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Research on Integrated Models of Site Selection and Heritage Preservation Based on Multidimensional Evaluation

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Abstract: *With the acceleration of urbanization, global property developers need to balance the economic benefits and social value of projects when choosing construction sites, and focus on finding a balance between urban development and cultural heritage protection. In response to this, this study constructed a Sites Selection Model and selected 8 indicators that had a significant impact on the judgment of this issue. Taking Paris as an example, this study used ArcGIS to form the single-factor heat maps and synthesized them to determine the best construction site after relevant analysis. Meanwhile, to help community leaders better preserve historic landmarks, this paper established a preservation model. Based on the decision tree model, compare the net profit before and after relocation from the perspectives of the value that a landmark can bring and the required costs, to determine whether to relocate the landmark. Lastly, this study was based on this to construct a plan for the Candi Pawon. The study concludes that relocating the landmark is not a cost-effective choice proven by the comparison between pre-relocation net value and post-relocation net value.*

Keywords: *Sites Selection Model, ArcGIS, Decision Tree Model, Landmark Protection*

1. Introduction

With the acceleration of urbanization, property developers worldwide are facing enormous challenges in choosing suitable construction sites. Reasonable location selection can not only optimize resource allocation but also significantly enhance the economic benefits and social value of the project. However, current location selection models often lack comprehensive analysis and utilization of multidimensional data, leading to the neglect of key factors such as environment, history, and culture in the decision-making process. Meanwhile, the property developers also need to rebuild their investment strategy to make the properties more resilient and built deliberately. In addition, the protection and utilization of cultural heritage has become a global focus of attention. Many cultural sites face serious threats due to natural aging, human destruction, or environmental changes. How to find a balance between urban development and cultural heritage protection is an urgent issue that needs to be addressed. Especially in the decision-making process, how to evaluate the value and maintenance costs of cultural heritage, as well as how to improve its protection efficiency and economy through modern technological means, are important issues in the current field of cultural heritage research. Thus, exploring a practical method to help the stakeholders make better decisions is a sobering call to action.

Based on this, this study established a Sites Selection Model and processed the data using the min-max normalization method. In addition, regional visualization was also performed using ArcGIS. Such an approach is feasible. Gong et al (2021) discussed Space and temporal distribution characteristics of grottoes in China through this method [1]. Meanwhile, this study utilized a decision tree model to determine whether to relocate landmarks by comparing the net profits before and after relocation. Of course, this method is also desirable. Zhenzhen Xiong (2023) used this model to discuss the related issues about the commercial buildings in Shanghai[2].

Specifically, in terms of real estate investment strategy issues, this study selected eight factors: residential occupancy per capita, percentage of real estate firms, average number of emergencies per year, population density, annual growth rate of population, hourly wage per capita, GDP per capita, and the

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growth rate of GDP as the basis for constructing the Sites Selection Model. Taking 20 administrative regions in Paris, France as an example, this study collected data on these 8 factors from the French National Institute of Statistics and Economic Studies (INSEE) in the 20 regions of Paris in 2023, and used the min-max normalization method to process these variables. For each variable, this study used ArcGIS and created a visual map image based on a unified standard. After obtaining these images, this study conducted correlation analysis and overlaid them, selecting the darkest colored areas in the final image. These areas are worth investing in real estate.

In terms of determining whether to relocate landmarks, this study quantifies the value of landmarks from the perspectives of cultural, historical, economic, and community significance. It measures losses from damage, repair, relocation cost, and premium, and compares the two to determine its current situation. If the value is greater than the loss, it indicates a good situation, and vice versa, a bad situation. Faced with a difficult situation, this study considers whether it is possible to turn it into a better one. If not, consider relocating the landmark building. To make the decision, this study calculates the net pre-relocation value and the net post-relocation value of the landmark, which is equal to its value mines the expense. If the net post-relocation value is larger, then it can use the Sites Selection Model constructed earlier to find the best relocation location. If not, it's suggested that preservation should be done locally. Finally, this study uses Candi Pawon as an example to demonstrate the feasibility of the constructed model.

2. Sites Selection Model

2.1 Variables Defining and Pre-processing

To make a more comprehensive decision, this paper considers the following eight factors: residential occupancy per capita, percentage of real estate firms, average number of emergencies per year, population density, annual growth rate of population, hourly wage per capita, GDP per capita, and the growth rate of GDP. Among these, the first three are negatively correlated factors and the last five are positively correlated factors.

