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Maintainability and Evaluation of Construction Projects

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Abstract: The concept of sustainable development guides people to think about things, thereby achieving the goal of protecting the environment and maintaining ecological balance. Therefore, sustainable development needs to be reflected in the process of construction projects. The rapid expansion of construction projects poses increasingly severe challenges to the sustainable development of engineering projects. Research on sustainable methods for construction projects is conducive to promoting the healthy development of projects. This article mainly used the survey method and analytic hierarchy process to analyze the data related to the sustainable strategy of the project. The survey data showed that the weighted value of ROI (return on investment) in the sustainable development of the project reached 0.3, and the weighted value of community participation and ecological environment maintenance reached 0.25. Community residents should be encouraged to participate in the project decision-making process and establish transparent communication channels to avoid social conflicts and negative impacts.

1. Introduction

The process of urbanization is accelerating, and the number of construction projects is gradually increasing. Comprehensive planning of the project is required before implementation. It is necessary to build an effective sustainable development evaluation system to maximize the overall benefits of the project, and ensure and improve the healthy and stable operation of the construction industry and the real estate market. The sustainability of a construction project refers to fully considering environmental, social, economic, and other factors during the construction process to achieve the goal of long-term sustainable development.

The sustainability of construction projects is a complex issue involving multiple disciplines, including environmental, economic, and social aspects. The following are some relevant research contents that study the sustainability of construction projects from different perspectives. For example, some scholars have focused on the interaction between buildings and the environment and the sustainable development of buildings, and have studied green building technology, energy conservation and emission reduction, and building recycling [1-2]. Some scholars have also studied the sustainable development of construction projects from three aspects: “engineering management, engineering technology, and environmental engineering”, and conducted research on the cost of construction projects [3-4]. In addition, some scholars have studied building quantitative risk assessment and building safety management [5-6]. The research on the sustainability of

construction projects is a comprehensive issue involving multiple disciplines and fields, requiring cross cooperation between different experts and scholars to jointly promote the sustainable development of construction projects and protect the environment.

This article determined the weight values of various indicators by constructing an indicator system and influencing factor model, establishing a fuzzy comprehensive evaluation method, and expert scoring tables. Thirdly, according to the hierarchical analysis and principal component clustering, the scores of each individual evaluation factor and the membership function of their corresponding evaluation results were obtained, and the consistency test was conducted. Finally, the overall index of the construction project was obtained.

2. Maintainability and Evaluation of Construction Projects

2.1 Construction Project

Construction projects refer to all types of engineering projects, including real estate development, infrastructure construction, public utility construction, etc. A construction project typically involves multiple stages, including preparation, project approval, design preparation, bidding, construction execution, acceptance, and delivery. During project construction, various factors must be fully considered, such as technical feasibility, economic feasibility, guidelines, regulations, and environmental requirements, to ensure that the project achieves its expected objectives [7]. Construction projects typically include the following main components: preparatory work, market research, engineering project feasibility studies, environmental impact studies, and technical studies. Project application: A project team based on the preliminary work results is established to approve the construction project budget [8]. Design preparation: The basic design and construction drawings of the project are prepared according to the project approval. Bidding: According to the design scheme, component and material suppliers are invited to bid. Construction execution: The execution of civil engineering includes material procurement, site management, project safety, quality monitoring, etc. Acceptance and delivery: After completion of the project, acceptance must be carried out, and the project quality must be confirmed according to relevant standards, before being delivered for use [9]. The successful implementation of a construction project requires effective management and implementation plans, including resource allocation, schedule control, and cost control, to ensure that the project achieves its expected objectives as planned. Therefore, construction projects require various support tools to support decision-making, planning, and execution, such as construction project management software, asset management software, and project collaboration platforms.

Limiting the sustainable development of construction projects mainly involves the resource scarcity, and a large number of construction projects must consume significant natural resources, such as land, energy, and water. In the context of limited resources, sustainable development requires optimal utilization of resources, reduction of resource consumption, and promotion of resource protection and recycling [10]. Pollution: A large amount of waste and exhaust emissions are generated during construction, resulting in pollution. Sustainable development requires measures to reduce pollution and raise environmental awareness, such as the use of environmentally friendly materials and energy-saving technologies. Social factors: Construction projects may have negative impacts on the environment and community residents, such as noise pollution, safety risks, etc. Achieving sustainable development requires strengthening communication with communities, promoting social consensus and responsibility, and better managing social risks [11]. Economic pressure requires significant investment in construction projects, and profitability is the main criterion for assessing project success. In order to achieve sustainable development, social and environmental development needs must be considered on the basis of balancing economic benefits.

