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Study of IDV Historic Building Preservation and Decision Making Model Based on AHP Approach

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Abstract: *This paper mainly studies the impact of climate change on community construction and historic landmark protection, and uses IDV model to evaluate the conservation value of buildings. First, we developed an IDV conservation and decision model based on the AHP method, which establishes five specific indicators to evaluate buildings in terms of both ontological value and development value. Secondly, taking sea Guanyin in Sanya, China as an example, IDV protection decision model is used to analyze its protection value and confirm that it has significant protection value. Finally, from the perspective of short-term and long-term conservation, suggestions are made to the local community to ensure the long-term safety and sustainable development of the landmark.*

Keywords: *Building Conservation, AHP Method, IDV Model*

1. Introduction

Extreme weather events such as hurricanes, floods and typhoons are hitting with increasing frequency, posing unprecedented challenges to the protection of buildings. These natural disasters not only place tremendous economic pressure on property owners and insurance companies, but also threaten the survival and development of communities. As an important carrier and asset of human activities, the loss of buildings from extreme weather events not only affects individual interests, but also has a profound impact on the whole social and economic system. Therefore, the establishment of a scientific and effective protection mechanism to mitigate the devastating impact of extreme weather events has become a key issue that needs to be solved in today's society [1].

In this context, we have developed an AHP conservation and decision-making model [2-3] that aims to provide community leaders with scientific decision-making advice by assessing the intrinsic value and development potential of buildings. Using Sea Guanyin in Sanya, China as a pilot, we analyzed the underwriting risk of the building from an underwriter's perspective, evaluated its conservation value using the IDV conservation decision model, and ultimately came up with a comprehensive recommendation to find the best solution for the community and insurance company to balance risk management with economic development.

2. IDV protection and decision model

In order to build a model for developing effective conservation and development measures for use by community leaders, we build a conservation model based on the AHP model that consists of cultural and historical characteristics and economic and social benefits. We can construct a model based on the Analytic Hierarchy Process (AHP) [4]. This model integrates the dimensions of ontological value (chronological features, historical relevance, and visibility) and development value (economic and social benefits) based on the consideration of cultural-historical features and economic-social benefits to ensure that economic and social benefits can be promoted while preserving historical and cultural heritage.

2.1 Algorithm selection

In systems analysis of problems in the field of socio-economic and scientific management, people are often confronted with a complex and often quantitatively unavailable system consisting of a multitude of

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interconnected and mutually constraining factors. When we try to obtain the weight of mainly five aspects as the first-class index and the weight of several second-class index, subjective judgment is ill-considered. So, we choose the Analytic Hierarchy Process (AHP) as the way to conform the weighting coefficient of all the indicators in the evaluation system.

2.2 Model construction

1) Determine the judging matrix:

We use the pairwise comparison method and one-nine method to construct judging matrix.

$$A = \begin{bmatrix} 1 & 2 & 3 & 2 & 2 \\ \frac{1}{2} & 1 & 2 & 2 & 2 \\ \frac{1}{3} & \frac{1}{2} & 1 & 3 & 2 \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{3} & 1 & \frac{1}{3} \\ \frac{1}{2} & \frac{1}{2} & \frac{1}{2} & 3 & 1 \end{bmatrix} \tag{1}$$

$$a_{ik} * a_{kj} = a_{ij} \tag{2}$$

Where, a_{ij} is set according to the one-nine method.

2)Calculate the eigenvalues and eigenvectors:

The greatest eigenvalue of matrix A is λ_{max}, and the corresponding eigenvector is u = $(u_1, u_2, .., u_n)^T$. Then we normalize the u by the expression:

$$x_i = \frac{u_i}{\sum_{j=0}^{n} u_j} \tag{3}$$

3)Do the consistency check formula:

The indicator of consistency check formula:

$$CI = \frac{\lambda_{max} - n}{n-1} \tag{4}$$

Find the corresponding average stochastic consistency indicatorRI

The expression of consistency ratio:

$$CR = \frac{CI}{RI} \tag{5}$$

Where $RI = 1.1143$,when $n = 5$,the calculated 0.083<0.1, passed the consistency test.

