

Evaluation and Optimization of Public Service Facility Accessibility in Planning Future Community Living Circles: A Case Study of Yangpu District, Shanghai, China

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Abstract

Addressing imbalanced public cultural and sports facility (PCSF) allocation amidst China's urban quality enhancement and "15-minute community life circle" initiatives, this study investigates Siping Road Sub-district, Shanghai, to reveal PCSF supply-demand contradictions and propose optimization strategies. It innovatively employs an "availability-accessibility-adaptability" framework, integrating objective supply-demand metrics with subjective satisfaction surveys. Availability is assessed via current statistics; accessibility via the 2SFCA method and resident usage (time, preferences); and adaptability via questionnaires and regression models analyzing satisfaction and its influencing factors. Finally, the Importance-Performance Analysis (IPA) model identifies core contradictions, with "place-based" and "people-based" optimization suggestions providing empirical references for precise PCSF allocation and "15-minute community life circle" construction.

Keywords: Life Circle; Public Cultural and Sports Facilities; Supply-Demand Relationship; Accessibility; Satisfaction

1. Introduction

1.1 Research Background

The "14th Five-Year Plan" mandates accelerating urban development transformation, promoting urban spatial structure optimization and quality improvement. Consequently, the "Shanghai '15-Minute Community Life Circle' Planning Guidelines (Trial)" emerged, offering a new policy framework for improving residential public service facility allocation (Wu and Sun 2024). However, despite China's promotion of national fitness and modern public cultural services, public cultural and sports facility supply-demand contradictions persist (Peng et al. 2023). These include insufficient venues, uneven high-quality resource distribution, service-need disconnects, and varied facility management levels, causing significant allocation imbalances and inadequacies (Song, Kong and Cheng 2024). Shanghai's "15-minute community life circle" initiative, which prioritizes rectifying cultural and sports facility shortcomings and enhancing service efficiency to improve community life quality and resident well-being, necessitates this research.

1.2 Research Purpose and Significance

This study selects Siping Road Sub-district, Yangpu District, Shanghai, to: comprehensively evaluate its public cultural and sports facility allocation and resident perception; deeply analyze facility supply and resident demand matching (supply-demand ratio, usage behavior, satisfaction); accurately identify current allocation's main contradictions; and propose targeted, operable optimization strategies from the "15-minute community life circle" perspective, integrating "place-based" and "people-based" ideas.

The research's significance is: theoretically, constructing a multi-dimensional "Availability-Accessibility-Adaptability" evaluation framework for cultural and sports facility planning, deepening understanding of community residents' behavioral geography; practically, providing decision support for Siping Road Sub-district and similar areas' cultural/sports facility planning and "15-minute community life circle" construction, aiming to enhance living environments and resident well-being.

1.3 Relevant Theoretical Basis

This research uses Public Service Facility Accessibility theory. Accessibility, a core measure of residents' ease of accessing public services, includes physical access (distance, transport) and non-spatial dimensions (service acquisition fairness, subjective service quality perception). Classic methods include shortest distance and 2SFCA. (Xie et al. 2023)

This study adapts Wiszbinski and Thomas et al.'s 5A service accessibility model (Availability, Accessibility, Affordability, Acceptability, Adaptability). (Peng et al. 2023) Considering cultural/sports facilities' public welfare nature and research focus, a localized, simplified three-dimensional framework was built:

1)Availability: Objective supply level of public cultural/sports facilities (type, quantity, scale, coverage)—the basis for evaluating supply-demand.

2)Accessibility: Convenience of resident access/utilization and facility service capacity manifestation—how supply-demand plays out in service. Measured by supply-demand ratio and resident usage behavior (time, preference).

3)Adaptability: Degree facilities meet diverse, personalized resident needs and residents' subjective service evaluation—demand feedback. Measured by resident satisfaction and influencing factors.

This framework aims for a comprehensive evaluation from “objective facility existence” to “actual resident use” to “residents' subjective feelings,” reflecting true service effectiveness.

2.Research Area Overview and Facility Status

2.1 Overview of Siping Road Sub-district

Siping Road Sub-district, in central-western Yangpu District, Shanghai (approx. 2.64 km²), is core to the “Tongji Knowledge Economy Circle.” Dominated by education/research and residential functions, it hosts many design/creative industries. Residential buildings, mainly 1950s-1980s workers' new villages (low-rise, high-density), face renewal pressure. High population density shows an “elderly, young, and highly educated” structure: many over 60s and college-educated individuals, plus adolescents, creating diverse demands for public cultural/sports facilities.

2.2 Current Status of Public Cultural and Sports Facilities in Siping Road Sub-district

Field surveys, data collection, and POI analysis show:

Sports Facilities: Mainly outdoor small fitness points and simple park venues; lacks large, comprehensive indoor stadiums. Quality resources (standard fields, pools) are concentrated in units like Tongji University, with limited community sharing, creating scarcity. Overall: “many small points, limited types, difficult quality resource sharing, limited service radius,” failing to meet growing, diverse fitness needs, especially for young/middle-aged groups.

Cultural Facilities: Mainly elderly activity rooms, neighborhood center chess/card/reading rooms; lacks comprehensive centers, libraries, exhibition halls, small theaters for all ages, especially young/middle-aged. Uneven spatial distribution (mostly southeast) shows: “elderly-focused, singular functions, no comprehensive venues, uneven distribution,” failing diverse cultural exchange, learning, leisure needs. Generally, Siping's facilities lack sharing, quantity/quality, functional diversity, and balanced layout, short of “15-minute community life circle” goals.



Fig.1. The current distribution of sports facilities

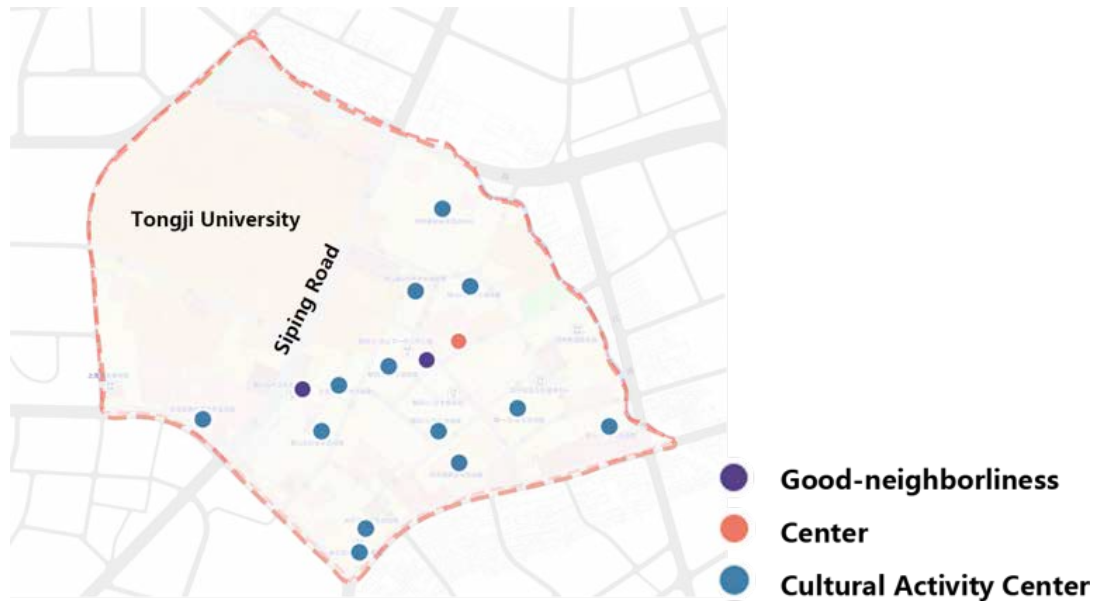


Fig.2. The current distribution of cultural facilities

2.3 Life Circle Division and Resident Cognition

Siping Sub-district has two main life circle types:

1 University Life Circle: Around Tongji University, serving mainly students, faculty, some nearby residents. Facilities are partly campus-internal, with sharing barriers.

2 Residential Life Circle: Covering vast workers' new villages; high population density, high aging, urgent need for embedded, accessible cultural/sports facilities.

A preliminary survey on resident facility perception found: over half feel a lack of facilities (especially cultural), prominent in southeastern older areas. Information is mainly via community/internet promotions. Nearly a quarter perceive no facilities within a 15-minute walk. Most are willing to use facilities, but unsuitable functions, poor accessibility, conflicting hours, and outdatedness are obstacles. A 10-15 minute walk is desired. These findings underpin deeper analysis and highlight the need for a resident-centric view.

3. Research Design and Methods

This study, using the "Availability-Accessibility-Adaptability" framework, employs multi-source data and quantitative methods to evaluate Siping's public cultural/sports facility supply-demand. Availability evaluation integrates field surveys, government data, and Gaode POI data (facility types, quantities, distribution), using GIS for spatial visualization/density analysis. Accessibility evaluation (neighborhood committee as unit) uses 2SFCA to quantify facility service capacity-population demand matching, with spatial autocorrelation for supply-demand ratio clustering. Concurrently, 182 resident questionnaires analyze usage frequency, time preferences, and functional demand differences. Adaptability evaluation (subjective resident perception) uses multiple linear regression to identify impacts of eight factors (e.g., environment, functional richness) on overall satisfaction. IPA, correlating supply-demand ratios with satisfaction, identifies four contradictory area types (e.g., high supply-demand/high satisfaction), guiding differentiated optimization.

Data sources: 1) Facility data: field mapping, government documents, POI cross-validation. 2) Population data: sub-district office's neighborhood committee-level statistics. 3) Resident behavior/satisfaction: stratified sampling (online/offline surveys) covering usage, satisfaction, importance ranking. Methods: GIS spatial analysis (layout balance), 2SFCA (spatial accessibility), statistical regression (satisfaction drivers), IPA (priority improvement areas), achieving objective supply-subjective demand diagnosis.

4. Research Results and Analysis

4.1 Availability Analysis of Public Cultural and Sports Facilities

As per Section 2.2, Siping's facilities are deficient in total quantity, type diversity, spatial distribution balance, and quality resource sharing. Sports facilities are mainly small-scale/outdoor; large comprehensive venues are scarce, campus resources undershared. Cultural facilities favor elderly services, lacking comprehensive, high-quality venues for other groups. This supply-level "inherent deficiency" underlies subsequent supply-demand issues.

4.2 Accessibility Analysis of Public Cultural and Sports Facilities

4.2.1 Supply-Demand Matching Analysis (based on 2SFCA)

2SFCA calculation of Siping's neighborhood committee cultural/sports facility supply-demand ratios shows significant overall "demand exceeding supply." Spatially, matching is heterogeneous: Tongji University and adjacent areas have higher ratios (due to campus resources, despite sharing issues); most dense, older workers' new villages are supply-demand "lowlands" due to severe under-configuration. Spatial autocorrelation (Moran's I) confirmed non-random spatial distribution: significant positive correlation (high-high, low-low clustering). Local LISA maps identified "Low-Low" clusters, mainly in workers' new villages—key deficient areas needing urgent attention.

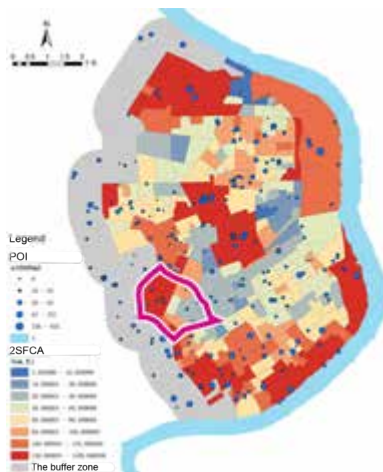


Fig.3. 2SFCA for calculating the supply-demand ratio

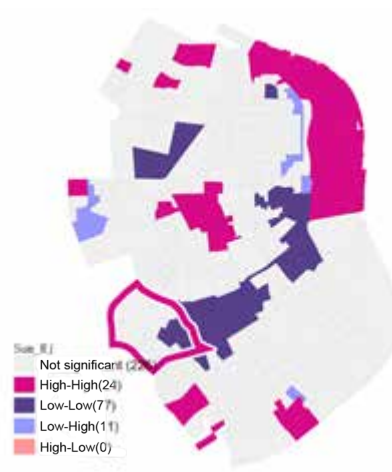


Fig.4. Spatial clustering analysis

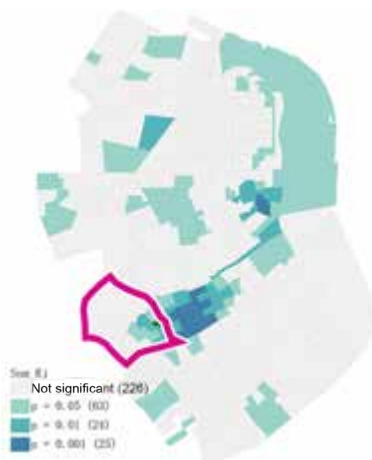


Fig.5. Analysis of spatial agglomeration significance

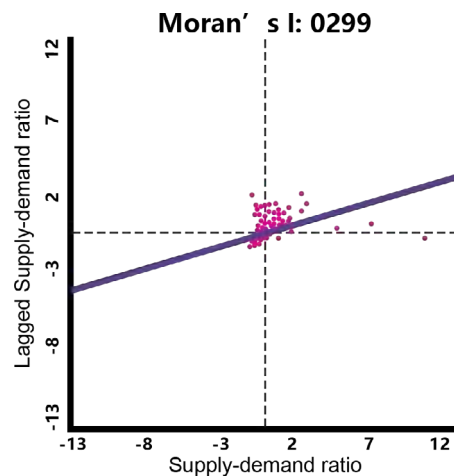


Fig.6. Moran index scatter plot

4.2.2 Analysis of Resident Usage Time Characteristics

Questionnaire data show distinct age-group patterns in facility usage times:

Usage Frequency: Younger (19-28 years) and elderly (over 60 years) groups are more frequent users. Younger individuals for post-study/work leisure/fitness; elderly due to more retirement leisure. Middle-aged (29-45, 46-60 years) use is less frequent/consistent, likely due to work/family pressures.

