Utility Evaluation and Planning Implications of Large City-Ring Parks: A Case Study of Shanghai

WAN Yi, ZHAO Min

Abstract: Taking Shanghai's large city-ring parks as the study object, this paper evaluates their recreational-service utility by combining utility theory with big-data analysis. First, the off-season and peak-season performance of the sample parks is assessed along three dimensions: service intensity, service scope, and service attributes. Second, differences in utility are explained through a comparative analysis of the parks' internal and external characteristics, including functional distinctiveness and diversity, the appeal of themed events, transport accessibility, location, and the types of adjacent communities. The paper then derives planning implications and proposes strategies for improving the quality and performance of large city-ring parks. These include tailoring improvement measures to each park's development stage and service potential; determining spatial structure, themed programming, and facility provision according to functional positioning; and coordinating the planning and construction of urban park-and-green-space systems with road and transport systems.

Keywords: large city-ring parks; recreational service; utility evaluation; planning implications; planning strategy

Shanghai's central city has long had high building and population densities but relatively limited parkland and green space, creating sustained pressure for outward urban expansion. At the same time, urban districts and towns beyond the central city have continued to develop. Without effective control and guidance, these processes could produce disorderly sprawl and contiguous built-up development. Shanghai responded by establishing greenbelts and various large parks around the central city [1]. These spaces perform ecological and safety functions while also serving as important recreational destinations. This paper reviews the planning and development of such parks, evaluates their recreational-service utility, explains differences between off-season and peak-season performance, and discusses the resulting planning implications and strategies.

1 Planning and Development of Shanghai's Large City-Ring Parks

During the 1990s, Shanghai experienced rapid socioeconomic growth and large-scale urban development. To address the outward spread of the central city caused by substantial industrial and population growth, together with metropolitan problems such as insufficient public green space and an intensifying urban heat-island effect, the city's master-planning process proposed a 500 m-wide greenbelt around the central city. Its original purpose was to prevent the central city from merging continuously with surrounding areas and to provide ecological green space [1]. This concept was incorporated into the *Shanghai Urban Master Plan (1999–2020)*, which designated areas surrounding the central city as “development-sensitive zones” and established an “ecological greenbelt” along the Outer Ring Road as the central city's development boundary, thereby guiding orderly spatial expansion [2].

Relevant sectoral plans assigned the ring greenbelt a broader set of functions. The 1994 *Shanghai Urban Ring Greenbelt Plan*, for example, proposed a “vine-and-gourds” structure: where land conditions were favorable, the greenbelt would widen to accommodate large parks dominated by planting design and themed around forest experiences, cultural appreciation, leisure, and sports [3]. This arrangement enriched the city's public open-space system and partially compensated for its shortage of urban parks.

As Shanghai's built-up area expanded and major urban districts beyond the former central city took shape, the Outer Ring Greenbelt effectively became an internal green chain within the main urban area (Figure 1). To some extent, its functional identity shifted from “ecological green space encircling the central city” to “parkland traversing the main urban area,” while recreation increasingly became its dominant function. Existing studies show that the recreational potential of different segments of the Outer Ring Greenbelt varies and that supporting services around completed parks still require improvement [4]. Other studies indicate that large parks also provide everyday leisure services and that discrepancies may exist between their planned positioning and actual utility [5–7]. However, in-depth empirical research on the recreational-service utility of Shanghai's large city-ring parks, particularly its seasonal variation, remains limited.

Figure 1. Green-space network and plan of large parks in Shanghai's main urban area.

Source: *Shanghai Master Plan (2017–2035)*.

2 Research Design

2.1 Basic Concepts and Research Framework

2.1.1 Utility Theory and the Recreational-Service Utility of Parks

Utility theory originated in economics and was subsequently extended to management science, behavioral science, and other fields [8]. In simple terms, the utility of a good or service is the degree to which owning or consuming it satisfies a person's wants. Utility theory therefore focuses on preferences and value choices and formulates assumptions that allow usefulness to be quantified [9]. In this study, the recreational-service utility of parkland and green space refers specifically to their usefulness to users, on the assumption that users exhibit identifiable preferences.

According to the interpenetration perspective in environment–behavior studies [10], environments exert profound effects on human behavior, while human activities also feed back into environments and may alter the meaning of places. Accordingly, the recreational-service utility of parks can be represented by users' choices among park spaces and by their behavioral characteristics, both of which can be quantified [7].