4) Calculated weight

After the consistency test, we can find the weights, we selected the geometric mean method to find the weights, the calculation results are shown in Figure 1.

Figure 1: Weightage od indicators

We believe that for an area to be worthy of protection, it needs to be of medium value for ontological value and have a certain amount of development value in order to be protected. If the ontological value score is medium but the development value score is too low, or vice versa, protection measures are not recommended, as this may lead to a waste of resources.

We set the total score to 5, and we divided the composite score to 1.9 based on the data measurements, and only when this score is reached, the area has the value of being protected. Otherwise, the area has

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the value of being protected in extreme weather, both in terms of ontological value and development value, as shown in Figure 2.

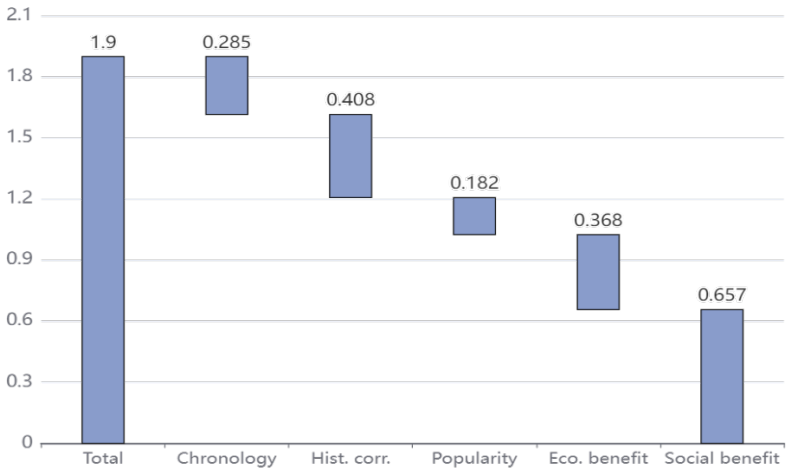

Figure 2: Minimum score distribution

2.3 Strategies and suggestions

If an area is assessed as not recommended for coverage in the risk model, but also has conservation value, community leaders need to weigh the importance of protecting cultural heritage against the risk of coverage. Below are some suggestions, as shown in Figure 3, to help community leaders make decisions in this situation:

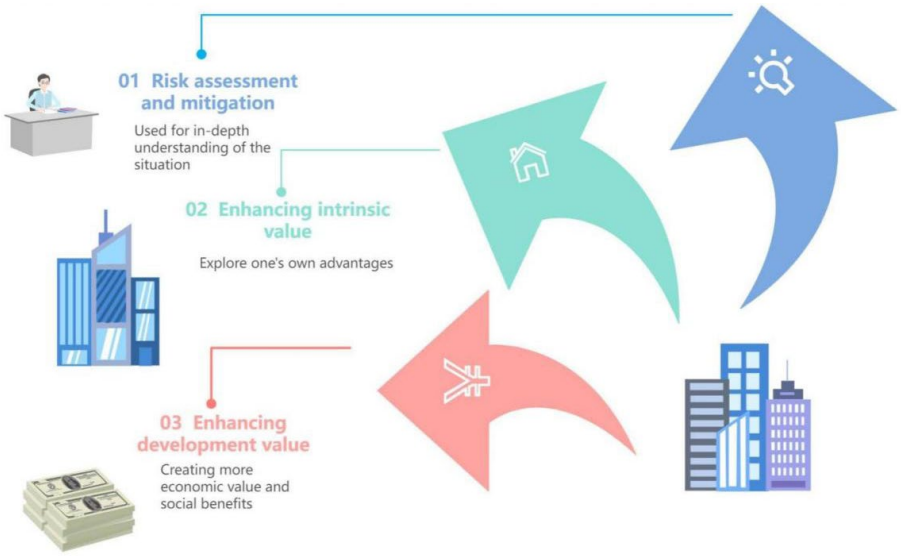

Figure 3: Solution strategy

1) Risk Assessment and Mitigation:

Conduct an in-depth risk assessment of the area to understand the specific impacts of extreme weather on cultural heritage and develop appropriate risk mitigation measures.