Technical restrictions: When implementing construction projects, there may be restrictions on the research and development of technologies and materials, such as the research and development of new technologies, the application of high-tech materials, etc. [12]. In order to achieve sustainable development, it is necessary to promote the application of innovative technology and technological innovation, improve resource utilization efficiency through scientific and technological means, and improve the sustainability of construction projects. Therefore, in order to address these constraints, it is necessary to thoroughly review the implementation of construction projects, and take measures such as policy guidance, technological innovation, and management model innovation to achieve sustainable development of construction projects [13].

2.2 Retainability

Sustainability evaluation of construction projects refers to the assessment of the economic, social and environmental impacts of a construction project to ensure that the project complies with the principles of sustainable development and minimises negative impacts on the ecological environment [14]. Such evaluations usually involve three aspects:

Economic sustainability: assesses the impact of the project on the local economy, including factors such as employment opportunities, output growth and tax revenues. Also, projects are evaluated to determine whether they have financial and resource sustainability issues and to determine their long-term development prospects. The economic benefits of the construction project are assessed, including return on investment, productivity, tax increment and other benefits. Social sustainability: The impact of the project on the local community is assessed, including factors such as social justice, social welfare, and social participation. At the same time, the compliance of the management measures adopted by the project with relevant local laws and regulations and international standards is assessed to minimize social conflicts and instability. Environmental impact assessment: The impact of the project on the local ecology is assessed, including factors such as water, soil, and air quality. Also, the impact of the project on local natural resources (such as biodiversity) and the potential for environmental damage should be evaluated.

By evaluating these aspects, a sustainable project plan can be developed, including aspects such as rational land use, environmental protection measures, safety and health management, social responsibility, etc., and monitoring and evaluation can be strengthened during project implementation to ensure that construction projects are fully considered and implemented in terms of sustainability [15]. To evaluate the sustainability of construction projects, a number of scientific, systematic and rational methods need to be used, such as:

Life cycle: The sustainability degree of a construction project is determined by evaluating the impact of each stage of its entire life cycle. Multi-attribute decision-making: By calculating and analyzing the weights of different factors, multiple factors that affect the sustainability of construction projects are comprehensively considered. Regional sustainability: The sustainability of construction projects in a specific region is assessed and compared to guide policy decisions and planning [16]. Socio-economic impact: Taking socio-economic impact as the judgment criterion, the sustainability evaluation of a construction project is conducted to determine its foundation, links, performance, and other factors. Ability evaluation of construction projects, identifying its basis, links, performance and other factors.

In conclusion, evaluating the maintainability of construction projects is a long-term and complex task that requires the comprehensive consideration of multiple aspects and the implementation of scientific, systematic and rational evaluation methods to support the long-term sustainability of construction projects.

2.3 Construction Project Evaluation

Construction project appraisal is a comprehensive assessment of the feasibility, economic, social and environmental aspects of a construction project to determine whether it should be continued or optimised and improved [17]. Sustainability assessment of construction projects is an important part of construction project management. The following are some of the key elements of a construction project assessment:

Feasibility assessment: Feasibility study is the main task of construction project assessment, including market analysis, technical study, financial budget, resource feasibility, etc., to determine the prospect and feasibility of project implementation. Economic benefit assessment: It mainly assesses the capital investment and benefits of the project, including economic indicators such as cost-benefit analysis, investment return and benefit forecast, in order to determine the investment value and economic benefits of the project. Social impact assessment: It mainly discusses the impact of the project on social life and the environment, including employment opportunities, social welfare, income, education, culture, community response, etc., to assess the contribution and impact of the project on society. Environmental impact assessment: It discusses the impact of the project on the natural environment and the environment, including soil resources, water resources, air pollution, noise and other environmental issues, and assesses the impact and risk of the project on the environment. The following methods can be used to evaluate construction projects:

