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Site Selection of Large Shopping Malls in Wanbailin District of Taiyuan City

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Abstract: The construction and site selection of shopping malls are directly related to their commercial operation effectiveness and market competitiveness. Some scholars have conducted extensive research in this field, particularly achieving notable results in terms of influencing factors, methodologies, and technological applications for site selection, yet there are still some deficiencies. Traditional site selection methods primarily rely on qualitative analysis and empirical judgment. However, with technological advancements, Geographic Information System technology has gradually been applied to shopping mall site selection. GIS technology enables the integration of multiple data sources, spatial analysis, and visualization, providing a scientific basis for site selection decisions. This article utilizes ArcGIS software to construct an application model for shopping mall site selection in Wanbailin District. Through spatial analysis, eligible areas are identified, achieving a scientific and visual approach to site selection. By considering the main factors affecting the location of large shopping malls in Wanbailin District and using ArcGIS as the basic platform, an application model is built to find the optimal location for building shopping malls. The results show that introducing GIS into mall location planning improves efficiency and accuracy while providing a reliable basis for scientific location.

Keywords: ArcGIS, buffer analysis, site selection analysis, spatial analysis of vector data.

1. Introduction

The scientific nature of a mall's location directly influences its attractiveness to consumers and its own operating conditions. If the location selection is unreasonable, it will directly harm the mall's vital interests, potentially severely hindering or constraining its business expansion [1]. Conversely, a well-chosen location benefits the mall's development, enhancing overall profitability. The factors influencing mall location are numerous, intricate, and interconnected, requiring a reasonable analysis and comprehensive evaluation based on specific requirements.

However, traditional location selection models have several shortcoming: abstract mathematical models that deviate from reality and fail to reflect issues intuitively; difficulties in considering the complex and diverse location factors and their impacts comprehensively; challenges in organizing multi-source data for comprehensive analysis, particularly spatial geographical data; cumbersome and inaccurate data input procedures; a lack of intuitive, interactive analysis tools for decision-makers; and limited dynamic interactions between decision-makers and computers [2]. These limitations make it difficult to meet the increasingly complex requirements and refined standards of current location selection processes.

With the continuous innovation and development of computer technology, simulation methods have become more profound and specific in describing actual location selection problems [3]. However, this approach demands analysts or managers describe the problems with extreme accuracy, and some qualitative factors in location selection cannot be analyzed through algebraic and logical methods or accurately described in computer languages [4]. Nevertheless, by integrating Geographic Information System (GIS) technology, the decisive factors considered in heuristics can be vividly represented on maps. Leveraging the powerful spatial information analysis capabilities of ArcGIS software, the realistic influencing factors in location selection problems can be effectively addressed [5]. Urban spatial layout and development are normative, so the location of shopping malls needs to follow the urban development strategy and the laws of surrounding population activities [6]. This paper utilizes GIS technology and heuristic methods to identify qualified candidate locations for malls based on the requirements of mall location selection and abundant geographic information. Subsequently, considering the principle of maximizing profits, a mall location selection model is established, and optimization is performed to derive the optimal location.

2. Influencing Factors of Site Selection

Given the thriving growth of the commodity economy, coupled with the ever-increasing options available to consumers when it comes to shopping venues, and taking into account the comprehensive pursuit of maximizing economic benefits for malls, mall developers have established stricter and more diverse high-standard requirements for factors such as the prime location, environmental comfort, and transportation convenience of malls. At the same time, it is crucial to note that the influence of these specific factors will undergo significant changes as the economic environment in which the mall operates evolves through different stages, necessitating continuous monitoring and flexible responses.

Based on the characteristics and spatial distribution of influencing factors, they can be categorized into two major types: continuous and discrete. Continuous influencing factors specifically refer to those that have a direct and definite impact on a specific region and do not have discrete properties, with population size being a typical example [7]. In contrast, discrete influencing factors exhibit distinct characteristics of discreteness, uncertainty, and indirectness, and their impact on site selection decisions often depends on their scale or the distance between them and the potential site location, with road conditions serving as an illustration of such factors. After comprehensively considering these two types of factors, the crux of mall construction lies in systematically collecting and analyzing relevant information to enhance decision-making efficiency, ultimately determining the most optimal site for construction.

The principles of site selection mainly encompass three aspects: Firstly, to ensure that the mall has a sufficient radiation range covering the surrounding residential areas. Secondly, to guarantee convenient transportation with supporting facilities such as parking lots nearby. Thirdly, to avoid or reduce malicious competition by ensuring that there are no other similar mall facilities in the vicinity.

