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Construction and Application of Coral Reef Resources Garden Engineering Based on Ecological Value Assessment

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ABSTRACT

This paper proposes a method for evaluating the ecological value of coral reef resources and garden engineering construction assets. By analyzing the state transition of coral reef ecosystems after multiple disturbances, it is shown that ecological resilience is crucial to maintaining the stability and sustainability of the system. Among the many factors that determine coral reef ecosystems, the loss of biodiversity will make the system more vulnerable to external disturbances and continue to degrade. On the basis of relevant research work at home and abroad, combined with China's coral reef ecosystem monitoring capabilities, a set of evaluation index systems for China's coral reef ecosystems are proposed to provide a reference for in-depth understanding of the resilience of China's coral reef ecosystems, and establish a system to protect and improve coral reefs. Ecosystem-oriented management will provide more options for addressing the degradation of coral reef resources.

KEYWORDS

Assessment, Coral Reef, Ecological Value, Landscape Engineering

1. INTRODUCTION

Coral reefs are a very unique type of ecosystem in the ocean and are known as the "tropical rainforest in the ocean" and the "oasis in the blue desert" due to their high primary productivity and biodiversity (Wang & Li, 2021). It not only provides abundant marine products, medicines, and construction and industrial raw materials to human society, but also has the ecological benefits of bank protection, environmental protection, and high aesthetic and scientific research value (Ai et al., 2022). It is an important life support system. Coral reef ecosystems are sensitive to changes in the external environment (Ju et al., 2022). In recent years, due to climate change and human activities, global coral reefs have experienced significant decline (Xu et al., 2022). Aubrecht et al., (2008) present a satellite-based approach to gather information about the threat to coral reefs worldwide. Continuing coral-reef degradation in the western Atlantic is resulting in loss of ecological and geologic functions of reefs. With the goal of assisting resource managers and stewards of reefs in setting and measuring progress toward realistic goals for coral-reef conservation and restoration, Kuffner et al., (2016) examine reef degradation in this region from a geological perspective. Hoegh-Guldberg et al., (2018) argue for a coordinated, global coral reef conservation strategy that is centered on 50

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large (500km) regions that are the least vulnerable to climate change and which are positioned to facilitate future coral reef regeneration. Bellwood et al., (2019) present a blueprint for future reef conservation that recognizes the need to better understand the processes that maintain Anthropocene reefs and the growing imperative to reform conservation efforts to address both specific local issues and larger-scale threats. Therefore, when using coral reef resources, it is necessary to carry out scientific assessment, formulate reasonable development strategies, strengthen management, and correctly handle the relationship between economic development and coral reef protection, so as to achieve the maximum benefit and sustainable utilization of resources (Guo & Wang, 2021). The evaluation of the value of natural resources is an inevitable trend of establishing and improving a socialist market economy and an inevitable requirement for building an ecological civilization and promoting economic development and transformation (Sowińska-Świerkosz et al., 2021). As one of the core concepts of ecological civilization construction, the evaluation of natural resources marks that the author's country's natural resource management is undergoing, and will continue to undergo, a major transformation, from focusing only on the physical form of natural resources to also attaching importance to the value form of natural resources (Hongyun et al., 2012). The rational allocation of resources turns to also focus on the rational disposal of natural resource assets (Tan & Yin, 2021).

The evaluation of the value of natural resource assets is of great significance for multiple reasons. First being, it helps to evaluate the total amount of natural resource assets in a country or a region, so as to judge the natural resources of a country or region (Ramadhan & Nuryanti, 2021). The increase or decrease in total resource assets serves as an important basis for assessing total natural capital (Abbas, 2022). Second, through the evolution and deepening of the natural resource balance sheet from a physical scale to a value scale, it is helpful to deduct the corresponding reduction in the value of natural resource assets from the economic accounting results and to achieve (statistical department) true "green accounting" (Martínez-Rendis et al., 2020). Third, it helps to promote the dynamic grasp of the changes of natural resource assets in development, utilization, protection, restoration, and other links. It helps to promote a timely grasp of the value changes of natural resource assets in the process of transfer between various uses and realize the preservation and appreciation of natural resource asset (Qian et al., 2019). Fourth, it assists in promoting (operating) natural resource assets to participate in rational operation in the form of sale, lease, shareholding, mortgage, guarantee, etc., to provide important support for economic growth, and to ensure the preservation and appreciation of natural resource assets in the process of operation (Song et al., 2022). Finally, it is the basis for scientifically and rationally confirming the taxes and fees of natural resource assets and promotes the rational distribution of income from natural resource assets (owned by the whole people or the state) (Zhang et al., 2022).

