Research Article

Site Selection of Precast Concrete Component Factory Based on PCA and GIS

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In China, with the expansion of the prefabricated construction market, the demand for precast concrete (PC) components is increasing and the construction of production plants to meet this need is expanding. To address the problem of siting PC component plants in China’s construction industry, a combination of qualitative and quantitative analysis using principal component analysis (PCA) and geographic information system (GIS) is proposed for their siting. Taking the site selection process of a PC component plant in Wuhan, Hubei Province, China as an example, the diamond model is combined with six dimensions of environmental factors, requirements, regional competition, related and supporting industries, technological innovation and policies and regulations to construct an indicators system for PC component plant site selection. In the preliminary selection stage, PCA was applied to analyze the site selection indexes to obtain the overall score and ranking of each district for the selection of PC component plants in Wuhan, and it was concluded that three districts, namely, Xinzhou, Hannan, and Huangpi, were more suitable for the construction of component plants. In the precise selection stage, based on the availability of data, Hannan was selected among the three areas suitable for site selection for GIS analysis, using the visual-spatial analysis function of GIS to quantify the four geographical information indicators of environmental factors, and the results showed that Area C in Hannan was the most suitable area. The results show that the method has high accuracy and good applicability.

1. Introduction

Prefabricated buildings, which waste fewer resources, converse energy conservation, and protect the environment, are of excellent quality and have a short construction cycle and controllable costs [1, 2]. Therefore, the Chinese government believes the development of prefabricated buildings is an important transformation and upgrade to the construction industry. Under this policy, the prefabricated building market is expanding continuously [3], and the demand for precast concrete (PC) components is increasing for housing construction projects. The scientific construction of precast concrete component factories requires attention. The construction of a PC component factory is greatly influenced by national policies and is characterized by large capital investment. The scientific and reasonable site selection of a PC component factory is an important problem. It must meet the market demand and reduce waste caused by excessive investment.

At present, existing research on PC component factory site selection mainly focuses on two aspects:

On the one hand, it affects the establishment of the indicator system of PC component factory site selection and the method of determining weight. Scholars analyzed the factors affecting the site selection of PC component factories from different dimensions and mainly focused on qualitative research. Luo divided the influencing factors into four dimensions: infrastructure, economic, social, and policy [4]. Qiu divided the influencing factors into four dimensions: industrial environment, social economy, infrastructure condition, and sustainable development [5]. There are many subjective factors in the establishment of an indicator system. The method regarding the weight of the indicator system includes the Delphi method, analytical hierarchy
process (AHP) method, entropy weight method, and grey correlation method. The Delphi method and AHP rely too much on expert experience and lack objectivity. The entropy weight method is inaccurate, and analysis of the grey correlation methods indicates problems exist in the model [6, 7]. Therefore, the indicator system and the objectivity of weight determination need improvements.

On the other hand, a geographic information system (GIS) has been applied to the site selection of airports, landfill sites, logistics centers, solar power plants, fire stations, and other fields with high accuracy in research on precise site selection [8–15]. Combined with characteristics of the site selection of the PC component factory, quantitative analysis of GIS’s powerful spatial analysis function is carried out, which can provide technical support for the site selection of a PC component factory.

Based on the above analysis, the indicator system establishment standardization should be improved, as should the objectivity and measurability of the weight determination method. GIS analysis should be applied to the study of precise site selection of PC component factories. Therefore, this study uses principal component analysis (PCA) and GIS to provide qualitative and quantitative analysis for the site selection of PC component factories. First, based on the constraint conditions of the site selection, the indicator system of influencing site selection was constructed via a diamond model. The weight of each indicator was determined using the PCA. Second, GIS is used for buffer analysis of environmental microfactors, and the weighted overlay analysis is carried out in combination with the weight of indicators to generate a quantitative site selection model to determine the optimal site selection area. Finally, an empirical study is made on the site selection decision-making process of a PC component factory in Wuhan, Hubei Province, China.

1.1. Literature Review. Recent qualitative and quantitative studies have examined the influencing factors and evaluation methods of the site selection of PC component factories. Wang used the grey correlation analysis method to analyze and then screen out the key factors affecting the site selection of the prefabricated construction factories. The final evaluation of the options in the case was then carried out using the fuzzy integrated evaluation method for the purpose of site selection [16]. Yao et al. used a BP neural network to establish the evaluation and prediction model of the factory site by comprehensively considering nine factors such as geographical site, landform, land scale, transportation facilities, raw materials, and labor [17]. The above analysis is mainly qualitative, the research system is not scientific and systematic, and there are many subjective factors, so it is difficult to directly reflect the problem of site selection.