Overall, sports facility usage frequency is generally higher than cultural facilities, reflecting stronger daily fitness demand.

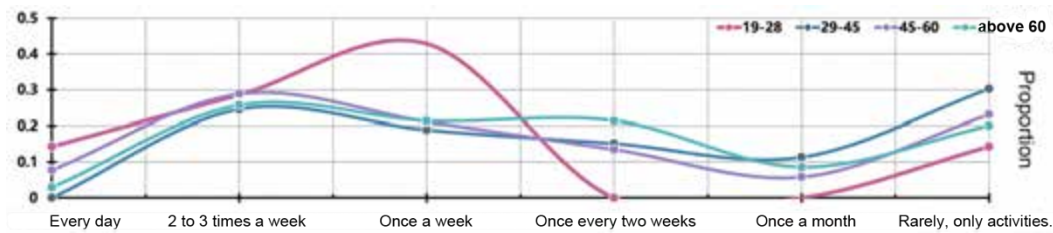


Fig.7. Frequency of use of public cultural facilities

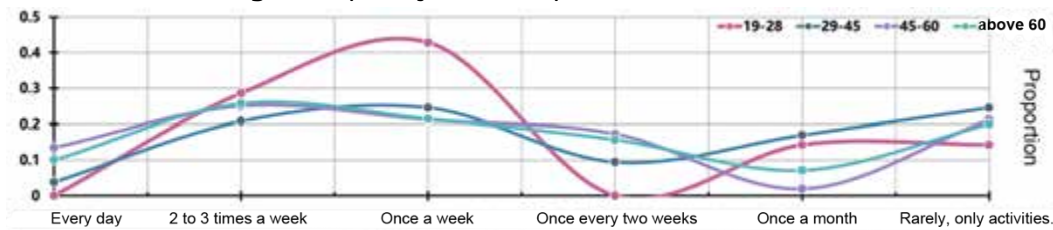


Fig.8. Frequency of use of public sport facilities

Usage Duration: Younger and elderly groups spend longer average times per visit. Middle-aged groups prefer shorter, efficient use (e.g., <30-min fitness). Elderly cultural activity time is increasing.

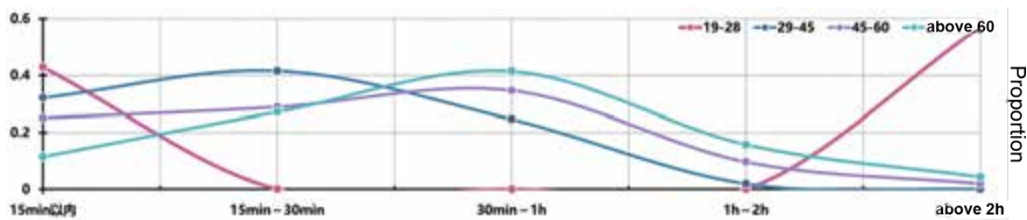


Fig.9. The duration of use of public cultural facilities

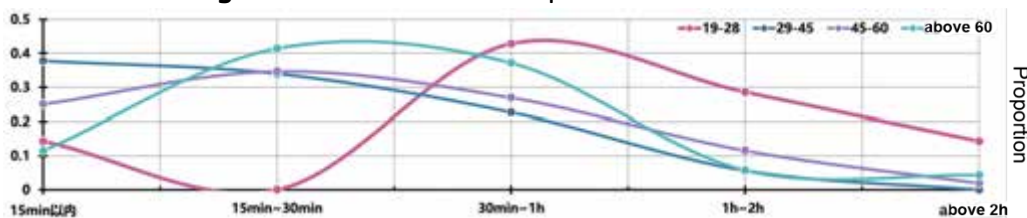


Fig.10. The duration of use of public sport facilities

Usage Time Distribution (Weekdays and Weekends):

Cultural Facilities:

1-Younger groups: Mainly weekend daytime (e.g., 9:00-18:00).

2-Middle-aged groups: More often weekday evenings (e.g., 18:00-21:00) and weekends.

3-Elderly groups: Widely distributed, but early mornings (weekdays/weekends) (e.g., 6:00-9:00) are a peak for cultural activities (morning exercises, reading).

Sports Facilities: Bimodal or multimodal characteristics across age groups.

1-Younger groups: Peaks on weekday evenings and weekends.

2-Middle-aged groups: Primarily weekday evenings for fitness.

3-Elderly groups: Early mornings (weekdays/weekends) (morning exercises) and off-peak daytime are main times.

