

Inequalities in Public Cultural Facility Distribution: A Comparative Analysis Across Demographic Groups in Wenzhou, China

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Abstract

This study focuses on public cultural facilities in Wenzhou. It examines the spatial distribution of cultural facilities and disparities in facility access among demographic groups. Kernel density analysis, the 2SFCA model, Pearson correlation analysis, Spatial Autocorrelation analysis, and the Spatial Lag Regression model are used to analyse the data. The findings reveal three major inequalities: 1) central areas have more facilities; 2) facility accessibility remains inadequate and does not align with population demand; and 3) areas with more floating populations and youth have more facilities, while elderly-dominated areas have fewer. Key contributing factors to these inequities include historical development patterns, economic disparities, and the supply-oriented approach to planning. Based on these findings, Wenzhou can implement more targeted strategies to build quality cultural life circles.

Keywords: public cultural facilities, spatial distribution, population characteristics, vulnerable population, social equity

1. Introduction

With the introduction of the “Equalisation of Basic Public Services” concept and the increasing public demand for a better life in China, the provision of public services has become a crucial factor influencing people’s sense of fulfilment, happiness, and security. Basic public services in China mainly include eight key areas: public education, employment and entrepreneurship, social insurance, medical and health care, social services, housing security, culture and sports, and services for the disabled (Yin, 2023). However, significant challenges remain in addressing imbalances and inadequacies of public services, particularly in terms of regional, urban-rural, and demographic disparities (Xu et al., 2022). Therefore, there is an urgent need to promote public service equity by optimising resource allocation mechanisms and ensuring that facility distribution aligns more effectively with demographic characteristics.

Studying disparities in the distribution of public facilities across different regions, urban-rural divides, and demographic groups is essential for understanding social inclusion, enhancing residents’ quality of life, and promoting sustainable social development. Academic research has made significant progress in exploring the spatial distribution of basic public facilities (Zhan et al., 2019). However, existing studies still have certain limitations.

On the one hand, the discussion of facility types remains limited. Research primarily focuses on green spaces (Liu et al., 2022), hospitals (Gao et al., 2021), sports facilities (Liu et al., 2009), and elderly care facilities (Liu et al., 2024). Methods such as density analysis, potential model analysis (Rong et al., 2020), Gaussian-based Two-Step Floating Catchment Area (2SFCA) (Liu et al., 2023), geographically weighted regression (GWR) (Yang et al., 2022), and coupling coordination analysis (Xu et al., 2022) have been employed to examine the availability and accessibility of these types of public facilities. In contrast, research on public cultural facilities remains inadequate. Most research on cultural facilities emphasises their quantity, density, and accessibility through quantitative statistics, effectiveness evaluations, density analysis, and urban network analysis (Xie & Chang, 2023) (Park et al., 2015). Even when accessibility is considered, the focus often remains on facility location, with limited attention to other important factors such as facility size. Furthermore, existing research predominantly examines public cultural facilities in major cities (He et al., 2017), with limited attention to Wenzhou and other mid-sized cities.

On the other hand, few studies systematically explore the relationship between public facility supply and population demand, or evaluate how facility distribution aligns with demographic characteristics. Existing research often focuses on the suitability of specific facilities for particular groups—for example, age-friendly facilities for the elderly (Liu et al., 2024)—but provides limited insight into disparities in access to the same facilities

among different demographic groups.

Furthermore, Wenzhou is the birthplace of the City Study Room, a distinctive type of public cultural facility. Unlike traditional libraries, city study rooms are characterised by their small scale, strong community orientation, and 24-hour self-service access. As public, non-profit spaces, they offer a new way of providing cultural services (Duan & Xiong, 2020). Therefore, Wenzhou's public cultural facilities hold significant research value.

With the development of globalisation, the significance of cultural services has grown, as cultural resources play a crucial role in maintaining local identity and fostering social inclusion (Bonang & Fitriyah, 2022). Therefore, cultural equity has emerged as a key indicator of social development, highlighting the need to address the rights of vulnerable groups and underdeveloped areas (Fan & Hou, 2021).

In summary, public services—particularly public cultural services—hold significant research value. While there are many theoretical studies on public services, research on public culture services remains relatively limited. Therefore, this study analyses the spatial distribution of public cultural facilities and explores disparities in access among different demographic groups. Furthermore, optimisation strategies are proposed to guide the planning of public cultural facilities in Wenzhou and other similar cities around the world.