To improve the standardization and systematic nature of the site selection indicator system, the diamond model has a strong guiding value for the construction of the indicator framework system. The diamond model proposed by Professor Michael Porter of Harvard Business School focuses on production, enterprise strategy and industry competition, demand conditions, relevant supporting industries, opportunities, and the role of the government and other factors, which is an important means to analyze industrial clusters and industrial competitiveness [18]. As an effective analysis method, the diamond model can be applied in the study of equestrian industry competitiveness, port competitiveness, aviation industry cluster competitiveness, and other issues [19–21]. The site selection of a PC component factory is not only based on market demand but also on the profit-seeking characteristics of investors. In the analysis of specific industry of PC component factory, it is necessary to consider the competitiveness of a certain region must be considered.

Corresponding quantitative site selection research has also attracted the attention of scholars. Hu predicted the land price factors of each region in the future planning period through the grey prediction method established the site selection model with a 0–1 integer programming method and solved the optimal site selection area of component production base [22]. Song used the greedy takeaway heuristic algorithm to solve the objective function with the optimal total cost and verified the model’s feasibility [23]. The existing quantitative analysis is studied mostly from the perspective of a model algorithm, and the quantitative aspect of the site selection indicator and the site selection method needs improvement.

PCA is a statistical analysis method that simplifies multiple indicators into a few comprehensive indicators. It uses a few variables to reflect the original variables as much as possible, so as to ensure the loss of the original information and the number of variables as little as possible. It is mostly used in the correlation analysis of an indicator system. For example, Yang used PCA to optimize the indicator when evaluating building energy conservation design. And the application in site selection is relatively mature, mostly used in the site of retail stores, real estate, and other facilities [24]. Wang and Qi estimated the market potential of the target area by establishing a PCA-BP model for retail stores [25, 26]. Zeng combined PCA and GIS to determine the optimization direction in the site selection optimization of urban elderly care facilities [27].

GIS is widely used in various research fields due to its powerful spatial analysis ability. It processes basic data to obtain new information and provides decision support. GIS was applied to a variety of site selection problems. Colak used GIS to study Turkey’s solar photovoltaic (PV) power plant site selection, taking into account solar energy potential, roads, and energy transmission lines. They used the AHP to calculate the weight of factors, and the map to show the optimal location of solar power plants [28]. Castro-Santos developed a method of using GIS spatial analysis in the development of floating offshore wind farms [29]. They analyzed some of the limiting factors (environmental area, navigation restricted area, depth, port, shipyard, etc.), and added these to the GIS for site selection analysis.

Some scholars have a goal of PC component factory site selection. The indicator system for the site selection of a PC component factory is in the exploration stage and lacks qualitative and quantitative integration. Spatial problems may be solved in combination with GIS. Therefore, based on
2. Materials and Methods

2.1. Indicator System of Factors Affecting the Site Selection of a PC Component Factory

2.1.1. Constraint Condition Analysis of PC Component Factory Site Selection. The PC component factory has unique construction, production, and operation stages and is greatly affected by the following factors:

The construction and operation of a PC component factory rely heavily on policies [1, 30]. Due to a large amount of investment in a PC component factory, the current stage mainly depends on land concessions, planning incentives, special fund support, and industrial and tax preferential policies to improve investor enthusiasm. For the market, the present stage mainly includes mandatory standards to expand the market demand, the prefabricated construction area, and monomer project mandatory measures, such as the prefabricated rate, through the volume rate of reward and merit bidding policy and cost accounting policies to encourage developers to build modern projects.

The market demand for PC components in different provinces and cities varies greatly [1, 31]. The development policies of prefabricated buildings in China are divided into regions (regions that have active promotions and those that do not) to promote development promote development. Market demands in different regions vary greatly. In some regions, fierce competition among PC component factories, excess design capacity, low capacity release rate, and poor management have emerged. For the newly-built PC component factory, it is important to consider market demand, potential market share, and whether there is already an oversupply phenomenon or a monopolistic manufacturer in the area.