In the report of the 19th National Congress of the Communist Party of China, General Secretary Xi Jinping clearly put forward the focus of future work to "accelerate the reform of the ecological civilization system and build a beautiful China" (Liu et al., 2022). It specified work requirements such as, "increasing the protection of ecosystems," "improving the quality and stability of ecosystems," and "improving the ecological environment management system" (Moarrab et al., 2021). It also points out a new direction for the study of coral reef ecological protection (Lei & Jain, 2022). At present, there are relatively mature studies on the value of ecosystem services abroad, which are used in the current research and future planning of coral reef ecosystems, and relevant planning and standards have been formulated according to these (Beceiro et al., 2022). This paper aims to provide reference standards for the evaluation and protection of coral reef ecosystem services by exploring and studying the status quo of coral reef and the key points of protection.

2. MATERIALS AND METHODS

2.1 Characteristics and Status of Coral Reef Resources

Coral reefs are considered to be the most biologically diverse system in the marine ecosystem (Do et al., 2022). They are formed by the accumulation of coral skeletons that grow in situ and develop in shallow waters with high wave energy(Yuguda et al., 2022). Among the more than 200,000 species of marine life in the world, nearly 10,000 species are distributed in coral reef waters (Reguero et al., 2018). The colorful coral reefs are not only tourist resources for diving, but also have hard calcareous skeletons, which are not easily broken and flattened by wind and waves and can block the erosion of sea waves and water, decompose harmful substances in seawater, and purify the environment (Golomb et al., 2020). Coral reefs are estimated to generate approximately US $400 billion in annual fisheries and tourism benefits for humans (Golomb et al., 2020).

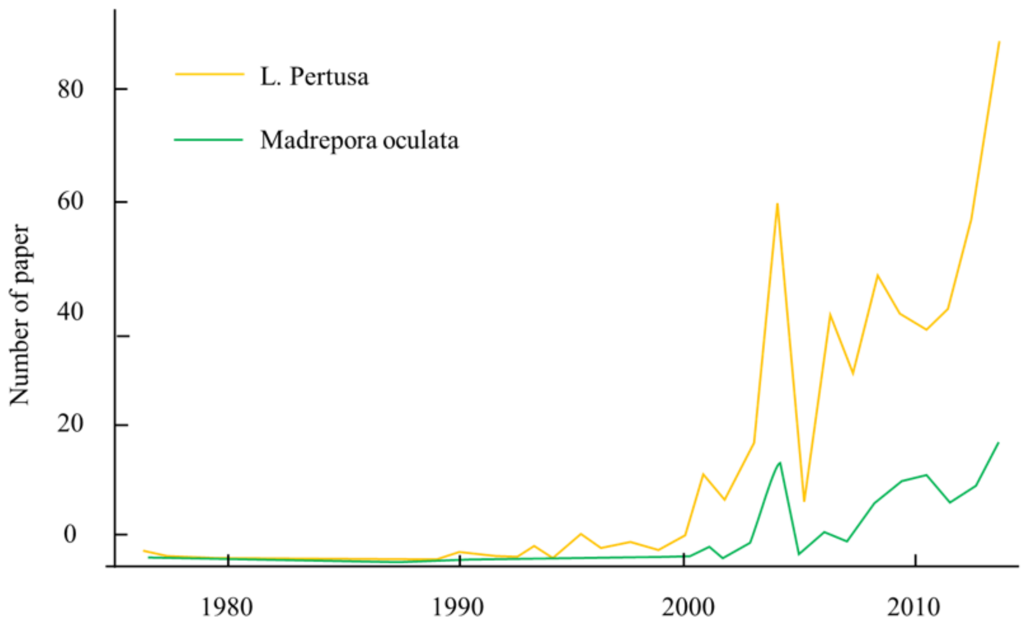
The formation of coral reefs is mainly affected by temperature, salinity, water depth, currents, wind waves and turbidity (Storlazzi & Jaffe, 2008). The optimal seawater temperature is 23-27°C, not lower than 18°C and higher than 35°C; the optimal salinity is 34-36, not lower than 27; the water depth range of 10-20m is the most ideal environment for coral life. The depth of the water should not exceed 60m, and the water should be clear, oligotrophic, and the sun should be sufficient (Waltham & Sheaves, 2015). The substrate requirements for coral fixation are rocky reefs, and loose sandy and soft muddy substrates are not suitable for corals to grow. In modern oceans, coral reefs are only distributed between 32° latitude north and 32° south latitude (Grabowski & Peterson, 2007). In recent years, due to the rising ocean temperature caused by the El Niño phenomenon, a large number of corals have died around the world. For example, 90% of the corals in the Maldives and Seychelles in the Indian Ocean have died due to rising sea temperatures.

