Application of Computer Aided Design in the Optimal Design of CBD Micro-green Space: Take Tianhe District, Guangzhou as an Example

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Abstract

In urban renewal and fine governance, micro-green space plays a crucial role in the urban central business district (CBD) due to its efficient use of space, environmental enhancement, and contribution to residents' quality of life. This paper focuses on six representative micro-green spaces in Tianhe District of Guangzhou as its research subjects. Employing the post-use assessment (POE) method, combined with questionnaire surveys and interviews, this study conducts data collection and coupling analysis on the physical space status, user behavior, and demand of green spaces from the user perspective. The results indicate that while the micro-green space construction foundation of the CBD in Tianhe District of Guangzhou is sound, several common problems exist in urban green space planning, facility perfection, regional characteristics, and later maintenance. In light of these issues, and in conjunction with user needs, this paper proposes an optimization design strategy comprising system planning and function integration, soft space boundary layout, additional landscape facilities, multi-level plant healing space, and cultural landscape with Guangfu characteristics. A more intuitive computer-aided design method is employed to simulate the landscape optimization design results of micro-green space, aiming to meet the needs of the public and enhance the quality of the urban environment. This will further improve the quality of the urban ecological environment and citizens' quality of life.

Keywords: Micro green space, post-occupancy evaluation (POE), CBD space, green landscape space, computer-aided design.

1. Introduction

In urban renewal and fine-grained governance initiatives, micro-green spaces play a crucial role in optimizing space utilization, enhancing environmental quality, and improving residents' quality of life. These spaces alleviate urban syndromes, such as dust and heat, generated by the interconnected network of reinforced concrete structures and roads in central business districts (CBDs), effectively alleviating the "urban irritability" experienced by individuals working in these areas for extended periods **Error! Reference source not found.**. This is an essential aspect of CBD green spaces. Micro-green spaces are small-scale, public, open spaces designed for urban populations [2], aiming to offer nearby residents with areas for relaxation and social interaction. These spaces take on various forms, including small parks, street green spaces, and three-dimensional greenery integrated into buildings, such as roofs, terraces, and balconies [3]. Currently, there is no universally accepted definition regarding the area size of micro-green spaces or pocket parks. Referencing China's Park Design Code, it is generally understood that green spaces with an area less than 1hm2 can be classified as micro-green spaces or pocket parks [4][6]. Due to their adaptable layouts and multifaceted functions, micro-green spaces have

captivated increasing attention as a prominent research area in ecology, landscape design, and other related fields. They are also recognized as a significant trend in high-density urban development [7][8].

However, current foundational research on micro-green spaces and pocket parks in urban central business districts (CBDs) remains limited [8]. Specifically, the construction and renovation of public green spaces often prioritize design, neglecting evidence-based research and post-occupancy evaluations. This discrepancy often results in a significant difference between intended design functionality and actual user experience [9]. The landscape planning, facilities, services, and regional characteristics of micro-green spaces in the Tianhe District CBD present numerous challenges. Therefore, this study conducts an in-depth analysis into micro-green spaces in the Tianhe District CBD, aiming to offer optimization strategies for rational planning and design from a user-centric perspective, thereby better aligning with urban development needs.

With advancements in science and technology and the onset of the information age, computer-aided design (CAD) represents a fundamental tool supporting modern landscape design. CAD empowers designers to conceptualize, refine, and present designs with enhanced efficiency and precision [10].

This study evaluates six typical CBD micro-green spaces in Guangzhou's Tianhe District. Employing the Post-Occupancy Evaluation (POE) method, this study analyzes the physical space, user behavior, demand, and other aspects of these micro-green spaces. In addition, it analyzes their shortcomings in conjunction with users' post-use evaluations of CBD micro-green spaces. To cultivate sustainable urban development and inform future research and practice, this study proposes optimization suggestions for CBD micro-green space patterns and landscape design, including the optimization effects of computer-aided design simulation.

2. Overview of CBD Micro Green Space in Tianhe District, Guangzhou

Guangzhou is a rapidly developing megacity [11], with Tianhe District characterized by a large population and high density. The central business district consists of a planned area of 20 square kilometers, including a built-up area of 12 square kilometers, with an additional 8 square kilometers under development and construction as part of the Guangzhou International City (Note: data sourced from the People's Government of Guangzhou Tianhe https://zs.thnet.gov.cn/index). However, with urban land reaching saturation, expanding public green spaces to meet the growing needs of the population has become increasingly difficult, leading to an overburdened system. This has resulted in conflicts between the city and urban life, and between urban residents and available open spaces [12]. In high population flow, density, and intensity, micro green spaces, transformed from fragmented, small, and vertical spaces in the city, offer a crucial supplement to large and medium-sized parks. They effectively reduce the contradiction between recreational space supply and demand in high-density urban areas [13][16] while offering nearby residents a much-needed respite from daily stressors. Characterized by their "small scale, targeted functions, strong community focus, human scale, and diverse venues", these spaces facilitate physical and mental rejuvenation and restoration [17][19].

3. Research Methods for Post-use Evaluation of Micro Green Space

3.1 Post-use evaluation method

The concept of post-occupancy evaluation (POE) was originally introduced by American scholars Preiser, Rabinowitz, and White [20]. Employing a mixed-methods approach, POE synthesizes extensive data through observation, documentation, questionnaires, interviews, and other research methods. This in-depth analysis generates an evaluation report on the utilization of outdoor spaces, with a central focus on user needs and experiences. By analyzing the effect of previous design choices and facility operations, POE offers valuable insights to inform future design [21]. In addition to optimizing operational management for completed projects, this method offers crucial guidance for similar projects from the early design stages. The theories and methods of post-occupancy evaluation have progressively matured, prompting discussions on evaluation criteria and corresponding measurement indicators. This has led to the extension of POE into other domains in China, including urban design and garden design [22]. However, comprehensive evaluation research specifically focused on urban CBD usage remains in its exploratory stages of exploration.

3.2 Survey subjects and scope

This study focuses on six micro green spaces in the Tianhe District CBD of Guangzhou: the green space in KWG International Financial Plaza, the green space next to KWG International Financial Plaza, the miniature green space beside Guangzhou Avenue, the Guangzhou Avenue pocket park, the miniature green space next to Rosewood Hotel, and the Guangzhou East Station front square green space. Representing a diverse range of site conditions and surrounding demographics in the core area of Tianhe District CBD, these six green spaces offer valuable insights into micro green space utilization. The general situation is shown in Table 1 as follows:

Table 1 Basic information of six micro green areas.

Survey Sample	Green space characteristics	Location	Area/m^2	Landscape Keywords
Green space in KWG International Financial Plaza	Located in the core financial area, offering a quiet resting space	No. 8 Huaxia Road, Zhujiang New Town, KWG International Financial Plaza	1139	Flat square venue, central water feature, circular rest seats, open green space
Green space next to KWG International Financial Plaza	Located in the core financial area, small but exquisite	Next to KWG International Financial Plaza, Huaxia Road, Zhujiang New Town	412	Flat, strip-shaped area, tree pools, streetside green spaces, open green spaces
Miniature green space beside Guangzhou Avenue	Adjacent to the main urban road in Tianhe District, relieving traffic pressure and improving air quality	Between Guangzhou Avenue Middle and Huaxun Street	3728	Square venues, tree pits, hard ground squares, open green spaces
Guangzhou Avenue Pocket Park	A small open space with greenery beside the main road in Tianhe District	Between Guangzhou Avenue Middle and Huaxun Street	3265	Rectangular site, plant enclosure, tree pond, two entrances and exits
Miniature green space next to Rosewood Hotel	Located in a high-end business district, an artistic outdoor leisure space	No. 6 Zhujiang East Road, next to Rosewood Guangzhou	6156	Flat rectangular site, plant enclosure, open small lawn, fountain, five entrances, and exits
Guangzhou East Station front square green space	The green space attached to the transportation hub demonstrates the image of the city	Linhe Middle Road (next to Exit G of Guangzhou East Railway Station Subway Station)	6622	Flat square site, open hard square, left and right tree pools, open green space

Note: The area data comes from the measurement tool on the Mapbox satellite map.

3.3 Survey content and methods

3.3.1 Survey content

From a user perspective, this study focuses on six typical micro-green spaces in the CBD of Guangzhou's Tianhe District. The specific research content is as follows:

(1) Physical Space Analysis: An analysis of the existing green spaces, considering factors such as topography, vegetation, lighting infrastructure, and landscape features, will be conducted to identify potential shortcomings in their current design and construction.