The production and storage of PC components place heavy demands on the site [31]. PC components are large, and the layout of the production workshop needs to meet production requirements. The area of the workshop and the component yard is large, with a ratio of about 2:1. Large storage yards will lower the floor area ratio of the factory, so it is necessary to ensure that the floor area ratio of the site meets the local construction indicators. Components in the stacking and transportation of the plant must meet requirements to prevent uneven force cracks and poor quality.

The scope of service of the PC component factory is limited and mainly includes road transportation [1]. Transportation distance and the cost of raw materials should be considered, as well as the influence of transportation distance on cost. Therefore, the service radius of China’s PC component factory is about 100 km, and the transportation of PC components is mainly by road. Large components have high requirements for road accessibility, traffic capacity, and traffic conditions.

2.1.2. Establish One-Level Indicators. Analysis is based on PC component plant sitting constraints and diamond model theory. Considering the six aspects of environmental factors, demand conditions, regional competition, related and supporting industries, technological innovation, and policies and regulations, a revised diamond model of PC component factory site selection is constructed. The key factors are environmental factors, regional competition, requirements, and related and supporting industries. Auxiliary factors are technological innovation and policies and regulations (Figure 2).

Environment Factors. When selecting a site for a PC component factory, it is necessary to consider not only the production status in the factory but also whether the site selection area has conditions for appropriate building a factory.

Requirements. The market demand for PC components also varies greatly and there is overcapacity or under capacity in some regions [32].

Regional Competition. The industrial layout and economic status and strength of the PC component factory in each region differ. The demand of the PC component is monopolized is the comparison benchmark.

Related and Supporting Industries. The industrial production of PC components covers the whole life cycle of design, production, construction, and transportation and involves the owner, the designer, the material supplier, and other subjects. The above-mentioned subjects are summarized as the investment and financing situation, raw material supply situation, fuel, energy and power situation, and construction party support situation.

Technology Innovation. The particularities of the prefabricated building make them not only inseparable from innovation in the selection of raw materials and processing technologies but also inseparable from innovation in the research of new technology, new material, and new process [33].

Policies and Regulations. The promotion policies for prefabricated buildings and the preferential policies for building and developing the PC component factories differ by region.

2.1.3. Establish Two-Level Indicators. Taking into account the characteristics of the PC component factory in the production, transportation, and operation stages and guidance of the revised diamond model, this study used different keywords and databases to conduct a detailed review of literature related to PC component factories in the past five years (February 2016 to February 2021). We used keywords such as "site selection," "prefabricated building," and “PC component factory” in databases such as Web of Science, Elsevier, and Springer Link. We downloaded a total of 82 articles and selected 19 articles after screening and
deleting duplicates. In total, 55% of the articles were sourced from Web of Science, 34% from Elsevier, and 11% from Springer Link. The site selection criteria were summarized into 16 specific items in 6 dimensions. The specific content is listed in Table 1.

2.2. Principal Component Analysis. The determination of weights is an important step in the evaluation process. Each evaluation factor has a different degree of influence on the overall evaluation of the target; the weights are an objective reflection of this subjective difference, and reasonable weights can strengthen the authenticity of the evaluation system and the validity of the evaluation results. In order to accurately evaluate the suitability of each region for the construction of the PC component plant site, it is necessary to choose a suitable calculation method. At present, there are many methods to calculate the weight of indicators, in which Delphi and hierarchical analyses are too dependent on people’s experience and subjective factors play a dominant role, while the entropy method tends to ignore the importance of the site selection indicators themselves, and sometimes the difference with the expected results is large, so this study adopts the principal component analysis to determine the weight of site selection indicators.

Principal component analysis (PCA) was proposed by Pearson, a British statistician, in 1901 [34]. It analyzes the correlation of information from multiple initial indicators through mathematical dimension reduction thought and simplifies it into representative general indicators. This expresses as much information as possible from the initial indicators [35]. PCA can be used in multi-indicator and multivariable problems. It can transform many linear indicators, such as PC component factory site, into a few linear independent indicators [36]. At the same time, due to linear independence, the interference of relevant indicator factors can be cut off when analyzing the indicator variables of a site. This allows the discovery of dominant factors of a site and more accurate estimation. This provides important guidance for site research of a PC component factory.

The process of PCA is as follows [37]: (1) the original indicator data were standardized; (2) the correlation coefficient matrix was calculated. This can be used to express the correlation between the indicators. (3) The cumulative variance contribution rate of eigenvalues was calculated. The larger the eigenvalue, the higher the important component of the corresponding principal component. (4) The component load matrix was calculated. (5) The weight coefficients of principal component score matrix and factors were calculated. (6) The comprehensive score of each indicator
was calculated and normalized to get the weight of each indicator in the indicator system.

