Spatial Distribution Analysis of Convenience Stores in Kaifeng City Based on POI Data

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Abstract. In this paper, the visual analysis of POI data is used as the research method. The Arc GIS series software is used as a research platform. 567 convenience stores in Kaifeng City are selected as samples to analyze the layout characteristics and influencing factors of Kaifeng retail industry. This paper aims to plan and guide the layout of convenience stores in Kaifeng from the perspective of the government, propose improvement measures, improve the service level of convenience stores, provide convenience for residents, provide some suggestions and reference for the development of its regulatory role and the creation of “smart city”.

1. Introduction

Convenience stores, as a retail format close to residents' lives, play an important role in meeting the immediate consumption needs of residents. According to the overall situation of Kaifeng City, the development of convenience stores is relatively complete and comprehensive [1]. However, due to the unreasonable layout, there are problems such as too dense convenience stores in one area and insufficient coverage of services. Applying Arc GIS's analysis function of spatial data, through spatial layout and analysis of its influencing factors, from the perspective of the government, providing advice for the development of convenience stores in Kaifeng City, is conducive to planning and building special blocks in Kaifeng City commercial outlets, helping to reduce The phenomenon of waste of resources, defusing the vicious competition between convenience stores, the rational layout of urban retail commercial space, the optimization of the overall commercial space structure of the city, and even the improvement of urban economic benefits are of great significance, play a regulatory role, and create a smart city.

Considering the moderate advancement of retail network optimization, the paper determines that the study area is the Kaifeng City Limited Area [2]. Map data, including Kaifeng City administrative boundary data, traffic road network data, etc., from CSDN website, Google Earth, Gaode map; population distribution data from Kaifeng City Statistical Yearbook. The POI data, the distribution point of the convenience store, obtained data through field research, and conducted a site inspection of the convenience store in Kaifeng City with the boundary area of Kaifeng City as the boundary, and
obtained 567 location data. The residential area data is derived from 851 samples from Anjuke Community. The spatial distribution of Kaifeng City is obtained by GIS spatial matching.

2. **Analysis of spatial layout characteristics**

This chapter uses the nuclear density estimation method to explore the overall layout characteristics of convenience stores in Kaifeng City; analyzes the impact of traffic accessibility, population density and land price on convenience stores [3]; and uses the method of neighborhood analysis to explore the relationship between convenience stores and residential areas.

![Figure 1. Nuclear density distribution map of convenience store in Kaifeng City.](image)

2.1. **Relying on the layout of traffic trunks, the spatial form of multi-center development**

From the overall view of Figure 1, the convenience stores located in Kaifeng City are laid along the trunk line. The spatial distribution rules are block accumulation, shaft extension and The pattern of multi-center development shows that the central area is dense and sparse, the main roads on both sides are distributed around, and the east side area is denser than the west side area, with typical regional characteristics.

2.2. **Centered on the traffic node, it is an "L-shaped" axial gathering space form.**

As can be seen from Figure 1, the nuclear density of the convenience store is contiguous, and the three centers are located in the Longting District, Gulou District and Shunhe Hui Nationality. The main retail agglomeration centers can be divided into 12, which are in the form of “L-shaped” axial gathering space [4]. The highest traffic accessibility is the Xiguan North Street-Jinyao Road hotspot area. Convenience stores in the surrounding urban areas are limited by distance factors and do not have the location conditions for developing convenience stores.

3. **Analysis of factors affecting the spatial distribution of convenience stores**

He Weichun introduced the impact of traffic accessibility factors in the analysis of the retail industry layout in Kaifeng City. Through the ordered multi-class logistic regression analysis in SPSS20.0, in the model, all the independent partial regression coefficients are 0. The likelihood ratio test is performed. All the models pass the likelihood ratio test (P<0.001), indicating that the selected explanatory variables have good location selection for retail commercial outlets [5]. The traffic factor is significant at the 99% confidence level. Public transportation conditions have a significant impact on the location selection of such outlets. With the improvement of public transportation conditions, the integrated retail outlets exhibit the characteristics of centrifugal layout.

As can be seen from Figure 2, about 80% of convenience stores are gathered near the main traffic lanes in the main urban area of Kaifeng, and more than 90% of the secondary gathering areas are distributed at the intersections. This shows that convenience stores attract customers and traffic accessibility. The change is positively related.
3.1. The impact of demand population on the distribution of convenience stores

With the development of Kaifeng City, the influence of consumer groups, purchasing power and other factors on the spatial agglomeration of retail business activities, the retail space is gradually expanding along the Yellow River Street. Longting District and Gulou District are the main development areas of the retail industry.

Table 1. Population density statistic of Kaifeng city in 2018.

| No. | Districts' Name | Population | Area | Population Density |
|-----|----------------|------------|------|--------------------|
| 1   | Longting       | 989383     | 345  | 2867.78            |
| 2   | Gulou          | 1345365    | 58.2 | 3899.61            |
| 3   | Shunhehuizu    | 1994474    | 90.25| 22099.43           |
| 4   | Yuwangtai      | 123422     | 60   | 2057.03            |

The demand population factor has become the main factor affecting the concentration of convenience store formats. The distribution of convenience stores in the Shunhe Hui, Longting and Gulou districts are distributed according to the demand-populated areas, and the distribution in the Wangwangtai District does not match the situation.

3.2. The impact of land prices on the distribution of convenience stores

During the survey, the store area of 132 convenience stores was counted, including 96 under 50, 30 at 50-100, 4 at 100-150, and 2 at 150, which can be used as sample pairs. Analyze globally.
It can be seen from the data that the distribution law of Kaifeng land price is centered on the city center and is radial, gradually increasing to the edge of the city, and reaching the level of six-level land price by the first level [6]. According to the urban land price theory, as the distance from the central business district is getting closer, the land price is getting higher and higher. The dot layout does not conform to the urban land price theory [7]. Explain that the land price factor is not strong enough to restrict convenience stores.