(2) User behavior and demand: Through an analysis of user behavior patterns and space utilization intensity in each green space, considering the demographics of the primary user groups, the study aims to further explain the specific needs and preferences of the community concerning these spaces.

(3) Problem Identification and Design Recommendations: The research will synthesize the findings to identify common issues and challenges in Tianhe District's micro green spaces. Based on these insights, targeted recommendations will be proposed to optimize the design and functionality of such spaces.

3.3.2 Survey methods

To assess the current utilization of micro-green spaces in the Tianhe District CBD, this study employed a mixed-methods approach. Participatory observation and random interviews were conducted across six micro-green spaces in the Tianhe District CBD, in conjunction with the distribution of online and offline questionnaires to measure residents' usage preferences. The survey period spanned from April 1 to May 1, 2023, including both weekdays and holidays. During weekdays in April and May, questionnaire distribution occurred on April 3rd, 13th, 19th, and 26th, specifically between 9:00 AM to 11:00 AM and 2:00 PM to 4:00 PM when green space usage is typically concentrated. During the holidays during the research period, a total of five questionnaire distributions were carried out, random sampling was adopted, and footfall counts were conducted at 15-minute intervals from 9:00 a.m. to 10:00 p.m. The spatial crowd distribution, plant configurations, and

landscape service facilities were selected as the main objects of the study, and the behavioural characteristics of the citizens in the site were recorded.

In addition, the literature research method was used to search for domestic and international research results and opinions on CBD micro green space, and relevant research methods were summarised and analysed, and the theoretical analysis method was used to quantitatively analyse and graphically describe the basic information.

4. Survey Results and Analysis of Micro Green Space in Tianhe District, Guangzhou

A total of 200 questionnaires were distributed and collected, yielding 187 valid responses for an efficiency rate of 93.5% (Table 2). Besides, random interviews were conducted with diverse groups in each green space, deriving a total of 50 interviews. The survey primarily centered on the current state of micro-green spaces in the Tianhe District CBD and the corresponding needs of users. Through the questionnaire, core aspects such as green space planning distribution, spatial boundaries, landscape service facility development, plant landscaping, post-management and maintenance practices, existing challenges, and overall satisfaction levels were subjected to in-depth analysis, in conjunction with discussions on user behavioral characteristics and needs. Finally, a coupling analysis of the current situation and user survey data was performed to formulate comprehensive and effective improvement recommendations.

Table 2 Questionnaire distribution.

Questionnaire distribution	200
Questionnaire collection	200
Valid questionnaire	187
Valid questionnaire rate	93.5 %
Waste roll rate	6.5%

4.1 From the perspective of the current material and spatial situation of micro green space

4.1.1 Current situation survey results

The survey findings regarding Tianhe District's CBD micro-green spaces indicate a fragmented and uneven distribution, failing to establish a cohesive and balanced network structure. The rigid spatial boundaries lack dynamism, decreasing individuals from staying and engaging in social interaction. Landscape service facilities exhibit shortcomings, including inadequate basic functions and a dearth of human-centric amenities such as seating and lighting. Plant landscapings lack seasonal landscapes and Lingnan characteristics, while the richness and layering of plant communities are insufficient. In addition, inadequate post-development management and maintenance practices result in poorly maintained landscapes and compromised sanitation. These issues collectively detract from the overall quality and user experience of these green spaces.

4.1.2 Current situation survey and analysis

(1) Green space planning and distribution: The Urban Green Space Planning Standard dictates that "urban green spaces should be evenly distributed, park green spaces in new urban areas should be evenly distributed, and old urban areas should be optimized in combination with renewal to increase coverage." The National Garden City Standard emphasizes the principle of "small, numerous, and even" distribution. This measure mandates that green space be visible within 300 meters, and gardens accessible within 500 meters [Error! Reference source not found.].

The distribution of micro-green spaces in Tianhe District primarily exhibits fragmentation (Figure 1). Some micro-green spaces cluster near larger square green spaces, while those on the outskirt of the clusters have a scattered distribution along roadways. The significant distance between green spaces results in an unbalanced and dispersed distribution, failing to form a cohesive and balanced micro-green space network structure.
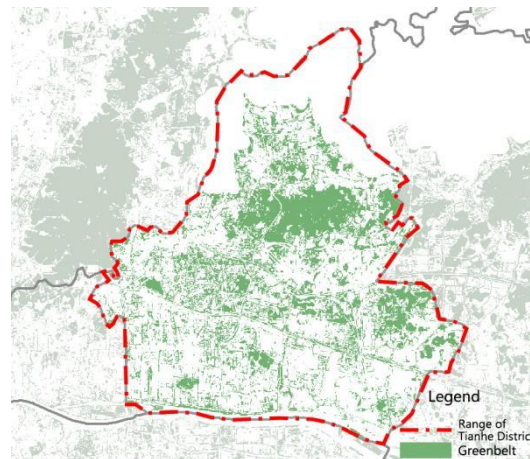
Figure 1 Distribution of green space in Tianhe District

(Note: Image data source research data of Chinese urban green space, https://mp.weixin.qq.com/s/nPuxWwgsqYJ68_v51wDH8w)

(2) Spatial Boundary: The spatial boundary design is crucial for enhancing the usability and appeal of urban areas. In Tianhe District, micro-green spaces along streets exhibit a unique pattern of usage, with flower beds, bumps, corners, border benches, and areas near trees, walls, and stones being particularly popular **Error! Reference source not found.**. However, investigation and observation indicate that the spatial boundary design of many micro-green spaces is overly abrupt (Figure 2), hindering their ability to facilitate lingering and social interaction.

Figure 2 Regular rectangles rigidly divide the space

(3) Construction of landscape service facilities: User feedback indicates that the Tianhe District CBD's micro-green spaces lack sufficient amenities for relaxation, while service facilities lack both aesthetic appeal and a human touch (Figure 3, 4), resulting in a subpar user experience. Firstly, the absence of adequate rest areas in most micro-green spaces fails to accommodate the needs of the public, leading to brief stays. Moreover, the landscape design lacks artistic merit, and the lighting equipment does not adhere to the "Code for Design of Urban Nightscape Lighting" (JGJ/T163-2008) which stipulates that "The horizontal illumination of green space should be ≤3lx (1lx=Lm/m^2)" [14]. This creates potential safety hazards during nighttime, particularly for the elderly who are more susceptible to risks in low-light conditions **Error! Reference source not found.**. Secondly, the green space design overlooks essential human needs, such as the provision of public restrooms, accessible facilities, and children's play areas, it did not suffice in satisfying the diverse needs of citizens of all ages.
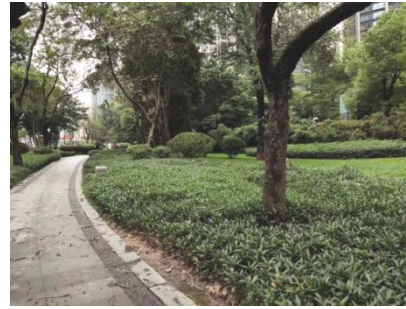
Figure 3 Lack of artistic sense

Figure 4 Lack of lighting facilities

(4) Plant landscaping: During field research conducted in the Tianhe District CBD's micro-green spaces, landmark buildings were adopted as reference points for observation and on-site photography. Then, computer-aided technology, specifically the magic wand and pen tools in Photoshop software, was employed to process the images and assess the green coverage rate of each space (Figure 5-10). Image analysis indicated that all six green spaces featured a green coverage rate exceeding 50%. This abundance of greenery effectively contributes to reducing eye strain and alleviating psychological stress.

Figure 5 Green view rate of Guangzhou East Station front square green space

Figure 6 Green view rate of Guangzhou Avenue Pocket Park

Figure 7 Green view rate of miniature green space beside Guangzhou Avenue

Figure 8 Green view rate of green space next to KWG International Financial Plaza

Figure 9 Green view rate of green space in KWG International Financial Plaza

Figure 10 Green view rate of miniature green space next to Rosewood Hotel

Interviews with users found that despite the year-round evergreen nature of the area, several issues were apparent. These included a lack of plant diversity, limited layering and three-dimensionality, an absence of emphasis on native plants and cultural characteristics, and inadequate plant maintenance and management. The survey identified the primary plant species in the micro-green spaces as banyan trees, Schefflera chinensis, Terminalia microphylla, and Aspidistra spp., resulting in a monotonous palette and a lack of variation in plant strata. therefore, the seasonal landscape changes and the regional characteristics of Lingnan are not effectively demonstrated, reducing the overall aesthetic appeal. Besides, the spatial layout of the micro-green spaces is simplistic, mainly focusing on horizontal expansion with minimal vertical greening elements.