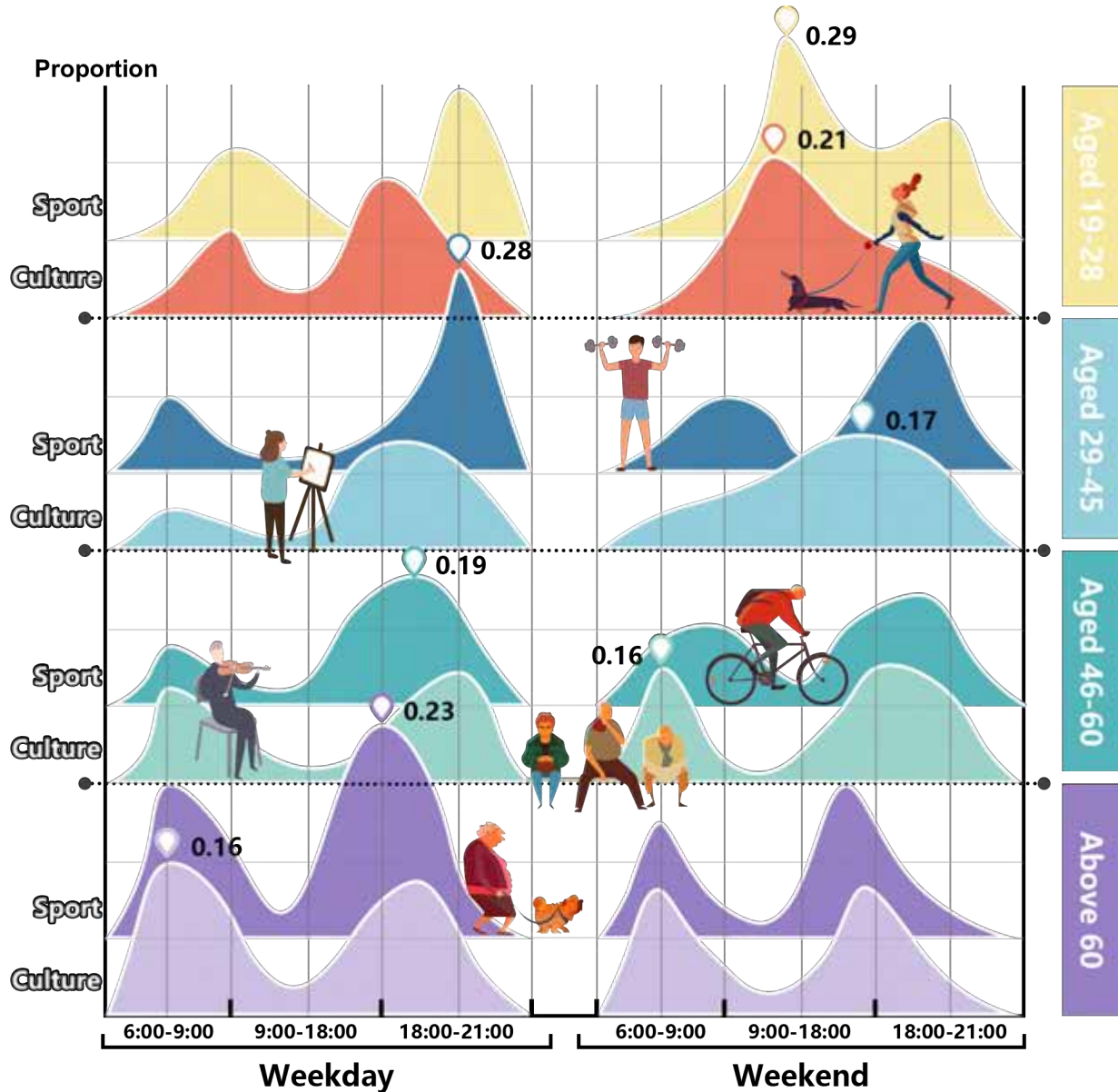


Fig.11. Analysis of the time distribution of community residents using public cultural and sports facilities

These time differences demand specific facility opening hours, off-peak guidance, and enhanced nighttime service.

4.2.3 Analysis of Resident Usage Preferences

Facility type/function preferences show significant age differentiation:

Cultural Facility Preferences:

Facility Type:

- 1-All ages: Libraries and cinemas (if available/accessible) are popular.
- 2-Younger: Higher demand for museums, art/exhibition halls.
- 3-Middle-aged: Besides libraries, community classrooms, art studios (skills/interests).
- 4-Elderly: Strongest demand for community cultural centers, elderly activity/chess/calligraphy rooms.

Facility Function:

- 1-Younger: Emphasize exhibitions, reading/research, knowledge acquisition, skills training.
- 2-Middle-aged/Elderly: Prefer leisure/entertainment, social interaction, cultural activities/festivals.
- 3-Universal: Leisure/entertainment and reading/research are core expectations.

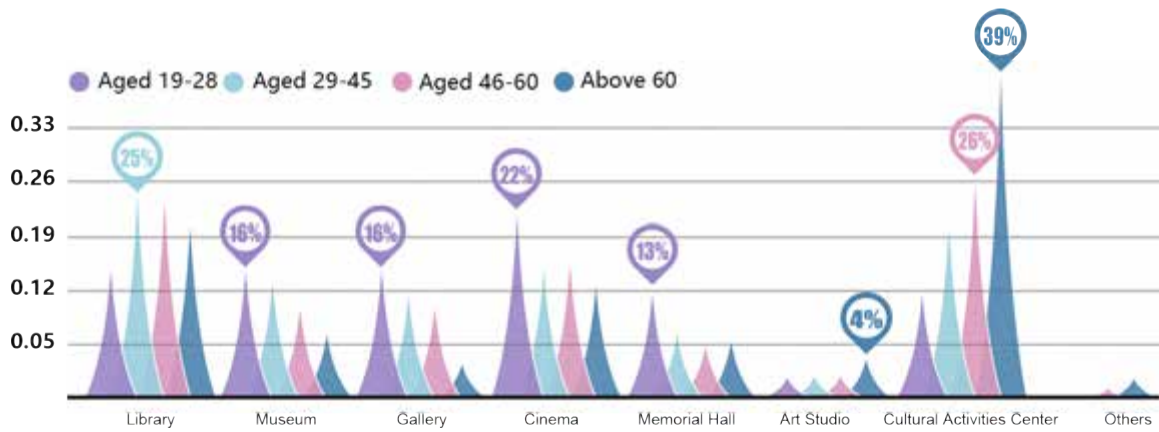


Fig 12. Analysis of Public Cultural Facilities Preference Types

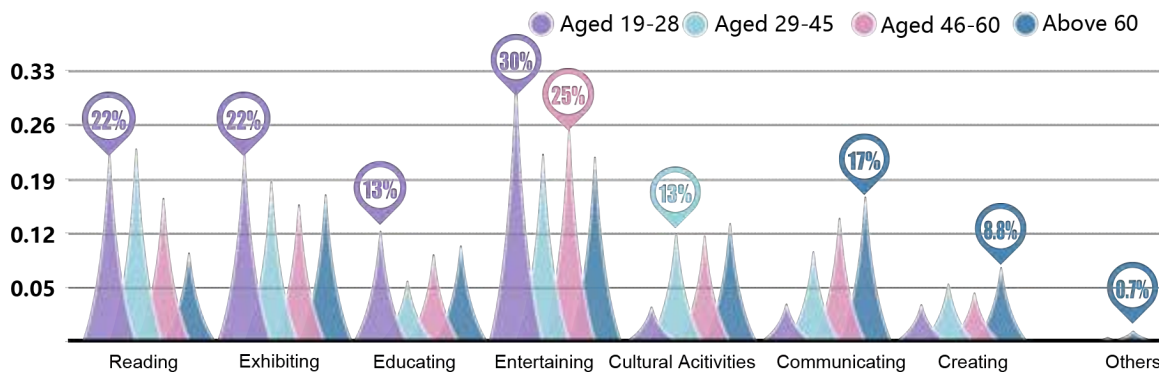


Fig 13. Analysis of Functional Preferences for Public Cultural Facilities

Sports Facility Preferences:

Facility Type:

- 1-Younger: Prefer comprehensive fitness centers, pools, courts (basketball, badminton, tennis), climbing gyms; strong demand for open school facilities.
 - 2-Middle-aged: Higher demand for gyms, multi-functional sports grounds, fitness trails.
 - 3-Elderly: Most use outdoor venues (parks, squares), outdoor equipment, gateball courts, Tai Chi areas, community fitness trails; indicates lack of suitable indoor elderly facilities.
- Community sports centers (if composite) can meet some needs across ages.

Facility Function:

- 1-All ages: Fitness/exercise is core.
- 2-Younger: Prefer sports training, competitions, courses.
- 3-Middle-aged: Also health guidance, relaxation.
- 4-Elderly: Increasing demand for leisure, social interaction, health preservation.