According to textual research, the Xuwen coral reef group was first formed 10,000 years ago, with horn coral (a branch or horn-shaped coral) and pontocoral (a spherical coral) as the dominant species. In recent decades, due to its vigorous growth, it has formed a colorful and magnificent scene, including staghorn-shaped, bull-horn-shaped, and dendritic branch coral, and head-shaped, honeycomb-shaped, brain-lamellar, ancient armor-shaped spherical, massive coral. The colors include white, shades of yellow, orange, etc., and rarely, the occasional red and blue. Different shapes, different colors, and different coral reefs are combined together, which are uneven and spectacular. Coupled with the colorful tropical fish passing freely, it constitutes a beautiful tropical seabed scenery line, and the tourism development value is very high. Coral reef resources in many parts of the world have seriously declined, and some coral reef areas in the country of study have also experienced damage and decline. For example, the coral reefs on Weizhou Island in Guangxi, if no effective measures are taken, within 15 years, will be completely destroyed. The main reasons for the decline of coral reefs are: Urban encroachment, such as port construction, reclamation, etc.; Industrial, agricultural and domestic sewage pollution, which hinder the feeding, growth and reproduction of coral polyps, and cause poisoning to corals, fish and invertebrates; Destruction Collection, for example, some people collect coral sand and burnt lime as building materials, and some units and individuals collect coral reefs for handicrafts. Every piece of coral reef the size of a palm will cause the death of several square meters of living coral; moreover, the coral grows only about 1cm per year on average. Its productivity is only 1kg/m^2 per year. Coral reefs have been impacted by overfishing, causing important species to maintain the balance of the reef; excessive loss; beaching of ships, destroying and scraping corals; continental freshwater scouring, which dilutes seawater salinity on the one hand and brings in sediment, suffocating dying corals; infection of corals and their symbiotic organisms (e.g. sea urchins) by sexually transmitted diseases. Figure 1 shows the number of research papers on coral reef resources.

2.2 Overview of Coral Reef Protection in China

In the first stage, the research focused on the biodiversity and sustainable development of the ecosystem. During this period, marine science, geography, and biology from the perspective of coral reef research set off a research boom, and breakthroughs were made in the ecological value of coral reefs, the biological symbiosis of coral reef systems, the causes of coral reef bleaching, and the ecological restoration of coral reefs. The second phase focuses on the construction and management of nature reserves. The Sanya Coral Reef Nature Reserve in Hainan, covering an area of about 8,500 hectares, was officially established in 1989 and became a national marine nature reserve in

Figure 1. Number of research papers on coral reef resources



1990. The Dongshan Coral Reef Provincial Nature Reserve in Hainan was approved in 1997, and later it was included in the South China Sea Marine Biodiversity Conservation and Management Demonstration Zone and became a key project funded by the Global Environment Facility under the United Nations Programme and Development. In the third stage, developing ecotourism under the premise of protecting coral reefs has become a new research hotspot. This paper focuses on the study of coral reef ecotourism in Hainan and analyzes the status quo of ecotourism development, ecotourism models, and the effectiveness of ecotourism development.

At present, the study of biodiversity has gradually expanded to the macro and micro levels, and ecosystem diversity and genetic diversity have become the focus of competing research. Genetic diversity is the most important source of species-level diversity. Genetic diversity determines (or influences) the way in which a species interacts with its environment, within and between species. Coral reef areas are huge gene pools, with a wide variety of organisms with different genotypes. The study of the genetic diversity of various species is important for clarifying the intrinsic adaptability of coral reef organisms and understanding the evolutionary dynamics and degree of variation.

Coral reef ecosystems are of great significance to the generation and change of biodiversity. It not only includes huge economic value, but also has immeasurable ecological value. Coral reef ecosystems participate in the global carbon and nutrient cycles, protect coastlines, and provide for marine life, subsistence homes, and other ecological values.

2.3 Ecological Value Assessment Methods

The choice of evaluation method is a key to the evaluation of ecosystem value. Abbas (2022) divided the evaluation methods of ecosystem value into four categories: material quality evaluation method, value evaluation method, emergy analysis method, and ecological model method. Ai et al. (2022) divided the evaluation methods into four categories. There are two categories of evaluation methods based on market theory and two evaluation methods based on ecological models. Aubrecht et al. (2008)

separately evaluates the value of forest products. The evaluation methods of individual indicators, such as the evaluation method of water conservation value, the evaluation method of soil conservation value, and so on, are discussed. Zhao Hailan compares the advantages and disadvantages of 10 specific methods included in the value evaluation method based on the chart. Li Li et al. divides the methods into two categories: direct evaluation method and indirect evaluation method based on market theory, in which the direct method includes objective evaluation method and subjective evaluation method, and the indirect method includes material conversion method and energy value conversion method.; Ouyang Zhiyun et al. summarized the evaluation methods of ecosystem services in China and divided the evaluation methods into ecosystem service value evaluation methods (including direct market method, alternative market method, and simulated market method) and technical methods for ecosystem service assessment (including parameter method, comprehensive model method, and quantitative index method).