2.1.2 Research Framework

Based on the above concepts and the empirical context, the recreational-service utility of Shanghai's large city-ring parks—hereafter “service utility”—is evaluated quantitatively along three dimensions [11–12]. The first is the number of park users, representing **service intensity**. The second is the spatial distribution of users, corresponding to travel distance and representing **service scope**. The third is visit frequency, which indicates whether a park functions primarily at the city or community level and thus represents its **service attributes**.

Field observations reveal substantial differences in visitor volumes between off-season and peak-season periods. It is therefore necessary to assess seasonal differences and fluctuations in the service utility of each sample park. Big data are used to identify off-season and peak-season visitor samples, after which utility and seasonal variation are evaluated across the three dimensions above. The causes of observed utility differences are then interpreted by comparing the internal and external characteristics of the parks, and their theoretical service potential is inferred. On this basis, the paper derives planning implications and formulates corresponding strategies.

2.2 Samples and Data

2.2.1 Sample Parks

Under Shanghai's classification standards, parkland larger than 50 ha is defined as a city-level park. Six completed large urban parks were selected in line with the research focus: four located on the Outer Ring Greenbelt—Minhang Sports Park, Binjiang Forest Park, Gucun Park, and Mianqing Park—together with Wusong Paotaiwan Wetland Park near the greenbelt and Gongqing Forest Park between the Middle and Outer Ring Roads (Figure 2).

Figure 2. Locations of the sample parks.

2.2.2 Definition of Off-Season and Peak-Season Periods

To ensure comparability, data were collected, as far as possible, for common or similar off-season and peak-season periods, and only during times when all parks were operating normally without major external disturbances. Visitor volumes were analyzed over the same 18-month period, from January 2020 to June 2021, to identify the off-season and peak-season ranges and select representative periods for each park (Table 1).

Table 1. Study periods for the off-season and peak-season performance of sample parks

Park	Area (ha)	Off-season period	Peak-season period
Minhang Sports Park	54.90	11–24 January 2021	12–25 May 2021
Gongqing Forest Park	124.74	11–24 January 2021	12–25 May 2021
Gucun Park	265.00	11–24 January 2021	1–14 April 2021
Wusong Paotaiwan Wetland Park	120.00	11–24 January 2021	15–29 October 2020
Binjiang Forest Park	114.25	11–24 January 2021	12–25 May 2021
Mianqing Park	60.40	11–24 January 2021	12–25 May 2021

2.2.3 Data Sources

The study combines big data with statistical data and adopts a 14-day research cycle, requiring records of users who visited each selected park during the two-week period. The location-based services (LBS) data were provided by an internet-technology company and generated through SDK plug-ins embedded in Android smartphones. Compared with mobile-phone signaling data based on cellular base stations, which have an average positioning accuracy of approximately 200 m, the LBS data used here have an accuracy of 2–30 m and are suitable for analyses at multiple spatial scales.

The database covers approximately 7.6 million users in Shanghai, equivalent to about 30% of all mobile-phone users in the city. The study includes roughly 130,000 user samples, 190,000 park visits, and about 45 million individual data records. Statistical information on parkland and green space was obtained from park lists and visitor-volume reports issued by the Shanghai Landscaping and City Appearance Administrative Bureau. Positional and boundary data were drawn from Baidu Maps and corrected where necessary. Although data collection took place during the COVID-19 pandemic in China, Shanghai's prevention and control conditions were favorable during the selected periods and the city operated normally overall.

3 Evaluation of the Service Utility of Shanghai's Large City-Ring Parks

The off-season and peak-season service utility of the six sample parks is evaluated in terms of service intensity, service scope, and service attributes.

3.1 Service Intensity

Park service intensity is measured by total visitor volume and visitor volume per unit area, which together indicate actual service intensity and vitality. Figure 3 shows that both indicators were substantially higher in the peak season than in the off-season for all six parks, although the magnitude of fluctuation varied. Minhang

Sports Park, for example, recorded a high number of visitors per unit area even during the off-season, indicating consistently efficient year-round use. Gucun Park, by contrast, exhibited a pronounced seasonal gap in total visitor volume: service intensity was high during the peak season, but annual utilization efficiency was less satisfactory.