To better demonstrate the modeling process, this study takes the example of 20 administrative districts in Paris, France as the research object. The French National Institute of Statistics and Economic Studies (INSEE), has collected data on these eight factors for the 20 districts of Paris in 2023. To simplify, this study uses variables 1-8 to represent the above ones in order.

After obtaining these data, this study applied the min-max normalization method to each variable. Take variable 1 as an example, it $u_{1,k}$ is used to represent the value of it in the Paris Ke arrondissement. Then normalize those variables and replace $u_{1,k}$ them with $v_{1,k}$.

$$v_{1,k} = \frac{u_{1,k} - \min(u_{1,1}, u_{1,2}, \ldots, u_{1,20})}{\max(u_{1,1}, u_{1,2}, \ldots, u_{1,20}) - \min(u_{1,1}, u_{1,2}, \ldots, u_{1,20})} \quad (1)$$

This study applies the same method to variable 2 to variable 8 and gets the normalized one.

2.2 Visualize Variables through ArcGIS

After pre-processing the variables, this paper placed the values of each variable in the [0,1] interval. To show the distribution of the variables across the twenty arrondissements, this paper uses ArcGIS maps to visualize the differences between regions.

For each variable, this paper uses ArcGIS and creates a visual map image according to a unified standard. Then it can get the single-factor heat maps, as shown in Figure 1. The darker the color, the better the region performs under that indicator.

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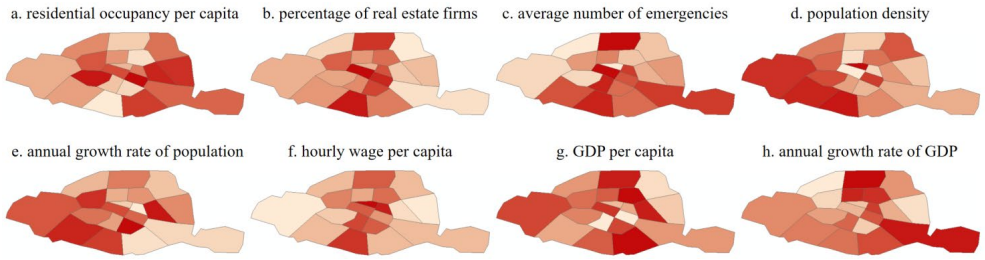

Figure 1: Single-factor Heat Maps

Considering all the factors, it needs to determine the correlation between those variables for better linear regression. As can be seen from the correlation matrix below, the complex correlation between eight variables is hard to disentangle, as shown in Figure 2. Thus, instead of using objective weighting methods such as entropy weighting, this study assumes that those eight factors have the same degree of influence on real estate strategy, which is a reasonable simplification.

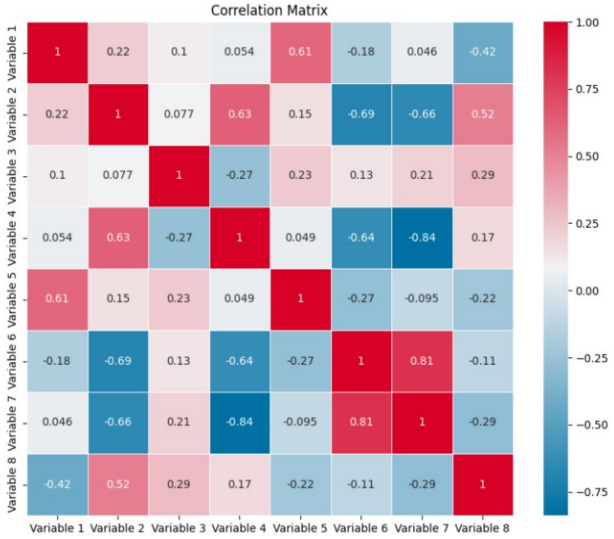

Figure 2: The Correlation Matrix

Now, it can directly superimpose the eight ArcGIS images to get the final one, which is shown in Figure 3. Communities and property developers should build on the regions that have the darkest color. From the final image, it is deduced that Paris, 10e Arrondissement & Paris, 16e Arrondissement are the most suitable sites to build on.