(5) Post-management and maintenance: The survey indicated several inadequacies in the upkeep and maintenance of six representative CBD micro green spaces. Deficiencies were observed in facility maintenance, cleanliness, and overall sanitation. Firstly, the landscape maintenance was subpar, with plant overgrowth in certain areas (Figure 11), detracting from the intended design aesthetics and visual appeal. Besides, the prolonged closure of pools and fountains resulted in a decline in water feature quality (Figure 12). The traces of pet wastes and inadequate night lighting further reduced the landscape's aesthetic and functional value. Secondly, the accumulation of garbage and pet excrement in certain areas, compounded by uncivilized behavior, has led to a decline in environmental quality in these green spaces. The resulting foul odor negatively affects the overall user experience.

Figure 11 Disorderly plants   Figure 12 Lack of water in the fountain landscape

4.2 From the perspective of use

4.2.1 Survey results

The comprehensive survey results indicate that micro-green spaces around the CBD in Tianhe District primarily attract middle-aged and young populations between 18 and 59 years old, with a slight female predominance. Specifically, the age and gender distribution of users may vary slightly across different green spaces. The primary user group comprises individuals employed in the vicinity, with peak visitation occurring during the afternoon period, followed by the evening period. Visitation frequency varies; excluding passerby, the majority of users visit 2~3 times weekly. Regarding behavioral patterns, "necessary activities" such as commuting or waiting for public transportation exhibit the highest frequency and persist throughout the day. These are followed by "spontaneous activities" and social interactions primarily centered around relaxation, enjoying the scenery, and conversation. These activities necessitate the provision of recreational amenities, highlighting the importance of incorporating public facilities into the design. Activities such as gaming are less prevalent, suggesting a lower demand for play-oriented amenities in micro green spaces near commercial areas. In summary, micro green spaces primarily offer recreational areas for business professionals, with their utilization closely associated with the work environment and exhibiting unique daily behavioral patterns.

(1) Green space users: A thorough analysis of questionnaire and interview data across all research sites, as depicted in Figure 13, indicates that women comprise a larger portion of users (57.81%) compared to men (42.19%). In addition, the user base is mainly in the 18~39 age range (57.81%), followed by the age group of 40~59 years old (19.83%), whereas the age group of 60 years and above accounts for 11.39%. Details are presented in Figures 13 and 14 as follows:
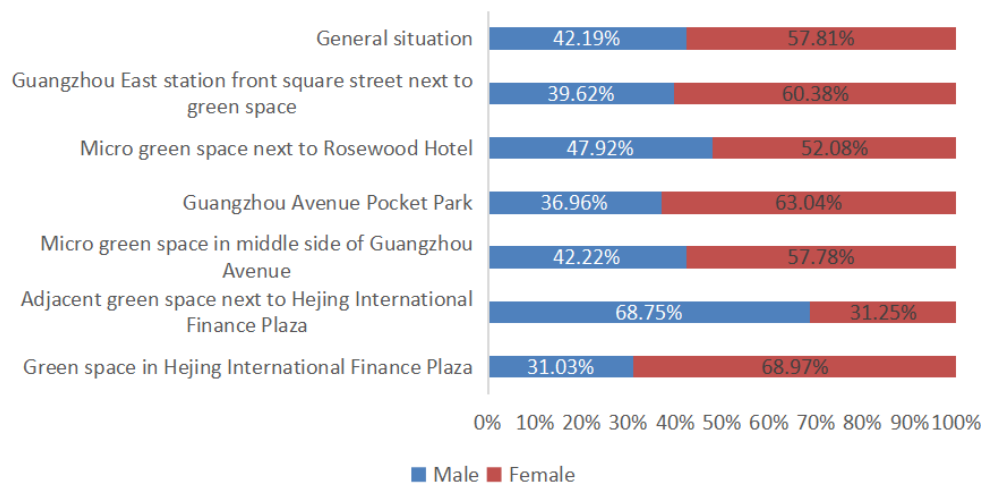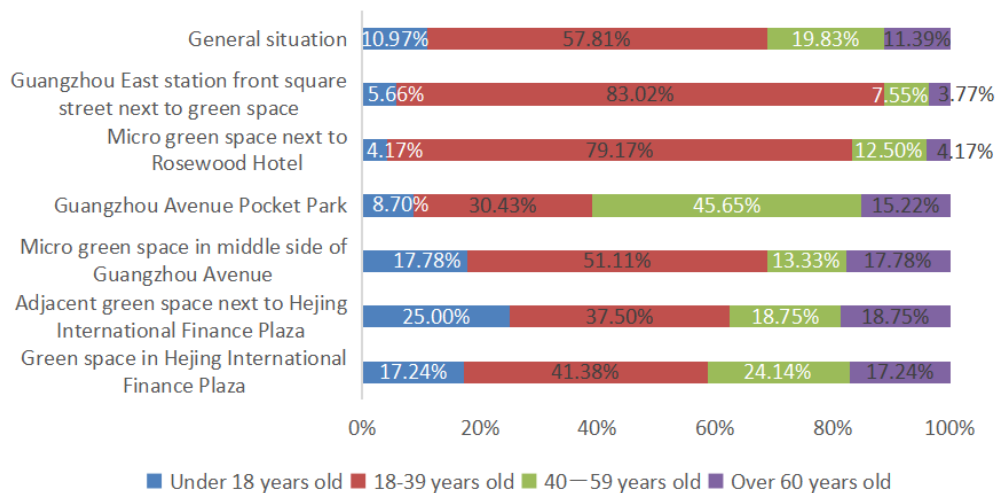
Figure 13 Gender of green space users

Figure 14 Age composition of green space users

(2) Visits by green space users: An analysis of green space user frequency and visit duration across each surveyed area (Figure 15). According to the analysis, 36.71% of the users are "passerby" with limited length of stay in the green space. This is followed closely by the users who visits once every 2~3 days (21.52%); while the remaining users exhibit a relatively uniform distribution in their visit frequency, where 12.24% visit at least once or multiple times per day, another 12.24% visit every 4~5 days, and 17.3% visit once every 6~7 days. A study of daily visit times, as depicted in Figure 15, indicates a peak in user activity during the afternoon hours. Across all six green spaces, morning visits account for 34.14% of total visits. Among the afternoon users, excluding the relatively limited use of green space in KWG International Financial Plaza (10.34%), the portion of user activity exceeds 30% across all five green spaces. Considering the location of all surveyed green areas in the vicinity of the CBD, and considering user demographics and visit times, it can be inferred that the primary users of these spaces are young and middle-aged adults between 18-39 years old, with peak usage occurring during afternoon and evening hours. Moreover, the user base of these CBD-adjacent green spaces appears to consist predominately of the surrounding working population and residents, utilizing these areas for leisure and respite. Details are presented in the charts (Figure 16, Table 3) as follows:
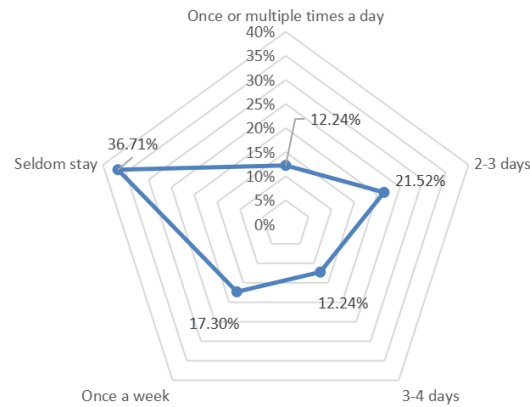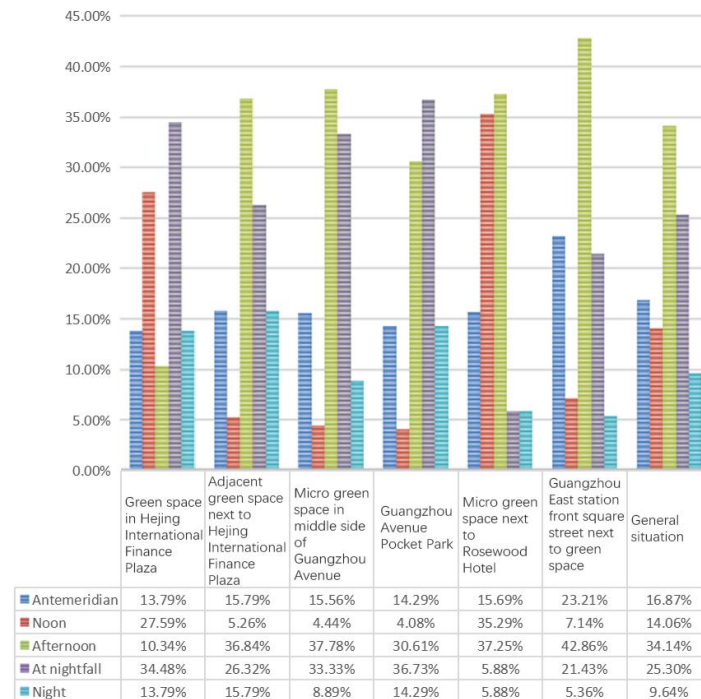
Figure 15 Frequency of users reaching green space