Total and per-area visitor volumes were further classified by the natural-breaks method into three levels (Table 2). Total visitor volume was categorized as high, medium, or low intensity, with breakpoints at 89,883 and 237,919 visits, and assigned scores of 3, 2, and 1, respectively. Visitor volume per unit area was categorized as high, medium, or low efficiency, with breakpoints at 25.4 and 55.3 visits per hectare per day, and likewise assigned scores of 3, 2, and 1. Adding the two scores produced an overall service-intensity score ranging from 2 to 6.

Table 2. Service-intensity classifications and scores for the sample parks

Park and period	Total visitor-volume class	Per-area visitor-volume class	Score
Minhang Sports Park, off-season (January)	Medium intensity	High efficiency	5
Minhang Sports Park, peak season (May)	Medium intensity	High efficiency	5
Gucun Park, off-season (January)	Low intensity	Low efficiency	2
Gucun Park, peak season (April)	High intensity	Medium efficiency	5
Gongqing Forest Park, off-season (January)	Low intensity	Low efficiency	2
Gongqing Forest Park, peak season (May)	High intensity	High efficiency	6
Wusong Paotaiwan Wetland Park, off-season (January)	Low intensity	Low efficiency	2
Wusong Paotaiwan Wetland Park, peak season (October)	Medium intensity	Medium efficiency	4
Binjiang Forest Park, off-season (January)	Low intensity	Low efficiency	2
Binjiang Forest Park, peak season (May)	Low intensity	Low efficiency	2
Mianqing Park, off-season (January)	Low intensity	Low efficiency	2
Mianqing Park, peak season (May)	Low intensity	Low efficiency	2

Gucun Park and Gongqing Forest Park received high-intensity ratings during their peak seasons. High-efficiency ratings were recorded for Minhang Sports Park in both seasons and for Gongqing Forest Park during the peak season. Overall, peak-season Gongqing Forest Park achieved the highest service-intensity score of 6, whereas Binjiang Forest Park and Mianqing Park received the minimum score in both seasons. Most parks therefore had low service intensity during the off-season, although a small number maintained relatively high performance.

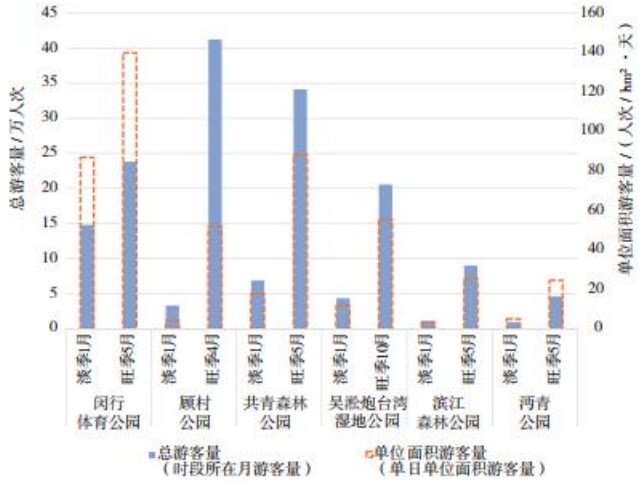

Figure 3. Off-season and peak-season service intensity of the sample parks.

3.2 Service Scope

Big data were used to trace visitors' places of residence and evaluate the service scope of each park. The visualized results (Figure 4) show that, during the peak season, nearly all of the large city-ring parks attracted visitors from throughout the central city. In terms of service scope, they thus broadly fulfilled the intended role of city-level parks and demonstrated strong year-round utility.

During the off-season, however, Gucun Park, Wusong Paotaiwan Wetland Park, and Binjiang Forest Park mainly served nearby populations. This localization of service scope effectively enabled them to provide some of the utility associated with community parks.

To compare seasonal differences, the actual service scope of each park was defined as the area enclosed by the contour containing the origins of the first 80% of cumulative park visits [13]. Off-season and peak-season service scopes were calculated accordingly (Figure 5). In general, the peak-season service scope exceeded the off-season scope for every park, but the size of the seasonal gap varied substantially. Wusong Paotaiwan Wetland Park exhibited the largest difference, reflecting a sharp decline in long-distance visitors during the off-season, whereas the two seasonal service scopes of Minhang Sports Park were nearly identical.