2.3. GIS Analysis. Geographic information system (GIS) was first established by the Canadian surveyor Roger in 1963 [38]. Its theoretical and technical systems have been developing continuously. There are many factors affecting site selection and a large amount of data to be processed [39]. By using the computer in GIS to store and manage geospatial data [40], the spatial data and attribute data related to site selection can be superimposed for a comprehensive analysis of site selection. Compared with the traditional site selection method, this method can quickly obtain information, with results represented by graphics and numbers. This is clearer and more intuitive, reduces the workload, and improves the efficiency and accuracy of site selection.

The selection, buffer classification, and reclassification functions in ArcGIS 10.0 are used to analyze the site of the PC component factory. The main process is divided into three steps: (1) land type screening: it uses screening tools to sift out suitable land types, creates new layers, and symbolize them for easy viewing. (2) Buffer analysis: by analyzing the geo-information data of each indicator, the multi-ring buffer is obtained. (3) Overlay analysis: the results of geographical information analysis of dominant indicators are weighted and superimposed to obtain site analysis. The detailed flow is shown in Figure 3.

3. Case Study

3.1. Study Area. Wuhan, Hubei Province, is located in the middle of China. The terrain is plain and supplemented by hills. Hubei province divides the modernization of construction industry into three stages (the demonstration period, the promotion and development period, and the popularization and application period). By the end of 2025, the assembly rate of concrete structure construction projects will reach more than 40%. The Wuhan government proposed that construction industry modernization should be promoted and applied from 2018 on. To meet the demand for PC components for prefabricated buildings, there are plans to build a new PC component factory in Wuhan. The PCA and GIS are used to research the preliminary selection and precise selection.

3.2. Preliminary Selection Stage. Because the site of a component factory faces requirements for radiation radius and transportation, this study uses seven administrative regions in the northwest of Wuhan as examples. Using the revised diamond model indicator system and the dimension reduction component of the PCA, important factors are extracted from many influencing factors to determine the weight of these factors. At the same time, the comprehensive score was obtained to accurately reflect the competitiveness and feasibility of a PC component factory construction in various regions.

To conduct PCA on the above 13 indicators, the original geographic information data of seven administrative districts of Wuhan were collected through the official government website and maps of Wuhan, as listed in Table 2. Since the listed indicators are quantitative, the quantitative model is more convenient for analysis. The size and output of the component plants in Wuhan do not vary greatly, so the local monopoly is analyzed according to the number of component plants. However, the indicators of policies and

<table>
<thead>
<tr>
<th>Target</th>
<th>One-level indicators</th>
<th>Two-level indicators</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site selection of PC component factory</td>
<td>Environmental factor</td>
<td>Land use condition X1</td>
<td>Proportion of industrial land area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hydrologic condition X2</td>
<td>Proportion of lake area in water area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Site condition X3</td>
<td>Flatness ratio</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Local monopoly X4</td>
<td>Number of existing PC component factories, and the size/size/output of similar factories</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Transportation X5</td>
<td>Average transportation time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Prefabricated construction projects X6</td>
<td>Construction in progress and to be constructed</td>
</tr>
<tr>
<td></td>
<td>Factory area radiation range X7</td>
<td>150 km</td>
<td></td>
</tr>
<tr>
<td>Site selection of PC component factory</td>
<td>Regional competition</td>
<td>PC component industry competitiveness X8</td>
<td>Proportion of prefabricated buildings (built) in total project area</td>
</tr>
<tr>
<td></td>
<td>Related and supporting industries</td>
<td>Raw material supply X9</td>
<td>Output value of each raw material industry</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fuel, energy, and power conditions X10</td>
<td>Total supply capacity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Construction support X11</td>
<td>Completed output value of the project</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Technical innovation personnel X12</td>
<td>R&amp;D personnel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Technical innovation cost X13</td>
<td>Total internal expenditure of R&amp;D activities</td>
</tr>
<tr>
<td></td>
<td>Government’s industry planning X14</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>City planning X15</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Policies and regulations</td>
<td>Favorable government</td>
<td>Policies X16</td>
<td>—</td>
</tr>
</tbody>
</table>
regulations cannot be quantitatively analyzed, and they belong to the scope of qualitative analysis. Therefore, they will be considered in further studies.

