

Suggestions for Optimizing the Spatial Layout of Community Sports Facilities Based on a Complete Community Perspective

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Abstract: Community sports facilities are the main places for residents to carry out physical exercise in urban communities in China, and the situation of community residents' participation in fitness activities and the degree of utilization of fitness equipment are closely related to their location. Based on the GIS technology to analyze the current situation of the layout of community sports facilities in the study area, based on the policy vision of complete community construction, the problems existing in the layout of community sports facilities in the study area are dissected, and the corresponding optimization countermeasures are proposed, so as to improve the management of the community sports facilities in the study area, the rational layout, and to enhance the utilization rate of the facilities, and to provide a basis for the scientific development of community sports facilities.

Keywords: community sports facilities, GIS, spatial distribution

1. Introduction

1.1. The Evolution of a Complete Community

Academic Wu Liangyong [1] first proposed the concept of "complete community" in China, stressing that people are the focus of the city and community planning should prioritize residents' needs. In 2019, the National Housing and Urban-Rural Development Work Conference identified the construction of joint creation and promotion of "complete communities" as a priority in 2020, including facilities, services, spatial environments, cultures, and governance systems. The State Council issued the Guiding Opinions on Reconstruction of Old Urban Districts and the Opinions on Mending the Shortcomings of Urban Residential Communities in 2020, emphasizing the importance of constructing complete communities to address community-based problems and improve overall quality of life[2]. In addition, the Construction Standards for Complete Residential Communities (for Trial Implementation) (hereinafter referred to as the Standards for Complete Residential Communities) was also released in the form of an annex, which further clarifies the objectives, main contents and specific requirements for the construction of complete residential communities.

1.2. The meaning of a complete community

Complete communities provide essential services and facilities for daily living[3]. With a 5-10 minute walk for elderly and children as the standard, these communities integrate childcare, elderly care, service stations, and convenience stores, enhancing residents' sense of well-being and accessibility. Complete communities are the fundamental units of cities, optimizing layout, improving functions, stimulating vitality, and transforming and developing cities through these units. These communities facilitate a convenient, comfortable, and beautiful lifestyle for the public.

The complete residential community is the basic unit of social governance. By carrying out the social practice activity of "building a beautiful environment and a happy life together", creating a community culture with a common spirit, and building a "vertical to the end" and "horizontal to the end", "build, govern and share" urban and rural governance systems.

1.3. Requirements for the construction of community sports facilities under the Guide to Building Complete Communities

Complete community construction standards require ample public activity and green areas. Each community should have a public activity site of at least 150 square metres with fitness equipment, trails, rest areas, children's play areas, and ball game facilities that can be converted into emergency shelters. New communities should have multi-functional sports venues of at least 800 square metres equipped with 5-a-side football, basketball, volleyball, etc. Existing communities should increase public space by transforming open space between houses, and new and old urban neighborhoods should utilize unused space to increase public space and encourage neighborly sharing. Public activity areas should be safe, comfortable, and varied.

2. Overview of the study area and data sources

2.1. Overview of the study area

Jiangbei New Area is a state-level new area in China, with a total of seven streets under its jurisdiction. It covers an area of 386.25 square kilometres. Located at the "T" intersection of the Yangtze River Economic Belt and the Beijing-Shanghai two major trunk routes, Jiangbei New Area serves as an important node for the development of the Yangtze River's middle and upper reaches. The new area places a high emphasis on national fitness, promoting the construction of a "10-minute sports and fitness circle" to improve the exercise environment for residents. Special government funds and sports lottery proceeds are used to fund construction projects and facilities. Through these initiatives, Jiangbei New Area has achieved a more perfect sports and fitness facilities network at the district, street, and community levels. The sports lottery public welfare funds have played a significant role in promoting national fitness and achieving the goal of a "ten-minute fitness circle".

This study takes the spatial distribution characteristics of community sports facilities within the direct administration area of Jiangbei New District in Nanjing City as the research object. It should be noted that due to the planning and development of Jiangbei New Area, only one community is left in Changlu Street in its direct administration area, and the rest of the communities have experienced demolitions and relocations in recent years and have long since moved to other streets in the direct administration area, so the spatial distribution characteristics of community sports facilities in Changlu Street are excluded from the present study.