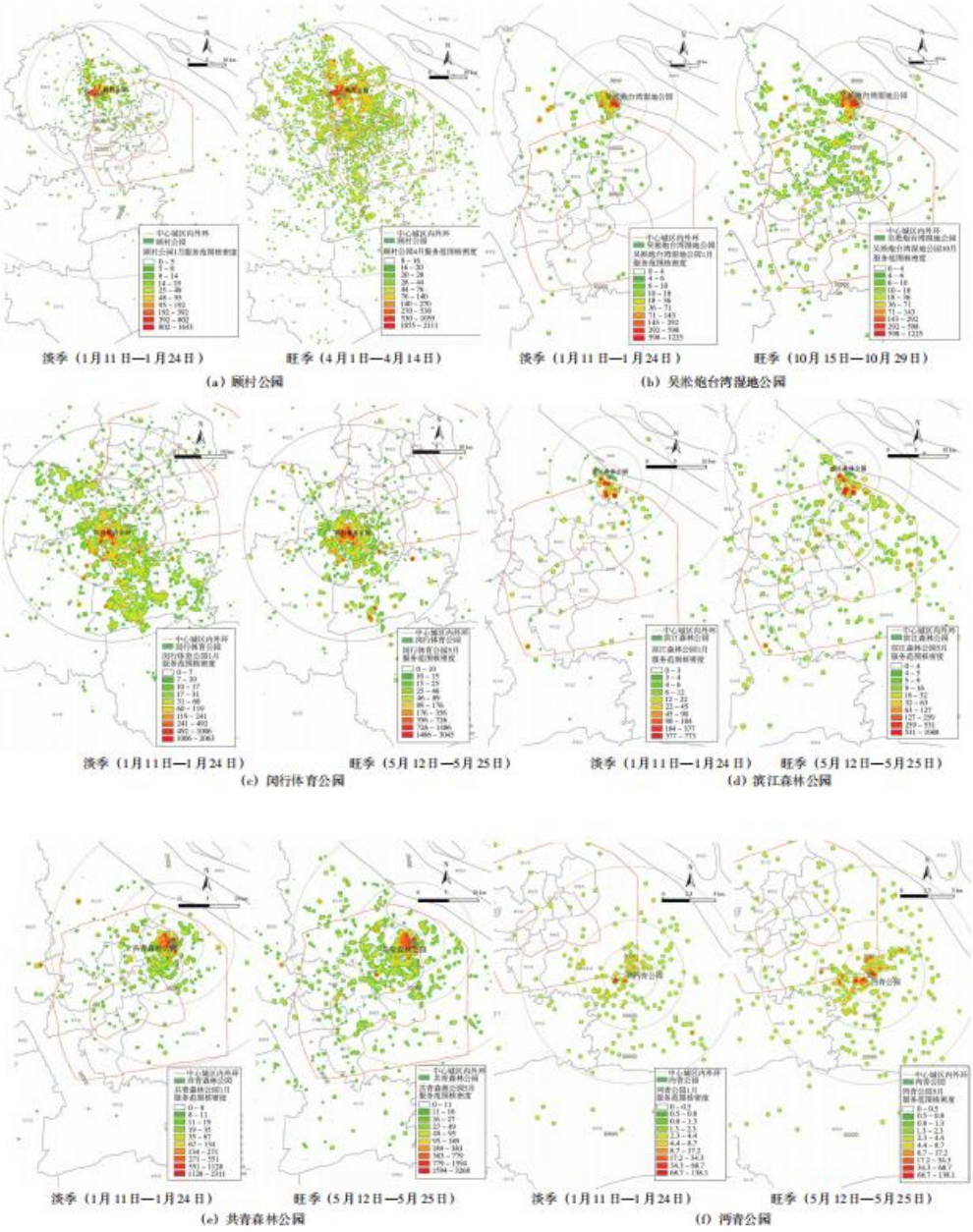

Figure 4. Off-season and peak-season service scopes of the sample parks.

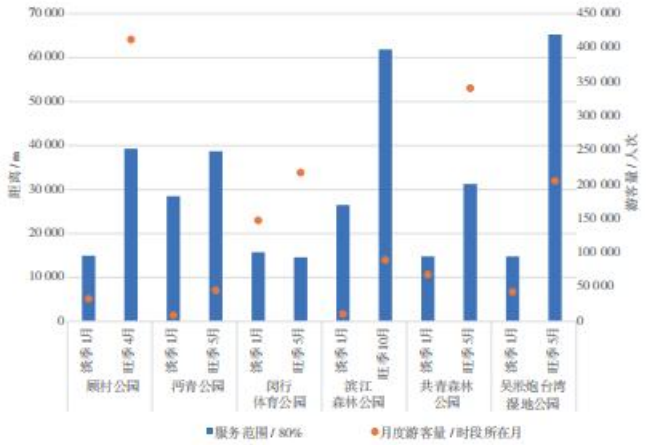

Figure 5. Comparison of visitor volume and service scope in off-season and peak-season periods.