	Green space in Hejing International Finance Plaza	Adjacent green space next to Hejing International Finance Plaza	Micro green space in middle side of Guangzhou Avenue	Guangzhou Avenue Pocket Park	Micro green space next to Rosewood Hotel	Guangzhou East station front square street next to green space	General situation
Antemeridian	13.79%	15.79%	15.56%	14.29%	15.69%	23.21%	16.87%
Noon	27.59%	5.26%	4.44%	4.08%	35.29%	7.14%	14.06%
Afternoon	10.34%	36.84%	37.78%	30.61%	37.25%	42.86%	34.14%
At nightfall	34.48%	26.32%	33.33%	36.73%	5.88%	21.43%	25.30%
Night	13.79%	15.79%	8.89%	14.29%	5.88%	5.36%	9.64%

Figure 16 Period when users arrive at green space

Table 3 Period for users to arrive at green spaces.

period	Green space in KWG International Financial Plaza		Green space next to KWG International Financial Plaza		Miniature green space beside Guangzhou Avenue		Guangzhou Avenue Pocket Park		Miniature green space next to Rosewood Hotel		Guangzhou East Station front square green space	
	Number of arrivals	Proportion	Number of arrivals	Proportion	Number of arrivals	Proportion	Number of arrivals	Proportion	Number of arrivals	Proportion	Number of arrivals	Proportion
morning	4	13.79%	3	15.79%	7	15.56%	7	14.29%	8	15.69%	13	23.21%
noon	8	27.59%	1	5.26%	2	4.44%	2	4.08%	18	35.29%	4	7.14%
afternoon	3	10.34%	7	36.84%	17	37.78%	15	30.61%	19	37.25%	24	42.86%
evening	10	34.48%	5	26.32%	15	33.33%	18	36.73%	3	5.88%	12	21.43%
night	4	13.79%	3	15.79%	4	8.89%	7	14.29%	3	5.88%	3	5.36%

Further analysis into the habits of green space users, including extensive field surveys, public surveys, and fixed-point observation of micro green spaces in Tianhe District, has indicated three categories of crowd behavior (Figure 17): necessary activities, such as commuting or waiting for public transportation, typically occurring at transportation hubs; spontaneous activities, such as strolling or relaxation, often taking place in

green spaces near residential areas; and social activities, such as conversation or engaging with children, tending to congregate in green spaces with appealing environments. The ten primary behaviors observed include exercising, cultural recreation, chatting, resting, seeing the sights, walking, looking after children, playing games, passing by and others.
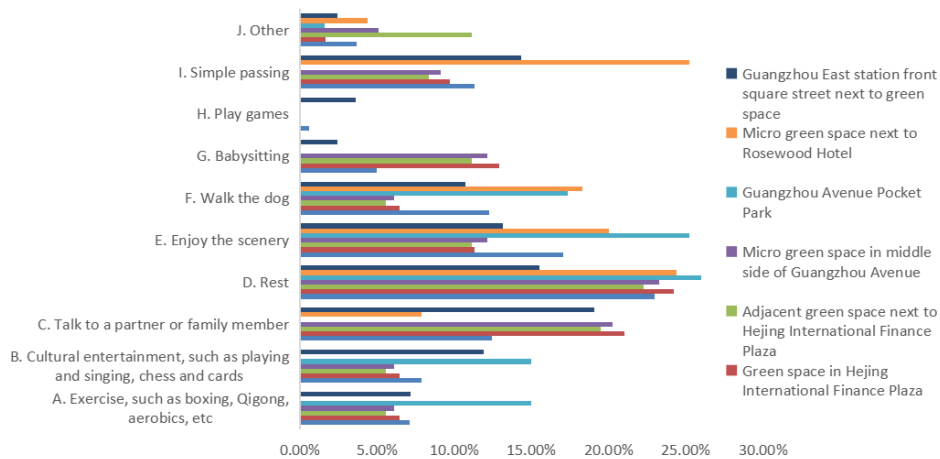

Figure 17 Ten main behaviors of users in green spaces

Analysis of the collected data and interviews indicates that relaxation, enjoying the scenery, conversation with peers or family, walking dogs, and leisurely strolls constitute the primary behavioral activities of miniature green space users. Considering that the majority of users in the surveyed area are business professionals, they constitute the main user group who prefer enjoying afternoon tea during the afternoon period in tranquil environments with comfortable seating. Such amenities can attract them to dine for a brief respite, alleviating the stress of their work environment. Moreover, during the evening hours, following periods of concentrated work, enjoying the scenery in nearby green spaces, engaging in conversation with colleagues appear to be the preferred activities for this demographic. During the morning hours, a greater number of nearby residents can be observed walking their dogs and enjoying leisurely strolls, taking advantage of the tranquility and freshness the morning offers. Among all surveyed areas, the needs for entertainment accounted for the lowest proportion of activities, suggesting that the demand for green spaces near the central business district for recreational purposes is relatively low.

Further analysis of the duration and temporal distribution of various behaviors demonstrates that users who "merely passing by" the micro green space exhibit the most extended period and the highest frequency, spanning up to 15 hours, indicating a relatively high volume of pedestrian traffic in these spaces. Following closely, the frequency of individuals utilizing the micro green space for conversation is second only to the users who "merely passing by", extending up to 13 hours. This behavior necessitates certain amenities for relaxation, highlighting the importance of incorporating public rest facilities into the design process. Due to the limited size of micro green spaces and the limitations on available space for vending, the frequency of stalls and shopping activities remains low, primarily concentrated in the morning hours.

4.3 Coupling analysis of the current physical space of micro green spaces and user survey

A comprehensive analysis of on-site crowd usage observations and questionnaire survey data, as depicted in Table 4 and Figure 18, provides a summary of the analysis between crowd behavior and micro-green spaces. The data indicates that users are primarily drawn to outdoor activities in green spaces due to factors such as convenient accessibility, scenic views with fresh air, sanitation conditions, etc. Specifically, the factor of convenient accessibility constituted the highest proportion (18.64%), followed the factor of closely by scenic views with fresh air (17.67%), and sanitation conditions (15.72%). This analysis highlights a strong correlation between the usage of CBD micro-green spaces and factors such as location, infrastructure, and the quality of the green environment. Appealing street green spaces attract users to enjoy meals or conversations during their lunch breaks. Suboptimal environmental quality discourages individuals from lingering and resting in these

spaces. On the contrary, a higher quality environment encourages extended periods of social interaction and spontaneous activities.

Table 4 Analysis of venue activity period and frequency of use.