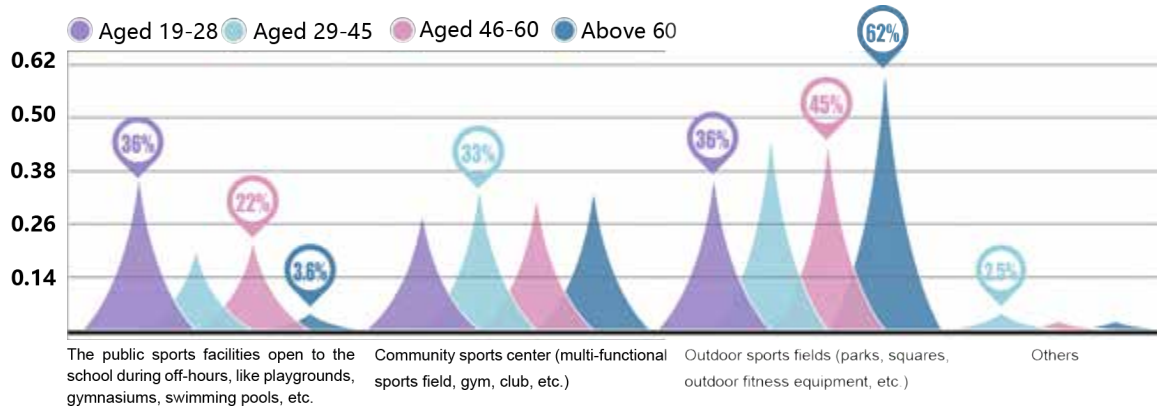


Fig 14. Analysis of Public Sports Facilities Preference Types

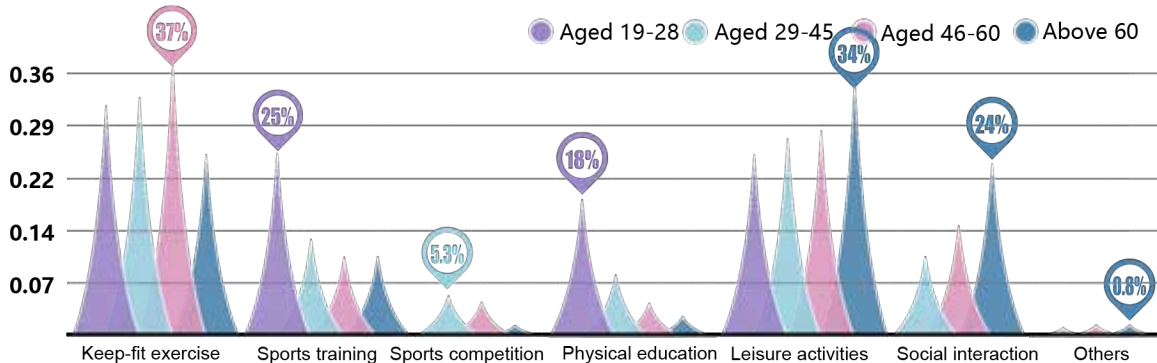


Fig 15. Analysis of Functional Preferences for Public Sports Facilities

Matching Degree: Existing Functions vs. Resident Needs:

- 1-A significant gap exists; complete matching is very low. Original data: cultural facilities 10.7% complete match, sports 3.6%.
- 2-Specific mismatches: High demand for cultural leisure/reading, but supply/quality need improvement, especially for middle-aged/elderly. Sports: high demand for fitness/leisure, but existing facilities insufficient, especially for middle-aged. Elderly better, but need age-appropriate, guided indoor options.
- 3-The middle-aged group (29-45 years) shows severe cultural/sports functional mismatch, needing focus. These preferences guide facility type, function, design, and service innovation.

4.3 Adaptability Analysis of Public Cultural and Sports Facilities (Satisfaction Evaluation)

4.3.1 Overall Resident Satisfaction

Relatively high overall dissatisfaction: Over 30% "overall dissatisfied" or "somewhat dissatisfied." Sports facilities: 35% dissatisfied; cultural: 33.5%. Widespread problems meeting expectations.

Significant age differences:

- 1-Elderly (over 60): lowest overall satisfaction. Possibly due to stronger reliance but unmet needs (accessibility, age-friendly design, service).
- 2-Middle-aged (29-45), especially younger segment: relatively higher satisfaction. Possibly due to lower use frequency or expectations; needs further analysis.

Satisfaction with specific indicators:

1-Sports: 19-45 age group: higher satisfaction with opening hours, environment, functional richness, participation convenience. Elderly (over 60): significantly lower satisfaction with accessibility, opening hours (insufficient morning/early evening closure), environment (outdated equipment, uneven grounds, no shade/rain protection).
2-Cultural: 19-45 age group: higher satisfaction with environment, functional richness, participation convenience, educational value. Over 46, especially elderly (over 60): lower satisfaction, particularly accessibility (distance, no elevators), opening hours (insufficient lunch/weekend opening), environment (small spaces, poor lighting, uncomfortable seating).

Key factors influencing satisfaction (resident perspective, preliminary ranking): Facility accessibility, opening hours, environment, special group friendliness considered most important. Cleanliness, safety, comfort directly impact experience; distance/transport affect use; schedule-matching opening hours crucial; elderly/child-friendly design significantly enhances satisfaction.

4.3.2 Analysis of Satisfaction Influencing Factors (Based on Multiple Linear Regression Model)

To more scientifically reveal the specific contribution of each sub-item to overall satisfaction, this study utilized multiple linear regression analysis.

Table 1. Analysis of Influencing Factors of Satisfaction

	Facility accessibility	Opening hours	Facilities and environment	Functional richness	Convenience of participation	Educational Value	Interactive experience	Friendliness to special groups
Satisfaction with public sports facilities	0.07	0.083	0.357	0.195	0.19	0.02	0.098	0.024
Satisfaction with public cultural facilities	0.203	0.134	0.218	0.087	0.045	0.257	0.032	0.138
Comprehensive satisfaction with public cultural and sports facilities	0.125	0.09	0.256	0.137	0.168	0.151	0.041	0.056

Main drivers of satisfaction with public sports facilities:

1-Facilities and Environment (largest standardized regression coefficient, strongest impact): This includes the cleanliness of the venue, the condition and maintenance of equipment, safety during use, and overall aesthetics and comfort. A good physical environment is fundamental to guaranteeing the sports activity experience.

2-Functional Richness: This refers to whether the types of programs offered by sports facilities are diverse and can meet the needs of different age groups and people with different sports preferences. Facilities with monotonous functions struggle to attract residents in the long term.

3-Convenience of Participation: This includes the simplicity of the reservation process, waiting time for venue use, and ease of information access. Convenient participation channels can effectively increase usage frequency and satisfaction.