2. Methods

2.1 Research Framework

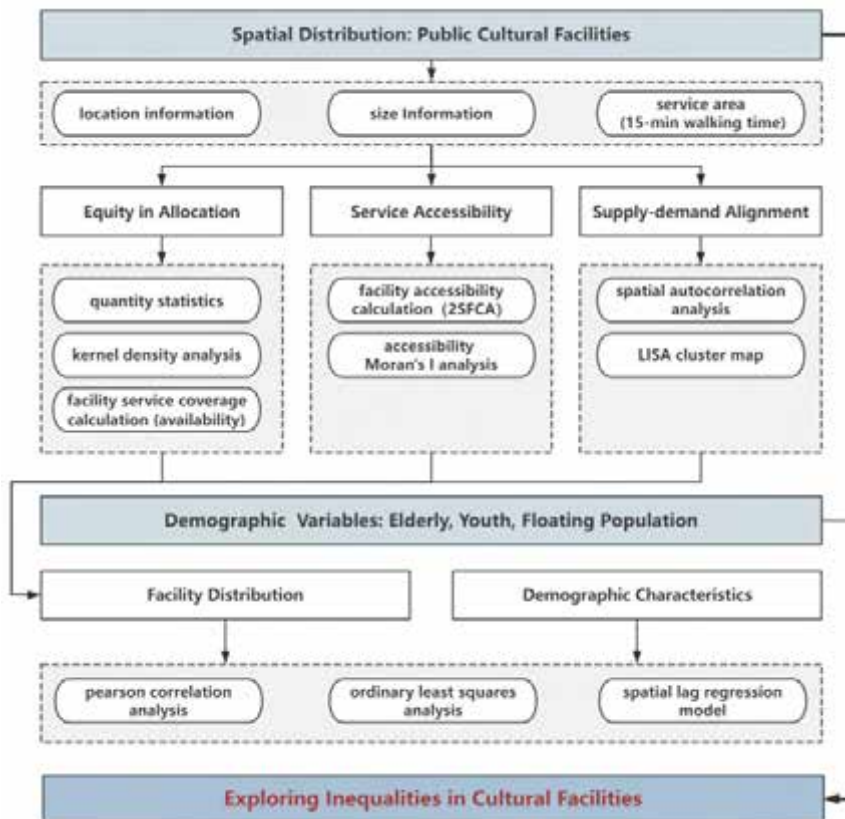


Figure 1. Framework to explore inequalities in cultural facilities

This study examined the spatial distribution of public cultural facilities across three key dimensions: equity in allocation, service accessibility, and supply-demand alignment. The equity analysis in facility allocation utilised

ArcGIS to quantify the number of facilities within each spatial unit and used kernel density analysis to evaluate their density. Facility availability was assessed by defining service buffer zones and calculating the coverage. Accessibility was calculated using the 2SFCA method and further examined using Moran's I index (Zhang et al., 2024). For supply-demand alignment, GeoDa was used to analyse the spatial autocorrelation between facility accessibility and the total population, producing a Local Indicators of Spatial Association (LISA) cluster map (Wang et al., 2024).

Based on the analysis of the spatial distribution, this study further examined the alignment between facility distribution and different demographic groups, with a focus on vulnerable populations, including the elderly, the youth, and the floating population. To analyse disparities in access to cultural facilities, Pearson correlation analysis, ordinary least squares (OLS), and spatial lag regression models were used, assessing whether certain groups faced restricted access to public cultural services (Fig.1).

2.2 Facility Coverage

As public service, cultural facilities should maximise their coverage of built-up spaces, ensuring broader access to cultural services for residents. Therefore, this study evaluated the spatial coverage of the facilities and revealed disparities in cultural service provision across different areas. To define the service range of each facility, buffer zones were established. In line with Wenzhou's goal of creating "15-minute quality cultural life circles", 1,000-metre buffers—representing a 15-minute walking distance—were generated around the facilities. R_{CF} was then used to quantify the proportion of built-up areas covered by buffer zones.

$$R_{CF} = \frac{A_{CFA}}{A_{BUA}} \times 100\% \quad (1)$$

A_{CFA} represents the area of built-up space covered by buffer zones of cultural facilities within each spatial unit, with overlapping areas counted only once. A_{BUA} represents the total area of built-up space within each spatial unit.

2.3 Facility Accessibility

This study used 2SFCA method to measure the accessibility of cultural facilities (Zhang et al., 2024). Step 1: Calculating the Supply-to-Demand Ratio R_j .

$$R_j = \frac{S_j}{\sum_{k \in [d_{kj} \leq d_0]} G(d_{kj}) P_k} \quad (2)$$

S_j represents the building area of facility j , while P_k represents the population of spatial unit k . d_0 represents the predefined threshold distance (1000m). d_{kj} represents the distance from spatial unit k to facility j . $G(d_{kj})$ is the Gaussian equation considering the distance decay.

$$G(d_{kj}) = \frac{e^{-\frac{1}{2} \left(\frac{d_{kj}}{d_0} \right)^2} - e^{-\frac{1}{2}}}{1 - e^{-\frac{1}{2}}} \quad (d_{kj} \leq d_0) \quad (3)$$

Step 2: Aggregating Accessibility at Each Demand Location.

$$A_k = \sum_{j \in \{d_{ij} \leq d_{k0}\}} G(d_{ij}) R_j \quad (4)$$

A higher A_k represents greater accessibility to cultural facilities.

3. Study Area and Data Sources

Wenzhou, located in south-eastern China, enjoys a strategically advantageous geographic position. Renowned for its dynamic economy characterised by “small commodities and large markets”, the city also possesses a rich cultural heritage, including traditional handicrafts, OuYue culture, and a strong entrepreneurial spirit. Wenzhou consists of 12 districts. The core urban area includes Lucheng, Longwan, Ouhai, and Dongtou districts. Longgang and its surrounding areas serve as the secondary urban centre. Ruian and Yueqing are considered non-core areas, while Yongjia, Wencheng, Pingyang, Taishun, and Cangnan are considered rural areas (Fig.2).



Figure 2. Districts in Wenzhou

Population data in Wenzhou were collected from the 2020 China Population Census Data by Township, Town, and Sub-district. The youth population includes individuals aged 0 to 14, while the elderly population includes those aged 60 and older. The floating population is defined as the difference between the total population and the local population. The local population is defined as individuals whose registered household location matches their place of residence.