3.3 Service Attributes

Visitor types can be approximated by visit frequency. Occasional visitors are treated as recreation-oriented users making destination trips, whereas frequent visitors are treated as everyday leisure users. This distinction allows the actual service attributes of a park to be evaluated: recreation reflects a city-level function, while routine leisure reflects a community-level function.

Within the 14-day sampling period, visitors were classified into four groups: occasional (one day), sometimes (two to three days), frequent (four to seven days), and daily (eight to fourteen days). These groups correspond respectively to recreational, predominantly leisure-oriented, leisure, and intensive everyday-leisure demand (Table 3).

Table 3. Visitor classifications and associated demand types

Visit frequency within 14 days	Visitor category	Corresponding demand
1 day	Occasional	Recreation
2–3 days	Sometimes	Predominantly routine leisure
4–7 days	Frequent	Routine leisure
8–14 days	Daily	Intensive routine leisure

After calculating the share of each visitor group, the percentage of occasional visitors was used to classify park attributes. Where recreation-oriented demand accounted for more than 90%, the park was categorized as having a city-level service attribute. Where it accounted for more than 50% but less than 90%, the park combined recreation and everyday leisure and was categorized as having dual city–community attributes. The results are shown in Table 4.

Table 4. Visitor shares by visit frequency and resulting service attributes

Park and period	Occasional, 1 day (%)	Sometimes, 2–3 days (%)	Frequent, 4–7 days (%)	Daily, 8–14 days (%)	Service attribute
Gucun Park, off-season	87.3	8.3	2.4	2.0	City–community
Gucun Park, peak season	95.2	3.4	1.0	0.5	City
Mianqing Park, off-season	95.8	3.8	0.3	0.1	City
Mianqing Park, peak season	90.7	8.0	0.9	0.4	City
Minhang Sports Park, off-season	92.6	4.6	1.9	0.9	City
Minhang Sports Park, peak season	84.7	9.6	3.8	1.9	City–community
Binjiang Forest Park, off-season	80.8	7.3	6.2	5.7	City–community
Binjiang Forest Park, peak season	91.8	4.7	1.5	2.0	City
Gongqing Forest Park, off-season	75.7	13.2	7.5	3.6	City–community
Gongqing Forest Park, peak season	80.2	11.9	5.4	2.5	City–community
Wusong Paotaiwan Wetland Park, off-season	51.6	34.3	11.3	2.8	City–community
Wusong Paotaiwan Wetland Park, peak season	87.3	7.7	2.8	2.1	City–community

Overall, recreation-oriented visitors formed the majority in both seasons, broadly matching the service attributes expected of city-level parks. At the same time, predominantly leisure-oriented and routine-leisure visitors accounted for substantial shares in several parks, indicating an additional community-service role. Gongqing Forest Park and Wusong Paotaiwan Wetland Park had comparatively high shares of such users in both seasons. Minhang Sports Park and Binjiang Forest Park displayed clearer seasonal variation: the former had stronger everyday-leisure demand during the peak season, whereas the latter served more routine leisure users during the off-season.

4 Causes of Differences in Service Utility

Following the seasonal evaluation, differences in service utility are interpreted through a comparative analysis of the internal and external characteristics of the sample parks.

4.1 Functional Distinctiveness and Diversity

Comparison of the sample parks shows that creative spatial planning and distinctive functional programming generally strengthen visitor appeal. Gongqing Forest Park, for example, was formerly a large nursery and therefore possessed excellent vegetation conditions for conversion into a forest park. Its development created a rich site structure appropriate to a large urban park and connected attractive waterscapes and landform areas through a system of visitor routes. It also introduced diverse recreational and sports activities, including outdoor barbecuing, horse riding, rock climbing, and ball games. The integration of forest-park and urban-park qualities generates strong appeal to urban residents, helping explain why Gongqing Forest Park achieved the highest peak-season service intensity among the sample parks.