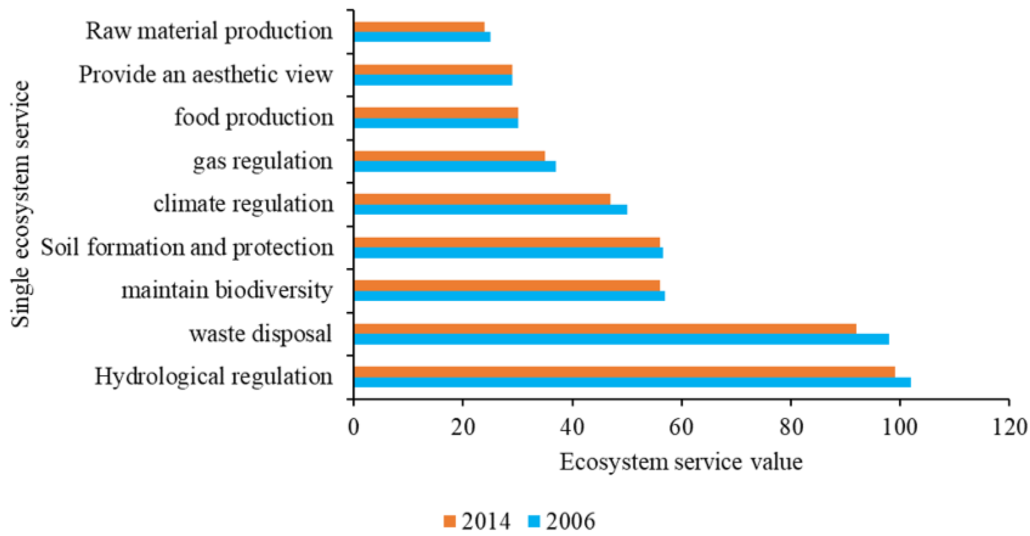
Twenty-five percent of the evaluations use the parametric method, which is usually used with reference to the research results of Costanza or Chinese scholar Xie Gaodi, combined with the actual improvement results in the country of study. For example, Li Zhe et al. studied the changes of ecosystem service value in Lake Aibi Wetland Nature Reserve from 1998 to 2014 with reference to Costanza's research results. Li et al. corrected and calculated changes in the value of ecosystem services in protected areas from 1980 to 2005. Two percent of the assessments use the model method, which is mainly used to study the dynamic changes of the ecological value of protected areas. However, due to the difficulty in obtaining the required parameters, it is not widely used in the ecological assessment of protected areas. Liu Shuang used the In-VEST model to evaluate the ecosystem service function of Dagu River Nature Reserve at three time points in 1996, 2005 and 2017. Fan Yuanxin used the InVEST model to calculate the four ecological function values of carbon sequestration, water conservation, soil conservation, and biodiversity protection in the Kanas Nature Reserve. In addition to these three methods, some protected area assessments use the emergy analysis method. Sun Fan et al. used the emergy analysis method to calculate the total value of the protected area and each individual value in the study of Xuebaoshan ecosystem value. Chen Huadan et al. used the emergy analysis method to calculate the ecosystem service function value of the Tianbaoyan Nature Reserve in Fujian. On the whole, in the selection of value evaluation methods, the three methods are usually used comprehensively, and in the selection of evaluation technology methods, the quantitative index method is usually the main method. Figure 2 shows the comparison of ecosystem service value and individual ecosystem services in 2006 and 2014.

2.4 The Operation Mechanism of the Construction Quality Control of Landscape Engineering

In each stage of the construction process, it is necessary to maintain the overall concept and overall awareness, starting from the overall quality goal, focusing on the establishment of the quality control system, focusing on the production and operation of the enterprise, and maintaining the good operation of the PDCA cycle in the construction quality control to ensure that both the construction effect and the economic output are maximized at the same time. There are generally multiple construction parties such as water, electricity and heating pipe networks, fire protection, and building main bodies on the site of the coral reef landscape project, which are prone to safety liability accidents. Taking into account the complexity and particularity of the project construction, after the formal signing of each construction contract, an in-depth analysis of each construction design drawing, the requirements of each contract and the quality indicators of each sub-item should be carried out in a timely manner, ensuring the unified deployment of construction plans.

The setting of construction quality plans and quality objectives mainly relies on previous homogeneous construction project experience, contract standards, and inferences on actual quality levels. The main key is:

Figure 2. Comparison of ecosystem service value and individual ecosystem services in 2006 and 2014



① Scientific quality objectives have important guiding significance for the construction direction;
② Quality planning is the step-by-step procedure, the clear goal, the decomposition and refinement of the goal, and the overall reduction of quality deviation.