Wenzhou's population shows a clear trend of concentration. The total population is concentrated in the core urban area and the secondary urban centre. The floating population is also more densely located in economically developed central districts. In contrast, both youth and elderly residents are less concentrated in the core urban area (Fig.3 -6). Additionally, the population dynamics show a clear trend of inflow and growth. The floating people from outside Wenzhou account for 26.1% of the permanent population. Most of these floating people move from rural to urban areas and generally have lower educational backgrounds. Meanwhile, the implementation of fertility policies has led to an increase in the 0 to 14 age group. At the same time, population ageing has accelerated, with the proportion of residents aged 60 and older rising significantly. Given these demographic

characteristics and shifts, it is essential to explore disparities in access to cultural facilities among the youth, the elderly, and the floating population in Wenzhou.

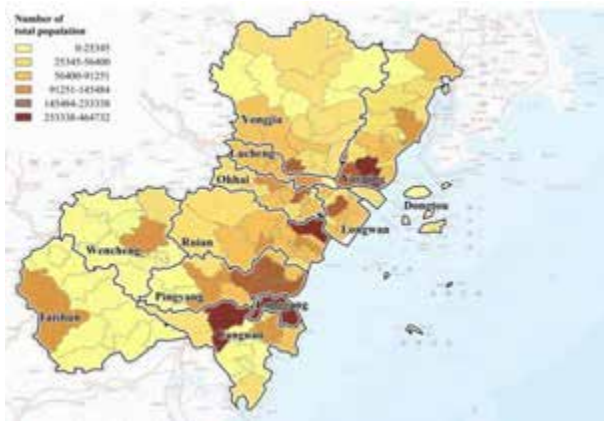


Figure 3. Distribution of the total population

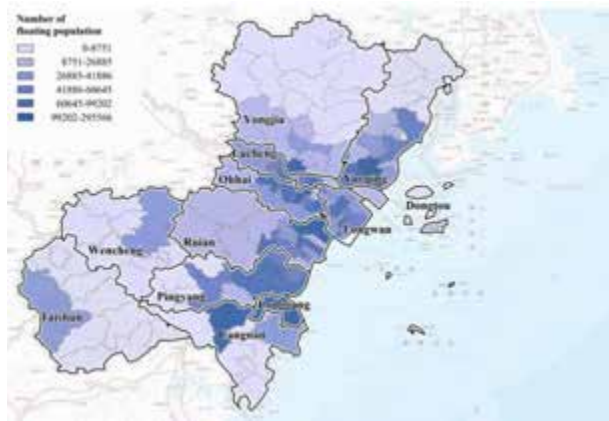


Figure 4. Distribution of the floating population

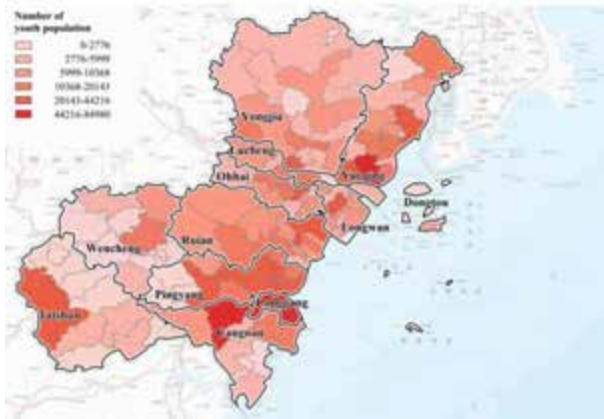


Figure 5. Distribution of the youth population



Figure 6. Distribution of the elderly population

This study defines public cultural facilities as government-led, socially supported institutions that provide cultural services. These facilities include reading spaces such as libraries, city study rooms, community reading rooms, and mobile libraries, as well as exhibition venues such as museums, cultural centres, memorial halls, art galleries, and science centres. The data on public cultural facilities in Wenzhou were obtained from publicly available records provided by the Wenzhou Government, updated as of January 2024. After data processing, 337 facilities were identified, with details including facility names, locations, and area sizes.

4. Results

4.1. Spatial Distribution of Cultural Facilities

4.1.1 Equity in Allocation

The spatial distribution of public cultural facilities in Wenzhou is uneven, with district disparities and concentrations in specific areas. Cultural facilities in Wenzhou are mainly concentrated in the core urban area of Lucheng, Longwan, and Ouhai districts. Although Dongtou District is also planned as an urban centre area, its island location limits connectivity with other districts, resulting in a lower concentration of public facilities. Statistical analysis indicates that all sub-districts with more than 10 facilities are located exclusively in Lucheng and Longwan. Kernel density analysis further highlights a particularly high concentration in Wuma, Nanhui, and Binjiang sub-districts of Lucheng District. In Ruian District, as a non-core area, moderate clustering is observed in Xincheng, Feiyun, Anyang, and Tingtian sub-districts. A slight degree of clustering is also found in the rural areas of Wencheng and Taishun districts. However, there is no obvious clustering in Yueqing, Longgang, or Cangnan districts. Although Longgang is the secondary urban centre of Wenzhou, it also lacks a concentration of facilities (Fig.7).