SPSS analysis software was used to analyze and calculate the original data of the site selection indicator of the PC component factory. The eigenvalue and cumulative contribution rate of the correlation coefficient matrix obtained after calculation are listed in Table 3.

It can be seen from Table 3 that two principal components, F1 and F2, are composed of information extracted from the 13 indicators, and the proportion of these two principal components is 95.79%. The greater the variance contribution rate is, the more important the corresponding principal component is and the greater its contribution to the summary of the original variable. The lower the order, the less important it is and the lower its contribution is.

Table 4 lists the indicator load of each influencing factor in the principal component. The coefficient of the indicator in the linear combination can be calculated by the indicator load number. The first main factor, F1, has a large load. Hydrological conditions, site conditions, transportation conditions, prefabricated building projects, industrial competitiveness of PC component factory, fuel, energy, and power conditions play a major role, which are the basic factors of PC component factory site selection. The second main factor (F2) has a large load on the site. That is, land use conditions and raw material supply play a major role. These are the potential factors of PC component factory site selection.

The scores of each major factor and the ranking of each region were calculated, as listed in Table 5.

We normalized the coefficient of the comprehensive scoring model to get the weight of each indicator in the indicator system, as listed in Table 6.

The calculation results show that the top three regions, Xinzhou, Hannan, and Huangpi, are all suitable for the construction of PC component factories. Regarding the calculation results of indicator weight, the weight of a prefabricated construction project is 0.2099, accounting for the largest proportion, followed by the competitiveness of the PC component industry. Building a PC component factory depends on the demand for the PC components and whether it can be sustainably developed. To a certain extent, the demand situation affects the weight of related and supporting industries. Only when regions have demand for PC components, this chain can have power. Only with the

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**Table 2: Original data of site selection indicator of PC component factory in 7 administrative districts of Wuhan.**

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Qiaokou</th>
<th>Dongxihu</th>
<th>Huangpi</th>
<th>Xinzhou</th>
<th>Hanyang</th>
<th>Caidian</th>
<th>Hannan</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1 (%)</td>
<td>1.5</td>
<td>10.5</td>
<td>4.3</td>
<td>7</td>
<td>3.9</td>
<td>0.2</td>
<td>8.6</td>
</tr>
<tr>
<td>X2 (%)</td>
<td>1.3</td>
<td>0.98</td>
<td>5.1</td>
<td>5.4</td>
<td>4.7</td>
<td>6.7</td>
<td>5.2</td>
</tr>
<tr>
<td>X3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>X4</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>X5 (min)</td>
<td>15</td>
<td>10</td>
<td>12</td>
<td>10</td>
<td>15</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>X6 (%)</td>
<td>12</td>
<td>7</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>X7 (km)</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>X8 (%)</td>
<td>12</td>
<td>7</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>X9 (billion)</td>
<td>64.46</td>
<td>823.78</td>
<td>3716</td>
<td>2401</td>
<td>179.17</td>
<td>1801</td>
<td>1104</td>
</tr>
<tr>
<td>X10 (million)</td>
<td>12.42</td>
<td>158.77</td>
<td>716.18</td>
<td>462.9</td>
<td>34.53</td>
<td>347.1</td>
<td>95</td>
</tr>
<tr>
<td>X11 (10000 square meters)</td>
<td>16.37</td>
<td>208.68</td>
<td>940.68</td>
<td>608</td>
<td>45.17</td>
<td>456.04</td>
<td>124.9</td>
</tr>
<tr>
<td>X12 (ten thousand people)</td>
<td>0.83</td>
<td>10.54</td>
<td>47.56</td>
<td>30.73</td>
<td>2.29</td>
<td>23.05</td>
<td>6.31</td>
</tr>
<tr>
<td>X13 (billion)</td>
<td>2.13</td>
<td>27.26</td>
<td>122.96</td>
<td>79.46</td>
<td>5.93</td>
<td>59.60</td>
<td>32.62</td>
</tr>
</tbody>
</table>
operation of related and supporting industries, the PC component factory can have a foundation for development. Among the environmental factors, the transportation and land use conditions have a large weight. The environment is a microindicator, so it is necessary to investigate the regional environment before making a site decision.