Minhang Sports Park likewise maintained high service intensity in both seasons, although its service scope was relatively limited. This outcome is closely related to its distinctive positioning as a sports park. In addition to standard park functions, its spatial plan and facility system include basketball courts, tennis courts, football fields, and other sports venues. Institutionally and spatially, the park is integrated with Minhang District Gymnasium. It therefore provides city-park recreation while also delivering high-quality, year-round sports services to nearby district residents.

4.2 Appeal of Themed Events

Field investigation indicates that each park organizes several themed events annually to enhance visibility and visitor appeal. A compelling event concentrated in one part of a park can raise the service utility of the park as a whole. The most representative example is Gucun Park's cherry-blossom season, which attracts visitors citywide and produces a sharp peak-season increase in visitor volume relative to the off-season.

The internal distribution and clustering of visitors in Gucun Park (Figure 6) are generally balanced, and the principal clustering locations change little between seasons, indicating relatively full use of its spatial system. Additional peak-season visitors are concentrated mainly along the central axis where cherry trees are intensively planted, but visitor density also increases in other areas. The themed event thus not only activates its immediate venue but also improves the overall service utility of the park.

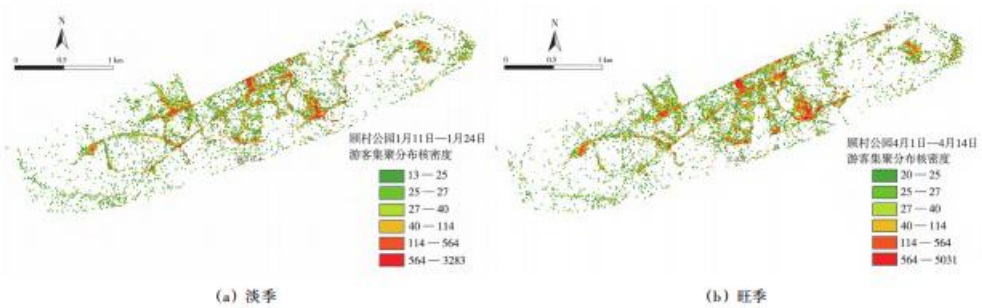

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Figure 6. Spatial distribution of visitors in Gucun Park during off-season and peak-season periods.

4.3 Transport Accessibility

Differences in service scope and service intensity are also closely associated with accessibility, especially because peak-season service scope depends heavily on the convenience of external transport. Gucun Park is directly served by stations on Metro Lines 7 and 15. Its southward service area visibly overlaps the corridor of Line 15 and corresponds approximately to a one-hour travel catchment. Gongqing Forest Park has no direct metro access and requires a bus transfer; its effective service radius likewise approximates a one-hour catchment.

A station on Metro Line 12 is located near Minhang Sports Park, yet its service area is relatively localized and extends north–south within Minhang District in a pattern overlapping expressway corridors. This suggests a

substantial share of non-motorized and private-car trips. Binjiang Forest Park performs poorly largely because public transport access is inconvenient, particularly because it lacks direct metro service. Even in the peak season, visitor volumes remain low, and during the off-season the park receives very few visitors. Its peak-season service scope is nevertheless extensive, with origins scattered from south to north along the Inner, Middle, and Outer Ring corridors, indicating that many visitors travel by private car.

4.4 Location and Types of Adjacent Communities

The sample parks also differ in location and surrounding settlement context. Some adjoin established urban residential communities, whereas others are bordered by dispersed rural settlements. These conditions significantly affect service scope and attributes. Where a park lies near a large, mature residential community, the sizable and diverse population can both raise service utility and enable a city-level park to accommodate community-level functions.

Wusong Paotaiwan Wetland Park and Gongqing Forest Park, for example, were classified as city–community parks in both seasons. The former is located within an urban subdistrict in the core Wusong area of Baoshan, while the latter adjoins the large Zhongyuan residential area in Yangpu. Both have substantial nearby populations who routinely use the parks for daily leisure. By contrast, suburban Binjiang Forest Park and Mianqing Park recorded low service intensity in both seasons. Binjiang Forest Park lies at the northernmost edge of Pudong New Area, while Mianqing Park adjoins Tangxiang Central Village in Kangqiao Town and Huanxi Residential Community in Zhangjiang Town. These locations have limited accessibility and remain semi-urbanized, so surrounding demand and functional support for park use are still weak.

5 Planning Implications and Strategies

The evaluation and causal analysis yield several planning implications that can be translated into practical strategies.