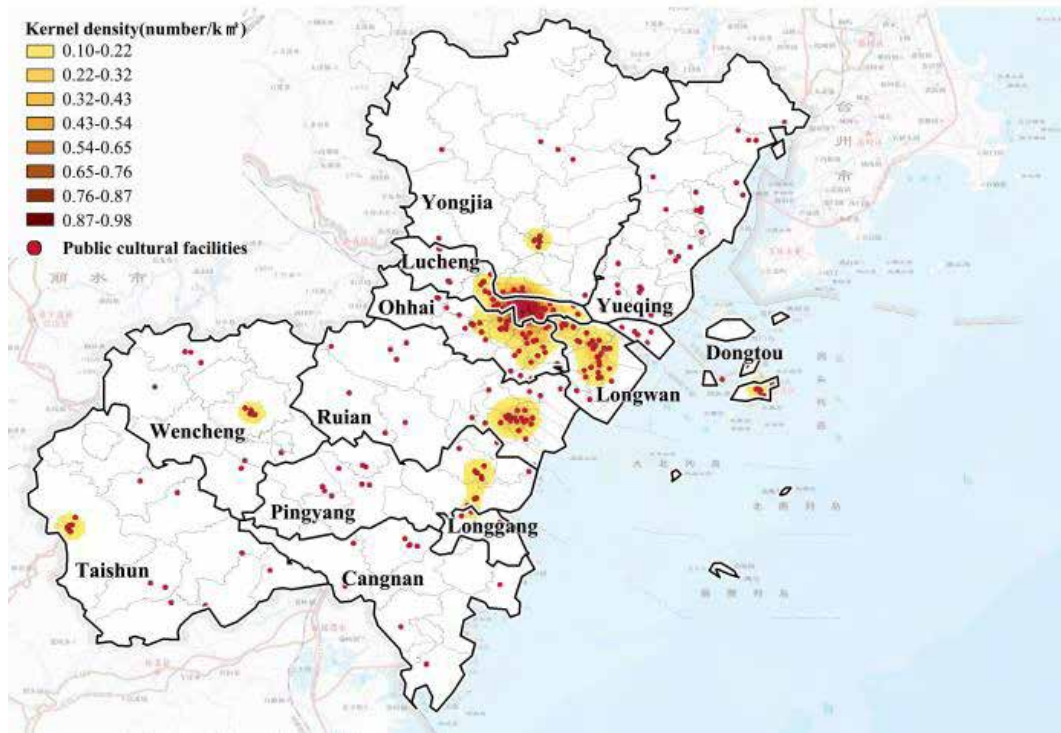


Figure 7. Kernel density map of public cultural facilities

The availability of cultural facilities in Wenzhou remains insufficient and requires significant improvement. For each spatial unit, the more built-up areas are covered by 1000m buffer zones, the higher the availability is. However, the average coverage rate (R_{CF}) is only 23.36%, with a median of 13.12%, highlighting the overall inadequacy of cultural facility availability in Wenzhou. Additionally, there are spatial disparities in facility availability, with higher coverage rates primarily concentrated in core urban areas. For instance, Wuma and Binjiang sub-districts in Lucheng District, along with Puzhou sub-district in Longwan District, have R_{CF} values exceeding 88%. In contrast, areas located farther from the city's geographic and planning center exhibit very low facility availability. For example, the western part of Ruian District and the northern part of Yueqing District have R_{CF} values close to zero. Many rural areas, including most of Wencheng and Taishun Districts, also show similarly low R_{CF} values (Fig.8).

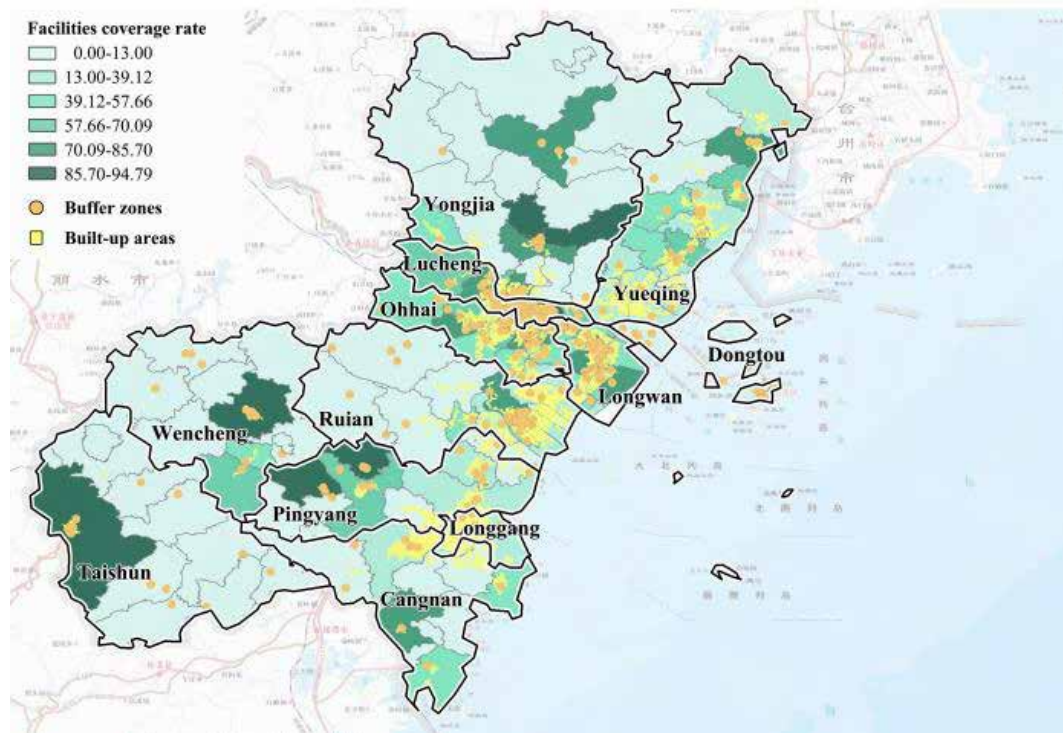


Figure 8. Services area and coverage of cultural facilities

4.1.2 Service Accessibility

The study use the 2SFCA method, evaluating facility accessibility by considering both population size and the area of public cultural facilities. The analysis reveals that only 29 sub-districts (21% of the total) have facility accessibility that exceeds the per capita area of public cultural facilities. Notably, sub-districts with high accessibility are not necessarily clustered around Wenzhou's core urban area or secondary centre. In fact, some sub-districts in rural areas demonstrate higher accessibility than those in the urban core. For instance, Fanshan sub-district in Cangnan District has the highest facility accessibility among all sub-districts, despite being situated in a rural area (Fig.9). To examine the spatial patterns of facility accessibility, the spatial autocorrelation analysis was used. The univariate Moran's I value was -0.023 (close to 0), with a p-value of 0.366 (>0.05), indicating that facility accessibility is spatially random, without significant clustering or dispersion.