2.4.1 The Overall Quality Plan of the Construction Project and the Overall Quality Target Setting Procedure

1. Based on a comprehensive analysis of the construction contract, the surrounding environment and construction characteristics, the pros and cons of the construction are pre-estimated.
2. Based on the accumulated experience in the past, a reasonable target plan for the construction of this project is formulated.
3. Estimate the effect of construction quality in an idealized state in advance.
4. Research and implement specific improvement measures to ensure that the predetermined quality target expectations are achieved.
5. Select a program. The above program is shown as:

This procedure is only a single action in an ideal state, and is a simple PDCA cycle. If the final quality target is selected, it is generally necessary to alternately go back and forth in this process, repeatedly demonstrating, revising and perfecting, in order to formulate the final quality target.

2.4.2 Decomposition of Quality Objectives

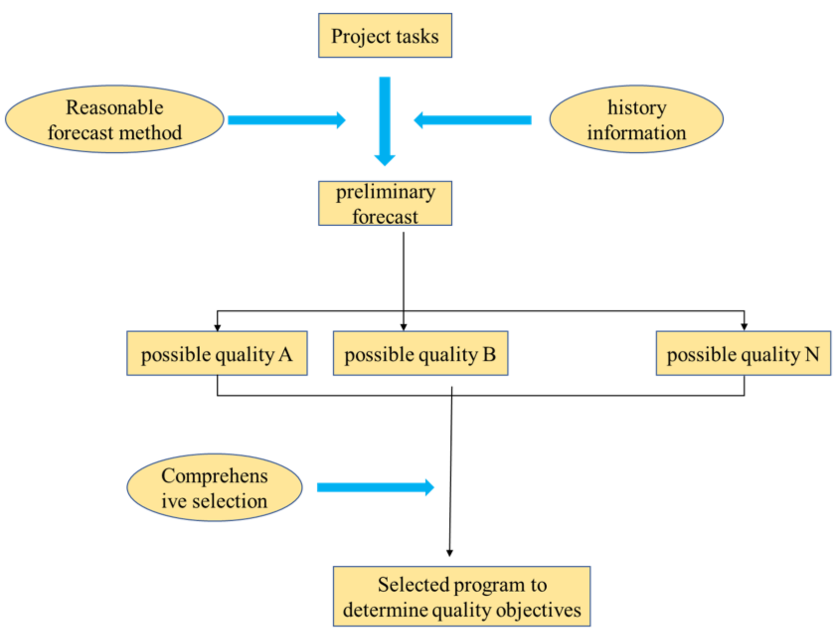
It is to decompose the entire quality target, from the overall common target to the target of each sub-project, and finally to the target of each process, from the overall target of the enterprise to the division of each post. Goals are gradually decomposed from the overall goals of the entire construction period to the monthly total goals and then to the weekly total goals. Decomposing goals can better clarify key nodes and phase goals of the project. Therefore, it is necessary for each construction personnel to have clear responsibilities and tasks and contribute to promoting the project to the best level. After effectively decomposing the contract content and target plan, clarifying the target positioning and construction difficulties, the implementation plans of each project, etc., can accurately, carefully, and specifically describe the tasks and responsibilities of each job position, and carefully formulate specific construction measures and emergency plans. At the same time, in accordance with the PDCA cycle operation mode, proactive prevention in advance, flexible construction during the event, and thorough inspection after the event, keep the whole process continuous, controllable, and orderly, and achieve the predetermined goal with quality and quantity as planned, as shown in Figure 3.

2.5 Collection of Fuzzy Group Evaluation Values

There are two ways to aggregate individual evaluations into group consciousness, which can be simply described as ”integration first and then evaluation” or “evaluation first and then synthesis” (Beceiro et al., 2022). The former is to synthesize the fuzzy evaluations made by different evaluators on the scheme, and then make a unified evaluation based on the comprehensive information. In short, it is to transform the multi-node fuzzy group evaluation problem into a fuzzy multi-attribute evaluation problem of feature consistency and arbitrariness. The evaluators first evaluate according to their own judgments, and then combine the evaluations of different evaluators to form the final judgment result. The center of this assembly approach is to decompose the coral reef works into several fuzzy multi-attribute problems, which are suitable for evaluating each node scheme in the coral reef protection stage, and then reserve the node with the highest score of beauty, and finally integrate it to maximize the overall beauty. This method is suitable for the partial retention process of each scheme in the scheme evaluation process.

As long as the invitees evaluate the coral reef plan, regardless of their professional background, they are allowed to have their own aesthetic preferences, and experts are also allowed to use their intuition to make judgments. That is to say, this method can avoid the cognitive difference between “industry experts” and “non-industry experts” caused by other methods. After all, the users of the coral reef are many types of people, and it is not limited to a specific group of people to visit.