The hierarchical analysis method: This method divides evaluation indicators into different levels, analyses them layer by layer from macro to micro, compares the importance and impact of indicators at different levels, and arrives at a comprehensive evaluation result. The formula for calculating the maximum characteristic value for the hierarchical analysis method $\ell_{\max}$ is as follows:

$$\ell_{\max} \approx \sum_{i=1}^{m} \frac{(XV)_i}{mV_i} \tag{1}$$

Among them, XV_i is the i-th component of vector XV. Normalisation of the judgement matrix τ_{ik}:

$$\tau_{\mathrm{ik}} = x_{ik} / \sum_{i=1}^{m} x_{ik} \tag{2}$$

It is summed by row v_i :

$$V_i = \sum_{k=1}^{m} \tau_{ik} \tag{3}$$

Entropy weighting method, which is a statistical method to mine the information in the data, determine the weight of each evaluation index and then conduct a comprehensive evaluation. Grey system theory is mainly applied to the preliminary assessment and prediction of the environmental effects of construction projects, and through the analysis of time series data, the prediction results and evaluation conclusions are drawn [18]. Environmental impact assessment theory emphasises impartiality, science and public participation in the evaluation process, and evaluates the impact of construction projects on the environment, society and economy from the perspective of environmental laws and regulations. Multi-objective planning theory is mainly used for construction projects with multiple objectives and evaluates the sustainability of the project from a holistic and systematic perspective [19].

In conclusion, sustainability evaluation of construction projects involves several factors and requires the application of multiple theories and methods for assessment. As research progresses and technology advances, the theories and methods for sustainability evaluation of construction projects continue to be enriched and improved [20]. The evaluation process needs to take into account all factors and carry out risk assessment to ensure that the project can proceed smoothly, and it also needs to be evaluated and adjusted regularly to suit the needs of different development stages.

3. Evaluation Models for Construction Projects

3.1 Evaluation Models

The steps that need to be included in a sustainability evaluation model for a construction project are shown in Figure 1:

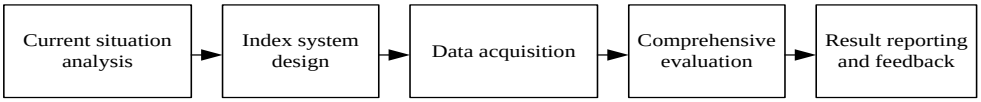

Figure 1: Evaluation Model of Construction Project Sustainability

Analysis of the current situation: By a detailed analysis of the current social, economic and environmental situation of the construction project, the reference standards and indicator system for sustainability evaluation is determined. Indicator system design: Based on the results of the current situation analysis, a sustainability evaluation indicator system is developed, including indicators of economic, environmental and social aspects, and corresponding weights are set for each indicator. Data collection: The data required for the project is collected, including economic, environmental and social aspects, in order to carry out a comprehensive assessment. Comprehensive assessment: Professional software is used to quantify and assess the evaluation indicators, calculate the overall score of the project based on the weights of the different indicators, and analyse and interpret the assessment results. Result report and feedback: The report is prepared based on the evaluation results, and suggestions and improvement suggestions are provided to the evaluation object.

Specifically, sustainability evaluation models can be constructed using a variety of methods such as hierarchical analysis, fuzzy mathematics and grey system theory. The final evaluation results should be comprehensive, objective and scientific, and able to provide substantial guidance for decision-making.

3.2 Ecological Footprint of the Project Sustainable

Sustainability of construction projects based on the ecological footprint is the use of the ecological footprint as an important indicator of the impact of a construction project on the natural environment of the construction project, by reducing or optimising the consumption of natural resources. Construction projects have caused damage to resources and the environment. The ecological footprint is the area occupied by humans who consume natural resources and damage the environment over a period of time. The sustainability of construction projects based on the ecological footprint includes the following main aspects:

In order to reduce land take and development, building projects must take up a large amount of land and resources. Therefore, the ecological footprint can be avoided by reducing land occupation and careful planning. Measures such as sustainable green building techniques can be taken to reduce land use through urbanisation by reducing floor space and height. To conserve energy and

resources, building projects consume large amounts of energy and resources. In order to achieve sustainable development, energy and resource conservation methods such as promoting clean energy, implementing a circular economy and improving energy efficiency, implementing environmental protection measures and implementing environmental protection measures for construction projects must be adopted. In order to promote ecological civilisation, construction projects should focus on ecological civilisation and achieve a balance between architecture and ecology. By building green public spaces, promoting urban greening and implementing public relations and environmental protection education, the quality of life of urban residents and the ecological environment can be improved.