5.1 Tailor Improvement Strategies to Development Stage and Service Potential

A park's development stage can be broadly inferred from its service intensity. Low intensity may indicate an immature stage in which either internal construction remains incomplete or external supporting conditions are inadequate. Seasonal differences in service intensity and utility also reveal service potential. A park with low intensity and pronounced seasonal variation performs poorly in current terms, but may have considerable latent development potential. Improvement strategies should therefore balance current performance against future potential.

Where service intensity is low but the service scope changes little between seasons, utility is stable and planning should identify binding constraints and optimize operations. Where the service scope fluctuates substantially but visitor volume changes little, the park has a degree of attraction, but its service potential requires further development. Where both scope and visitor volume fluctuate—especially where visitor-volume variation is greater—the park performs fully during the peak season but needs to strengthen off-season appeal. If adjustments have already raised off-season intensity while peak-season intensity approaches saturation, insufficient space has become the constraint; planning should either expand capacity or manage visitor flows to maintain a high-quality experience.

5.2 Determine Spatial Structure, Themed Programming, and Facilities from Park Positioning

Overall spatial structure, themed activities, and facility provision are fundamental to the continuity and stability of service utility. They should not follow a uniform model but instead reflect each park's functional positioning and service attributes. Some parks should capitalize on peripheral locations to express the wild and ecological qualities of forest landscapes [14]. Others should introduce major themed events that can evolve into citywide “events.” Still others should integrate community-park functions so that city-level and community-level roles operate in parallel.

Parks with predominantly city-level attributes should prioritize spaces and programs for destination recreation, including extensive woodland leisure areas, open woodland lawns, and linear green corridors suitable for camping, outdoor barbecues, horse riding, and similar activities. Parks that also serve communities should supplement standard sports grounds, fitness facilities, and children's activity areas with comfortable spaces for lingering—such as tree-grid plazas and hard-surfaced open spaces—to support nearby residents' everyday leisure and social activities.

Planning should also reserve suitable venues for large events such as carnivals, food markets, and craft fairs, as well as smaller community activities. Adding localized attractions can improve the service utility of the entire park. Seasonal landscapes can play a similar role [15]. Gucun Park's cherry-blossom season demonstrates how a localized attraction node can market the park as a whole and substantially increase overall utility.

5.3 Coordinate Park-and-Green-Space Systems with Road and Transport Systems

The analysis confirms that accessibility is a prerequisite for large parks to realize their service utility. Urban park-and-green-space systems should therefore be planned and developed in close coordination with road and transport systems. This includes arranging public-transport routes and stops according to the location and service attributes of each park and, in response to growing private-car ownership, providing adequate parking [16].

Given the emerging one-hour recreational catchments of large city-ring parks, coordinated planning of green-space and transport systems can create a network of large parks and green rings covering the entire main urban area even where land is limited [17–18]. Within these catchments, planners should provide walking and cycling routes, service stations, motor-vehicle and bicycle parking, food and beverage services, and other supporting facilities. Such provision can increase ecological-service supply while giving residents more and higher-quality recreation and everyday-leisure spaces, thereby fostering functional complementarity and mutually reinforcing effects between the catchment hinterlands and the large city-ring parks.

6 Conclusion

Like many other megacities, Shanghai established greenbelts, wedge-shaped green spaces, and large parks around its central city to contain disorderly sprawl and contiguous urban development [19–20]. These spaces form important components of the urban ecological-green system and open-space network. The planning and development of Shanghai's city-ring and other large parks have generated multiple benefits, including ecological effects and changes in residents' leisure lifestyles. Research on behavior during the cherry-blossom festival suggests that some residents have shifted from indoor leisure—such as gatherings, shopping, indoor entertainment, and relaxing at home—to outdoor recreation, including flower viewing, walking, and exercise [6], with clear benefits for physical and mental health [21].

The utility evaluation nevertheless reveals pronounced imbalance. Service performance differs not only between seasons but also substantially among parks. These disparities simultaneously indicate where improvement potential lies. Drawing on the evaluation and causal analysis, this paper proposes several planning strategies for strengthening park functions and service utility. Although city-ring green spaces arise from specific locational and development conditions, the planning and construction of large peri-urban parks also follow common principles. The findings may therefore inform the planning and development of large parkland and green spaces around the central areas of megacities and large cities more broadly.

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