3.3. Precise Selection Stage. This study analyzes the environmental factors of site selection by GIS. Accurate site selection mainly depends on whether the environmental factors in the area are suitable for the construction and development of a PC component factory. Due to the availability of data, Hannan was selected as an example in the accurate selection stage. The buffer distance is set for the four geographic information indicators of the environmental factors, and the indicator information of GIS spatial analysis is listed in Table 7.

(1) Land Use Condition. According to the classification of land use status, land use is divided into four subcategories: water area, construction land, highway land, and other nonconstruction lands. As shown in Figure 4(a), most areas of Hannan in Wuhan are suitable for a PC component factory, and the construction land area is larger. The land buffer area of influence is set as below 500 m, 500–1000 m, 1000–1500 m, and above 1500 m, assigning values of 4, 3, 2, 1, respectively.

(2) Hydrologic Condition. The production of a PC component factory causes pollution and needs to take place far from water. The spatial analysis of...
Table 7: GIS spatial analysis of the indicator information.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Grade</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land use</td>
<td>According to the different land properties in the land use map, the land is divided into water area and building area and is divided into four grades according to the distance between the water area. The grading value is 500, 1000, 1500, and 2000</td>
<td>4, 3, 2, 1</td>
</tr>
<tr>
<td>Slope gradient</td>
<td>According to different slopes, it is divided into 4 grades, and the grading value is 100, 200, 300, and 400</td>
<td>4, 3, 2, 1</td>
</tr>
<tr>
<td>Existing factory</td>
<td>According to the relative distance of similar factories, four grades are divided. The grading value is 1000, 2000, 3000, and 4000</td>
<td>4, 3, 2, 1</td>
</tr>
<tr>
<td>Highway</td>
<td>There are four grades based on the relative distance of the highway, and the grading value is 500, 1000, 1500, and 2000</td>
<td>1, 2, 3, 4</td>
</tr>
<tr>
<td>Main road</td>
<td>There are four grades based on the relative distance of the main roads, and the grading value is 500, 1000, 1500, and 2000</td>
<td>1, 2, 3, 4</td>
</tr>
<tr>
<td>Secondary road</td>
<td>According to the relative distance of the secondary road, there are four grades. The grading value is 500, 1000, 1500, and 2000</td>
<td>1, 2, 3, 4</td>
</tr>
</tbody>
</table>

Figure 4: Continued.
hydrological conditions is understood as the distance analysis from the river. As shown in Figure 4(b), Hannan has abundant water resources, and the water area is at the edge of the city. There are more water areas in the northeast and the Yangtze River is in the southeast. The lighter the color in the figure, the farther it is from the water area.

(3) **Site Condition.** Elevation and slope must be considered in a site selection decision. Because of the particularity of PC component factories, the components produced must have a good storage environment before they are shipped out. Based on elevation DEM data, a gradient map was drawn after rasterization (Figure 4(c)), and the slope was buffered for analysis. The effect was shown in Figure 4(d). The area with a higher score, indicated by a lighter color, indicated a smaller slope and high suitability. With reference to the previous study and the relevant regulations, the elevation influence range was set to below 500 m, 500–1000 m, 1000–1500 m, and above 1500 m, with values of 4, 3, 2, 1, respectively.

(4) **Local Monopoly.** As can be seen from Figure 4(e), the lighter the color, the more suitable the site selection. There is only one existing PC component factory in Hannan, and the area is small and the output is small, so it is difficult to maintain adequate demand for Hannan, Wuhan, and surrounding cities. The competition strength in this area is small and suitable for the construction of new plants. It effectively makes up for the Wuhan plant market vacancy. Four classes are classified according to the relative distance of similar plants, and the impact range is set to less than 1000 m, 1000–2000 m, 2000–3000 m, and more than 4000 m, with values of 4, 3, 2, 1, respectively.

(5) **Transportation.** As can be seen from Figure 4(f), through the establishment of buffer zones for expressways, main roads, and secondary roads in Hannan, the southwest and east of this district have better road conditions. This is convenient for component transportation and suitable for the supply and transportation conditions of upstream material suppliers. The analysis results show that the close distance to the three roads is limited in the coverage area, which narrows the site selection range of the component factory and makes the site selection more accurate. By reviewing the relevant literature, the distance from the PC component plant to the road was assigned a value of 4, 3, 2, and 1 according to less than 500 m, 500–1000 m, 1000–1500 m, and more than 2000 m.