The sustainability of construction projects based on an ecological footprint emphasises ecological conservation and the sustainable use of resources. During construction, active measures are taken to protect the natural environment, optimise resource use and develop the construction project sustainably.

3.3 Integrated Evaluation Implementation

The process of implementing the master sustainability assessment for construction projects generally includes the following steps:

Project data collection: Economic, social, and environmental data related to construction projects are collected to establish sustainable development assessment models. Development of evaluation index system: According to the nature and scale of the construction project, an evaluation index system that meets the actual situation is developed. Determination of indicator weight: Relevant methods (such as analytic hierarchy process, entropy weight method, etc.) are used to quantify each evaluation indicator and determine its relative weight. Evaluation: Combining data and indicator weights, the construction project is evaluated from social, environmental, and economic aspects, and the overall evaluation results are given. Analysis and improvement: The evaluation results are analyzed and targeted improvement measures are proposed to improve the sustainable development plan of the construction project.

During the specific implementation, attention should be paid to the following aspects. The sustainable development objectives of the construction project are defined as the basis for evaluation. According to the characteristics of the construction project, suitable evaluation indicators are selected. At the same time, the correlation between indicators should be considered. The selected evaluation indicators are converted into quantifiable data for subsequent comprehensive evaluation. Each evaluation index is quantified and its relative weight is determined based on the actual situation. Attention is paid to the impact of social feedback on construction projects, especially environmental and social issues. As a part of the sustainable development plan for construction projects, the evaluation results need to be continuously improved and improved. The comprehensive evaluation of sustainable development of construction projects should consider multiple factors, and require a scientific, comprehensive, and objective evaluation to promote the sustainable development of construction projects based on this.

3.4 Related Surveys

Expert consultation methods play an important role in the sustainable assessment of construction projects. During the consultation process, the questions and objectives of the consultation need to be clarified. Appropriate assessment criteria and methods are selected according to the needs and scope of the project. Environmental indicators such as carbon footprint, ecological footprint and energy efficiency can be used for assessment. In the social field, methods such as social impact assessment and community participation assessment can be used. Experts in specialist areas relevant to the

consultation problem are selected, such as architectural design, mechatronics, civil engineering, environmental science, etc. Solutions, techniques and policies for solving the problem are discussed with the experts and their opinions and recommendations are collected. The survey heard from a total of 20 experts. The recommendations should take into account factors such as project feasibility, economic benefits, social benefits and environmental impacts. Assessment and analysis is carried out through research, data collection and other methods based on the selected assessment criteria and methods. Experts can be evaluated through discussions, research data and field visits to understand the current status and subject matter of the project. Based on the results of the evaluation, the experts make appropriate recommendations and solutions. These proposals and plans should take full account of the economic, social and environmental impacts of the project in order to ensure its sustainable development. The recommendations and attitudes of the experts are analysed and compared in order to find the best solutions. Among other things, the attitudes of experts can be divided into three types: agreement, disagreement and indifference. In the event of a dispute, it is necessary to continue discussions with the experts in order to find the most appropriate solution. The experts prepare a report and express an opinion based on the results of the assessment. The aim of this report is to provide a clear overview of the evaluation results, to make recommendations and solutions, and to assess and analyse the sustainability of the project. An implementation plan is developed based on the final plan, including budget, timeline, implementation steps and accountability. During implementation, it is necessary to continuously monitor the effectiveness of the consultations and make adjustments where necessary.

Expert consultation on construction projects is a complex process that requires close collaboration with experts to ensure the viability and success of the project. At the same time, it is important to remain open to suggestions and advice from experts and to actively explore solutions in order to achieve the goal of improving the quality and efficiency of the project.

4. Findings of the Sustainability Evaluation of Construction Projects

4.1 Sustainability Evaluation Indicator Weights

The determination of the weights of sustainability evaluation indicators for construction projects is an important part of the sustainability evaluation of construction projects. The evaluation indicators include social, environmental and economic aspects, and methods such as hierarchical analysis or entropy weighting are often used. In this paper, after investigation and expert consultation, the sustainability evaluation indicators of construction projects and their relative weights are calculated to produce relevant data.