2.2. Data sources and pre-processing

GIS, also known as Geographic Information Systems (Geographic Information Systems), refers to the use of computer systems for spatial geographic information input, storage, analysis, as well as query, display of data management systems, as a spatial information analysis technology, often used for a variety of resources, environmental information data management, based on the results of the analysis, people can make More scientific decision-making[4].The data used in this study include community sports facilities, traffic and road networks, administrative divisions, socio-economic data and other data sources. We use latitude and longitude to obtain the geographic coordinates of the community sports facilities, save them as Excel table style, and use the Add XY Data tool in ArcGIS10.2 software to turn the table data into spatial vector points in the form of spatial display in ArcGIS10.2 software, and the attribute data such as the area and type of the community sports facilities are modified and improved through the field survey (see Figure 1); the traffic road network data are obtained by crawling bugs. It is modified and improved through the field survey (see Figure 1); the traffic road network data is crawled through the crawler technology to crawl the Gaode map data; the residential data is crawled through the crawler technology to crawl the POI data of Gaode map and processed through the same steps of the community sports facilities; the vector data of the administrative district is vectorised by using the ArcGIS10.2 software to vectorise the map pieces of the administrative district of the new area in the north of Jiangbei; and the socio-economic data were obtained from the website of Nanjing Jiangbei New Area Management Committee (<http://njna.nanjing.gov.cn/>).

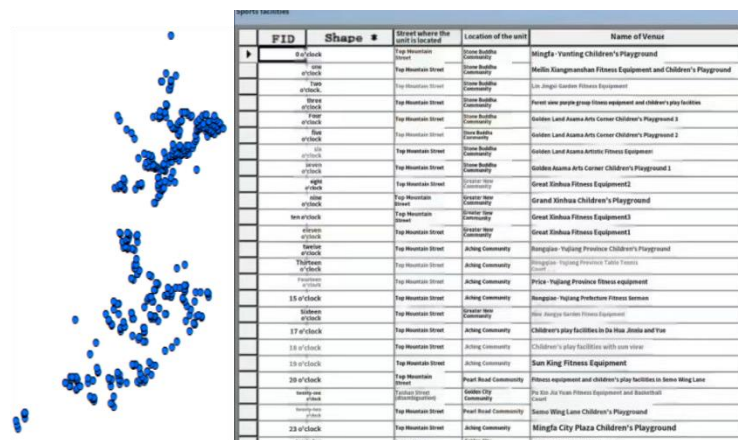


Figure 1: Spatial display of community sports facilities (left) with attribute table section (right).

2.3. Spatial distribution GIS database establishment

ArcGIS10.2 software is used to establish a geographic database containing comprehensive data on community sports facilities, road traffic, administrative divisions, etc., so that spatial data and attribute data can achieve one-to-one correspondence and facilitate spatial processing and analysis. The database data mainly contains three types of elements: point, line and surface. Among them, the point element mainly includes community sports facilities; the line element mainly includes road traffic and administrative boundaries; and the surface element mainly includes the Jiangbei New Area and the administrative areas of each street. The community sports facilities layer mainly contains attribute information such as name, address, street, etc.; the road traffic layer includes attribute information such as road length, road class, etc.; and the administrative area of each street contains attribute information such as population and area[5].

3. Current Situation of Community Sports Facilities in Jiangbei New District of Nanjing City

3.1. Current situation of the supply capacity of community sports facilities in Jiangbei New District, Nanjing City

The size of the supply capacity of community sports facilities is mainly based on the data obtained in the survey, which analyses the supply capacity of community sports facilities in Jiangbei New District of Nanjing from the three aspects of the number of community sports facilities, the types of equipment of community sports facilities and the area of community sports facilities sites, which in turn provides a reference for the later study.

(1) Number of Community Sports Facilities Projects in Jiangbei New District, Nanjing, China

Based on the results of the study, there are differences in the number of community sports facility projects built in different years in Jiangbei New District, Nanjing. Most of the community sports facility projects were built after 1996 (including 1996), with the highest number of community sports facility projects constructed in 2019, amounting to 129. Between 1975 and 2002, except for 4 and 5 community sports facilities projects built in 1998 and 1999 respectively, there were almost no community sports facilities projects built in other years, and the construction of community sports facilities projects in Jiangbei New Area is close to stagnation.

The number of community sports facilities in Dafang Street has the highest percentage in the study area at 25 per cent, followed by community sports facilities in Yanjiang Street at 21 per cent, and the number of community sports facilities in Pancheng Street has the lowest percentage at 10 per cent.

(2) Types of equipment for community sports facilities in Jiangbei New District, Nanjing, China

The type of community sports facilities is an important symbol reflecting the supply capacity of community sports facilities, and it is found that the community sports facilities in the study area contain three types of facilities, namely, national fitness sports sites, fitness trails and various types of courts. As of 13 October 2023, there were a total of 527 community sports facilities in the study area, of which 435 were national fitness paths, accounting for 82.54% of the total number of community sports facilities, with the largest number and proportion, and 92 of the other three types of community sports facilities, accounting for 17.46% of the total number of community sports facilities, with the number of fitness trails and various types of courts in descending order.

