JOURNAL OF TAIWAN AGRICULTURAL ENGINEERING
VOL. 67, NO. 2, JUNE 2021
DOI - 10.29974/JTAE.202106_67(2).0006

農村工程綠色項目管理績效評價研究

RESEARCH ON PERFORMANCE EVALUATION OF GREEN PROJECT MANAGEMENT FOR RURAL ENGINEERING

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摘 要

隨著經濟的高速發展，環境危害和能源短缺問題日益嚴重。分析農村工程綠色項目管理的績效，可以為項目管理者提供參考意見。針對農村工程綠色項目管理的現狀，從管理、組織、技術和環境影響四個角度開展農村工程綠色項目管理績效的綜合評價。基於層次分析法(AHP)和突變級數理論提出農村綠色項目管理績效評價體系，運用多指標績效參數根據順序對各種複雜因素進行分類，使用層次分析法(AHP)計算權重值，然後結合突變模型和案例分析進行農村工程綠色項目管理績效綜合評價。結論表明，該項目的綠色管理績效水平較高，說明綠色管理績效工作做得很好，而項目環境因素突變程度最低，說明該環節最薄弱，有待改進。兩種方法的結合使用建立了農村工程工程項目綠色管理績效評價指標體系，為農村工程綠色管理績效科學合理化提供參考。

關鍵詞：卷綠色項目管理、層次分析法、突變級數法(MPM)、農村工程管理。

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ABSTRACT

With the rapid development of the economy, environmental hazards and energy shortages are becoming more and more serious. Analyzing the performance of green project management in rural engineering can provide a reference for project managers. Given the current situation of rural green project management, a comprehensive evaluation of rural green project management performance was carried out from four perspectives, namely management, organization, technology, and environmental impact. Based on the analytic hierarchy process (AHP) and mutation progression theory put forward rural green project management performance evaluation system, by using multi-index performance parameters are classified according to the order of various complicated factors, using the analytic hierarchy process (AHP) to calculate the weight value, and then combined mutation model and case analysis of rural green engineering project management performance evaluation. The conclusion shows that the green management performance level of the project is high, indicating that the green management performance has been done well, while the environmental factor mutation degree of the project is the lowest, indicating that the link is the weakest and needs to be improved. The combination of the two methods establishes the performance evaluation index system of green management of rural engineering projects, which provides a reference for the scientific rationalization of the performance of green management of rural engineering.

Keywords: Green project management, Analytic hierarchy process, Mutation progression method (MPM), Rural engineering management.

Li, X.J.*, Lu, L.L. & Tserng, H.P. (2021). "Research on Performance Evaluation of Green Project Management for Rural Engineering." *Journal of Taiwan Agricultural Engineering,* 67(2), 56-67.
https://doi.org/10.29974/JTAE.202106_67(2).0006

DOI - 10.29974/JTAE.202106_67(2).0006

1. Introduction

With the continuous development of the social economy, green environmental protection, energy conservation, and emission reduction have become the development theme of the current era. The construction industry in the world is also gradually changing from the form of buildings with high energy consumption and high pollution to ecological and green construction projects. Nowadays, environmental problems are becoming more and more serious, and the awareness of environmental protection is gradually enhanced so that green project management is gradually becoming the mainstream. And the level of green project management will affect the success of the project, so the performance evaluation of green project management cannot be underestimated [1]. Rural engineering green project management performance evaluation can reflect the management status and implementation effect, to improve the level of project management and better implement related projects [2]. To ensure the effective implementation of green management of rural engineering projects and to evaluate the performance of project management scientifically and effectively, engineering green project management performance evaluation has become one of the important tasks necessary for realizing the goals of green engineering projects, and also an important task to be solved under the current social and economic development.