Figure 3. The procedure for setting the overall quality target and overall quality plan of the construction project



Based on the existing literature, such as the "operator ensemble intuitionistic fuzzy" formula proposed by Xu and Yager, that is, let:

$$\alpha_j = \left(\mu_{\alpha_j}, v_{\alpha_j}\right)\left(j = 1,2,\ldots,n\right) \tag{1}$$

Fuzzy judgment value for a series of preferences.

$$\omega = \left(\omega_1, \omega_2, \ldots, \omega_n\right)^T \tag{2}$$

is the corresponding weight vector, and satisfies ωj∈[0,1] and

$$\sum_{j=1}^{n} \omega_j = 1 \tag{3}$$

Then, there is an aesthetic preference fuzzy weighted arithmetic average operator as the mapping IFWA: Θn →Θ, and satisfy:

$$IFWA(\alpha_1, \alpha_2, \ldots, \alpha_n) = \sum_{j=1}^{n} \left(\omega_j \alpha_j\right) \tag{4}$$

In particular, when:

$$\omega = \left(1 / n, 1 / n, \ldots, 1 / n\right)^T \tag{5}$$

When the IFWA operator degenerates into the aesthetic preference fuzzy arithmetic average operator (IFA), and the two are commutative.

Step analysis:

Step 1 On the set of alternatives

$$D = \left\{D_1, D_2, \cdots, D_m\right\} \tag{6}$$

expert group conducting the evaluation

$$C = \left\{C_1, C_2, \cdots, C_s\right\} \tag{7}$$

The assigned weight is λ, λh > 0, and

$$\sum_{h=1}^{s} \lambda_h = 1 \tag{8}$$

After reviewing the scheme, expert Ch gives the fuzzy evaluation value of aesthetic preference r (h) ik (i, k = 1, 2, ···, m), thus obtaining the fuzzy relation of aesthetic preference.

$$R^{(h)} = (r_{ik}^{(h)})_{m\times m} \tag{9}$$

The second step is to evaluate each aesthetic preference fuzzy scheme, according to the model of formula (1); the third step is to use MATLAB or LINGO software to solve these fractional models, and obtain the aesthetic preference fuzzy priority vector of each aesthetic preference fuzzy relationship.

$$\tilde{\omega}^{(h)} = \left(\tilde{\omega}_1^{(h)},\tilde{\omega}_2^{(h)},\ldots,\tilde{\omega}_m^{(h)}\right)^T \tag{10}$$

The fourth step uses the IFWA operator given by the above equations (1) to (4) to integrate the fuzzy priority weight vector of each expert's aesthetic preference into the overall aesthetic preference fuzzy priority weight vector.

Step 5, according to the sorting formula,

$$L\left(\alpha\right) = (1-\nu_\alpha) / \left(1+\mu_\alpha\right) \tag{11}$$

In formula (11): L(α) represents the similarity function, and the aesthetic preference fuzzy number α=(μα, να). Equation (4) is a total order scheme for comparing any two aesthetic preference fuzzy numbers αi = (μαi, ναi) and αj = (μαj, ναj).

if

$$L\left(\alpha_i\right) < L\left(\alpha_j\right) \tag{12}$$

Then, αi < αj

if

$$L\left(\alpha_i\right) = L\left(\alpha_j\right) \tag{13}$$

Then it may be αi < αj, or αi = αj.

In particular, when the aesthetic preference for fuzzy numbers

$$\alpha = \left(\mu_\alpha, v_\alpha\right) = \tilde{\omega}_m \tag{14}$$

m (m is the number of solutions), then

$$L\left(\alpha\right) = L\left(\tilde{\omega}_m\right) \tag{15}$$

It's the beauty value. Calculate the similarity value of the fuzzy priority weight of the overall aesthetic preference, that is to say, if the similarity values of each scheme are equal, then calculate the accuracy, and obtain the ranking of multiple coral reef protection alternatives. At the same time, calculate the value of each coral reef scheme. Once the beauty evaluation value is calculated, the process is complete.

3. RESULTS AND DISCUSSION

3.1 Experimental Data and Environment

Due to space limitations, this paper uses a simple example to illustrate. It is known that 4 units ($m = 4$) were shortlisted after the bidding of a coral reef project in a certain city and the submitting of the coral reef protection scheme. Within the specified time period, 1,561 valid evaluation questionnaires were recovered, and the contracting party confirmed and had no objection. The set of four sets of coral reef protection schemes can be expressed as $D = \{D1, D2, D3, D4\}$. In order to sort the above four sets of schemes, due to space limitations, only three people ($s = 3$) are selected as the evaluation experts expressed in this paper, which can be expressed as Ch ($h = 1, 2, 3$). The value of the weight vector λ is $\lambda = (0.3, 0.4, 0.3)$ T. The expert evaluation group formed to compare the options to be selected, and used the preference fuzzy number to give their preference value to judge the beauty of each plan.