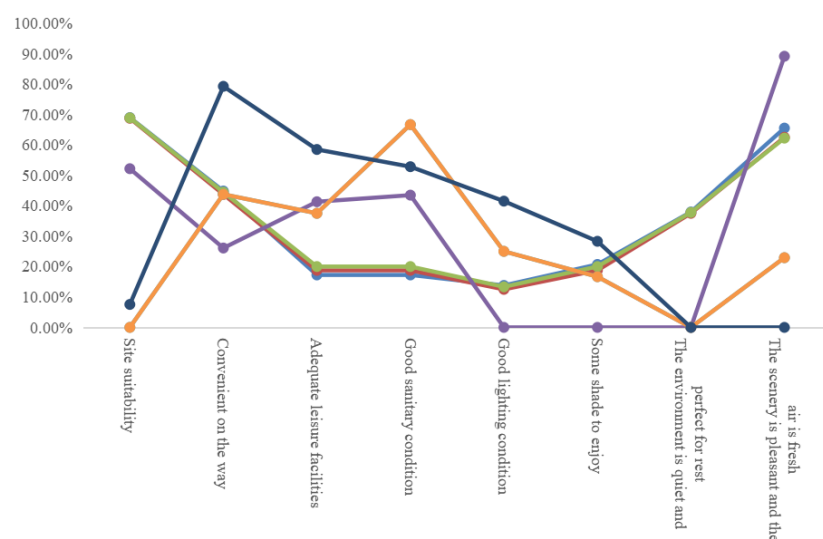| Analysis of causes of outdoor activities	Green space in KWG International Financial Plaza		Green space next to KWG International Financial Plaza		Miniature green space beside Guangzhou Avenue		Guangzhou Avenue Pocket Park		Miniature green space next to Rosewood Hotel		Guangzhou East Station front square green space	
	Frequency	Proportion	Frequency	Proportion	Frequency	Proportion	Frequency	Proportion	Frequency	Proportion	Frequency	Proportion
Suitable site size	20	24.10%	11	24.44%	31	24.03%	24	20.69%	0	0.00%	4	2.82%
Convenient on the way	13	15.66%	7	15.56%	20	15.50%	12	10.34%	21	20.59%	42	29.58%
Adequate recreational facilities	5	6.02%	3	6.67%	9	6.98%	19	16.38%	18	17.65%	31	21.83%
Good sanitary conditions	5	6.02%	3	6.67%	9	6.98%	20	17.24%	32	31.37%	28	19.72%
Good lighting conditions	4	4.82%	2	4.44%	6	4.65%	0	0.00%	12	11.76%	22	15.49%
shade trees	6	7.23%	3	6.67%	9	6.98%	0	0.00%	8	7.84%	15	10.56%
Quiet environment, suitable for rest	11	13.25%	6	13.33%	17	13.18%	0	0.00%	0	0.00%	0	0.00%
Pleasant scenery and fresh air	19	22.89%	10	22.22%	28	21.71%	41	35.34%	11	10.78%	0	0.00%

Figure 18 Analysis of the main reasons for outdoor activities in street green spaces

5. Space Optimization Strategy for Micro Green Spaces in Tianhe District

5.1 Green space optimization strategy

5.1.1 Micro green space system planning and functional integration under the guidance of top-level design

The spatial layout of CBD micro-green spaces necessitates a comprehensive and systematic micro-green space layout plan guided by top-level design principles [23],**Error! Reference source not found.**. This plan must consider factors such as accessibility, connectivity, and frequency of use to ensure equitable distribution throughout the business district, effectively serving the needs of both office workers and residents. Connect fragmented micro-green spaces through the addition of walking and cycling paths to form a complete green network. Establishing "green corridors" that connect various sections of the business district through green spaces further enhances spatial coherence and accessibility. Micro-green space design should incorporate diverse functions and landscapes to cater to a wide range of user preferences while promoting functional complementarity between green spaces.

Simultaneously, adhering to principles of eco-friendliness and sustainability, cultivating public engagement and community collaboration, and regularly updating the green space layout plan in response to urban development and population shifts are crucial. These actions ensure the green space system remains aligned with the evolving needs of the city, contributing to the creation of a more livable and healthy urban green space system.

5.1.2 Soft border processing and optimized space layout

The optimization of the boundary design by incorporating curves and irregular shapes, departs from rigid straight lines and angles. Introduce flexible landscape elements such as plant hedges, small landscape features at the boundary, or mixed paving that combines hard surfaces with turf or ground cover plants. Moreover, consider incorporating iconic and allegorical paving patterns to offer visual guidance, which not only strengthens the different functional areas in the green space but also reduces visual fatigue, offering a and welcoming spatial experience. These design strategies soften the transition between the green space and the surrounding urban environment, cultivating a sense of fluidity and intimacy in the space while enhancing the attractiveness and practicality of the site.

5.1.3 Add landscape service facilities

To cater to the diverse needs of user groups, micro green spaces should be equipped with a variety of service and recreational amenities [25] that reflect artistic beauty and human-centered design principles. Examples include aesthetically pleasing sunshade pavilions, public restrooms, conveniently located shared charging stations, tree ponds, and flower beds with integrated rest areas, and essential barrier-free facilities. These amenities enhance the comfort of use and introduce a sense of layering to the landscape.

In terms of nighttime illumination, lighting facilities imbue the micro green space in the city's CBD with vibrancy. This not only strengthens the recognition of the central area and cultivates a unique ambiance but also enhances safety for citizens engaging in nighttime activities. The placement and effects of lighting elements create a dreamlike nocturnal garden that stands in contrast to its daytime counterpart. Trees, vegetation, waterscapes, and buildings take on an enchanting charm under the background of light and shadow, beckoning individuals to enter a serene and mysterious world. A leisurely stroll here offers a temporary escape from the city's bustle, allowing one to immerse themselves in the harmony and tranquility of nature.

In areas with suitable terrain, recreational facilities catering to all age groups can be integrated to fulfill the leisure needs of community residents. These multifunctional amenities transform micro-green spaces into idyllic settings for daily relaxation and act as vital spaces for cultivating community culture and recreational exchanges, significantly enhancing the quality of urban life and enhancing residents' well-being.

Utilizing the rendering and modeling capabilities of Photoshop and SketchUp design software, night atmosphere diagrams for a CBD micro-green space were created (Figures 19-24). In addition, effect diagrams illustrating landscape rest facilities, charging kiosks, fitness and entertainment facilities, etc. were generated (Figures 25-32). These diagrams effectively visualize the optimized micro-green space, showcasing its aesthetic appeal, comfort, and composite functionality. This approach reflects the integration of efficient space utilization and the principles of ecological city design.
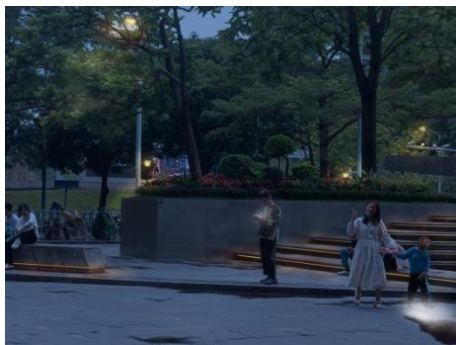

Figure 19 Night view of the green space in KWG   Figure 20 Night view of the green space next to KWG
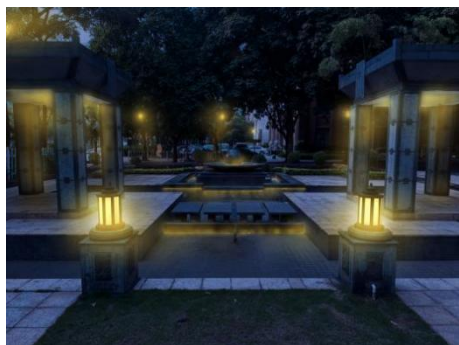
International Financial Plaza

International Financial Plaza

Figure 21 Night view of the miniature green space beside Guangzhou Avenue

Figure 22 Night view of the Guangzhou Avenue Pocket Park
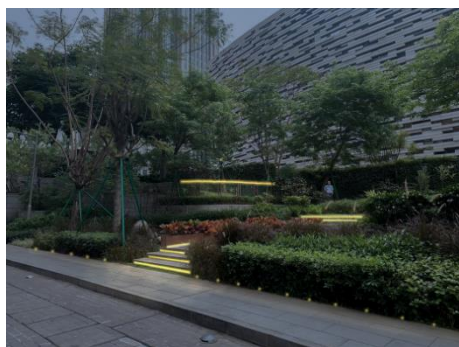

Figure 23 Night view of the miniature green space next to the Rosewood Hotel

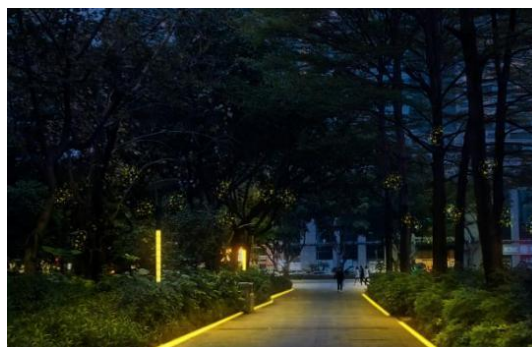Figure 24 Night view of the Guangzhou East Station front square green space

