



# Research on Spatial Layout and Use Perception of Public Service Facilities in County Towns Based on POI Data - Taking Shiquan County as an Example

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**Abstract.** In order to improve the quality of life of county residents, we need to attach importance to the rational planning of public service facilities in county towns, which will promote the development of urban and rural planning and the construction of smart cities. This paper selects the public service facility POI in Shiquan County, Shaanxi Province as the sample study object, establishes the county level urban public service facility residents' perception index system through the analytic hierarchy process, and then obtains the geospatial data of 2172 POI points through the web crawler technology, and uses the Gini coefficient and kernel density estimation to reveal their geospatial distribution laws. Finally, the development level of public service facilities and its development stage are evaluated through questionnaire survey. The research finds that: ①The public service facilities in Shiquan County have a significant multi center characteristic, and present a scattered multi center development pattern. ②The residents of Shiquan County are generally satisfied with the perceived quality of local public service facilities. ③The weight of sense of security is the highest through analytic hierarchy process. Among them, the government's investment is the primary indicator to measure the infrastructure construction of county towns, while the weight of happiness of county residents is the lowest. ④The comprehensive score of Shiquan County's public service is 65.12 through quality evaluation, indicating that its quality is in the development stage. This paper aims to provide decision-making basis for improving the quality of public services in county towns and promoting the development of new urbanization.

**Keywords:** Geographic Information System · POI · Urban and rural planning · Public service facilities

## 1 Introduction

In recent years, China has issued a series of policies and documents on the public service system, such as the report of the 19th Party Congress, which [1–3]. In the report of the Nineteenth Party Congress, it is stated that "the basic realization of equalization of basic

public services" is one of the goals for the realization of a strong socialist modern State, and it is pointed out that the public service system should be improved to enhance the people's sense of happiness, access and security, so as to make the people more fulfilled, more secure and more sustainable [4, 5]. County towns are the core part of the new urbanization and the key strategic area for high-quality development and the enhancement of residents' happiness, but in the process of developing county towns, more attention is paid to the development of economic and physical space, and the existing infrastructure configuration of county towns can no longer meet the steadily increasing demand of residents for a better life so far, so attention should be paid to the development of public service facilities in county towns.

In terms of the in-depth study of public service facilities, foreign scholars have experienced the selection of regional location and layout mode [7], the fairness and accessibility of spatial layout [8, 9], and the social differences in spatial layout and the method and mechanism of their formation [10]. The research Angle has developed from a single econometric geography to interleaving with many disciplines such as economics and sociology, and finally developing towards a more people-oriented direction [11]. The related research of our country is relatively late, and domestic scholars mainly care about public service facilities from big cities and developed cities, such as Beijing [12], Guangzhou [13], Wuhan [14], Jinan [15]. The main research method only discusses the equilibrium degree of its distribution from the direction of supply of service facilities and quantity demand, but ignores the externality of space facilities, the scale of facilities, and the differences in the scale of space research [16]. With the deepening of geospatial data research, many scholars use big data to study various facilities in different regions.

In summary, foreign studies focus on resource quality improvement, while domestic studies mostly use integrated methods to study macroscopic scales such as urban agglomerations, large cities and central cities, lacking research on small units in counties, especially poor mountainous areas, and ignoring local residents' perceived evaluation and diverse needs for public service facilities. In view of this, this paper tries to combine public service facilities with geographic space, and selects Shiquan County, Ankang City, Shaanxi Province, as a case study to evaluate its perceived quality, with a view to facilitating the optimization and upgrading of public service facilities in the region, suggesting suggestions and countermeasures for the layout and management of public service facilities in county towns, and providing a new perspective for the sustainable development of the county.

## **2 Construction of the Evaluation Index System for the Perceived Use of Public Service Facilities in County Towns**

### **2.1 Research Methodology**

#### **(1) Nuclear density analysis method**

The kernel probability density estimation method is mainly used to calculate the density within the surrounding range of the elements. The aggregation and discrete state of data points can be obtained by picking up POI data through computer network crawler

technology and then using GIS for visual analysis. Its general form is<sup>18</sup>:

$$f(s) = \sum_{i=1}^n \frac{k}{\pi r^2} \left( \frac{d_{is}}{r} \right)$$

where:  $f(s)$  is the location,  $S$  density,  $n$  is the number of samples (pieces),  $d_{is}$  is the distance (m) from point  $i$  to  $S$ , and  $k$  is the kernel function of the ratio of  $d_{is}$  to  $r$ ;  $R$  is the bandwidth (m).