The influencing factors considered in this paper are mainly categorized into four aspects: Firstly, the level of transportation convenience, which takes into account the ease of access for consumers to the mall and the transportation of goods, requires the selected mall location to be within a certain distance from major traffic arteries. Secondly, the distribution of parking lots: as the number of vehicles increases, malls need to provide parking spaces for customers or ensure access to other parking facilities. Thirdly, the distribution of residential areas, where the mall should not be too close to residential areas to avoid affecting residents' quality of life, nor too far away to hinder consumer accessibility, thus, the mall should be situated within a certain perimeter of surrounding residential

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areas. Lastly, the distribution of existing malls, in order to minimize competition with existing malls and maximize economic benefits, the selected mall location should be as far away as possible from other mall facilities.

3. Spatial Optimization and Site Selection Process

First, set a constraint range for it, which mainly includes the following four aspects: first, it should be 50m away from the main traffic trunk roads to ensure the accessibility and convenience of the shopping mall; second, it should be within 150m of the main residential areas to ensure a stable source of customers for the shopping mall; third, it should be more than 500m away from the existing shopping malls, which will help reduce vicious competition among peers and increase the profits of the shopping mall; fourth, it should be within 100m of the parking lot to facilitate customers parking their vehicles. Table 1 shows the relationship between the influencing factors considered in the site selection process and the corresponding buffer layers created in ArcGIS. Each factor has a specific filename for its buffer layer, and the buffer range indicates the distance from the factor that is considered significant for the site selection analysis.

Table 1: Location Selection Dataset

Name	Establishing shp layer	Buffer Zone Range	Establishing a buffer zone shp layer
existing shopping mall	Mall.shp	500	Mall-buff.shp
existing residential areas	Residental.shp	150	Residental-buff.shp
existing parking lot	Parking.shp	100	Parking-buff.shp
existing major traffic arteries	Roads.shp	50	Roads-buffer.shp

3.1. Data Sorting and Filtering

Before data sorting and filtering, it is necessary to comprehensively collect various geospatial data related to the site selection of shopping malls [8]. Subsequently, preprocess the collected raw data to meet the requirements of the analysis model. Load the data into the ArcGIS software and sort it for subsequent analysis and processing. Next, based on the site selection requirements, set distance conditions related to major traffic arteries, residential areas, parking lots, and existing malls, eliminating data points that are too far or too close. After sorting and filtering, categorize the qualified data points into different types and create separate layers for each type.

3.2. Existing Shopping Mall

According to the collected data, there is a shopping mall within the study area. Using the buffer analysis function of ArcMap, a buffer zone is established around the shopping mall with a buffer range set at 500m. This buffer zone is then converted into a raster image to facilitate subsequent classification. The light red circle in the upper right position of Figure 1 represents the buffer zone of the existing shopping mall. The dark red line elements are major traffic roads, and the cyan line elements are rivers.

Figure 1: Mall-buff.

3.3. Existing Parking Lots

Due to the constraints and limitations in the spatial locations of parking lots and shopping malls, the 71 parking lots within the study area are taken as the main research objects. A buffer layer with a range of 100m is established for the split parking lot layer, and the vector data is converted into raster data. The closer the location of the candidate shopping mall is to the parking lot, the higher its evaluation index will be, making it more suitable as a candidate site. Finally, the above results are reclassified. The gray circle in Figure 2 represents the buffer zone of the existing parking lot. The parking lots are mainly distributed in the northeastern part of Wanbailin, with a small number in the southwestern area. The dark red line elements are major traffic roads, and the cyan line elements are rivers.

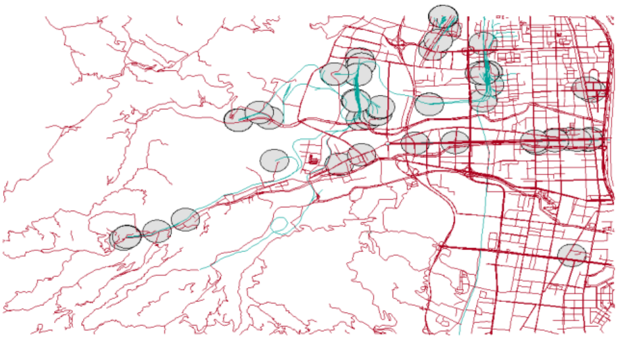

Figure 2: Parking-buff.