Main drivers of satisfaction with public cultural facilities:

1-Educational Value (largest standardized regression coefficient, strongest impact): This refers to whether the content provided by cultural facilities contributes to knowledge dissemination, skill learning, cultural inheritance, and personal literacy improvement. Residents' demand for the spiritual and cultural aspects of cultural facilities is increasing.

2-Facilities and Environment: Similar to sports facilities, the cleanliness, comfort, safety, and cultural atmosphere of cultural facilities are also important factors affecting satisfaction.

3-Facility Accessibility: Convenient geographical location, smooth traffic connections, and reasonable walking distances are prerequisites for residents to choose and use cultural facilities.

Gap analysis between importance and current satisfaction status:

By comparing the "importance" scores (representing expectation levels) and "satisfaction" scores (representing current status evaluations) for each sub-item in the questionnaire, it was found that: for both public sports facilities and public cultural facilities, residents' average expectation level for each indicator was higher than their average evaluation of the current situation.

The items with larger gaps, indicating significant shortcomings, were mainly concentrated in: Facilities and Environment (high expectations, but generally low current evaluations), Functional Richness (desire for diverse facility functions, but current supply is monotonous), and Friendliness to Special Groups (e.g., designs and services suitable for the elderly and children, high expectations, but generally insufficient currently). These gap items are the key areas where future facility optimization and improvement efforts should be focused and invested.

4.4 Analysis of Supply-Demand Contradictions in Public Cultural and Sports Facilities (Based on IPA Model)

To comprehensively present the complex relationship between supply-demand matching (represented by the "supply-demand ratio") and residents' subjective perceptions (represented by "overall satisfaction"), this study drew on the IPA model concept to classify each neighborhood committee into four quadrants, thereby identifying different types of supply-demand contradictions. Fig.16 illustrates the supply-demand ratio values for each neighborhood committee, Fig.17 shows the overall satisfaction with public cultural and sports facilities in each neighborhood committee, and Fig.18 depicts the heterogeneity of the IPA result space.

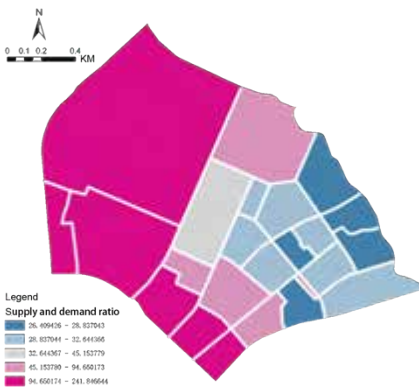


Fig.16. The supply-demand ratio values of each neighborhood committee

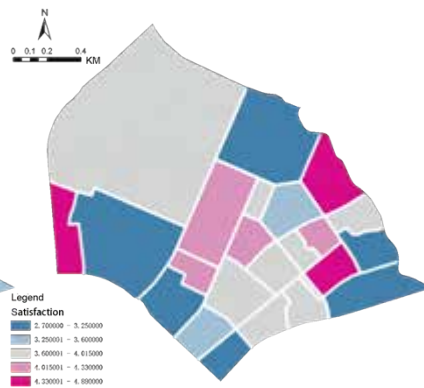


Fig.17. Overall satisfaction with public cultural and sports facilities in each neighborhood committee

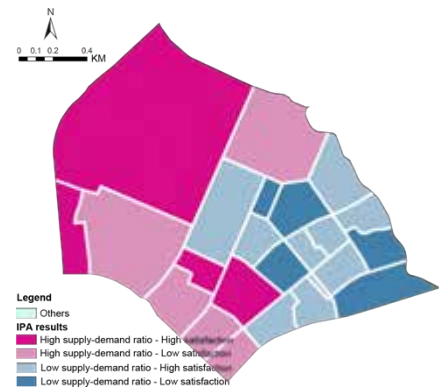


Fig.18. Heterogeneity of the IPA result space

Quadrant A: High Supply-Demand Ratio - High Satisfaction (Advantage Maintenance Zone):

Characteristics: These areas (such as Miyun Road Neighborhood Committee, Jin'an Neighborhood Committee, etc., mentioned in the original report) have relatively abundant cultural and sports facility resources, and residents' satisfaction with these facilities is also high.

Interpretation: This indicates that in these areas, not only is the quantity of facilities relatively guaranteed, but their quality, operation management, and services also effectively meet residents' needs. Strategically, existing service levels should be maintained and enhanced, and these areas can serve as models for promotion.

Quadrant B: Low Supply-Demand Ratio - High Satisfaction (Potential Mining Zone / Priority Area for Improving Supply):

∑ **Characteristics:** In these areas (such as Anshan Third Village Neighborhood Committee, etc.), although the objective supply of cultural and sports facilities (supply-demand ratio) is not high, residents' satisfaction is relatively high.

∑ **Interpretation:** This may imply that the few facilities in these areas are of high quality and well-operated, or that residents have low expectations for community facilities, or that specialized services accurately meet the needs of specific groups. Strategically, while maintaining the existing service quality and features, the focus should be on increasing the quantity and types of facilities to alleviate the pressure of insufficient supply and further enhance the overall service level.

Quadrant C: High Supply-Demand Ratio - Low Satisfaction (Key Service Improvement Zone / Prominent Human-Oriented Contradiction Zone):

∑ **Characteristics:** These areas (such as Tongji New Village Neighborhood Committee, Anshan Sixth Village Neighborhood Committee, etc.) have a relatively large number of cultural and sports facilities (higher supply-demand ratio), but residents' satisfaction is low.

∑ **Interpretation:** This is a typical phenomenon of "supply-demand mismatch" or "quantity without quality". Possible reasons include: facility types not matching residents' needs, outdated and poorly maintained facilities, chaotic management, poor service quality, unreasonable opening hours, or overcrowding leading to a poor user experience. Strategically, instead of blindly increasing quantity, the focus should be on improving facility quality, optimizing functional combinations, enhancing operational management, and enriching service content to address unmet "human-oriented needs".

Quadrant D: Low Supply-Demand Ratio - Low Satisfaction (Comprehensive Improvement Zone / Coexisting Human-Land Contradiction Zone):

∑ **Characteristics:** In these areas (such as Anshan First Village Third Neighborhood Committee, etc.), the supply of cultural and sports facilities is severely insufficient, and residents' satisfaction is also very low.

∑ **Interpretation:** This is the most problematic area, with significant shortcomings in both the quantity and quality of facilities, representing the most concentrated manifestation of supply-demand contradictions. Strategically, comprehensive and systematic improvements are needed, including increasing facility quantity, optimizing spatial layout, enhancing facility quality, and enriching service content.