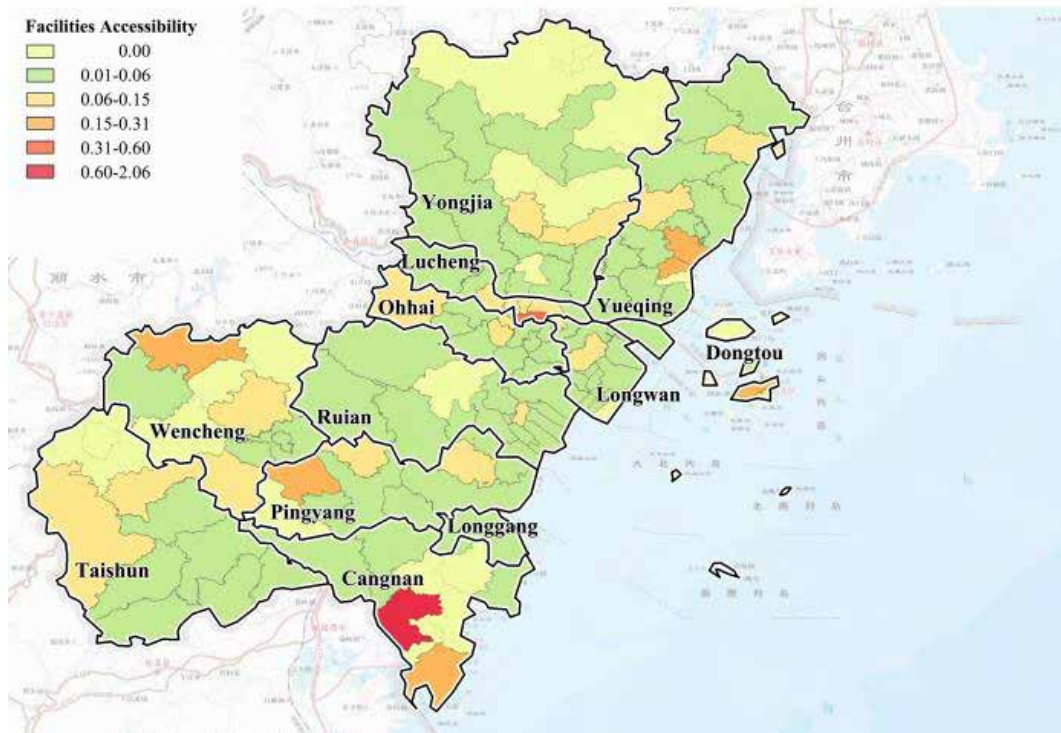


Figure 9. Accessibility of cultural facilities

4.1.3 Supply-demand Alignment

This study evaluates the alignment between facility accessibility and population demand by using a bivariate Moran's I analysis and generating a LISA cluster map. This map shows spatial units with significant mismatches between accessibility and population demand, along with their clustering locations. The LISA cluster map shows that only one sub-district—Songtai, located in the core urban area of Lucheng District—meets the “high accessibility-high demand” condition. Sub-districts classified as “low accessibility-high demand” are primarily clustered around the secondary urban centre in Longgang. Similar mismatches are also observed in the non-core areas, including Yanpen, Wengyang, and Baishi sub-districts in Yueqing District, as well as the Tingtian sub-district in Ruian District. In contrast, some sub-districts in rural areas, such as Nantian, Dajun, and Shanxi in Wencheng District, Mazhan in Cangnan District, and Luoyang in Taishun District belong to the “high accessibility-low demand” category due to their relatively small populations (Fig.10).