Figure 25 Landscape chairs in the Guangzhou Avenue Pocket Park

Figure 26 Landscape chairs in the miniature green space beside Guangzhou Avenue

Figure 27 Landscape seats in the Guangzhou East Station front square green space

Figure 28 A resting landscape pavilion in the Guangzhou East Station front square green space

Figure 29 Charging chairs in the Guangzhou East Station front square green space

Figure 30 Charging chairs in the Guangzhou Avenue Pocket Park

Figure 31 Fitness facilities in the Guangzhou Avenue Pocket Park

Figure 32 Entertainment facilities in the Guangzhou East Station front square green space

5.1.4 Create a multi-level plant healing space

According to the environmental characteristics of the micro-green space and the subtropical monsoon climate of Guangzhou, we integrated sponge city technologies into the plant landscaping of the CBD micro-green space. These technologies, including permeable pavement, grass-planted ditches, rainwater gardens, and sunken green spaces, collectively contribute to the establishment of an ecologically sound and visually captivating plant landscape. in the key visual zones or designated rest areas of the CBD micro-green space, a five-tiered planting space landscaping can be implemented (Table 5). This configuration comprises landscape-defining large trees, medium-sized trees, a variety of smaller trees, large shrubs and spherical plants, small shrubs, and ground cover shrubs, and finally, seasonal flowers interspersed with lawns. The resulting landscape effect is characterized by rich layering and diverse visual appeal. Alternatively, a micro-topography with undulating terrain can be designed. By leveraging the therapeutic properties of garden plants (Table 6 and 7), a five-sense garden with "healing power" can be established in designated "moving" and "quiet" spaces (Figures 33 and 34). At landscape nodes intended for social gatherings, a plant community integrating aesthetics and ecology can be created through the incorporation of elements such as plant aroma, color, texture, sound, and touch [26].

Table 5 Five sense plant configuration table.

Five Senses	Serial number	name	category	Flowering period	Latin	Ornamental characteristics	Remark
visual feeling	1	Kapok	arbor	March-April	Bombax malabaricum DC. (Bombacaceae)	The bark is grayish white, the flowers are solitary, usually red, large, and beautiful, and the tree has a majestic posture. It can be planted as an ornamental tree in the garden or as a street tree.	Native tree species
	2	Roystonea regia	arbor	March-April	Roystonea regia (Kunth) OF Cook (Palmae)	The trunk is thick and straight, and the leaves spread out naturally, resembling a big umbrella. The tree is tall and the trunk resembles a wine bottle.	Native tree species
	3	Handroanthus chrysotrichus	arbor	March-April	Handroanthus chrysanthus (Jacq.) S.O.Grose	The branches and leaves are sparse in the spring, with yellow flowers blooming around the Qingming Festival. In the summer, the leaves grow and bear pods. In the autumn, the branches and leaves are lush. In the winter, the branches and leaves fall.	
	4	Kurogane Holly	arbor	March-April	Ilex rotunda Thunb. (Aquifoliaceae)	The branches and leaves are luxuriant and evergreen all year round. The flowers turn from yellow to red. The holly trees are strong and healthy, and the tree shape is simple and beautiful.	Native tree species
	5	Michelia chapensis	arbor	March-April	Michelia chapensis Dandy (Magnoliaceae)	The tree has a beautiful shape, luxuriant branches and leaves, and fragrant flowers. It is a precious tree species for garden greening and ecological landscape.	Native tree species
	6	Ochna integerrima	shrub	March-April	Ochna integerrima (Lour.) Merr.	The seeds of the nasturtium turn from green to black. They are suitable for cultivation in botanical gardens and parks for	Native tree species

				(Ochnaceae)	science education and can also be utilized as a landscape tree species.	
7	Woodfordia fruticosa	shrub	March-April	Woodfordia fruticosa (L.) Kurz. (Lythraceae)	The flowers are shaped akin to small shrimps and are usually cultivated for ornamental purposes. They are suitable for planting in courtyards, pools, lawns, or as potted plants.	Native tree species
8	Bauhinia variegata	arbor	March-May	Bauhinia variegata	The tree is deciduous with dark brown, nearly smooth bark and leathery, broadly ovate to nearly round leaves. It blooms in many seasons, and the flowers are almost all purple-red.	Native tree species
9	Vernicia montana	arbor	March-May	Vernicia montana Lour. (Euphorbiaceae)	The tree is deciduous. The petals are white or purple-red at the base with purple-red veins.	Native tree species
10	Saraca dives	arbor	March-May	Saraca dives (Leguminosae)	The young leaves are slightly purple-red, and the leaflets are nearly leathery, oblong, ovate-lanceolate, or obovate. The flowers are large and beautiful, making it a good garden and ornamental tree species.	
11	Viburnum macrocephalum	shrub	March-May	Weigela japonica Thunb. var. sinica (Rehd.) Bailey (Caprifoliaceae)	The inflorescences are large white flowers that resemble hydrangeas and are beautiful. It is an excellent ornamental tree species for landscaping.	
12	Musa basjoo Siebold	Herb	March-May	Musa basjoo (Musaceae)	The leaves are bright green, and the petioles are thick. It is mostly cultivated in gardens and near farmhouses.	
13	Rose	shrub	March-July	Rosa chinensis Jacq. (Rosaceae)	The flowers are mostly small in shape, mostly pink or red, and can be utilized as ornamental plants.	
14	Acer palmatum	arbor	March-August	Acer palmatum Thunb. (Aceraceae)	The leaves are beautiful in shape and turn bright red in autumn. They are as bright as flowers and as brilliant as clouds. It is an excellent ornamental foliage tree species.	
15	Callistemon rigidus	shrub	March-October	Callistemon rigidus R. Br. (Myrtaceae)	The flowers are peculiar in shape, bright and beautiful in color, and resemble flaming red flowers when blooming. They are of high ornamental value.	
16	Tall Bottle-brush	shrub	March-October	Callistemon viminalis (Soland.) Cheel.	The flower resembles a red bottle brush, hence its name "red brush." The branches are soft and drooping. It is a flowering ornamental plant in the city or garden.	
17	Jacaranda mimosifolia	arbor	April-May	Jacaranda mimosifolia D. Don (Bignoniaceae)	The tree is full of purple-blue flowers during the flowering period. The flowers are elegant and beautiful, and the tree shape, and branches and leaves are graceful.	
18	Erythrina variegata	arbor	April-May	Erythrina variegata Linn. (Leguminosae)	The flowers are large, bright red, shaped akin to peppers, and have long inflorescences.	
19	Amaryllis	Herbal	April-May	Hippeastrum rutilum (Ker-Gawl.) Herb. (Amaryllidaceae)	The bulb is nearly spherical, with tepals, magenta, slightly green, and small scales on the throat.	
20	Salvia farinacea	Herbal	April-October	Salvia farinacea Benth.	It has strong growth potential, long and fragrant flowering period, and can be widely utilized in the beautification of roadside greening, flower beds, and garden attractions.	
21	Yulania denudata	arbor	May-June	Magnolia denudata Desr. (Magnoliaceae)	It is a deciduous or evergreen tree or shrub with spreading branches forming a broad crown.	Native tree species
22	Banyan Tree	arbor	May-June	Ficus microcarpa (Moraceae)	Old trees often have aerial roots, dark grey bark, and thin leathery leaves with a dark green surface.	Native tree species
23	Hybrida vicary privet	shrub	May-June	Ligustrum vicaryi	The leaf leather is thin, the new leaves are golden yellow, and the old leaves are yellow-green to green.	
24	Iris	Herbal	May-June	Iris tectorum (Iridaceae)	The flowers are blue-purple and can be utilized for ornamental purposes. They have a light fragrance and can be utilized to make perfume.	
25	Schima superba	arbor	May-August	Schima superba Gardn. et Champ. (Theaceae)	It prefers light and tolerates shade when young. It is an excellent tree species for greening and timber.	Native tree species
26	Teak	arbor	May-August	Tectona grandis L. f. (Verbenaceae)	The bark is brown or gray, the branches are quadrangular, the leaves are extremely large and oval, and it blooms in autumn. The flowers are white and fragrant.	
27	Salvia splendens	Herb	May-November	Salvia splendens Ker-Gawl. (Labiatae)	The flowers are in the shape of small long tubes, bright red in color, and resemble red firecrackers when they bloom.	
28	Lagerstroemia	arbor	June-September	Lagerstroemia indica L. (Lythraceae)	The tree is graceful, with smooth and clean trunks and brightly colored flowers.	Native tree species
29	Daylily	Herb	June-September	Hemerocallis fulva (L.) L. (Liliaceae)	The corolla is funnel-shaped, mostly orange-red or bright yellow.	
30	Camellia	shrub	October-April of the following year	Camellia japonica L. (Theaceae)	There are many varieties of flower colors, most are red or light red, and some are white.	Native tree species
31	Bougainvillea glabra	shrub	November-June of the following	Bougainvillea glabra Choisy (Nyctaginaceae)	The flowers are small, yellow-green, and the red bracts on the periphery are large and beautiful, ranging from bright red, orange, and purple, to milky white.	