(3) Area of Community Sports Facilities in Jiangbei New District, Nanjing, China

As can be seen from information obtained from the Nanjing Municipal Sports Bureau, the total area of community sports facilities and fitness venues in the Jiangbei New Area of Nanjing has reached 1,895,900 square metres, accounting for approximately 0.49 per cent of the administrative area of the entire area. Among the three types of community sports facilities, the area occupied by national fitness sports grounds is the largest, accounting for about 46.86% of the total area of community sports facilities and fitness venues in the district; followed by fitness trails, ball fields.

3.2. Characterisation of the spatial distribution of community sports facilities in Jiangbei New District, Nanjing City

The analysis of the spatial distribution of community sports facilities helps to spatially understand the distribution of community sports facilities in various areas of the study area. In this section, three methods, namely kernel density, buffer zone and spatial autocorrelation model, are used to analyse the current situation of community sports facilities in the study area from multiple perspectives at a deeper level.

(1) Characterisation of the spatial distribution of community sports facilities based on kernel density calculations

In general (see Figure 2), community sports facilities in the study area as a whole show a spatial imbalance in the distribution of "group-type" characteristics. Community sports facilities are centrally distributed in the high density areas centred on Gertang Street, Dafang Street, Yanjiang Street and Dingshan Street, where the density contours of Dafang Street, Yanjiang Street and Dingshan Street are dense, indicating that the three streets change strongly with distance, and the density contours of Taishan Street are sparse, indicating that the streets change gently with distance; while most of Pancheng Street is a low density area, reflecting the insufficient distribution of community sports facilities in the area. reflects the insufficient distribution of community sports facilities in the region.

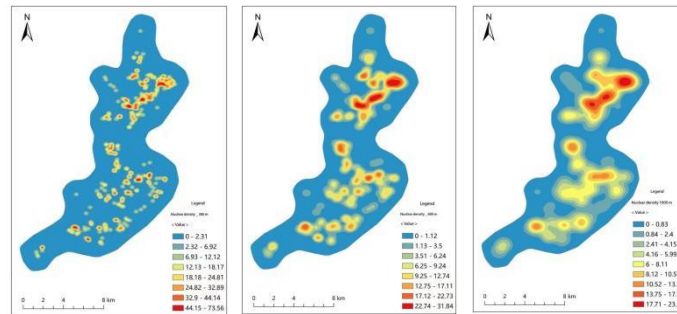


Figure 2: Nucleus density map of community sports facilities in Jiangbei New District, Nanjing

(2) Characterisation of the spatial distribution of community sports facilities based on buffer zones

As can be seen from Figure 4, the 1,000-metre buffer zone of community sports facilities covers 100% of the area of Jiangbei New Area, indicating that the coverage rate of community sports facilities in Jiangbei New Area has reached 100%, and 100% of the area is within the 15-minute service range, with a relatively high level of overall coverage.

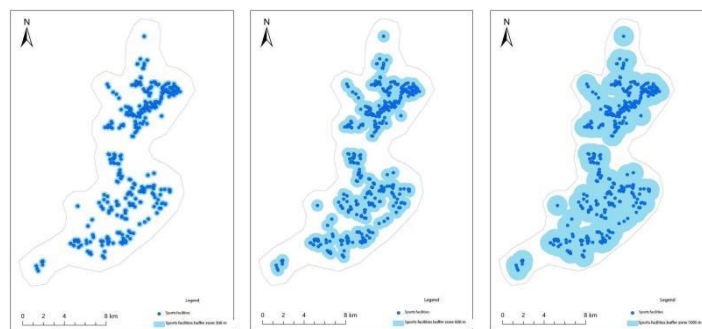


Figure 3: Nanjing Jiangbei New District Community Sports Facilities Buffer Zone Map

(3) Characterisation of the spatial distribution of community sports facilities based on spatial autocorrelation

Analysed from Table 1, the number of facility points, the number of facility points per capita, the area of fitness places and the area of fitness places per capita of the community sports facilities in Jiangbei New Area of Nanjing City, Moran's I are 0.280614, 0.011875, 0.469483 and 0.011371, respectively, which are greater than 0, and pass the test of 1% significance level, which indicates that there is a positive correlation between the spatial distribution of community sports facilities in Jiangbei New District, Nanjing, presenting spatial agglomeration characteristics.