Consider establishing disaster prevention and emergency response plans to reduce potential losses

2) Enhance ontological value:

Strengthening the restoration and maintenance of historical buildings and cultural heritage to ensure that their historical and cultural values are properly protected.

Raise public awareness of and respect for the cultural heritage of the region through education and awareness-raising activities.

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3) Enhanced development value:

Explore sustainable tourism and economic development models that complement cultural heritage, such as cultural experience programs, handicraft production, etc.

Promote local economic development to enhance the overall well-being of the community by creating jobs and increasing the incomes of residents.

Through these measures, community leaders can work to increase the area's attractiveness for underwriting while preserving cultural heritage. This not only contributes to the long-term preservation of cultural heritage, but also brings economic and social benefits to the community, thereby reducing the risk to insurers to some extent and increasing the likelihood of obtaining coverage.

3. Model analysis: Sanya Nanhai Guanyin

In order to apply our model to a historical landmark that has experienced an extreme weather event, to be able to make a detailed assessment and to propose specific preservation measures, we chose the Sea Goddess of Mercy in Sanya, China, a historical landmark that connects the past with the present, witnesses the fusion of Chinese Buddhist art and architectural craftsmanship, and embodies the deep heritage of traditional Chinese culture and the legacy of traditional beliefs. It is a legacy of traditional beliefs.

3.1 Model solving

The Guanyin on the Sea is part of China's and the world's cultural heritage, and is of irreplaceable value to the study and understanding of Buddhist culture, art, and architectural development (Sanya, where the Guanyin on the Sea is located, is known for its four-seasonal climate, but has to face the challenges posed by extreme weather. In the summer, the area can be hit by typhoons, which are accompanied by violent storms and rough waves, posing a serious threat to coastal buildings [5]. In addition, persistent rainfall during the rainy season can lead to flooding, testing the drainage systems and structural stability of buildings. High temperatures should also not be ignored, as they may lead to thermal expansion of building materials, which can trigger structural deformation, cracks and even damage. The combined effect of these natural factors poses a serious challenge to the long-term protection and maintenance of the Guanyin on the Sea, a historical landmark.

For Guanyin on the Sea, the city of Sanya where this historical landmark is located, we applied the IDV model for value assessment, as shown in Figure 4.

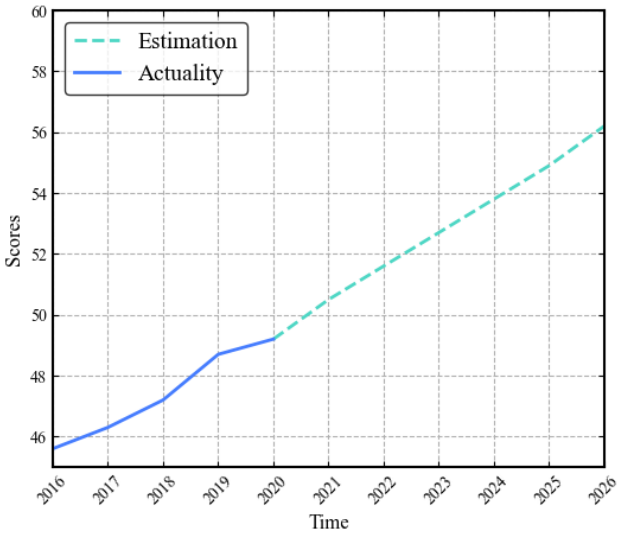

Figure 4: Sanya risk prediction

In terms of value assessment, we have rated the chronological features, historical relevance, popularity, economic benefits and social effects of the Guanyin of the Sea. Based on our literature survey and relevant economic data statistics, we rated the chronological features score as 1, the historical relevance score as 1, the visibility score as 4, the economic benefits score as 3, and the social benefits

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score as 4, with a composite score of 3.088, which is more than 1.9. In terms of ontological value, the landmark is significant in terms of its chronological features, which usually means that it represents the architectural style or cultural characteristics of a certain period of architectural style or cultural identity and has irreplaceable historic value. This value is the basis for its development potential, as it provides a unique resource for future cultural transmission and education; in terms of development value, it indicates that the Guanyin on the Sea, as a historical landmark, is not only culturally and socially important, but also shows potential for development economically

For the community, the Guanyin on the Sea is not only a historical heritage worth preserving, but also an important asset in driving local development. However, in the face of possible increased risks of extreme weather in the future, we need to put in place appropriate conservation measures to ensure the safety of this valuable heritage. This includes, but is not limited to, strengthening the resilience of the buildings, formulating plans to cope with extreme weather, and carrying out structural reinforcement where necessary. Through these measures, we can preserve the Guanyin on the Sea while realizing its sustainable development culturally, socially and economically.