Due to the need for social and economic development and the lack of awareness of energy conservation and environmental protection, few projects that can be used for green project management in rural engineering in China. However, no matter whether the project organization can carry out green project management of rural engineering in the real sense, the actual management will involve more or less green environmental protection [3]. At present, some domestic and foreign scholars have made relevant researches on green management of engineering projects, and introduced a series of theories and methods [4-5] into the research on performance evaluation of engineering project management, and conducted researches on green project management [6-8]. In the study of a green project of rural engineering, Li [7] evaluated the green project management of rural engineering based on the analytic hierarchy process, established the steps, index system, and calculation method, and finally realized the evaluation of green degree. Guo *et al*. [8] studied green projects in rural engineering by adopting special management measures through green construction project management planning. Lauren Bradley Robichaud [9] believes that in the sustainable development of buildings, green project management must be comprehensively evaluated according to specific sustainability characteristics. Bon-gang Hwang [10] surveyed 31 industry experts, identified common obstacles to green building project management, and finally proposed some solutions to overcome the obstacles. The above research shows that most scholars analyze the influencing factors of green project management in rural engineering, while the research on green project management performance evaluation is limited.

The evaluation methods of green projects in rural engineering mainly include the analytic hierarchy process, fuzzy evaluation method, and principal component analysis method, etc. Although these methods have their own characteristics, the weight problem is not easy to solve, and the calculation process is tedious. At the same time, these methods are difficult to evaluate the management performance of green projects in rural engineering. Due to the influence of the social environment, the green project management of rural engineering is characterized by complexity and uncertainty, so the performance evaluation of green project management of rural engineering should follow the principle of consistent goal, clear hierarchy, comprehensive system, easy operation, and strong pertinence, and strive to be open and fair [11]. To achieve the goal of effective green management, green evaluation, and analysis of project management have been done. This paper firstly selects the green project management performance evaluation index of rural engineering and then combines the analytic hierarchy process (AHP) with the mutation progression method to introduce it into the green project management performance evaluation of rural engineering, to make the evaluation result more consistent with the actual situation.

2. Rural engineering green project management performance indicator system

2.1 Rural engineering green project management performance

Rural engineering green project management can be understood as: in the whole life cycle of project management, each stage should adhere to the green principle, and adopt effective evaluation, control, and implementation methods, and pay attention to the management of resources and environment. By saving resources and controlling pollution, the project can achieve the unity of economic benefit, social benefit, and environmental benefit, and promote sustainable development [12], which is the goal of green project management to reduce project pollution, improve material utilization rate, and energy recycling rate. It is a key link in realizing green buildings because of its coordination and integration with society and the environment. Green project management performance evaluation of rural engineering needs to consider the input and output. As a systematic project, due to the wide range of considerations, the selection of indicators should take into account the behavioral performance and outcome performance.

2.2 Rural engineering green project management performance indicator system

2.2.1 Organization and management

The factors of organization and management have a great impact on the performance of project management. Even if the materials are of high quality and the equipment is advanced, the overall quality of personnel is not high and the system is not coordinated, which will directly lead to the failure of project management [13]. The indicators of organizational management can be divided into four categories: management attention, green system guarantee, project group level, and green education measures.

2.2.2 Technical factors

In the green building project management process, it pays attention to the use of advanced technology. Advanced technology can promote the implementation of green project management in rural engineering, while backward technology will hinder its development and produce negative effects on the natural environment and social development. Therefore, green project management in rural engineering should focus on the application of advanced technology [14]. Advanced construction technology, safety guarantee measures, environmental protection technology, and energy-saving equipment can be taken as the evaluation index of technical factor criterion. Among them, advanced construction technology mainly considers construction technology and construction modernization level, environmental protection technology considers pollution treatment technology, etc. Security measures mainly include personnel security measures and social security measures. The use of energy-saving equipment can promote the development of the project.

2.2.3 Management factors

Project management mainly includes three important factors: quality, cost, and time limit. Based on project management, green engineering advocates green factors and considers social sustainable coordination, paying special attention to environmental, resource, and social factors. Therefore, among the factors of green project management, the indicators related to green project management include quality management, progress management, foreign investment management, and green management. In the process of project management, indicators related to green management pay attention to the implementation of project management by the project organization, mainly including the importance of management strategy, management system, improvement degree, the development of green education, the construction of green culture and so on.