Table 1: Moran's I Index of Community Sports Facilities in JNTD

	Moran's I	z	p
Number of facility sites	0.291614	1.865437	0.061374
Number of facility sites per capita	0.020875	0.519684	0.593801
Area of fitness space	0.469483	2.765148	0.005729
Area of fitness space per capita	0.011371	0.47069	0.649176

(4) Characterisation of the spatial distribution of community sports facilities based on road network accessibility

Overall (see Figure 4), the areas with poor accessibility are mainly located in Pancheng Street, mainly due to the relatively sparse road traffic on the street and the long distance to community sports facilities. The accessibility of community sports facilities in Dafang Street, Yanjiang Street, Getang Street and Taishan Street are all better, which also reflects the obvious differences in the spatial accessibility of community sports facilities in different streets of Jiangbei New Area.

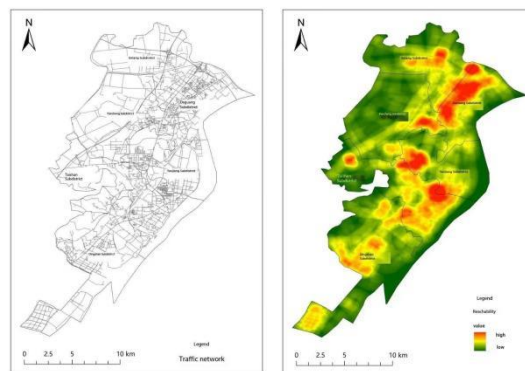


Figure 4: Jiangbei New District Road Transportation Network (left) and Accessibility (right)

4. Conclusion

4.1. Differences in sports facilities between old and new neighborhoods

At the outset of planning, new communities have given comprehensive consideration to sports facilities, and some developers have actively constructed sports facilities as a means of improving the quality of life in their settlements. Therefore, the construction scale of sports facilities in this type of community has basically reached the standard, and the level of sports facilities is relatively high. The older neighborhoods, on the other hand, have high population density and poor environmental quality, making it difficult for them to meet the requirements of modern sports facilities, so the scale of sports facilities in these neighborhoods does not meet the national standards.

4.2. Lack of management of community sports facilities

During the visit, it was found that some community sports facilities sites have been crowded out and diverted for other purposes. Some residents of the neighborhood will be community sports facilities site as a miscellaneous dump, some residents of the neighborhood in the community sports facilities site to dry quilts, drying clothes, some residents of the neighborhood will be fitness equipment for other purposes These crowded, diverted community sports facilities, not only occupies the residents of the fitness space, but also affects the use of others.

4.3. The layout of community sports facilities is unreasonable

However, it was found in the survey that the relevant departments did not give much consideration to the impact on residents when equipping them with sports facilities. For example, two sets of sports equipment are placed in the same place, resulting in the site used by residents for square dancing being occupied, making it impossible for them to carry out their activities; sports facilities are placed on uneven slopes, which has an impact on the safety of residents, and these inappropriate settings thus make the residents dissatisfied with the work of the relevant departments.

5. Optimisation strategy

5.1. Expanding the total number of community sports facilities

Community sports facilities need to be expanded to meet demand. To do this, outdoor fitness areas should be created with equipment, trails, and other features. Each new community should include an 150 square metre multi-purpose sports ground. Strict enforcement of national policies and norms ensures high-quality facilities.

Reuse space in neighborhoods by upgrading green courtyard spaces, creating "pocket parks", using street corners and unused plots for public activities, and sharing activity venues with neighboring areas. Incorporate residential communities without fitness facilities into the transformation of old urban areas, planning integrated community fitness facilities, and establishing non-standard fitness facilities where necessary.

5.2. Optimization of spatial layout

Distance between residents and community sports facilities affects usage frequency, with residents using facilities closest to their homes. The service radius of community sports facilities should be based on residents' exercise habits and walking distance. Research shows that 58.8% of residents accept public sports facilities within 10 minutes' walking distance, while 33.3% accept facilities within 10 to 30 minutes' walking distance [6].

Pancheng Street network is poor and should be improved. Construction of comfortable pedestrian roads and better connectivity to parks, public events, and public services are recommended to enhance livability and residents' health.

5.3. Improvement of facility types and management of site facilities

Sports facilities are essential for community sports activities. They should be set up based on residents' sports wishes and the age structure of the community to stimulate enthusiasm and improve participation. Planning and design should take into account residents' diverse needs and preferences. Community sports facilities can be improved through professional property services, but if not available, community trusteeship or other forms of property management can be used. To improve management, a special department can be established to manage complaints and provide assistance with maintenance and environmental health.

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