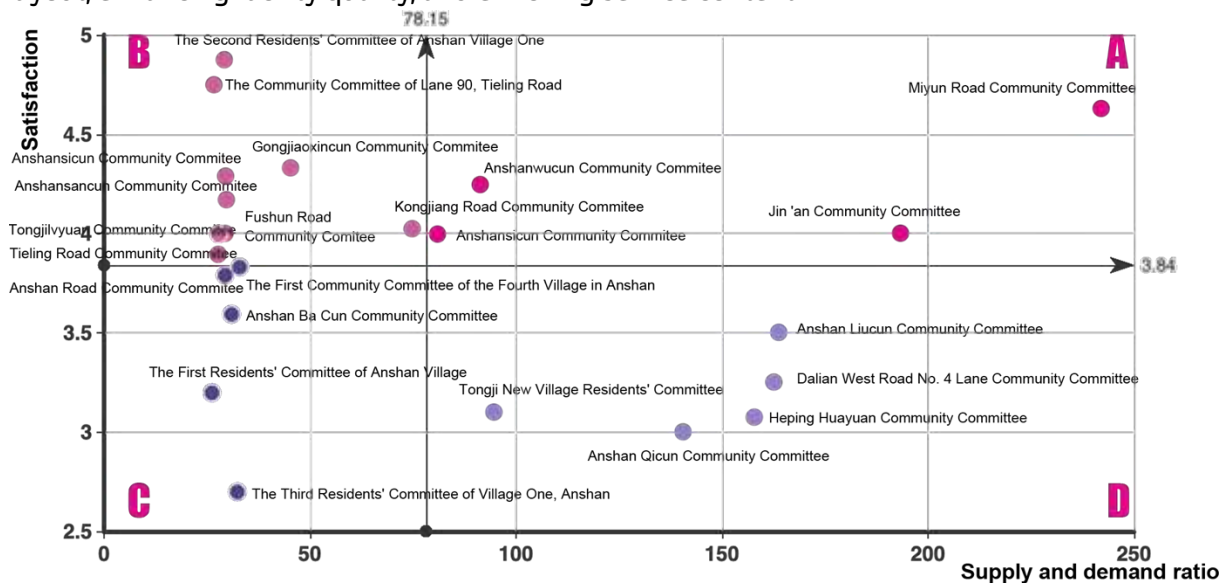


Fig 19. IPA Model Analysis

Based on the above analysis, the core supply-demand contradictions of public cultural and sports facilities in Siping Sub-district can be summarized as follows:

∑ 1-Contradictions at the Availability Level: Insufficient total quantity and monotonous types of facilities make it difficult to cover and meet the basic cultural and sports needs of diverse populations within the sub-district (especially for the young and middle-aged groups and those with different interest preferences). Barriers to the sharing of high-quality resources (such as facilities within universities) exacerbate the scarcity of available resources.

∑ 2-Contradictions at the Accessibility Level: Uneven spatial layout leads to some densely populated old residential communities becoming service blind spots or weak areas, resulting in poor convenience for residents to actually reach and use facilities. The functional supply of existing facilities does not fully match the actual usage behavior habits of residents (such as time preferences, functional preferences), leading to inefficient resource utilization.

∑ 3-Contradictions at the Adaptability Level: The quality, maintenance level, operational management, and service content of existing facilities have failed to effectively respond to the actual needs and expectations of residents, especially special groups such as the elderly, leading to low subjective satisfaction among residents. Facilities have shortcomings in terms of humanized design, professional guidance, interactive experience, and cultural atmosphere creation.

The identification of these contradictions lays a solid foundation for proposing targeted optimization strategies in the next stage.

5. Conclusions and Optimization Suggestions

5.1 Main Conclusions

Based on a systematic analysis of the availability, accessibility, and adaptability of public cultural and sports facilities in Siping Sub-district, this study draws the following main conclusions:

1-Coexistence of Supply-Side Structural Shortages and Spatial Imbalances: The total quantity of public cultural and sports facilities in Siping Sub-district struggles to meet the actual demands of its high-density population, presenting an overall situation where "supply falls short of demand". Concurrently, prominent issues include the homogeneity of facility types (sports facilities are predominantly small-scale outdoor equipment, while cultural facilities are largely oriented towards elderly services) and an uneven spatial distribution (high-quality resources are concentrated within universities or specific areas, with insufficient coverage in older residential communities). There is a particularly severe undersupply of cultural and sports spaces catering to young and middle-aged groups and meeting diverse, high-quality needs.

2-Significant Group and Temporal Differentiation in Resident Usage Behavior: The "young and old" demographic groups (youth and the elderly) are the primary users of public cultural and sports facilities, exhibiting relatively higher usage frequency and longer single-use durations. Clear, differentiated characteristics are observed among different age groups concerning preferences for facility types (e.g., youth prefer professional sports and experiential cultural activities, while the elderly favor outdoor fitness and social-cultural activities), functional demands (e.g., youth prioritize skill enhancement and knowledge acquisition, whereas middle-aged and elderly individuals focus on leisure, entertainment, and health-related social interaction), and usage time slots (e.g., youth during weekends and weekday evenings, the elderly in mornings and daytime).

3-Overall Resident Satisfaction is Not High, with a Gap Between Service Experience and Expectations: Over thirty percent of residents expressed dissatisfaction with existing cultural and sports facilities. Elderly groups, in particular, reported significantly lower satisfaction regarding facility accessibility, reasonableness of opening hours, comfort of the facility environment, and friendliness towards special groups. Regression analysis identified facility environment, functional richness, educational value (for cultural facilities), and convenience of participation as key factors influencing resident satisfaction. Residents' expectation levels for these factors generally surpassed their current evaluations, reflecting a considerable disparity between the service quality and experiential aspects of existing facilities and the actual needs and expectations of the residents.

4-The Phenomenon of Supply-Demand Mismatch Cannot Be Ignored; Precise Alignment is Key to Improvement: The IPA model analysis revealed instances of "high input (high supply-demand ratio) - low satisfaction" or "low input (low supply-demand ratio) - low satisfaction" in certain areas. This indicates that merely increasing the quantity of facilities cannot fully resolve the issues; the crucial aspect lies in achieving a precise alignment between facility provision and actual resident needs across multiple dimensions, including facility type, function, quality, and operational management.

5.2 Optimization and Improvement Strategies

Based on the above conclusions and identified core supply-demand contradictions, this study adheres to the principles of "problem-oriented, demand-led, context-specific adaptation, and classified policy implementation". From both "place-based" (focusing on spatial optimization and facility layout) and "people-based" (focusing on population needs and service improvement) dimensions, an "identification-evaluation-optimization-improvement" action system is constructed, proposing the following specific optimization and improvement strategies:

5.2.1 The "Identification-Evaluation-Optimization-Improvement" Action System Construction Logic

This system emphasizes first identifying specific supply-demand contradictions and their characteristics in different areas and for different facility types through scientific methods (such as 2SFCA, questionnaire surveys, IPA model); then conducting a multi-dimensional evaluation to clarify the severity of the problems and influencing factors; based on this, targeted optimization plans are formulated; finally, through continuous monitoring and feedback, the service capacity is continuously improved.