## (2) Gini coefficient

Gini coefficient is usually used to analyze the spatial distribution of discrete areas in geography. The higher the Gini coefficient, the more uneven the spatial distribution of geographical elements in the measured area. This paper refers to the Gini coefficient formula in the study of Su Jianjun [20], by importing POI data into Arcgis, the number of each facility is obtained through spatial connection, and finally calculated. The Gini coefficient formula is:

$$H = - \sum_{i=1}^N p_i \ln p_i \quad (1)$$

$$H_m = \ln N \quad (2)$$

$$\text{Gini} = H/H_m \quad (3)$$

$$C = 1 - \text{Cini} \quad (4)$$

(1)- (4) In the formula,  $P_i$  is the proportion of the number of public facility points in 11 townships and streets in Shiquan County to all public facility points in Shiquan County;  $N$  is the total number of township streets in Shiquan County ( $N = 11$ );  $C$  is the balance of the spatial distribution of public facilities. The Gini coefficient value is generally in the middle of 0 ~ 1. If the Gini coefficient value is closer to 0, it proves that the distribution of public facilities in this area is more average, which means that the distribution of public facilities in towns and streets of Shiquan County is equal; The closer the Gini coefficient is to 1, the more uneven the spatial distribution of public facilities in Shiquan County's towns and streets is, which means that the spatial distribution of public facilities is absolutely concentrated in a certain town and street.

## (3) Hierarchical analysis.

Analytic Hierarchy Process (AHP) is a decision-making method that decomposes decision-making objectives into several levels and then performs qualitative and quantitative analysis. This paper first constructs a judgment matrix, and then compares the relative importance of the elements in the target layer in pairs to obtain a judgment matrix. Finally, according to the comparison of the importance of each indicator, the judgment matrix of the target layer is obtained, and finally its maximum eigenvalue is checked<sup>17</sup>.

## 2.2 Data Sources

The data of this study comes from two aspects. 1. Questionnaire. In this paper, 160 questionnaires were obtained through field research in Shiquan County and the distribution of questionnaires. After screening, 138 questionnaires were finally selected as effective questionnaires, with an effective rate of 86.25%. Through SPSS analysis, the scores of various indicators and existing problems of public service facilities in Shiquan County were obtained. 2. POI data. This data comes from Gaode Map. This paper obtains the data of public service facilities in Shiquan County by referring to the API interface of Gaode Map, builds the foundation of POI database, and finally obtains 2204 POI values in total. Then use ArcGIS10.2 to mark the acquired POI values on the administrative division map of Shiquan County (WGS1984 coordinate system) in the form of point elements, and finally use the nuclear density estimation method to visualize the poi data. The deadline for obtaining POI data in this paper is November 18, 2021, and the obtained data includes the name, actual geographic location, spatial coordinates and other information of public service facilities. For the above values, 2172 pieces of data were obtained through coordinate correction, elimination of data not located in Shiquan County and unqualified data.

## 2.3 Determination of Indicator Weights and Evaluation Criteria

After several rounds of expert consultation, the evaluation index system of Shiquan County's public service quality was constructed, and the final weight summary results are shown in the following table.

In the above evaluation index system, each individual index reflects the development of the public service facilities in the county from all angles, but needs to further improve the overall level of the evaluation. Therefore, this paper uses the multi-level goal linear weighting method to conduct a comprehensive evaluation. According to the [33] research results of Liu Nenzi and other scholars, the quality evaluation standard table of public service facilities in the county was formulated.

The integrated assessment value is measured as  $A = \sum m_i = 1(\sum n_j = 1) I_j \times R_j \times B_i$ .

The above equation: A is the composite value of perceived quality of public service use in the county,  $I_j$  and  $R_j$  are individual indicator data and weights respectively, and  $B_i$  is the weight of each criterion level. The development stages of county public services are classified as preparation stage (  $A < 60$  points), development stage (  $60 \text{ points} \leq A < 70$  points), general improvement stage (  $70 \text{ points} \leq A < 80$  points), comparative improvement stage (  $70 \text{ points} \leq A < 80$  points), and maturity stage (  $A \geq 90$  points).