|						
			year			
	32	Tabebuia roseo-alba	arbor	December-March of the following year	Tabebuia pentaphylla	The corolla is bell-shaped, five-lobed, pink, with a bright yellow center, and the tree appearance is clear and beautiful.	
olfactory sensation	33	Cinnamom um camphora	arbor	March-May	Cinnamomum camphora (L.) presl (Lauraraceae)	The wood is tough, has a fragrant smell, and can purify the air.	Native tree species
	34	Rosemary	shrub	March-September	Rosmarinus officinalis Linn (Labiatae)	The leaves are clustered and linear, and the flowers are nearly sessile and opposite.	
	35	Myrtle	arbor	April-May	Rhodomyrtus tomentosa (Myrtaceae)	The young branches are densely pubescent, the backs of the leaves are gray-white, and the flowers are purple-red.	Native tree species
	36	Lonicera japonica	Herb	April-June	Lonicera japonica Thunb. (Caprifoliaceae)	The smell is fragrant, the taste is light and slightly bitter.	
	37	Rose	shrub	May-September	Rosa multiflora Thunb. (Rosaceae)	The scent is aromatic and can spread far.	
	38	Brunfelsia latifolia	shrub	April-October	Brunfelsia latifolia Benth.	The flowers are blue-purple at first and then turn white. Blue-purple and white flowers can be seen on the same plant.	
	39	Verbena	Herbal	June-August	Verbena officinalis L. (Verbenaceae)	It is a perennial herb with square stems and stiff hairs on nodes and ridges.	Native tree species
	40	Lavender	Herbal	June-September	Lavandula angustifolia (Labiatae)	It has a light fragrance and grassy smell.	
	41	Lythrum salicaria	Herb	July-September	Lythrum salicaria L. (Lythraceae)	The rhizomes lie horizontally underground, and the whole plant is green.	
	42	Mint	Herb	July-September	Mentha haplocalyx Briq. (Labiatae)	It has a light and unique aroma.	
	43	Osmanthus	arbor	September-October	Osmanthus fragrans (Thunb.) Lour. (Oleaceae)	The flowers are small and have a strong fragrance.	Native tree species
auditory sensation	44	Cuckoo	shrub	April-May	Rhododendron simsii Planch. (Ericaceae)	There are many branches, the twigs are fine and dense, and the leaves are diverse in shape and color.	Native tree species
	45	Common nandina	shrub	May-June	Nandina domestica Thunb. (Berberidaceae)	The branches and leaves are green and beautifully shaped, rustling in the wind.	Native tree species
	46	Campanula	Herbal	May-June	Campanula L. (Campanulaceae)	The plant has a sturdy shape, and the flowers are bell-shaped akin to wind chimes, with bright and elegant colors.	
	47	Cyperus alternifoliu s subsp. flabellifor mis	Herbal	September-December	Clinopodium urticifolium (Hance) CY Wu et Hsuan (Labiatae)	The rhizome is short and thick, with hard fibrous roots.	
Tactile sensation	48	Peach	shrub	February-April	Prunus persica	The tree has lush branches, graceful shapes, and beautiful flowers.	
	49	Robinia pseudoacac ia L.	shrub	April-June	Robinia pseucdoacacia	The leaves are similar to those of locust trees, there are stipule thorns on the branches, the bark is thick and dark, and the flowers are white and fragrant.	
	50	Jacobaea maritima	Herbal	June-September	Jacobaea maritima (L.) Pelser & Meijden	The surface is covered with silvery hairs and the leaves are thin. They glow when the light is good.	
	51	Evening Primrose	Herbal	June-September	Oenothera biennis L. (Onagraceae)	The basal rosette of leaves is close to the ground and is often mixed with glandular hairs at the upper ends of the stems and branches.	
Taste	52	litchi	arbor	March-April	Litchi chinensis Sonn. (Sapindaceae)	The trunk is fine, solid, moisture-resistant, and anti-corrosive, making it an excellent wood for building houses, boats, bridges, and making furniture.	Native tree species
	53	Cattail	Herbal	March-June	Typha orientalis (Typhaceae)	The rhizome is milky white. The aboveground stem is thick and gradually tapers upwards.	Native tree species
	54	Wolfberry	Herb	April-May	Lycium chinense Mill. (Solanaceae)	The branches are thin and light gray, and the corolla is funnel-shaped.	
	55	Pomegrana te	arbor	May-July	Punica granatum L. (Punicaceae)	The young branches are angular, the old branches are nearly cylindrical. The leaves are papery and the petals are usually large and red, yellow, or white.	
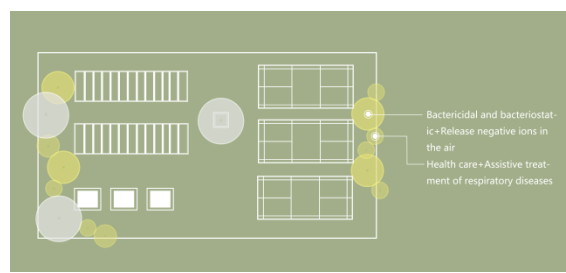
Figure 33 "Moving" space healing plant design
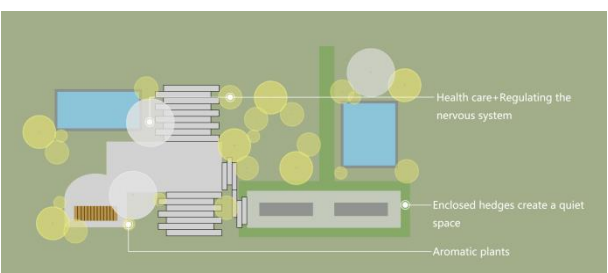
Figure 34 "Quiet" space healing plant design

Table 6 Plant landscaping of "dynamic" space healing plants.

Healing effect		Representative varieties
health benefits	Health care	Callistemon rigidus, Hybrida vicary privet, Acer palmatume
	Release negative ions in the air	Michelia, Osmanthus, Brunfelsia latifolia
	Bactericidal and bacteriostatic	Cinnamomum camphora
	Assistive treatment of respiratory diseases	Callistemon rigidus

Table 7 Plant landscaping of "quiet" space healing plants.

Healing effect		Representative varieties
health benefits	Health care	Callistemon rigidus, Hybrida vicary privet
	Regulating the nervous system	Michelia, Osmanthus, Brunfelsia latifolia
	Regulating the nervous system	Cinnamomum camphora

5.1.5 Create a cultural landscape with Cantonese characteristics

In response to the Green and Beautiful Guangdong - Green and Beautiful Protected Area Enhancement Action, the CBD micro-green space, as an integral facet of urban culture, can leverage digital landscape technology to demonstrate the rich historical culture and artistic legacy of Guangzhou. By employing augmented reality (AR) technology, it is possible to recreate historical scenes, enabling visitors to immerse themselves in the Cantonese culture, a captivating blend of ancient traditions and contemporary dynamism. Moreover, the installation of interactive landscape devices, such as smart signs (Figure 35) and display boards, can narrate the story of harmonious coexistence between humanity and nature, cultivating a deeper public understanding and appreciation for Guangdong's cultural heritage. The introduction of interactive elements, including smart lighting systems, audio equipment, and touch screens, paves the way for customized landscape experiences, such as interactive waterscapes, effectively stimulating public engagement.

