Primary School Site Selection Research Based on Big Data of Population Density
Jintang urban area of Chengdu as an example

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Abstract—In recent years, big data has been increasingly used in the location of urban public service facilities. This paper takes Jintang urban area of Chengdu as the research object, based on big data of population density, and five factors that affect the site selection of primary schools are studied, including traffic safety, traffic accessibility, existing primary schools, land usage nature, and land price. Spatial analysis methods such as GIS nuclear density analysis are applied to analyze and process related factors. The results show that on the basis of the existing planning and layout of Jintang urban area, the land for education and scientific research on the east side of Jinyuan street, the land for primary and secondary schools on the east side of Jinying road, and the southwest corner of Hantan community are the most suitable plots for primary and secondary schools. Among them, the education and scientific research land on the east side of Jinyuan street serves the most residential sites, which is the optimal plan for site selection for primary schools.

1. INTRODUCTION
With the development of education and the popularization of compulsory education, building more schools to meet the education demands of school-age children has become the focus of government work, and school site selection has also become an important research object of urban planning. Scientific school site selection is conducive to the equalization of educational resources, promotes educational equity, and improves teaching quality.

Traditional site selection methods rely more on the subjective experience of the operators, and often lack intuitive and scientific basis [1]. In recent years, network technology has developed rapidly. With the construction of smart cities, human behavior characteristics can be reflected through data. Collecting and analyzing these data can effectively predict the future development of cities. The influence of big data on the urban planning is increased [2], and many scholars have begun to apply big data for the site selection research of urban public service facilities.

In 2018, Fan Yujie selected four evaluation factors of residential area population density, distance from existing primary schools, terrain slope, and planning utilization properties. ArcGIS overlay analysis method and the two-step mobile search method were used to select the location of the new primary school in the central city of Dali. And he put forward countermeasures and suggestions for optimizing the layout of primary education land [3]. In the same year, Ramandi MM and Cheshme BG used the fuzzy analytic hierarchy process and network analysis method in GIS to determine the levels,
standards and sub-standards of elementary school site selection, and achieved the suitable elementary school site selection, and solved the problem of educational space imbalance [4].

Based on the big data of population density, this paper mainly combines the core density analysis method, the analytic hierarchy method and the network analysis method to study the six factors of population density, traffic safety, traffic accessibility, existing primary schools, land usage nature, and land price for the influence of elementary school site selection. Using network analysis to optimize the site selection plan is the innovation of this research.

2. DATA SOURCES AND RESEARCH METHODS

2.1 Data Sources
The data used in this study include: the satellite remote sensing image of Jintang county in 2019 obtained from Google Earth, the urban permanent population data obtained by the Jintang County Public Security Bureau, the population density big data of WeChat easygo in Jintang county in 2019, the city master plan of Jintang county in Chengdu achieved from the official website of Jintang County Planning Bureau, and the data information obtained from field survey.

2.2 Research methods
Four methods were mainly used in this research: nuclear density analysis, analytic hierarchy process, overlay analysis, and network analysis. Kernel density analysis is the calculation of the unit density of point and line element measurement values in the specified area, which can directly reflect the distribution of discrete measurement values in continuous areas, and it is mainly used for crowd density analysis [5]. Analytic hierarchy is the hierarchy of problems to be solved, according to the interrelationship among factors, the factors are divided into different levels, then combined into a multi-layer analysis structure model, which ultimately comes down to the question of the relative importance of the lowest level relative to the highest level or the relative order of superiority and inferiority [6]. The analytic hierarchy process is used in this article to construct an evaluation system for impact factors. Overlay analysis refers to the process of generating new data through a series of collective operations on multiple data under a unified spatial reference system. Network analysis is based on the network topological relationship, by investigating the space and attribute data of network elements, based on mathematical theoretical models, the performance characteristics of the network are analyzed and calculated in many ways. Network analysis is mainly used to calculate the neighboring relationship between primary schools and surrounding residential areas.

3. RESULTS AND ANALYSIS

3.1 Hierarchical analysis model
The problem of primary school site selection is hierarchized, and the highest decision-making goal of the model is determined as school site selection. Four main factors affecting school site selection: population density, the distribution of existing primary schools, transportation and land price factors are used as the first-level indicators of the hierarchical structure model. The traffic factors are subdivided into two aspects: safety and accessibility, namely two secondary indicators, the indicator factors are compared in pairs to establish a judgment matrix (Table 1). After calculation, the corresponding weights of five factors are obtained: population density 0.2633, traffic safety 0.0305, traffic accessibility 0.0914, land price 0.0569, and existing primary school 0.5579. The consistency check is 0.0444, which is within the acceptable range.

| Table 1. Judgment Matrix |
|--------------------------|
| Population density | Traffic Safety | Traffic accessibility | Existing primary school | Land price | Weight |
| Population density  | 1 | 12 | 4 | 1/3 | 5 | 0.2633 |
3.2 Impact factor data processing

This paper selects six factors which can affect the site selection of primary schools, including population density, traffic safety, traffic accessibility, existing primary schools, land usage properties, and land price.