## 3 Perceived Use of Public Service Facilities in Rock Springs County Evaluation

### 3.1 Overview of Case Sites

Shiquan County, known as the "Water Town of Qinba", is located in the western part of Ankang City, Shaanxi Province, near the Qinling Mountains in the north and the Ba Mountains in the south, in the hinterland of Qinba in southern Shaanxi Province and

**Table 1.** Table Perceived Use of Public Services in County Towns and Cities Evaluation Indicator System

Index System for Evaluating the Perceived Quality of Public Service Facility Use in County Towns	normative level	Relative weights	metric layer	absolute weight	sorted
	Sense of access (B1)	0.24	Type of public service facility number (C1)	0.04	11
			Layout scale of public service facilities (C2)	0.04	9
			Quality of public service facility content (C3)	0.04	10
			Public service facilities support facilities (C4)	0.05	7
			Transportation to public service facilities (C5)	0.07	5
	Sense of security (B2)	0.61	Public service facility signage system (C6)	0.07	4
			Government’s financial input (C7)	0.22	1
			Policy updates in relevant sectors (C8)	0.01	17
			Talent pool for public service facilities (C9)	0.05	8
			Regulatory oversight by relevant authorities (C10)	0.02	14
			Does the leadership pay attention (C11)	0.18	2

(continued)

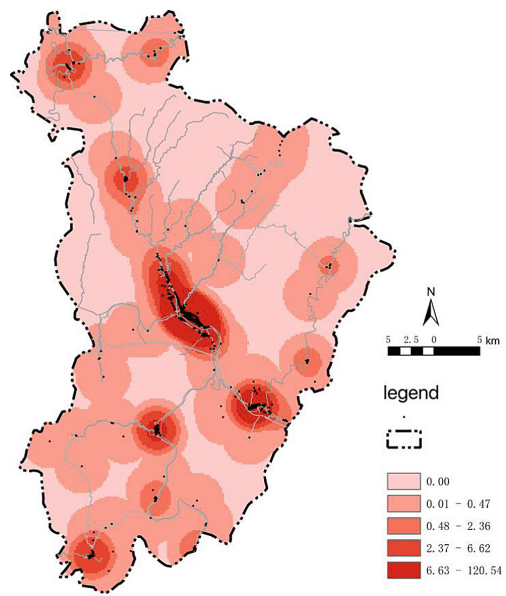
**Table 1.** (*continued*)

			Advocacy work in relevant sectors (C12)	0.04	12
			Accessibility of complaints (C13)	0.02	13
	Well-being (B3)	0.15	Residents' willingness to use (C14)	0.01	15
			Frequency of residential use (C15)	0.01	16
			Opening hours (C16)	0.05	6
			State of the Surroundings (C17)	0.08	3

on the shore of the Han River, famous for the “many springs in the stone gaps south of the city and the endless runoff”. Shiquan County is a key county in the national Qinba region, with a total area of 1525 square kilometers. It is an important part of the South-North Water Diversion Project; “Qinba Water Township, Shiquan Ten Beauties”, an important place for ecological tourism in Qinba Hanshui, is also a key power and energy base in the west; the first major county of sericulture in western China, known as “the source of silk, the hometown of the golden silkworm”. In 2016, it was identified by the National Tourism Administration as a national tourism demonstration county, marking the county’s tourism development into a new stage of development.<sup>6</sup>

### 3.2 Spatial Distribution of Public Service Facilities in Case Sites

In this paper, 2172 POIs of public service facilities in the region were picked up by crawling technology as specific research objects, and then the spatial clustering of public service facilities in Shiquan County was visualized by ARCGIS (as shown in Fig. 2). And according to the Gini coefficient formula operation,  $H = 1.03$ ,  $H_m = 2.398$ ,  $Gini = 0.43$ ,  $C = 0.57$ , which indicates that the concentration of public service facilities among towns in Shiquan County is moderate, and the spatial differentiation within the region is relatively uneven. Meanwhile, the results of kernel density analysis indicated that the overall arrangement of public service facilities was uneven, and the various types of service facilities in the study area were spatially characterized by a significant concentration center and a multi-source development. The most concentrated area is at the center of Chengguan town, indicating that the supporting facilities are more complete, showing the characteristics of multi-nuclear multi-point decreasing around the center



**Fig. 1.** Stone County Public Service Facilities Nuclear Density Map

of Chengguan town, ironing town, Houliu town, Chihe town and Lianghe town. The density of public service facilities is greatest at the dense junction of the transportation network, and with the Han River in the county center of Shiquan County, most facilities are distributed along the river due to the topography (Fig. 1).