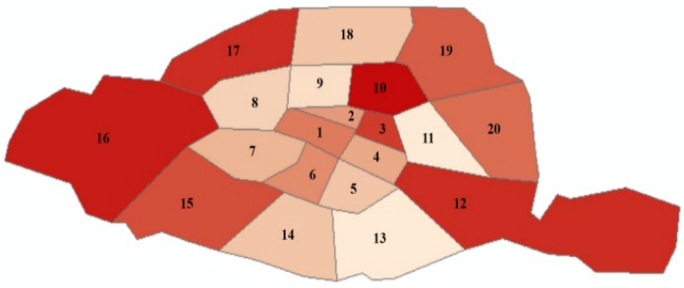

Figure 3: Multi-factor Heat Map

Taking Paris as an example, it shows how the site selection model can be used. The model is not only applicable to other parts of the world but can be refined according to the actual situation by changing the indicators and weights to better serve communities and property developers to make decisions.

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3. Assessing and Implementing the Cost and Value of Historic Landmark Preservation

3.1 Evaluate the Expense and Value of Preserving Landmarks

To determine each step of the approach to better preserve historic landmarks at a reasonable cost, it should consider both the expense and the value first.

This study divides the expense into four parts: premium inputs, projected costs of relocation, repair costs, and the damage caused by extreme weather events. After applying the min-max normalization to them, it can calculate the total expense before and after the relocation.

To quantify the value of the landmarks, this study considers their cultural, historical economic, and community value separately. Using CV, HV, EV, and CMV to represent each of them, this study obtains the following equation where the second one shows variables after relocation.

$$V = \alpha_1 CV + \alpha_2 HV + \alpha_3 EV + \alpha_4 CMV \tag{2}$$

$$V' = \alpha_1 CV' + \alpha_2 HV' + \alpha_3 EV' + \alpha_4 CMV' \tag{3}$$

For cultural value[3]: AC, the artistic and cultural characteristics measured by the length of existence. PC is the level of public affection measured by the number of visitors per year. EC, its educational value measured by the percentage of visitors who are minors.

$$CV = 0.375AC + 0.375HC + 0.25EC \tag{4}$$

For historical value[4]: AH, the Historical and periodical background measured by the time of establishment. SH, the state of conservation and original features measured by whether it has been rebuilt or repaired. TH, its historical importance, and its influence are measured by whether it is a witness to historical events.

$$HV = 0.433AH + 0.333SH + 0.234TH \tag{5}$$

For economic value: PL, the prosperity of its location. RI, the perimeter rental income. LC, its long-term value which can be measured by tourism revenue.

$$EV = 0.3PL + 0.3RI + 0.4LC \tag{6}$$

For community value[5]: IP, its importance to community. CC, its contribution to community cohesion and harmony.

$$CMV = 0.7IP + 0.3CC \tag{7}$$

Due to the correlation between the four variables, this study adopts the subjective assignment method. According to the researches conducted in Koumoutsea A[6] and David W. Look et al, this study takes the values of each of four weights as 0.33, 0.27, 0.27, and 0.13.

After all these preparations are done, this study can use the decision tree to develop the preservation model.

3.2 Decision Tree Used to Advance Preservation Strategy

When a landmark faces serious threats such as natural aging, human destruction, or environmental changes, it will involve consideration of whether to relocate. If the insurance company could pay for the risks faced by the building, the building would not move. If the insurance companies won't underwrite policies, the community ought to take the initiative. They can increase the premium or decrease the potential loss and detailed method.

If the premium investment is increased, it will not change the decision-making of the insurance company, the community leaders should decide whether the building ought to be relocated. To make the decision, this paper calculates the net pre-relocation value and the net post-relocation value of the landmark, which is equal to its value mines the expense. If the net post-relocation value is larger, then the community leaders can use the site selection model to find the best place for relocation. If not, it's suggested that preservation should be done locally.

So far, a complete preservation model has been successfully established.

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4. Insurance and Relocation Strategies for Candi Pawon Temple

The Candi Pawon, located in Magalan, Central Java, Indonesia, is an important part of the ancient history and culture of Central Java. However, the temple is now threatened by natural disaster challenges and other unavoidable contingencies. Thus, carrying out preservation measures is a sobering call to action.

