed. Service process optimization involves evaluating and improving the service processes of public toilets to enhance efficiency and user experience. This includes optimizing processes from the moment users enter the toilet to using the facilities, cleaning and maintenance, and payment processes. Measures such as simplifying processes, optimizing facility layouts, and providing convenient payment methods can reduce user waiting time and cumbersome operations, thereby improving overall service effectiveness.

In practice, an example of applying service design principles to city block public toilets is the "Tokyo Toilet" project in Japan. The project invited renowned designers to transform and redesign public toilets in Shibuya, Tokyo, with innovative and aesthetic designs. The facilities were equipped with user-friendly features, such as multifunctional toilets, sound devices, emergency assistance devices, and facilities catering to specific user groups like children and mothers. The project also incorporated touchless technology, challenging the common perception of public toilets being dirty and poorly maintained. Through these improvements, the project aimed to enhance the service experience and meet the diverse needs of users. To sum up, the application of service design principles in city block public toilets includes touchpoint analysis, stakeholder needs analysis, and service process optimization. These approaches can help improve user experience, meet the needs of different stakeholders, and enhance overall service quality. The "Tokyo Toilet" project serves as an example of successfully applying these principles in practice.

3. Principles and Strategies for Renovation Design of City Block Public Toilets

When it comes to the renovation design of city block public toilets, there are several principles and strategies that can be considered. [10]

- Accessibility: Ensuring that the public toilets are easily accessible to all individuals, including people with disabilities, elderly individuals, and parents with young children. This can involve providing ramps, wider doorways, and suitable amenities.
- Hygiene and Sanitation: Prioritizing cleanliness and hygiene in public toilets through regular cleaning and maintenance. Incorporating features like touchless technology, automatic flushing systems, and hand sanitizer dispensers can help maintain a clean and safe environment.
- Privacy and Security: Designing public toilets to provide adequate privacy and security for users. This can include individual stalls with lockable doors, well-lit areas, and surveillance systems to ensure user safety.
- Sustainability: Implementing sustainable design practices in the renovation of public toilets, such as incorporating energy-efficient lighting, water-saving fixtures, and using eco-friendly materials. This helps reduce the environmental impact and promotes a more sustainable urban environment.
- Aesthetics: Enhancing the visual appeal of public toilets to create a pleasant and inviting atmosphere. This can involve incorporating artistic elements, vibrant colors, and landscaping around the facilities.
- User Experience: Considering the overall user experience when designing public toilets. This includes factors like adequate ventilation, comfortable
seating, clear signage, and provision of amenities like baby-changing stations and accessible facilities for different user groups.

- Community Engagement: Involving the local community in the design process and gathering feedback to ensure that the renovated public toilets meet their needs and preferences. This can be achieved through surveys, public consultations, and collaboration with local stakeholders.

By adhering to these principles and implementing appropriate strategies, the renovation design of city block public toilets can greatly improve the overall quality, accessibility, and user satisfaction of these essential urban facilities. Principles and strategies for the renovation design of city block public toilets include facility renovation principles, spatial layout strategies, and service function enhancement strategies.

Facility renovation principles refer to the principles to consider when renovating public toilet facilities. This includes providing a clean and hygienic environment, ensuring the reliability and durability of the facilities, and meeting users' basic needs, such as providing an adequate number of seating, handwashing facilities, and hygiene supplies. Additionally, the needs of different user groups, such as providing accessible facilities to meet the needs of individuals with disabilities, should also be taken into account.

Spatial layout strategies involve considering appropriate spatial planning and layout in public toilet renovations. This includes determining the location of entrances and exits, the width of passageways, and the installation of partitions and dividers to provide privacy. It also involves arranging the placement of facilities such as washbasins, toilets, and trash cans. By implementing a scientific spatial layout, a more comfortable, safe, and efficient usage environment can be provided. Service function enhancement strategies involve considering the addition of new service functions in public toilet renovations. This can include adding facilities such as baby changing stations, nursing rooms, accessible facilities, and charging devices to meet the needs of different users. Additionally, the introduction of intelligent systems, such as automatic sensor devices, smart navigation, and information prompts, can enhance user experience and service effectiveness.

The renovation design of city block public toilets should adhere to facility renovation principles, rational spatial layout, and the consideration of adding new service functions. These principles and strategies can enhance the comfort, convenience, and user satisfaction of public toilets, providing better public services for urban residents and tourists.