This article analyzed the sustainability of construction projects from a social perspective and obtained relevant weighting coefficients for community participation, social stability, quality of life, public health, fairness and justice, and good labor relations. As shown in Figure 2, it can be seen from the data graph that the weight values for community participation, social stability and public health were large. Therefore, the public needs to be involved in the project design in a timely manner during the construction of the project and the support of the public is needed for the maintainability of the construction project. In addition, the life safety of the public should be taken into account in the construction of the project.

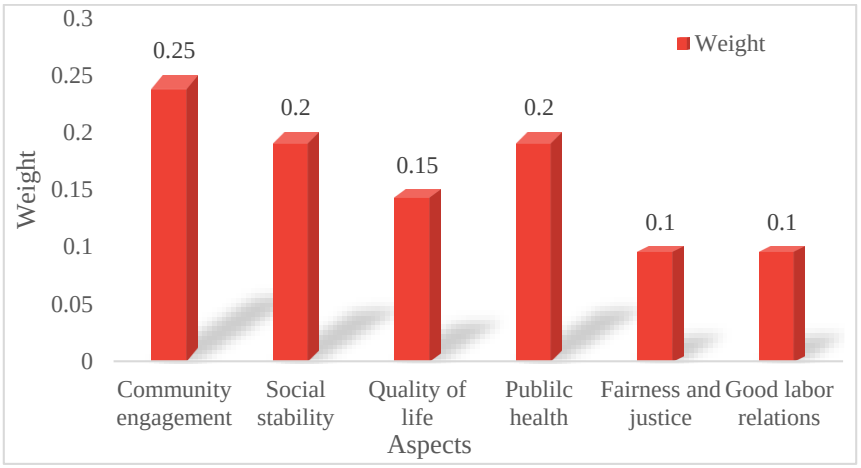

Figure 2: Social-level Sustainability of Construction Projects

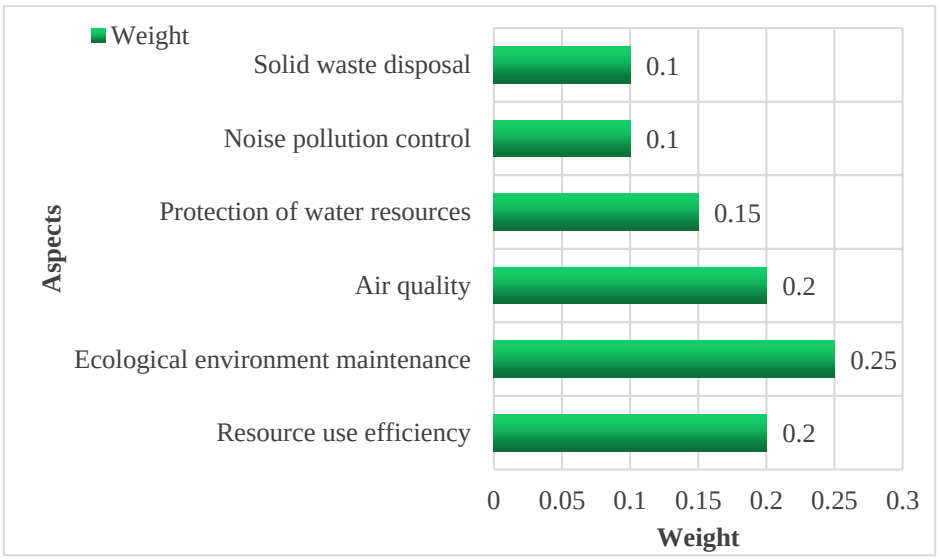

Figure 3: Construction Project Sustainability at the Environmental Level

This paper analyzed the sustainability of construction projects from the environmental perspective, and obtained relevant weight coefficients for resource utilization efficiency, ecological environment maintenance, air quality, water resource protection, noise pollution control, and solid waste treatment. As shown in Figure 3, it can be seen from the data graph that the weight values of ecological environment conservation, resource utilization efficiency, and air quality were relatively large. Therefore, during project construction, attention needs to be paid to environmental protection, reducing damage to natural ecology, effectively utilizing resources, and reducing resource waste.