3.2 Experimental Results and Analysis

The above is a description of the evaluation methods of fuzzy multi-element groups with different preferences. If there is no horizontal comparison with other methods, it may be unobjective. Therefore, this study uses a variety of methods (SBE method and BIB-LCJ method) to evaluate the same coral reef works. The same nodes are evaluated for the beauty degree to give points. There is landscape (beauty) transitivity in aesthetics, that is, several evaluation methods are allowed to be compared. If the data obtained by this method is consistent with the trend of the data obtained by the recognized method, this method can be considered reasonable. For the 30 nodes in a certain coral reef work that has been built, three methods are used to evaluate the beauty degree. The results are shown in Figure 4. The node evaluation of this method and the other two methods are more consistent. It can be seen that the evaluation of fuzzy multi-factor groups with different preferences is feasible.

Preliminary statistics on the occurrence of project costs under different project numbers and the calculation and comparison of the total project cost and the project per capita cost (total project cost ÷ number of people), found that the total project cost and the average project cost per capita both increased with the number of project participants. The increase is on the rise (shown in Figure 5). From this, it can be inferred that there is still an excess of project staffing in planning and design projects. Controlling the number of project participants can be used as an entry point for cost control.

Figure 4. Scores for evaluating the same node using multiple methods

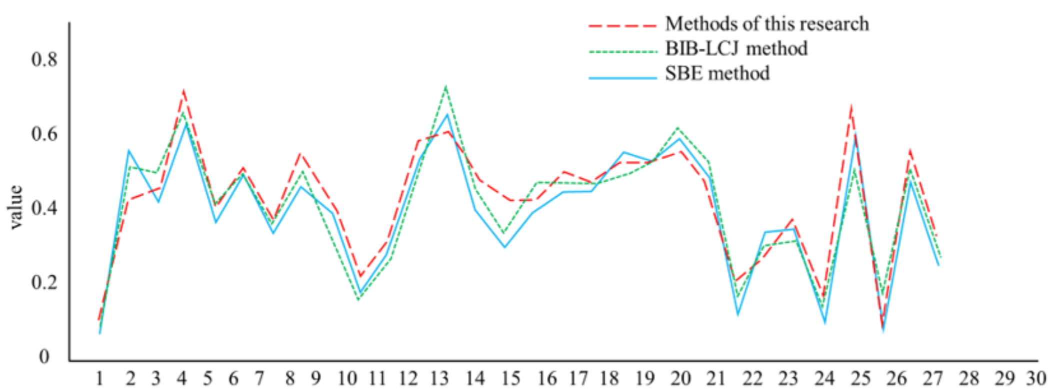
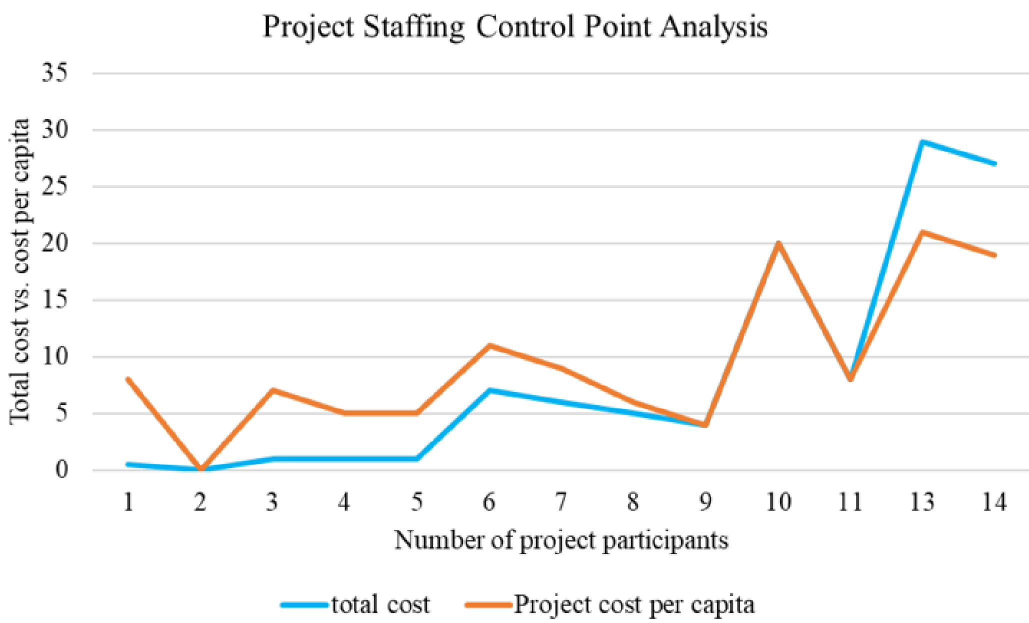