In addition, regarding the inheritance of traditional culture, we can draw inspiration from the classic elements of Lingnan gardens, such as wok-ear walls, Manchu windows, gray sculptures, pottery sculptures, brick carvings, wood carvings, and cave windows (Figure 36). Integrating these elements into landscape design can deepen citizens' understanding of local culture through mediums such as cultural walls and popular science corners. Besides, organizing regular cultural events such as exhibitions, performances, and workshops can revitalize public spaces and cultivate community cultural exchange and participation. While preserving and promoting regional culture, it is crucial to ensure these cultural elements harmonize with contemporary design principles, creating a leisure environment that is both traditional and modern.

Figure 35 Addition of electronic weather display screen

Figure 36 Addition of a plaster landscape wall

5.1.6 Strengthen the post-maintenance of green spaces

The maintenance and management of urban public green spaces are paramount in guaranteeing greening quality and ecological equilibrium. Surveys have indicated that the maintenance and management of micro-green spaces are often neglected in post-construction phases, particularly the daily upkeep of water features, transportation infrastructure, and service facilities **Error! Reference source not found.**. The key aspects of green space maintenance consist of strict adherence to maintenance standards, formulating comprehensive maintenance work plans, establishing a robust supervision and assessment mechanism, and offering professional training to enhance technical proficiency. To implement these management measures effectively, several recommendations are proposed: establishing comprehensive laws and regulations to support garden and green space management, increasing investment in maintenance funds to ensure the availability of necessary resources and equipment, promoting market-oriented operations and the transformation of government functions to enhance management efficiency, and by intensifying publicity and education efforts, we aim to strengthen the public's awareness of cherishing and protecting green areas.

6. Conclusion

In the process of urban renewal and fine governance, the optimal design of micro-green spaces has become a crucial component in supplementing outdoor recreational areas. The current state of these spaces holds significant implications for the urban economy, the lives of residents, and the development of a socially and ecologically conscious society. To enhance the efficiency of CBD micro-green spaces, this study employs the POE method to evaluate six such spaces in Guangzhou's Tianhe District. The findings indicate common issues across the six micro-green spaces, comprising aspects such as urban green space planning, facility enhancement, integration of regional characteristics, and ongoing maintenance. Building upon these observations, this study proposes optimization strategies and recommendations. These include: system planning and function integration, flexible soft space boundary layout, incorporation of additional landscape features, the creation of multi-level plant-based healing spaces, and the development of culturally significant landscapes that reflect the unique characteristics of Guangfu. Moreover, the study utilizes computer-aided design simulation to generate optimized renderings. This visualization aims to illustrate how CBD micro-green spaces can cater to the diverse needs of urban residents, transforming them into multifunctional green spaces that infuse the city with vitality. Further research can explore the incorporation of sound landscapes as a design element in CBD green spaces, actively contributing to the ecological development of a greener Guangdong.

References

[1]   Lin Feng, Xu Lei, Research on Landscape Morphology of Urban CBD (Central Business District). Low Carbon World, 2014, (15): 50-51.

[2]   He Hao, Zhu Changli, Qi Xiaoxuan. Research on the planning strategy of high-density urban green space: A case study of Jianghan District, Wuhan City. China city, vol. 2, 2023, pp. 71-77, doi: 10.19924 / j.carol carroll nki. 1674-4144.2023.002.010.

[3]   Qiu Baoxing. Rebuilding urban microcirculation: an upcoming trend. Urban Development Research, vol. 5, 2011, 1-13.

[4]   Zhang Susi. The application of Pocket Park in contemporary urban public space. Chengdu: Southwest Jiaotong University, 2007.

[5]   Hua Kai, Kang Yi. "Pocket Park" in Chaoyang pilot community. Beijing Daily,2014-1-10(6th edition).

[6]   Zhou Jianyou. Analysis on the emergence and development of American pocket park. Urban planning and Design, Beijing: Beijing Forestry University,2010

[7]   Wong N H, et al. Thermal evaluation of vertical greenery systems for building walls.Building and Environment, vol. 45, 2010, pp. 663-672.

[8]   Chen jing. Micro high-density urban green space design based on biological community diversity study. Journal of landscape garden Lin, vol. 1, 2014, pp. 59-62, doi:10.14085/j.f jyl. 2014.01.007.

[9]   Bai Xu, Yu Changsheng. An exploration of urban park public environment renewal based on post-use evaluation: A case study of Fusheng Park in Longchang City, Sichuan Province. China city, vol. 3, 2024, pp. 64-71, doi: 10.19924/j.carol carroll nki. 1674-4144.2024.003.009.

[10]   Lu Yin. Application of Computer-Aided Design Software in Landscape design. Information recording materials, vol. 1 2021, pp. 90-91, doi: 10.16009/j.carol carroll nki cn13-1295/tq. 2021.01.061.

[11]   Gong Zhihai. Typical urban carbon emissions accounting in our country and its driving factors analysis. Jiangxi normal university, 2020, doi: 10.27178/dc nki. Gjxsu. 2019.000420.

[12]   Zhang Yunlu, Li Xiong. Habitat renewal and green Leadership: the goal and path of urban renewal integrating landscape architectur. Landscape architecture, vol. 28, 2021, pp. 42-46, doi: 10.14085/j.f jyl. 2021.09.0042.05.

[13]   He Kun, Qin Zhenyan, Wang Benyao, et al. See "Micro" Knowledge: The status quo, frontiers and prospects of urban small and micro green space research, Chinese Journal of Landscape Architecture, vol.40, 2023, pp. 9-97.

[14]   Włodarczyk-Marciniak R, Sikorska D, Krauze K. Residents' awareness of the role of informal green spaces in a post-industrial city, with a focus on regulating services and urban adaptation potential. Sustain Cities Soc, vol. 59, p. 102236, August 2020 Aug, doi: 10.1016/j.scs.2020.102236. [Epub 2020 May 8. PMID: 32395422; PMCID: PMC7207117].

[15]   Plaku Rovena. Greenification of Dense Neighborhoods Through Pocket Parks— Inspiring Small Spaces to Transform Cities: The Case Study of Tirana, Albania. Springer Nature Switzerland, 2024, pp. 131-147.

[16]   Stefanie Kley and Tetiana Dovbischuk. The equigenic potential of green window views for city dwellers' well-being. Sustainable Cities and Society, vol. 108, 2024, pp. 105511-.

[17]   Escobedo F J,Giannico V, Jim C Y, et al. Urban Forests, Ecosystem Services, Green linfrastructure and Nature-based Solutions: Nexus or Evolving Metaphors?. Urban Forestry&Urban Greening, vol.37, 2019, pp. 3-12.

[18]   Paloma Egea Cariñanos et al. Uses, attitudes and perceptions of urban green spaces according to the sociodemographic profile: An exploratory analysis in Spain. Cities, vol.150, 2024, p. 104996-.

[19]   McCarthy Laura Jane and Russo Alessio. Exploring the role of nature-based typologies and stewardship schemes in enhancing urban green spaces: Citizen perceptions of landscape design scenarios and ecosystem services. Journal of Environmental Management, vol. 346, 2023, pp. 118944-118944.

[20]   Zhang Yiyao. Analysis on the application of POE in Landscape design. Modern garden art, vol.44, 2021, pp. 140-142, doi: 10.14051 / j.carol carroll nki xdyy. 2021.11.055.

[21]   Liao Yuxiang. Study on Xiangmi Park in Shenzhen City based on Post Use Evaluation (POE).] Urban construction, vol. 19, 2022, pp. 92-94, doi:10.19892 / j.carol carroll nki CSJZ. 2022.18.28.

[22]   Lu Jing. Spatial Analysis and landscape Optimization of urban conglomeration fitness activities. Fujian Agriculture and Forestry University,2016.

[23]   Song Zhengna, Chen Wen, Zhang Guixiang, et al. Spatial accessibility of public service facilities and its measurement methods. Progress in Geography, vol. 29, 2010, 1217-1224.

[24]   Battiston Alice and Schifanella Rossano. On the need for a multi-dimensional framework to measure accessibility to urban green. npj Urban Sustainability, 2024, 4(1), 1-11

[25]   Sacks Justin and Coulton Paul and Galabo Rosendy. Governing with Nature: Applying More-than-Human Design to the Management of Shared Urban Green Space. Springer Nature Singapore, 2022, pp. 3624-3624.

[26]   Sun Wei. Research on Landscape design of urban micro-green space. Anhui Agricultural University, 2019.