2.2.4 Environmental impact

Environmental impacts include the natural environment and social environment. The goal of green project management in rural engineering is to realize environment-friendly projects and reduce environmental pollution caused by projects as much as possible. The environmental impact of the project mainly includes two aspects: the impact on the natural environment and the impact on the social environment. The first impact is mainly air pollution, water pollution, land pollution, damage to the surrounding environment, the impact on animals and plants. The second impact mainly includes noise pollution, hidden safety risks, etc. [15]. Therefore, environmental factors mainly include the treatment of wastewater, waste gas, and solid waste, as well as environmental protection, noise control, and dust control.

3. Method

In the process of promoting energy conservation in green buildings, geographical differences lead to different intensity and scope of implementation, and some projects even only stay on the analysis and measurement of energy consumption of some buildings, which cannot be further implemented from the perspective of energy conservation of the whole project system [16]. In combination with the implementation of green project management in construction enterprises, this paper constructs a green project management performance evaluation index system suitable for China based on the analytic hierarchy process from the four aspects of organizational factors, technical factors, management factors, and environmental factors, and establishes a green project management performance evaluation model.

On the premise of constructing the evaluation index system of green project management in rural engineering, this paper combines AHP with the method of mutation progression to evaluate the performance of green project management in rural engineering. Calculating the weight value with AHP, sorting it according to the weight size, and evaluating it with the method of mutation progression.

3.1 Index ranking of rural engineering green project management performance evaluation based on the analytic hierarchy process

The analytic hierarchy process consists of the following steps: establishing the hierarchical structure model; Construct judgment matrix; Hierarchy single order, the importance of this level order; Consistency test of judgment matrix; Total hierarchy, from the top to the bottom order.

3.1.1 Construct judgment matrix

The analytic hierarchy process (AHP) can combine the qualitative and quantitative aspects of complex problems. Its most important feature is that it can construct a judgment matrix based on the importance degree between two evaluation indexes, to calculate the decision weight

Judgment matrix: The hierarchy model determines the relationship between the upper and lower elements, that is, a criterion of the above level constructs the pair judgment matrix of different levels, assuming the relative importance that for n elements C_1, C_2..., Cn, and the above layer element B_k is the criterion to compare the relative importance between C_1, C_2..., Cn, and B_k, from which the judgment matrix A is constructed.

3.1.2 Consistency test of judgment matrix

The negative arithmetic means the value of λ except $\lambda_{\max}$ in the judgment matrix is taken as the index of deviation consistency:

$$CI = \frac{\lambda_{\max} - n}{n - 1} \quad \text{......(1)}$$

Where, λ is the characteristic root, $\lambda_{\max}$ is the maximum characteristic root, and n is the divisor of the judgment matrix

When $CI = 0$, $\lambda_1 = \lambda_{\max} = n$, the judgment matrix has complete consistency.

The average random consistency index RI value of the judgment matrix should be introduced to judge the consistency and use of the Saaty1-9 scale method to determine the average random consistency index RI. See Tab. 1.

When the order of the judgment matrix is greater than 2, the ratio of CI to RI is the random consistency ratio, denoted as CR. when

$$CR = \frac{CI}{RI} < 0.10 \quad \text{......(2)}$$

That is, the judgment matrix satisfies the consistency condition.

Tab. 1. values of RI

1	2	3	4	5	6	7	8	9
0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45

Tab. 2. Mutation model

Catastrophic model	State variable	Control variable	Potential function	Normalized formula
Fold mutation	1	1	$F(x)=x^3+ux$	$x_u=\sqrt{u}$
Cusp catastrophe	1	2	$F(x)=x^4+ux^2+vx$	$x_u=\sqrt{u}$, $x_v=\sqrt[3]{v}$
Coattail catastrophe	1	3	$F(x)=x^5+ux^3+vx^2+wx$	$x_u=\sqrt{u}$, $x_v=\sqrt[3]{v}$, $x_w=\sqrt[4]{w}$
butterfly mutation	1	4	$F(x)=x^6+ux^4+vx^3+wx^2+tx$	$x_u=\sqrt{u}$, $x_v=\sqrt[3]{v}$, $x_w=\sqrt[4]{w}$, $x_t=\sqrt[5]{t}$

Note: u, v, w and t are the control variables, X_u, X_v, X_w, X_t and are the corresponding mutation level values.