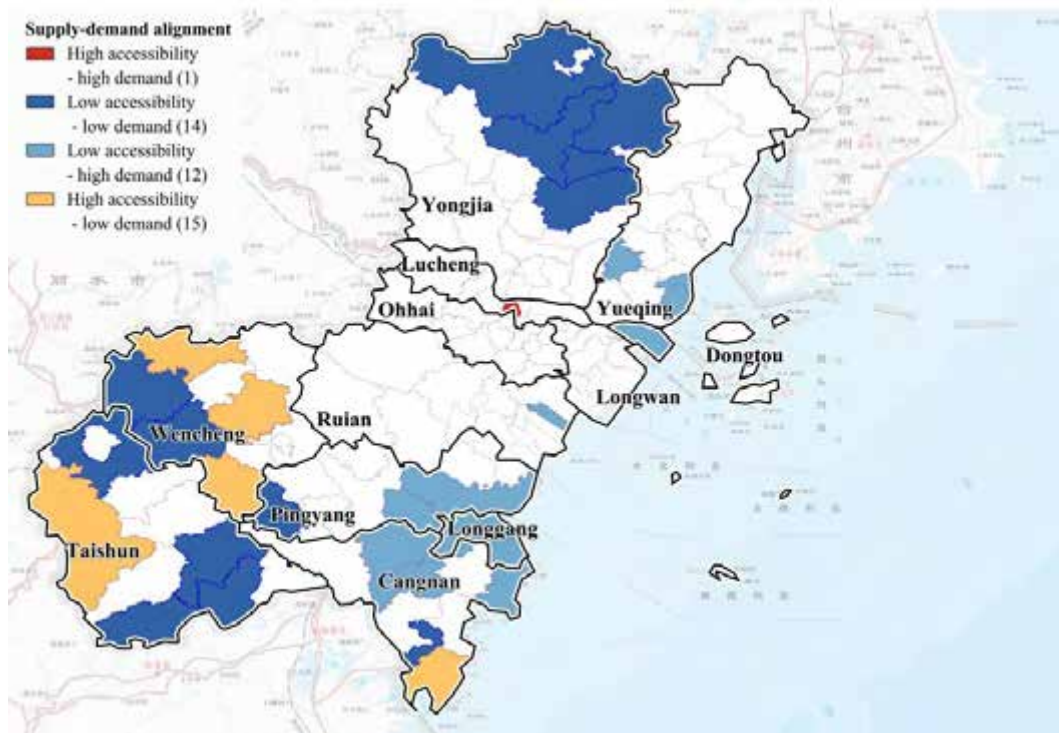


Figure 10. Supply-demand alignment of facilities and population

4.2. Facility Access Across Demographic Groups

4.2.1 Pearson Correlation Analysis

This study investigates the relationship between the public cultural facilities distribution and population variables. Pearson correlation are used to analyse the data. The findings show that the facility coverage rate (R_{CF}) is significantly positively correlated with both the total population and the floating population. In contrast, R_{CF} shows no evident correlation with the youth population and even exhibits a significant negative correlation with the elderly population. Additionally, facility accessibility (A_k) has no correlation with the youth, elderly, or the floating population. However, it is significantly positively correlated with facility coverage, quantity, and total building area (Table1).

Table 1. Results of correlation analysis

Variable	1	2	3	4	5	6	7	8
1 total population	1							
2 percentage of youth	0.15	1						
3 percentage of elderly	-.434**	.228**	1					
4 percentage of floating	.387**	-.411**	-.871**	1				
5 facility accessibility	-0.003	0.083	0.096	-0.082	1			
6 facility coverage	.199*	0.047	-.305**	.412**	.297**	1		
7 quantity of facilities	.451**	0.069	-.273**	.336**	.174*	.597**	1	
8 total facility area	.235**	0.16	-0.093	0.081	.701**	.429**	.574**	1

** indicates at the 0.01 level, the correlation is significant.

* indicates at the 0.05 level, the correlation is significant.

4.2.2 OLS and Spatial Lag Regression Analysis

Since Pearson correlation analysis does not account for spatial effects, this study further explores the relationship between facility coverage rate (R_{CF}) and population variables using OLS regression and spatial lag regression. The univariate Moran's I analysis of R_{CF} shows a statistically significant p-value (<0.05), confirming

the presence of spatial autocorrelation and supporting the use of regression modelling. The results indicate that the total population does not have a significant direct impact on facility coverage. However, the youth and floating populations have a significant positive effect on facility coverage, while the elderly population has no significant influence (Table2).

Table2. Results of regression analysis

spatial lag regression			OLS	
Variable	coef.	P	coef.	P
CONSTANT	-40.67*	0.01	-42.57*	0.01
total population	<-0.01	0.88	<-0.01	0.78
percentage of youth	1.89**	<0.01	1.93**	<0.01
percentage of elderly	0.34	0.42	0.51	0.27
percentage of floating	0.51**	<0.01	0.71**	<0.01
R-squared	0.324		0.230	
AIC	1236.34		1246.96	
Log likelihood	-612.17		-618.48	
R _{cf} Univariate Moran's I=0.2946< p-value= 0.001<z-value: 5.2172				

** P<0.01;* P<0.05

4.2.3 Supply-Demand Alignment Across Different Demographic Groups

The match between the demands of different population groups and facility accessibility is analysed. Using LISA cluster maps, it identifies areas where low accessibility coincides with high demand, revealing spatial mismatches among different demographic groups. For the floating population, these areas are concentrated in the districts of the core urban area. Among the youth, "low-accessibility, high-demand" areas are mainly located around the secondary urban centre and in non-core areas, including Longgang District along with its neighbouring Xiaojiang sub-district and Hongqiao sub-district in Yueqing District. Additionally, these areas are also found in rural regions, such as Shatou sub-district in Yongjia District. For the elderly, such areas are primarily located in the rural areas of Pingyang, Wencheng, Taishun, and Cangnan districts (Fig11).