4. Case Study: Renovation Design of Public Toilets in the Street Blocks near Daming Lake Scenic Area, Lixia District, Jinan City

Based on the interview survey data of users of the neighborhood public toilets (as shown in Fig. 1), it is evident that the main concerns of the users are focused on three aspects: hygiene conditions, facility conditions, and privacy conditions. Regarding hygiene conditions, 62.5% of the respondents selected "basically clean," 29.17% selected "not very clean," and 16.67% selected "poor cleanliness" inside the toilets. This indicates that the overall hygiene situation of the neighborhood public toilets is
relatively good, but there are still some issues. The reasons can be analyzed from two aspects. On one hand, user behavior contributes to the problem, as some individuals engage in uncivilized behavior that affects the cleanliness of the toilets. It is necessary to increase publicity efforts on civilized use of public toilets and provide warning signs for guidance. On the other hand, inadequate supervision and cleaning by the management staff may result in an unclean environment inside the toilets. Therefore, stronger supervision is needed to ensure a clean and comfortable environment. Additionally, in order to provide a better service experience, a survey was conducted to analyze the other needs of the users regarding the neighborhood public toilets. Among them, 77.32% of the respondents hoped that the toilets could provide more services. Specifically, 63.64% of the respondents expressed a demand for charging stations, 77.27% expressed a demand for female hygiene products, and 63.63% expressed a demand for rest/waiting areas. Furthermore, during the interviews, some respondents also suggested the inclusion of caring services and assistance for the elderly.

Fig. 1. Interview survey data on public toilets in the neighborhood

With the country officially entering an aging society, the scale and proportion of the elderly population in China have been consistently increasing over the past 30 years, with an accelerating growth rate. From 1990 to 2010, the total population of people aged 60 and above increased from 97 million to 178 million, with an average annual growth rate of approximately 3.06%. By the end of 2021, the national population of people aged 60 and above reached 267 million. According to statistics from the China Disabled Persons’ Federation in 2022, the total number of disabled people in China has reached 85 million. The significant size of the elderly and disabled population poses higher requirements for the caring construction of neighborhood public toilets. Survey data shows that 58.33% of the respondents express a need for barrier-free facilities, and 37.5% strongly emphasize the need for barrier-free facilities(as shown in Fig. 2). This indicates a high demand for barrier-free facilities among users. At the same time, the survey also found that there is a lack of third restrooms in neighborhood public toilets, with only 25% of the respondents stating that most neighborhood public toilets are equipped with a third restroom. For the large population of the elderly and disabled, it is evident that their needs are not being met.
Through user interviews, targeted renovation designs can be implemented for the public toilets in the street blocks near Daming Lake Scenic Area, Lixia District, Jinan City. This will enhance the user experience, meet diverse user needs, and provide better public services for urban residents and tourists. Based on the diversity of the street block environment, a modular design approach is adopted to divide the public toilets in the street blocks into five modules. This includes Barrier-free module modules, gender free public restroom modules, workroom modules, men's urinal modules, and additional service modules. The design incorporates the shape and color of lotus leaves, which are characteristic elements of Jinan, and applies them to each module in conjunction with the surrounding environment. This enhances the indoor and outdoor environments of the public toilets in the street blocks, transforming them from ordinary facilities into urban public service spaces with regional characteristics, providing a better service experience for city dwellers.

To improve the public toilet search process, a user-friendly navigation interface is optimized. The application displays the user's current location, nearby public toilets, and available parking spots in real-time. It provides information on the status of public toilets and plans the best route for users. After selecting a specific toilet, real-time information on service scope, opening hours, available stalls, and facilities is displayed. The system updates information promptly and includes a feedback interface for users to share their experience (as shown in Fig. 2).

The absence and confusion of wayfinding and indicator icons in the public restrooms of the block have brought difficulties to users. To address this issue, the design of wayfinding icons and indicator icons for street block public toilets has been created using simple lines combinations (as shown in Fig. 3), aims to clearly showcase the service functions provided by the street block public toilets.
The Barrier-free module is primarily designed for the elderly, mothers with infants, and disabled individuals. The overall space is set at 2.24 meters in length and 2.39 meters in width (as shown in Fig. 4). Considering that street block public toilets are mostly constructed on roadside locations with limited space, the accessibility facilities are integrated with the facilities for mothers and infants to create a comprehensive restroom space for special user groups (as shown in Fig.5). It is divided into a mother and infant area, a toilet area, and a cleaning area, with 1.5 meters of wheelchair activity space left in the middle to ensure easy access for wheelchair users.

Due to the different needs of different user groups, the height of the facilities within the space has been adjusted to accommodate them. Grab bars have been added to the washbasins, urinals, and toilets to provide support and protection for users during restroom use or cleaning. Considering the needs of the user group and the findings from preliminary research, smart toilets are used in the toilet area, and the operation buttons are placed on the side for integrated design (heating, flushing, etc.), providing clearer functional display and easier operation. Emergency call buttons are designed at low and high positions to ensure user safety. One of the main reasons for the rejection of toilet usage is hygiene concerns, so an induction device is installed on the side wall for automatic replacement of toilet seat covers by waving hands, ensuring the cleanliness of the toilet seat and improving user comfort (as shown in Fig. 6).