Firstly, this study collected the number of occurrences of extreme-weather events per year over the last 15 years as well as the annual premiums. Based on the reports from some insurance companies, currently the insurance companies will not insure the temple. This study considers whether some measures can be taken to change their decision-making

Consider the implementation of greater preservation measures first, which will result in lower losses when disasters happen. Based on the data compared to other local temples, the current protection measures are relatively complete. In other words, just implementing better protection measures is not enough to get an insurance promise.

Now it turns to consider the premium side. Based on the current annual premium paid by temples, to achieve the goal of having insurance companies purchase insurance, the community leaders should raise premiums to 2.37 times the original amount, which is inconsistent with reality.

From the above analysis, it concludes that getting insurance for the temple is quite difficult. To preserve this treasured landmark, relocation might be another practical method[7-9].

4.1 Quantify the Value and Cost of Relocation

Theoretically, this study should use the site selection model to find the best place for relocation in the first step. But before that, there was a similar case in Indonesia: the Indonesian government relocated the Borobudur Temple in the early 1900s due to volcanic eruptions and earthquake threats. Since the two cases are quite similar, this paper chose to relocate the Candi Pawon to Mount Uban, where the Borobudur Temple is located.

This study calculates the pre-relocation values based on the annual provincial, municipal, and district data from the Indonesian National Institute of Statistics (INSTAT). For the post-relocation values, this study converted the data from the Borobudur Temple into equal proportions after the relocation of the Candi Pawon.

Here briefly shows the calculation below and omits the detailed process.

$$\begin{cases} CV = 0.375AC + 0.375PC + 0.25EC = 0 + 0.20625 + 0.0695 = 0.27575 \\ HV = 0.433AH + 0.333SH + 0.234TH = 0.10825 + 0 + 0.234 = 0.34225 \\ EV = 0.3PL + 0.3RI + 0.4LC = 0.099 + 0.228 + 0.168 = 0.495 \\ CMV = 0.7IP + 0.3CC = 0.7 + 0.3 = 1 \end{cases} \tag{8}$$

Through the above variables, the value before relocation can be calculated:

$$V = \alpha_1 CV + \alpha_2 HV + \alpha_3 EV + \alpha_4 CMV = 0.090997 + 0.092408 + 0.13365 + 0.13 = 0.447055 \tag{9}$$

Similarly, we can calculate the value after relocation:

$$V' = \alpha_1 CV' + \alpha_2 HV' + \alpha_3 EV' + \alpha_4 CMV' = 0.0875325 + 0.1823175 + 0.090425 + 0 = 0.360275 \tag{10}$$

Next, this study applies the min-max normalization to the premium inputs, repair costs, and the damage caused by extreme weather events to get the expense when relocation is not needed. Projected costs of relocation will be added when considering the pre-relocation expense.

After calculation, the two values are 0.9197 and 1.1295.

Therefore, it can calculate the net value by subtracting the cost from the total value. Since the net value before relocation is -0.4727 while it is -0.7692 after relocation, relocating the Candi Pawon is not the best choice. However, as circumstances may change in the future, the exact year in which the relocation should take place will not be discussed here.

Based on this judgment, this paper suggests that community leaders should work out more effective methods to preserve the landmark locally.

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5. Conclusions

This paper established a Sites Selection Model to help property developers select proper sites to build on. This paper first determined eight indicators and used the Min-Max Normalization to pre-process them. Taking Paris as an example, it used ArcGIS to form the single-factor heat maps and synthesized them after the correlation analysis. The best site to build on can be seen in the final multi-factor heat map.

Besides, this paper established a preservation model to help community leaders better preserve historic landmarks. For the value: it quantified its cultural, historical, economic, and community significance. For the expense: it considered its damage, repair, relocation cost, and premium. Based on the decision tree, the core value of the model is to compare the net profit before and after relocation.

Meanwhile, this study used the Insurance and Preservation Model to construct a plan for the Candi Pawon. It concluded that insurance companies won't underwrite policies there unless raising the premium to 2.37 times the original one. However, relocating the landmark is not a cost-effective choice proven by the comparison between pre-relocation net value and post-relocation net value.

This article provides research ideas and frameworks for the field of real estate site selection and cultural heritage building protection. Practical research has shown that these studies can be well applied to Paris, France, and Candi Pawon. Therefore, the model proves that it can effectively solve the relevant problems in the aforementioned fields.

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