(6) **Weighted Superposition Analysis.** First, convert vector data analysis results to raster data. Next, enter the raster map in the weighted overlay command, enter the corresponding indicator weights into the weighted overlay table, and perform a weighted overlay analysis to produce a result layer (Figure 5). Different colors represent suitability. The area of grade 1 is the most suitable site potential area (red areas).

### 4. Results

According to the results of the weighted overlay analysis, three potential suitable construction areas are A, B, and C. A is located in the south of Hannan, adjacent to the
expressway, but it covers a long and narrow area and is relatively small. Compared with B and C, it has no obvious advantages. Combined with the land use planning and relevant policies regarding the development zone, the factory site was finally located in C, as shown by the red mark in Figure 5.

PC component is a new product being encouraged by the local government. The implementation of EPC of PC component is of positive significance for energy conservation and emission reduction, environmental protection, industrial technology developments, and sustainable development. The area has urban policy support, preferential tax relief, and land transfer. The site conditions of the selected plant construction area are superior, allowing the plant to be built far away from the river water area. The site is flat and suitable for stacking prefabricated components. The enterprise operates well, has sufficient funds for investment, and has stable labor conditions and a complete market. There is only one small factory in this area, which struggles to meet the market demand. The competitiveness is small and the road is unobstructed. After the project is put into operation, it can spread to many areas in Hubei Province and can expand the transportation radius to neighboring provinces and cities. This will effectively fill the market gap, form an effective complement with existing factories, and meet the strategic needs of the company's regional layout.

The above conditions not only lay the foundation for the vigorous development of a PC component factory but also provide strong foundational support for the development of prefabricated buildings.

5. Discussion

In the future, the site of PC component factories will be an important research field in China’s prefabricated construction industry [41]. How best to improve the scientific nature and operability of the site decision-making process is the focus of this research. Due to the complexity of a component factory site, it is necessary to comprehensively consider several influencing factors. On the basis of sorting out the related theoretical research and analyzing the particularity of PC component factory, based on the revised “Diamond Model” theory, the precast component factory location index was sorted out in more detail and a more comprehensive PC component factory location index was established. The system provides a reference for the subsequent index analysis of the site selection of the prefabricated component plant and the index analysis of other fields. To be less subjective and more accurate, the application of PCA adopts the idea of dimension reduction for many indicator factors and extracts one or more principal components, which are recombined. The cumulative variance percentage is more than 85% for analysis. We fully consider macro factors such as policy, market, and economy and use the powerful geographic information analysis function and visual display function of GIS technology to further narrow the scope of site selection. We utilize a detailed in-depth analysis of geographical indicators to provide more specific references for investment decision-making. The site selection method based on the combination of PCA and GIS effectively combines spatial information with nonspatial information, creating a reference for solving the problem of multicriteria quantification. This method can be applied in other fields.

6. Limitations

There are some limitations for the establishment of a PC component factory site selection indicator system, due to the exploratory nature of this research. This system requires a more practical application for improvements.

7. Conclusions

The construction of a PC component factory supports the development of prefabricated buildings. To meet the market demand and prevent excess investment, it is necessary to scientifically and reasonably determine the optimal location. Compared with the general factory, the location of a PC component factory depends on policy, regional differences in market demand, site demand, and the limited service scope.

Through analysis of the construction, production, and operation stages, four special constraints of PC component factory locations were sorted out, including dependence on policy, the market demand of different provinces and cities for PC components, site requirements for PC component production and storage, and transportation conditions limited by the service scope.

Based on the location characteristics of the PC component factory, the diamond model is modified to construct a location indicator system of the PC component factory based on environmental factors, requirements, regional competition, related and supporting industries, technological innovations, and policies and regulations. The six first-level indicators are refined into 16 second-level indicators.

GIS is used to make location decisions regarding PC component factories. Through data collection and data statistics, PCA is used to analyze the site selection indicators. Xinzhou, Hannan, and Huangpi are superior to other
regions in the construction and development of PC component factory site selection. In the precise selection stage, using GIS analysis tools, Hannan of Wuhan was analyzed as the final location area. A buffer zone was established and weighted overlay analysis and data processing of microenvironmental indicators were carried out to obtain the optimal location area.

The evaluation of the combination of PCA and GIS makes the location area more accurate and specific. The empirical results show that it has strong operability and applicability, which provides a reference for the scientific decision-making of determining the component factory location.

**Data Availability**

The data used to support the findings of this study are available from the corresponding author upon request.

**Conflicts of Interest**

The authors declare that they have no conflicts of interest.

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