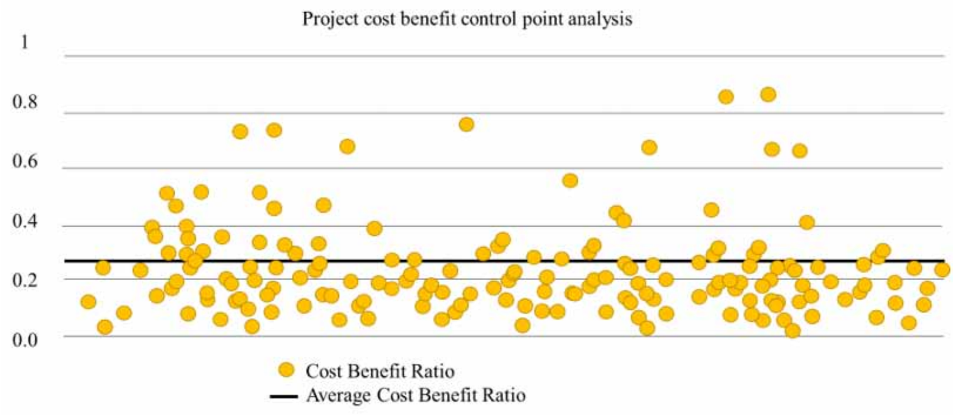
Figure 5. Analysis line chart of construction period control points of coral reef engineering construction projects



The evaluation standard of this control point is the project human resources cost control index. The larger the index, the greater the possibility of unreasonable expenditures caused by the unreasonable allocation of human resources in the project. The index of 0 means that the number of project personnel and the per capita cost of the project are both at a low level. It is unlikely that the project needs to implement cost control at this control point. An index of 1 indicates that the project has a large number of people, and the per capita cost of the project is relatively large and general project cost control is implemented. An index of 2 indicates that the project has a large number of participants and a large per capita cost and needs to focus on project cost control. The ultimate goal of this control point is to implement cost control by predicting the unreasonable expenditure projects caused by unreasonable allocation of human resources.

According to the cost-benefit analysis of the planning and design project cost and project output value of Research Institute A, the project cost-benefit ratio is calculated, and the scatter diagram shown in Figure 6 is drawn. It can be seen that the project cost-benefit concentration is below the horizontal value of 26.2%. At a low level, it can be seen that most of the cost-effectiveness levels are good, but there are still a few projects with cost-effectiveness exceeding 50%, and the cost-to-output value is relatively high, resulting in low efficiency, and even some cases where the cost-effectiveness ratio exceeds 100%. Therefore, linking the cost with the project output value, analyzing the cost-benefit ratio, and strengthening the project cost control for projects with lower benefits can help improve the cost-effectiveness of the project. It also changed the traditional cost control only for the project cost amount, ignoring the balance between cost and benefit. The control point divides the cost-benefit ratio of the project into three levels: first, if the cost-benefit ratio of the project is below 30%, it means that the cost-benefit ratio of the project is relatively good, and there is no need to pay too much attention; second, the cost-benefit ratio of the project is 30% ~ 50%, the cost-effectiveness of the project is relatively low, and general project cost control is implemented; third, if the cost-benefit ratio of the project exceeds 50%, it indicates that the cost-benefit status of the project is poor, and it is necessary to focus on the project cost control.

Figure 6. Analysis line chart of construction period control points of coral reef engineering construction projects



4. CONCLUSION

Coral reefs are valuable marine resources, providing various ecological products to human society continuously. However, coral reefs are undergoing severe degradation due to both changes in the natural environment and increased human activities. Using the marine ecological footprint to measure the utilization of coral reef resources by humans is an important method to evaluate the ecological impact of human activities on coral reefs. This study seeks to find ways to improve related work and promote the smooth progress of the author's country's urban greening work. In the past, people decided to let a coral reef protection win at the bidding review meeting. The expert scoring system, using technical and commercial standards, was relatively rough, and it was not possible to scientifically quantify ambiguity. Additionally, it could not fully evaluate and balance the weight of strong evaluators. The failure of the completed coral reef works may have been formed in the design stage, and effective screening is more critical. The fuzzy multi-factor group evaluation algorithm of different preferences can be applied to the fuzzy evaluation of coral reef beauty. Although the intuition and subjectivity of a single person is strong, when the intuition and fuzzy language of multiple people are assembled, accidental quantitative changes can be formed. Qualitative change, is the hoped for result. This method also involves the influence of the evaluator's weight and the consistency of the data results after the evaluation on the final goal.

DATA AVAILABILITY

The figures used to support the findings of this study are included in the article.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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