3.4. Existing Residential Areas

Due to the constraints and limitations in the spatial locations of existing residential areas and major traffic roads, 63 residential areas within the study area are taken as the research objects for proximity analysis. A buffer analysis with a hierarchy of 150m is conducted for the residential areas, and the vector data is converted into raster data. The closer the location of the candidate shopping mall is to the residential areas, the higher its evaluation index will be, making it more suitable as a candidate site. Finally, the above results are reclassified. In Figure 3, the blue circles represent the buffer zones of existing residential areas, which are mainly distributed on the eastern side of Wanbailin District. The dark red line elements represent major traffic roads, while the cyan line elements represent rivers.

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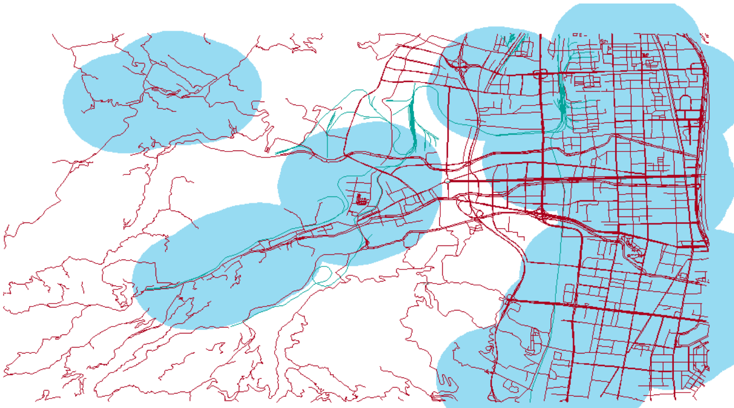

Figure 3: Residental-buff.

3.5. Existing Major Traffic Arteries

The main traffic roads directly affect whether consumers can quickly and conveniently reach the shopping mall. Therefore, buffer analysis is performed on the 2,249 roads within the study area. A buffer zone with a buffer radius of 50m is established for the traffic road layer to create a vector data map, which is then converted into raster data. After that, reclassification is conducted, and finally, an evaluation is made based on the results. In Figure 4, the yellow area elements represent the buffer zones of major traffic roads. The dark red line elements are the major traffic roads, and the cyan line elements are rivers.

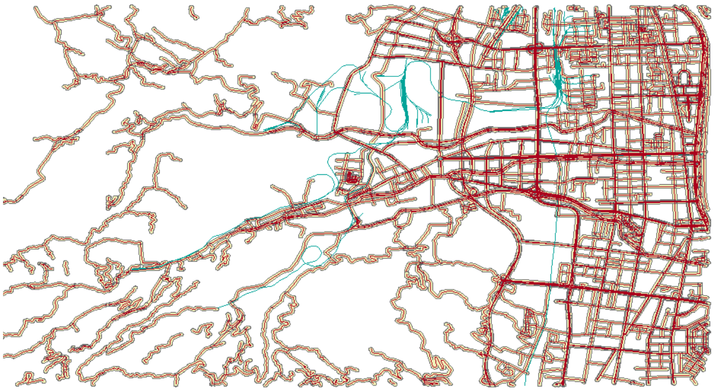

Figure 4: Roads-buffer.

3.6. Spatial Analysis and Visualization

After the preparation of materials is completed, the map calculation function of ArcGIS is used to process the various reclassified datasets to obtain the final suitability dataset. The higher the comprehensive evaluation index value of an area, the more suitable it is for the establishment of a shopping mall [9]. Below is the process of spatial analysis.

Stage 1: as shown in figure 5, create an "Union" layer that represents the intersection of the buffers for the four layers: "Residential," "Parking," "Roads," and "Mall."

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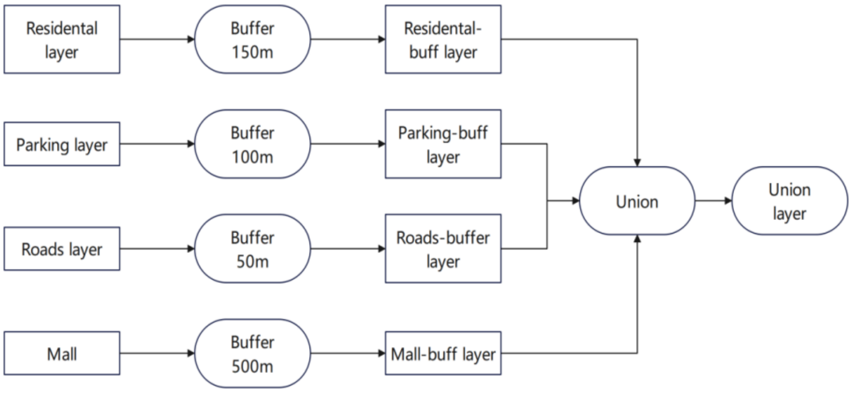

Figure 5: Spatial Analysis Flowchart.