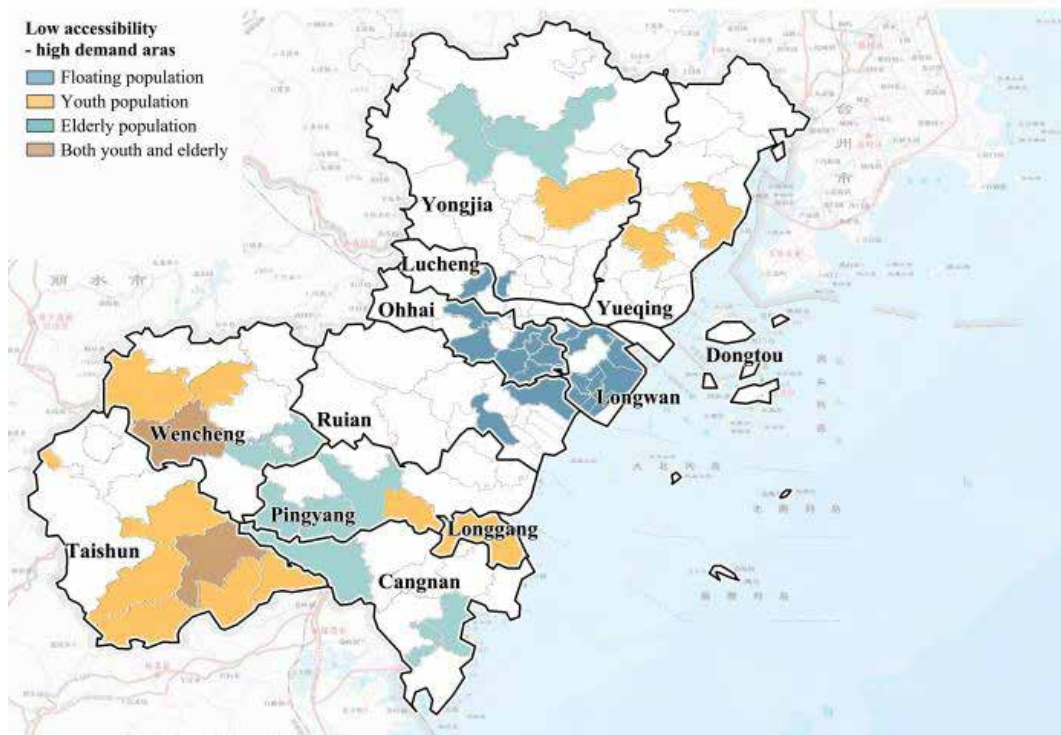


Figure11. Low-accessibility and high-demand areas for demographic groups

5. Discussion

5.1 Characteristics and Impact

The distribution of public cultural facilities in Wenzhou is highly uneven. Cultural facilities are concentrated in the core urban area, while the secondary urban centre faces a shortage. And rural areas have even fewer cultural facilities. This imbalance restricts cultural participation for lower-income residents and may exacerbate social stratification. Notably, individuals from lower social classes often have more active perceptions about the equalisation of basic public services (Chen et al., 2023). The lower their socio-economic classes, the higher their evaluation of and demand for public services (Liu & Qu, 2020). However, the current spatial distribution of cultural facilities fails to match these heightened demands, further exacerbating existing inequalities.

Cultural facilities in Wenzhou do not exhibit the typical pattern of declining accessibility from the urban core to the periphery (Zhao & Zhang, 2020). Instead, accessibility is unevenly distributed and lacks a clear hierarchical structure. Its random distribution may result in both over-concentration and under-provision, making it difficult to ensure spatial equity. Additionally, population distribution and facility accessibility are poorly matched, with only one sub-district achieving the high supply-demand balance. This misalignment highlights a significant shortcoming in the accessibility of cultural facilities in Wenzhou, making it difficult to meet people's cultural needs.

Different population groups have unequal access to facilities. The elderly are particularly highlighted as facing a shortage of public cultural resources. Areas with higher concentrations of youth and floating populations tend to have more facilities, while areas with larger elderly populations often have fewer. The youth, the elderly, and the floating population are vulnerable groups in accessing cultural facilities (Fan & Hou, 2021). They should have equal opportunities to utilise culture resources. Limited physical mobility restricts the elderly's access to facilities, and the negative correlation between facility and the elderly population further restricts their cultural participation. Furthermore, while areas with a high floating population tend to have more facilities, limited accessibility still restricts cultural participation, revealing a gap between provision and effective access.

5.2 Reasons

The historical development of Wenzhou has established the foundation for the spatial patterns of its facilities. Public facility construction follows a core-to-periphery expansion pattern (Li&Feng, 2017). Planning documents from 2003 and 2021 indicate that Wenzhou's urban development. Lucheng, Longwan, and Ouhai were initially planned as the core districts. Later, Yueqing, Ruian, and Dongtou were added as auxiliary areas, with Longgang identified as a secondary urban centre. As a result, cultural facilities are mainly concentrated in the core urban area and gradually extend to the surrounding areas along the planned axis (Fig12), while there are few cultural facilities in rural areas. However, Longgang was designated as a secondary urban centre only about six years ago. Before that, it was just a sub-district within Cangnan District, which partly explains its clear shortage of cultural facilities.