5.2.2 Specific Optimization and Improvement Strategies (Category-based Policies)

1-For "High Supply-Demand Ratio - Low Satisfaction" Areas (Prominent Human-Oriented Demand Contradiction, corresponding to Quadrant C of the IPA model):The core strategy for this area is to improve quality and efficiency and optimize the service experience. Specific measures include: comprehensively inspecting and optimizing the quality and environment of existing facilities, such as updating old equipment, improving site conditions (increasing lighting, seating, enhancing cleanliness, etc.), and creating a safe and comfortable atmosphere; conducting in-depth research on resident needs (especially for low-satisfaction groups) to reshape facility functions or update content, introducing more popular projects and courses; flexibly adjusting opening hours based on residents' usage time characteristics (e.g., extending evening hours, ensuring weekend availability), promoting staggered usage, and introducing professional management or volunteers to enhance guidance and service levels, and establishing convenient reservation and feedback mechanisms.

2-For "Low Supply-Demand Ratio - Low Satisfaction" Areas (Coexisting Human-Land Demand Contradiction, corresponding to Quadrant D of the IPA model):The core strategy for this area is to address shortcomings and improve quality simultaneously, carrying out systematic comprehensive improvement. Specific measures include: prioritizing from a "people-based" perspective, based on the demographic structure and needs assessment of the area, supplementing the most lacking facility types that residents urgently need, such as professional sports venues, fitness centers, or youth centers for young people, multi-functional activity rooms and fitness trails for young and middle-aged people, and health and wellness activity places and teaching points for elderly universities for the elderly; simultaneously, considering "place-based" conditions, fully tapping into potential spaces (such as idle factories, community rooms awaiting renovation), conducting scientific site selection and intensive, networked layout according to facility service radius and coverage gaps, avoiding new imbalances; and promoting the "1+N" embedded spatial layout model, i.e., creating a functionally composite "People's Square" style community comprehensive service core, supplemented by flexible, scattered "Six Arts Pavilion" style micro-service contact points, connected by slow-traffic systems to form a conveniently accessible service network.

3-For "Low Supply-Demand Ratio - High Satisfaction" Areas (Prominent Place-Based Demand Contradiction, corresponding to Quadrant B of the IPA model):The core strategy for this area is to focus on increasing supply while maintaining service quality. Specific measures include: learning from the successful operational experience of existing facilities, maintaining their service characteristics and quality; accurately identifying spatial coverage gaps, prioritizing the addition of similar or related types of high-quality facilities in service blind spots or underserved adjacent areas;

rationaly determining the type and scale of new facilities based on available site conditions and coordinating with the surrounding environment; while increasing quantity, continuously monitoring and enhancing facility quality and capacity to prevent service quality decline due to scale expansion.

4-Universal Optimization Strategies (Applicable to all areas): The open sharing of cultural and sports facilities in campuses and enterprises/institutions with the community should be vigorously promoted, with sound incentive and management mechanisms established to open up high-quality resources in phases, at different times, and under certain conditions to alleviate insufficient supply. At the same time, flexible and small-scale embedded cultural and sports spaces, such as the "Six Arts Pavilion" model (e.g., community shared living rooms, neighborhood libraries, pocket park fitness corners), should be actively introduced and cultivated to meet residents' immediate and fragmented needs. In all new construction, renovation, and operation of facilities, high attention must be paid to comprehensively improving friendliness towards special groups such as the elderly, children, and persons with disabilities, implementing barrier-free designs and age-appropriate/child-friendly services. Furthermore, intelligent empowerment and information-based management need to be strengthened, establishing a unified information release, inquiry, and reservation platform, promoting online services, and optimizing facility operations through big data analysis. Finally, social forces should be encouraged to participate in facility construction and operation through policy guidance, service procurement, and cooperative operation, forming a positive situation of multi-subject co-construction and co-governance.

6. Research Deficiencies and Prospects

Although this study has conducted a relatively systematic analysis of the supply-demand relationship concerning public cultural and sports facilities in Siping Sub-district and proposed specific optimization strategies, certain limitations still exist:

1-Sample Representativeness and Generalizability: Despite efforts to ensure the coverage of the questionnaire survey sample, the sample size (182 respondents) is relatively limited due to constraints in research time and resources. Caution should be exercised when generalizing these conclusions to a broader context. Future research could further expand the sample size and employ more refined stratified sampling techniques to enhance the statistical validity and generalizability of the findings.

2-Tracking of Dynamic Demand Changes: This study primarily reflects the demand situation of residents at a specific point in time. However, resident needs are dynamic and influenced by various factors such as social development, lifestyle changes, and unforeseen events (e.g., pandemics). Future research could consider incorporating longitudinal tracking surveys to better capture the evolutionary trends of demand.

3-Depth of "Qualitative" Assessment: The assessment of facility "quality" in this study relies mainly on residents' subjective satisfaction evaluations and some objective indicators (e.g., facility environment, functionality). For aspects such as the professionalism of services, the depth of cultural content, and the quality of activity organization, future research could employ more in-depth qualitative methods, including expert evaluations, in-depth interviews, and participatory observation.

4-Feasibility Assessment of Strategy Implementation: The optimization strategies proposed in this report are currently at a conceptual and directional level. Their concrete implementation requires more detailed feasibility assessments and scheme refinements, considering the sub-district's fiscal capacity, land resource constraints, multi-departmental coordination mechanisms, and residents' willingness to participate.

Looking ahead, the planning and development of urban public cultural and sports facilities will increasingly emphasize a people-oriented approach, precise supply, intelligent operations, and resilient adaptation.

Subsequent research can be extended in the following directions:

1-Refined Demand Profiling and Dynamic Monitoring Based on Big Data: Utilizing big data resources such as mobile signaling, social media, and smart wearable devices to more accurately delineate the spatio-temporal behavior patterns and cultural/sports activity preferences of different population groups, thereby achieving dynamic monitoring and prediction of demand.

2-Research on Revitalization and Innovative Design of Existing Stock Spaces: Against the backdrop of increasingly scarce land resources, in-depth research is needed on how to activate existing urban spatial resources through micro-renewal, adaptive reuse, and composite function implantation to create more attractive and vibrant community cultural and sports venues.

3-Exploration of Multi-Actor Collaborative Governance and Sustainable Operation Models: Investigating the establishment of effective collaborative governance mechanisms among government, market actors, social organizations, and community residents, and exploring sustainable development models featuring diversified investment, professionalized operation, and community participation.

4-Planning Responses for Cultural and Sports Facilities from the Perspectives of Healthy Cities and Active Aging: In conjunction with the "Healthy China" strategy and the national strategy for actively responding to population aging, future research should focus on how the optimized allocation of cultural and sports facilities can promote the formation of healthy lifestyles among residents and enhance the quality of life and sense of community integration for the elderly.

Through continuous in-depth research and practical exploration, it is anticipated that greater wisdom will be contributed to the improvement of planning, construction, operational, and managerial standards for urban community public cultural and sports facilities in China, ultimately aiding in the construction of a more equitable, efficient, inclusive, and vibrant city for the people.

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