3.2 Protection strategy

In terms of conservation value, the assessment of the IDV model indicates that Kwun Yum on the Sea has a high conservation value by virtue of its high visibility, economic value and social impact, reflecting the need for proactive conservation measures to ensure that this cultural heritage will continue to bring benefits to the community in the future.

The following recommendations are made in this regard:

In the short-term, it is advisable to seek support from the government and relevant organizations for policy concessions and financial subsidies aimed at reducing the financial burden of conservation projects. Additionally, it is recommended to collaborate with scientific research institutions to incorporate advanced conservation techniques and materials.

In the long-term, a Gantt chart schedule is provided, offering advice for the entire year as well as for each of the four seasons, as shown in Figure 5.

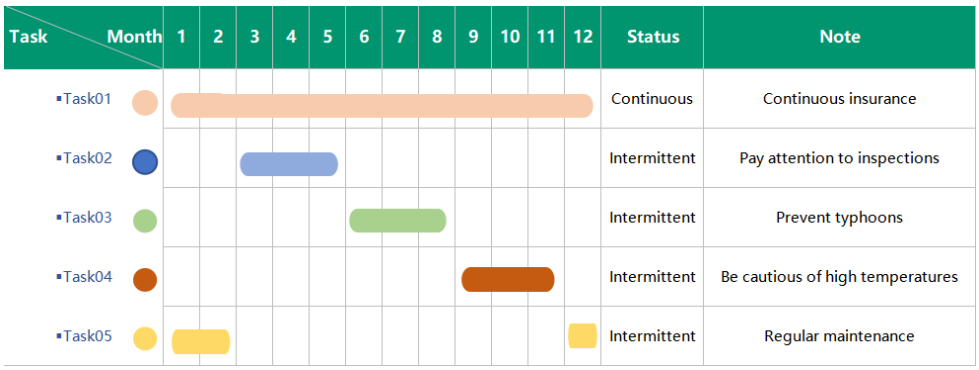

Figure 5: Gantt chart schedule

By adopting our proposal, insurance can cover the cost of repairs in case of damage, reducing direct financial loss while safeguarding the long-term maintenance and restoration of the building. Additionally, preventive maintenance plays a crucial role in preventing minor problems from escalating into major ones, thereby reducing the cost of significant repairs in the future.

By implementing these measures, we can ensure the safety of the historic Guanyin landmark while maximizing cost-effectiveness. This will enable us to achieve long-term conservation and sustainable development of the site.

4. Conclusions

This paper explores in depth the construction of a model for the preservation and decision-making of historic buildings under extreme weather conditions that integrates cultural and historical features as well as economic and social benefits to provide community leaders with effective conservation and development measures. First of all, in the algorithm selection, this paper determines the weight coefficient of each index based on the analytic Hierarchy process (AHP), and determines the weight by

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constructing the judgment matrix, calculating the eigenvalue and eigenvector, and carrying out consistency check. In the process of model construction, the construction method of judgment matrix, the calculation method of eigenvalue and eigenvector and the steps of consistency check are clarified, and the weights of each index are calculated at last. Secondly, according to the evaluation results of the model, specific protection strategies and suggestions are put forward, including risk assessment and mitigation, improvement of ontological value and improvement of development value. Finally, the model was applied to the historical landmark of Guanyin Sea in Sanya, China, and the challenges posed by extreme weather events faced by the region were analyzed. Through these measures, the paper argues that community leaders can promote economic and social benefits while protecting cultural heritage, thereby reducing the risks of insurance companies and increasing the possibility of obtaining coverage.

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