**3.3 Results of the Perceived Use of Public Services in Rock Springs County**

Spatial perception, in addition to the objective creation of material, also has a strong correlation with the perception of local residents. According to the calculation results of the weights of the criterion layer and the indicator layer, we can obtain the ranking of public service facility quality evaluation indicators in county towns, from the weight of the criterion layer, the sense of security (B2) has a greater weight, while the sense of happiness (B3) has the smallest weight, reflecting that the current residents of county towns are still to be stimulated in terms of satisfaction of use and frequency of use. From the total ranking weight of the indicator layer, the government’s financial investment (C7) and whether the leadership attaches importance to it (C11) have the highest weight and are the two most important factors affecting the quality indicators of public service facilities in county towns. This is followed by the condition of the surrounding environment (C17) and the signage system (C6). Less influential are the frequency of residents’ participation (C15), residents’ willingness to use (C14) and policy updates by relevant departments (C18), all with a weight of 0.01.

## 4 Conclusion

After the quality evaluation it is known that the overall score of public services in Rock Springs County is 65.12, which indicates that the quality of public service facilities in Rock Springs County is in the development stage. From the criterion level, the highest score is the sense of security and the lowest is the sense of well-being, and all criterion levels are at the development stage. Among them, the highest scores are for the publicity work of relevant departments and the frequency of use by residents, indicating that local residents recognize the importance attached by the local government to the public service facilities there and are willing to use the local public service facilities themselves. From the 17 indicator scores in the indicator tier, there are no indicators that reach 80 points or above. And 29.4% of the indicator items are below 60 points, among which the number of types (57), the signage system (57), the supporting facilities of public service facilities (57), the talent team of public service facilities (57) and the opening hours (57) have relatively low scores, which shows that there are still shortcomings in the construction of the sense of access as well as the sense of security in county towns.

In order to improve the quality of public service facilities in Shiquan County, to enhance the satisfaction of Shiquan County residents with the public service facilities there, to improve the sense of security, access, and happiness in life of Shiquan County residents, and to promote the development of a new type of urbanization, it is proposed to start from the following aspects.

- (1) In order to enhance the sense of access of county residents, the number and types of public service facilities in Shiquan County should be increased. Improve the consumption infrastructure and improve the county's consumption environment around the needs of industrial transformation and upgrading and residents' consumption upgrading. Renovate and upgrade department stores, large stores and special commercial streets, and develop new consumption clusters. Improve consumer service centers, public transportation stations, intelligent guidance systems, security facilities, and configure hardware facilities and software systems. Improve supporting facilities such as Shiquan County Visitor Service Center, tourist bus, tourist journey, tourist restrooms, and signage system. Construct a large number of cultural and sports service facilities to meet the spiritual and cultural needs of local residents, and should also build facilities such as astronomy and science museums, cultural books, indoor gymnasiums, fitness trails, outdoor sports public service facilities, etc. that are lacking in the local area.
- (2) In order to enhance the sense of security of county residents, the government should improve the degree of importance and control over the construction of public service facilities in Shiquan County, and promote the coordinated development of both the construction of public service facilities and economic and cultural construction, while it should increase the investment of funds in the construction and publicity of public service facilities, both extensive publicity by the relevant departments and substantial and effective supervision, and the need for government departments and relevant enterprises to strengthen the The effect of the construction of public service facilities test, and not just in the form, so that the entire county town public service environment of better quality. The introduction of talents to county towns should



also be increased to improve the organization and supervision and management of public service facilities in Shiquan County.

- (3) In order to enhance the well-being of county residents, the opening hours of public service facilities in Shiquan County should be adjusted, and public service facilities for the nighttime economy in Shiquan County should be built. The development of “night economy” services in county towns plays a significant role in boosting economic growth, enhancing the charm of the city, creating a harmonious social space, and meeting the social needs of residents.

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