Stage 2: assign a value of 1 to the evaluation index when one of the above conditions is met, and assign a value of 0 when the evaluation index is not met. Use this to conduct a graded evaluation of the location conditions of shopping malls within the study area. The evaluation criteria are as follows:

- First, Satisfying four conditions is grade one. The best area
- Second, Satisfying three conditions is grade two. Better area
- Thirdly, Satisfying two conditions is grade three. General area
- Fourthly, Satisfying one conditions is grade four. Reluctant area
- Fifthly, Satisfying zero conditions is grade five. Unsuitable area

After comprehensively analyzing the above conditions, add and assign values to the fields in the four established buffer layers. The main steps are as follows:

- First, For the existing shopping mall buffer, add a field named "Mall" and assign a value of "-1."
- Second, For the existing residential area buffer, add a field named "Residential" and assign a value of "1."
- Thirdly, For the existing parking lot buffer, add a field named "Parking" and assign a value of "1."
- Fourthly, For the existing major traffic roads, add a field named "Roads" and assign a value of "1."

Overlay the above areas and combine the four buffers to create a "Dissolve" layer. Add a field named "Grade" to its attribute table and include a calculation formula in the "Field Calculator" as follows: [Grade] = [Mall] + [Residential] + [Parking] + [Roads]

Obtain the evaluation grading results.

- (1)Grade=3, The best area.
- (2)Grade=2, Better area.
- (3)Grade=1, General area.
- (4)Grade=0, Reluctant area.
- (5)Grade=-1, Unsuitable area.

3.6.1. Creating a Site Selection Area Ranking Map

After the above spatial analysis, a ranking map of the shopping mall location area has been formed. As shown in Figure 6, the green represent the best area, primarily distributed in the eastern region of Wanbailin District, and its area is the smallest among the five grades, this area should be given priority as the final location for the shopping mall [10]. The pink are the better area, also primarily located in the eastern part of Wanbailin, with a certain correlation to the traffic roads in their distribution. The light blue are the general area. The dark blue are the reluctant area. The white represent the unsuitable area, which has the largest area among the five grades.

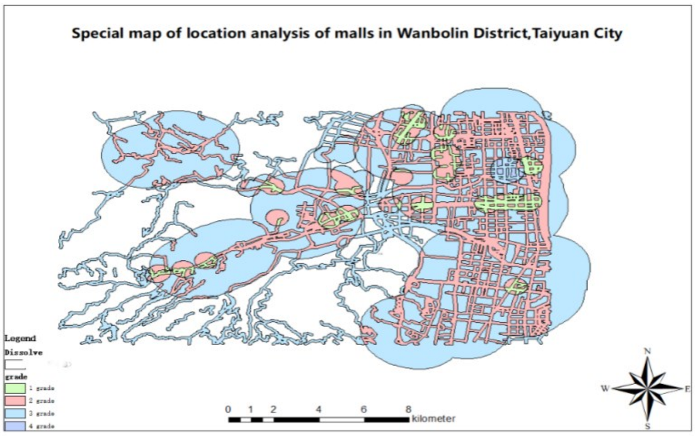

Figure 6: Special map of location analysis of malls in Wanbolin District,Taiyuan City.

4. Conclusion

Shopping malls have become an indispensable part of modern people's daily lives, and their layout and quantity are directly related to the living expenses and quality of life of surrounding residents. Therefore, leveraging GIS spatial analysis technology to conduct in-depth analysis of basic data, including surrounding population density, actual service coverage, and transportation convenience, can accurately calculate the most suitable locations, grades, and quantities for shopping mall establishment. Among them, the area with the highest comprehensive score should be prioritized as the final location for the shopping mall. This strategy can not only avoid unfavorable construction areas, accurately meet the living and consumption needs of residents, but also effectively alleviate competition within the industry, reduce construction costs, and increase profit margins. This analytical method not only accelerates work efficiency, reduces labor input, but also realizes real-time data updating and management, which has a positive impact on improving residents' quality of life and the commercial environment. However, in practical operations, the factors considered in shopping mall location selection are more complex and diverse, such as the personal preferences and positioning of mall managers, urban land prices/rental levels, urban planning directions, proximity to parks or scenic areas, and proximity to universities. It is necessary to carefully evaluate whether the conditions and threshold settings of the selected area are reasonable to ensure that the final location meets all predetermined requirements.

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