Perform nuclear density analysis on the population density data obtained through WeChat Travel. The population density is divided into four levels. The analysis shows that the population distribution is concentrated in the west of the city, as shown in Figure 1. Combined with the Design Code for Primary and Secondary Schools GB 50099-2011, the requirement that the service radius of complete primary schools in cities and towns should be 500 meters and the size of the school capacity is different. Schools with less than 30 classes will be buffered by 500 meters, and schools with classes of 30 and above will be buffered by 1000 meters as a first-level buffer. The buffers are successively increased by 1000 meters outwards as secondary, tertiary, and fourth-level buffers, as shown in Figure 2. Refer to the Design Code for Primary and Secondary Schools GB 50099-2011 for the main teaching rooms and highways, the distance between overground rail transit lines or urban arterial roads should not be less than 80 meters. Set the buffer radius of expressways and arterial roads in the plot to 80 meters, and the buffer radius of secondary arterial roads to 50 meters, as shown in Figure 3. Use network analysis for the community outside the service area of the existing elementary school, establish a reachable range of 500 meters, 1,000 meters, etc. from the residential area, as shown in Figure 4. Extract land plots suitable for building a primary school to form a buildable primary school, as shown in Figure 5. The level of land price refers to the proportional relationship between urban housing price and land price, and is divided into four levels from high to low, as shown in Figure 6.

Refer to related papers and documents, and classify the above data according to the degree of influence of factors on the site selection of new primary schools, as shown in Table 2.

| Evaluation factor grade | Population density(million/km²) | Distance from the school buffer zone (m) | Traffic Safety | Traffic accessibility (m) | Land price(yuan/㎡) |
|-----------------------|-----------------------------|---------------------------------|---------------|------------------------|------------------|
| 1                     | <1.5                        | <school buffer distance         | <road buffer  | >2000                  | 3000-5000        |
| 2                     | 1.5-3                       | <1000                           | >road buffer  | 1000-2000              | 5000-7000        |
| 3                     | 3-4.5                       | 1000-2000                       | /             | 500-1000               | 7000-9000        |
| 4                     | >4.5                        | >2000                           | /             | <500                   | >9000            |
Figure 1. Population nuclear density map

Figure 2. School buffer map

Figure 3. Road buffer map
Figure 4. Reachability hierarchy

Figure 5. Potential Primary School area map

Figure 6. Land price classification map
3.3 Results and analysis

According to the factor weights obtained by the analytic hierarchy process, the corresponding layers of the five impact factors are superimposed on the weighted summation analysis, and they are intersected with the area map of the primary school land that can be built, and reclassified according to the comprehensive evaluation values to obtain the elementary school site selection grade diagram (Figure 7). Based on the actual situation of the investigation, the areas where middle schools and public security bureaus have been built are excluded from the areas which are most suitable for building primary schools (red areas). The remaining areas most suitable for building primary schools are the site selection plans for new primary schools: A, B, C, D, as shown in Figure 8.

![Figure 7. Location hierarchy map](image)

![Figure 8. Site Plan](image)

Using network analysis, the site selection plan and existing primary schools are used to analyze the nearest facilities of the residential area to obtain the analysis diagram from the residential area to the nearest primary school, as shown in Figure 9. It can be seen that plan B serves the most residential areas and is the best choice for primary school site selection in the primary school site selection plans. Plan C and D are pretty close, either could be selected to build a primary school combined with other actual situations.
4. CONCLUSION
This paper takes Jintang urban area of Chengdu as an example, based on the big data of population density, combined with five impact factors such as traffic safety, using analysis methods such as nuclear density analysis, overlay analysis, network analysis, study the primary school site selection on the basis of big data of population density to analyze the most suitable area for building a primary school, and the analysis results were optimized. Due to the high population density of the educational and scientific research land on the east side of Jinyuan street and the most residential areas served, it is determined to be the best plan for the site selection of primary schools. The land for primary and secondary schools on the east side of Jinying road and the southwest corner of Hantan community are used as backup sites. The study of primary school site selection based on population density big data reveals the spatial correlation between primary school as a public service facility and the population it serves, and it can provide relevant references for the site selection of other similar public service facilities.

REFERENCES
[1] Jingbo Li and Ligang Wang, “Research on School Site Selection Based on GIS and Analytic Hierarchy Process,” China High Technology Enterprises. Beijing, vol. 34, pp. 41–42, 2010.
[2] Anyao Cui, “Research on location of urban chain stores based on big data,” Jilin University: Jilin, 2017.
[3] Yujie Fan, “Study on the optimization of primary school land layout in Dali City Center Based on GIS,” Yunnan University of Finance and Economics: Kunming, 2018.
[4] Ramandi MM and Cheshme BG,"Possess of locating the elementary schools using combined FAHP-Fuzzy logic in the GIS,” Biological Bulletin of Bogdan Chmelnitskiy Melitopol State Pedagogical University. Ukraine, vol. 8, pp. 255-265, 2018.
[5] Feng Zhen, “Urban studies and innovation in urban planning methods based on big data,” China Architecture Publishing., in press, 2015.
[6] Xiaolin Liu and Chengjie Wen, “Spatial location analysis using GIS,” Geomatics & Spatial Information Technology. Harbin, vol. 33, pp. 19–21, 2010.