In terms of mother and infant facilities, considering the needs of parents going out with their children, additional facilities are provided. A breastfeeding seat is set on the left side upon entering, and other amenities such as a foldable baby bed, foldable chair, changing pedal, and hot water supply are included to assist with diaper changing, temporary care, and clothing changes for infants. During interviews with mothers and infants, many mothers expressed the inconvenience of carrying multiple items when going out with their children. Therefore, baby supplies will be provided in the cabinet beside the washbasin to reduce the burden of travel.
The workspace module serves as a space for managing the cleanliness and inspection of street block public toilets. The overall space is set at 1.72 meters wide and 1.48 meters long (as shown in Fig. 7). It is divided into a cleaning area and a workspace monitoring area (as shown in Fig. 8).

Through multiple surveys, it has been found that the management of street block public toilets currently focuses on mechanized cleaning, with the workspace often left unattended and in a disorganized state. This lack of overall management can lead to usage issues. In the design of the workspace module, an intelligent monitoring screen is incorporated. The public toilet information system and management system are used to collect and analyze usage data from various modules. The indoor environment, air quality, and facility conditions are monitored. Managers can monitor and manage the various modules in real-time through the monitoring screen or mobile devices, ensuring their proper functioning. Considering the needs of the staff as stakeholders, provisions such as a refrigerator and microwave are added to one side, providing a better working environment for the staff (as shown in Fig. 9).

The original area of the public toilet at No.1 AnChasi Street is approximately 13.4m², and the surrounding environmental area is about 225m². It primarily includes gender-neutral toilets, a working area, and an accessible toilet (as shown in Fig. 10). However, a large amount of space around the public toilet remains unused, resulting in wasted environmental space. After the renovation, the north side of the public toilet's enclosing wall will be expanded, increasing the overall area to approximately 355m². Each module will be incorporated within this expanded space, creating a relatively spacious environment. Based on the terrain, the working area module, men's urinals module, and accessible module will be located on the west side, while the gender-neutral toilet module and additional services module will be placed on the north side, forming a semi-enclosed arrangement (as shown in Fig. 11).
During on-site investigations, it was found that bicycles were often placed haphazardly, causing blockages at the entrance of the public toilet. To address this issue, the bicycle parking area is reorganized, and a canopy and flower beds are added to define the designated area and prevent bicycles from being placed randomly. Additionally, many taxi and ride-hail drivers stop in the area. Therefore, a temporary parking area for cars is planned, along with the installation of charging stations to meet the demand for electric vehicle charging. A canopy design is added based on the application of the modules. Based on lotus leaves as the basic structure, the canopy of the No. 1 Anchasi Street public toilet combines solid and void structures. The lotus leaf structure is placed within the overall design area, and the remaining parts are formed as void structures through spatial segmentation. The combination of solid and void structures, along with the addition of raindrop-inspired lotus leaf shapes, enhances the transparency and aesthetic appeal of the design. The bottom is supported by lotus leaf root structures, creating the final shape (as shown in Fig. 12.13).
And seats will be added in the front transition area of the area, featuring a lotus leaf shaped circular pattern, making it convenient for toilet users to temporarily wait or rest.

The final design of the renovated public toilets prioritized accessibility, hygiene, aesthetics, sustainability, and user comfort. Measures such as installing ramps, widening doorways, and providing signage ensured accessibility for all individuals, including those with disabilities. Regular cleaning schedules and adequate supplies of
soap, toilet paper, and hand sanitizers maintained hygiene standards. The incorporation of touchless technology enhanced sanitation and minimized contact. Vibrant colors, artistic elements, and landscaping were used to create a visually appealing atmosphere (as shown in Fig. 14). Energy-efficient lighting, water-saving fixtures, and environmentally friendly materials promoted sustainability. User comfort was addressed through comfortable seating, well-ventilated spaces, temperature control, and amenities like baby-changing stations. Overall, the design aimed to provide a pleasant and inclusive experience for all users while minimizing environmental impact.

5. Conclusion

The research on renovating public toilets near Daming Lake Scenic Area in Lixia District, Jinan City, has achieved notable outcomes. Through on-site investigations, data collection, and user surveys, a renovation design scheme was developed and evaluated. In summary, the research successfully enhanced the quality and service level of the area's public toilets, meeting diverse user needs. The implemented renovation design garnered positive user feedback. Looking ahead, several recommendations are proposed for future renovations. Firstly, continuous monitoring and maintenance are crucial to ensure normal operation and ongoing service quality improvements. Regular inspections, prompt repairs/replacements, and cleanliness upkeep are essential. Secondly, involving users in decision-making and evaluation processes is vital. Gathering their opinions and suggestions through surveys, workshops, and suggestion boxes can better cater to their needs. Thirdly, innovative technologies like smart management systems, water-saving devices, and eco-friendly materials should be considered to enhance functionality and convenience. Lastly, sustainable development principles like energy conservation, emission reduction, and resource recycling should be prioritized. Well-planned layouts and facility selections can minimize environmental impact, while promoting sustainable management practices. In conclusion, significant progress has been made in renovating public toilets near Daming Lake Scenic Area. The findings offer valuable insights and recommendations for future designs, aiming to improve toilet quality and enhance user satisfaction.

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