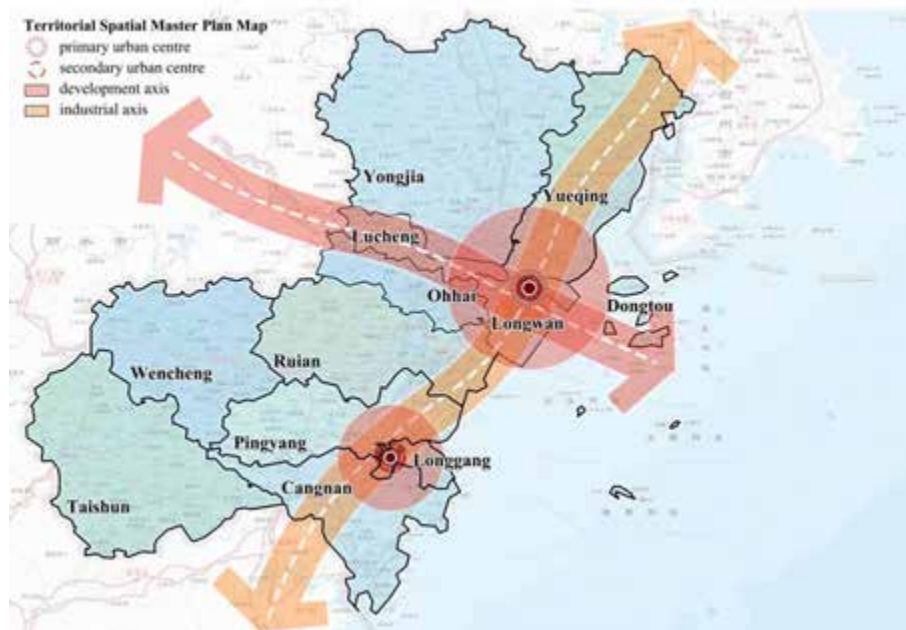


Figure 12. Territorial spatial plan map of Wenzhou

Wenzhou's public cultural facilities have relatively low accessibility, partly due to previous facility allocation policies. Wenzhou's cultural development policies set standards for facility quantity and service coverage but lack mandatory per capita area requirements. While the quantity of facilities has kept pace with urban and population growth, the quality often falls short of requirements, resulting in poor accessibility and mismatches between supply and demand. This issue has not only happened in Wenzhou. The early "supply-oriented" approaches to facility allocation ensured compliance with quantitative targets but often overlooked population needs and spatial accessibility. In recent years, however, China has gradually shifted toward a "demand-oriented" model in public facility planning (Chen et al., 2025).

Disparities in access to facilities among different population groups are influenced by policies and economic development. The floating population is primarily concentrated in economically developed areas, where cultural facilities are generally more abundant. For young people, spatial lag regression analysis indicates a positive relationship between their population distribution and the allocation of cultural facilities. This can be partly attributed to Wenzhou's cultural policies, which place a particular emphasis on youth services. The government has implemented measures to promote cultural exchange among youth and enhance the quality of their cultural life. In contrast, existing policies pay insufficient attention to the cultural needs of the elderly, often prioritizing pensions and healthcare. As a result, the elderly population is in a more vulnerable position in terms of access to cultural facilities.

5.3 Suggestions

Firstly, improving the socialisation of public cultural facilities. Public cultural facilities can be built together with other public facilities and social forces should also be encouraged to participate in their development. On the one hand, public cultural spaces can be combined with green parks, sports facilities, and stations to address shortages in facility distribution (Yang & Li, 2021). On the other hand, the development of public facilities also requires the joint participation of the government and social forces. For example, enterprises are a strong social force in the development of cultural facilities. Enterprises can provide funding and space, while cultural facilities enhance the area's attractiveness, creating mutual benefits. Wenzhou's non-core urban areas and the secondary centre have a high concentration of enterprises, which presents an opportunity to address the shortage of cultural facilities in these areas.

Secondly, promoting balanced facility development. Cultural resources should be allocated to rural areas to promote urban-rural integration. Constructing mobile cultural facilities and guaranteeing cultural spaces in both new and renovated residential areas are feasible actions. In addition, the cultural rights of the youth, the elderly, and the floating population should be protected. According to the distribution characteristics of various demographics, priority should be given to improving the "Low-accessibility and high-demand" areas. In areas with high demand for youth cultural services, facilities such as youth libraries and science museums can be established. Similarly, in areas with high demand for elderly cultural services, accessible and elderly-friendly cultural spaces can be developed. In areas with a large floating population, cultural exchange spaces can be provided.

Thirdly, promoting the integration of the floating population into local communities through cultural resources. It is worth emphasizing that cultural facilities play a crucial role in preserving and transmitting cultural memory. The adaptation of the floating population to the local culture promotes cultural integration and contributes to deeper social cohesion (Zhou et al., 2021). Therefore, it is an advantage that areas with high floating populations often have more cultural facilities. Wenzhou should expand the facility area to improve accessibility. At the same time, Wenzhou should take action to develop distinctive cultural facilities and hold activities that highlight OuYue traditional culture and the city's entrepreneurial spirit. This not only strengthens local residents' cultural identity but also helps the floating population integrate into the city.

6. Conclusion

The Equalisation of basic public services is essential for promoting social inclusion and harmony. To achieve a greater distribution of public services and better match supply with demand, vulnerable groups and underprivileged areas should be given attention.

This study examines 12 districts in Wenzhou, using sub-districts as the smallest spatial units. It examines the spatial distribution of public cultural facilities and their alignment with various demographic groups. The findings include: (1) Significant differences exist in the quantity and service coverage of cultural facilities. The core urban area is the most well-equipped, followed by secondary centre and non-core areas, while rural areas are the least equipped. (2) Facility accessibility remains inadequate and does not match population demand. (3) Access to facilities varies by demographic. Areas with a high elderly population tend to have fewer facilities. In contrast, areas with a large floating population have more facilities; however, low accessibility still restricts their effective utilisation.

Key contributing factors to these inequities include historical development patterns, economic disparities, and the supply-oriented approach to facility planning. Based on these findings, three improvement strategies are proposed: (1) Improving the socialisation of public cultural facilities. (2) Promoting balanced facility development by building facilities in rural areas as well as offering targeted cultural services for different demographic groups. (3) Promoting the integration of the floating population into local communities through cultural resources.

With the development of globalisation, the significance of cultural services has grown. As a key indicator of social

inclusion, cultural equity demands greater attention to the rights for vulnerable groups and underdeveloped areas. Based on the findings and underlying causes, Wenzhou can implement more targeted strategies to build quality cultural life circles and to establish a people-centred public cultural service system. Moreover, the insights gained from Wenzhou's example can guide other cities in advancing their cultural facility planning efforts.

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