3.3. Coupling analysis of spatial distribution of convenience stores and spatial distribution of population clusters

Qualitative analysis of the degree of coupling between the convenience store's spatial layout and the population gathering area. The overall conclusion can be drawn from the Table. The distribution in the Wangtai District does not match the situation. It can be concluded that the coupling degree of Yuwangtai District is the lowest; the coupling degree of the Shunhe Huizu area is higher, the coupling degree of Longting District is higher, and the coupling degree of Gulou District is the highest. The coupling degree of Longting District is relatively high, and the coupling degree of Gulou District is the highest.

![Figure 4. Location of Residential Areas and Nuclear Density Distribution of Convenience Stores.](image)

3.4. Analysis of the relationship between convenience store and community location

Conduct a spatial proximity analysis of the location where the convenience store is located and the residential area, and explore the overall service capacity of the convenience store. Compare the nearest distances from 567 convenience stores to residential areas. Because of the large number of samples, part of the data is intercepted.

According to the data analysis of the neighboring area, the convenience store is set at 50 meters from the classification range of the nearest residential area, so it is divided into 7 levels, and there are 154 within 50 meters. There are 182 in 50–100 meters, 106 in 100–150 meters, 60 in 150–200 meters, 26 in 200–250 meters, 17 in 250–300 meters, and 21 in 300–350 meters. The location of 49% of convenience stores is within 100 meters of the service target. As the distance increases, the density of convenience stores decreases gradually, but the sections of 250–300 meters and 300–350 meters still exist reasonable question.

4. Problem discovered

4.1. Insufficient service coverage

According to the theoretical service radius formula, where S represents the space area and n represents the number of convenience stores. By taking the space area of the main urban area (553.45) and the service radius (300m) into the formula, 1957 convenience stores can be theoretically distributed within the urban space, but at present, kaifeng is far from enough to reach the theoretical value, and it is difficult to reach the balance of supply and demand.
4.2. Unbalanced spatial distribution
Kernel density analysis and neighborhood analysis were used to evaluate the layout status quo. It can be seen that all nodes have the most basic hierarchical relationship, but there are problems in division and integration. The service population is still unreasonable. There is no convenience store distribution in the population aggregation area, and the convenience store in the area with low coupling degree is too dense.

4.3. Network layout is not very consistent with the urban land price theory
According to the theory of urban land price, the spatial layout of convenience stores in Kaifeng is not very reasonable. There are few gathering points in the second-level land price area, and most of them are distributed in the third-level and fourth-level land price area. Dot layout does not accord with urban land price theory.

5. Related recommendations and measures

5.1. Led to strengthen the government planning, achieving a uniform service range of comprehensive coverage
In the process of investigation, it is found that the community service convenience stores set up by the government are densely distributed with self-operated convenience stores. Therefore, the government should optimize the layout of Shuangyu convenience store. As there are few retail policies, the government should formulate and implement the development strategy and planning of convenience store, so as to provide some basis for guiding the adjustment and optimization of urban industrial structure.

5.2. Introduce new retail model
The government can develop convenience stores in combination with the new O2O retail model, introduce the concept of "smart stores" for the retail stores in Kaifeng, and obtain greater economic benefits through trend guidance, which is of great significance for the realization of diversification of regional economy, retail value-added and sustainable development.

5.3. Establish a convenience store distribution center to optimize resource allocation
In the future, government departments can establish a unified distribution center in business planning. Site selection using the Arc GIS Geographic Information System. This article is set up as a first-level distribution center and 12 second-level distribution centers.

![Figure 5. Coordinate location map of the first-level distribution center.](image_url)

For the distribution of convenience stores in Kaifeng City, it is recommended to set up a secondary distribution center, as shown in the following table:
Table 2. Secondary distribution center location coordinate table

| No. | Location       | No. | Location       |
|-----|---------------|-----|---------------|
| 1   | 34.81206,114.31476 | 10  | 34.78805,114.36244 |
| 2   | 34.81825,114.32363 | 11  | 34.78701,114.36626 |
| 3   | 34.81726,114.32916 | 12  | 34.78609,114.37251 |
| 4   | 34.79961,114.35791 | 13  | 34.79062,114.37314 |
| 5   | 34.79949,114.35920 | 14  | 34.79991,114.37575 |
| 6   | 34.77878,114.35804 | 15  | 34.80355,114.38020 |
| 7   | 34.80471,114.33321 | 16  | 34.81203,114.37695 |
| 8   | 34.79608,114.32725 | 17  | 34.77283,114.35213 |
| 9   | 34.78588,114.33276 | 18  | 34.79189,114.34666 |

The author only makes a preliminary selection of the location of the distribution center, and the specific operability needs further study.

6. Conclusion
In this paper, on the basis of the convenience store data in the Kaifeng, POI data visualization analysis as research method, a series of Arc GIS software as the research platform, from the limited number scale, analyzing the characteristic of the layout of Kaifeng retailing, found that Kaifeng convenience store space distribution form the whole block and axial extension and the polycentric development pattern, presents the center area of dense thin outside, on both sides of the main round distribution, than that on the east side to the west of the dense space state, which polycentric development state of aggregation are “L” type of shaft. Found the insufficient service coverage and other problems, proposed Suggestions to the government department, formulated the spatial layout development strategy of the retail industry in Kaifeng, provided layout optimization Suggestions for the convenience fair supermarket supported by it, introduced the new retail model, and established the convenience store distribution center. This paper provides some Suggestions and references for Kaifeng municipal government to guide the layout of convenience stores and play the role of regulation, as well as to build a “smart city”.

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