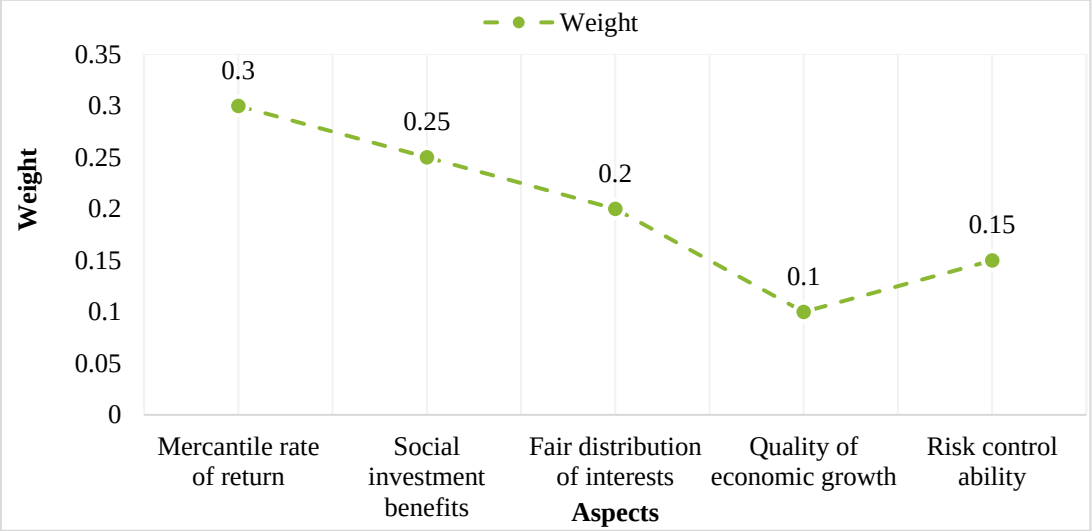

Figure 4: Economic Sustainability of Construction Projects

The paper concluded with an analysis of the sustainability of the construction project at an economic level to obtain the relevant weighting coefficients for return on investment, social investment benefits, equity in benefit distribution, quality of economic growth and risk control capability. As shown in Figure 4, it can be seen from the data graph that the weight values for return on investment, social investment benefits and fairness in the distribution of benefits were large. Therefore, in project construction, the cost of project construction needs to be accurately calculated and the timing of the return on investment needs to be considered to balance the interests at all levels.

It is important to note that the specific selection and calculation process of the weights and indicators may vary under different construction project types and scenarios and needs to be adjusted and optimised according to the actual situation.

4.2 Experts' Strategic Approach to the Sustainability of Construction Projects

Table 1: Experts' Strategic Attitude towards Sustainable Construction Projects

	Agree	General	Disagree
Economic development	65%	20%	15%
Environmental protection	70%	19%	11%
Social responsibility	68%	22%	10%
Energy utilization	60%	29%	11%
Town planning	65%	26%	9%
Community participation	60%	25%	15%

As shown in Table 1, the experts were divided into six areas regarding the sustainability strategy for the construction of the project. More than 60% of the experts endorsed the feasibility of economic, environmental, social, energy, urban planning and social participation. A small number of experts also had an indifferent attitude towards these aspects.

Projects should be sustainable by taking active measures to reduce negative impacts on the environment and by adopting clean energy and green technologies. Sustainability should be promoted instead of just pursuing economic growth. Companies should take more social responsibility, promote social equity and inclusiveness, and participate in the development affairs of

local communities. Measures should be taken to conserve energy and optimise resource use to achieve sustainable development.

5. Conclusions

In the current construction sector, maintainability assessment refers to the analysis and evaluation of construction projects in terms of schedule, quality and investment control. This paper presented a systematic analysis of the maintainability of construction projects. By constructing an evaluation index system and using methods such as hierarchical analysis and fuzzy comprehensive evaluation, the possible situations and root causes of problems in the construction project process were explored. When conducting the evaluation, various situations of influencing factors should be considered and various aspects of different levels should be analysed. It is also important to explore the path to sustainability in terms of policy and regulation to ensure that limited resources are used to the maximum extent possible while ensuring quality and safety.

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