3.2 Performance evaluation of rural engineering green project management based on mutation progression method

The abrupt progression method based on the abrupt theory decomposes the evaluation system into several indicators, which are synthesized layer by layer from the lower level to the upper level and calculated layer by layer with the normalized formula to obtain the abrupt membership function values of the indicators of each layer [17], and there are seven kinds of mutation models in the theory of mutation. In this paper, four common mutation models, namely folding mutation, cusp mutation, Coattail mutation, and butterfly mutation, are used to evaluate the management performance of rural engineering green projects. These four models decompose the upper index into multiple indexes respectively, that is, fold mutation into one sub-index, cusp mutation into two sub-indexes, swash mutation into three sub-indexes, and butterfly mutation into four sub-indexes. And the four commonly used catastrophe models and their normalized formulas are shown in Tab. 2. According to the quantitative relationship between state variables and control variables, the mutation model is determined. In this paper, green project management performance is divided into three grades from high to low [18], namely good, qualified, and poor. According to the normalization characteristics, the corresponding grading standard is [0.75,1] [0.5,0.75] [0,0.5].

4. Case analysis

4.1 Case 1 Project overview

This paper takes Baiyulan square with green technology as an example. Baiyulan square is located in the Tongan coastal area of Xiamen, Fujian, with a total construction area of 420,000 square meters. Relevant data were collected, the performance of green project management in rural engineering was evaluated by the method of hierarchy analysis and mutation progression, and the application of this method was verified.

4.2 Comprehensive evaluation

4.2.1 Determination of weights by AHP

Consulting relevant experts through a questionnaire survey, get the corresponding importance level according to the actual situation, calculate the weight of the index, and check whether the consistency is satisfied.

4.2.1.1 Judgment matrix of layer A-B

(1) Pairwise comparison judgment matrix

Tab. 3. Judgment matrix of layer A-B

A	B_1	B_2	B_3	B_4
B_1	1	1/2	1/2	1
B_2	2	1	1	1/2
B_3	2	1/2	1	1
B_4	1	2	1	1

(2) The characteristic root method is used to calculate the weight value of each index

A = (0.181, 0.257, 0.257, 0.305)

(3) Conduct a consistency test

$\lambda_{\max}=4.081$, when $n=4$, $RI=0.9$; $CI=\dfrac{\lambda_{\max}-n}{n-1}=0.027$, $CR=\dfrac{CI}{RI}=0.03<0.10$

The judgment matrix has satisfactory consistency.

4.2.12 Judgment matrix of layer B_1-C

(1) Pairwise comparison judgment matrix

Tab. 4. Judgment matrix of layer B1-C

B_1	C_1	C_2	C_3	C_4
C_1	1	2	2	3
C_2	1/2	1	1	2
C_3	1/2	1	1	3
C_4	1/3	1/2	1/3	1

(2) The characteristic root method is used to calculate the weight value of each index

A = (0.418, 0.225, 0.249, 0.109)

(3) Conduct a consistency test

$\lambda_{\max} = 4.046$, when $n = 4$, $RI = 0.9$; $CI = \dfrac{\lambda_{\max} - n}{n-1} = 0.015$, $CR = \dfrac{CI}{RI} = 0.0167 < 0.10$

The judgment matrix has satisfactory consistency.

4.2.1.3 Judgment matrix of layer B2-C

(1) Pairwise comparison judgment matrix

Tab. 5. Judgment matrix of layer B2-C

B_2	C_5	C_6	C_7	C_8
C_5	1	3	2	4
C_6	1/3	1	1	1/2
C_7	1/2	1	1	1/2
C_8	1/4	2	2	1

(2) The characteristic root method is used to calculate the weight value of each index

A = (0.485, 0.14, 0.155, 0.219)

(3) Conduct a consistency test

$\lambda_{\max} = 4.046$, when $n = 4$, $RI = 0.9$; $CI = \dfrac{\lambda_{\max} - n}{n-1} = 0.015$, $CR = \dfrac{CI}{RI} = 0.0167 < 0.10$

The judgment matrix has satisfactory consistency.

4.2.1.4 Judgment matrix of layer B3-C

(1) Pairwise comparison judgment matrix

Tab. 6. Judgment matrix of layer B3-C

B_3	C_9	C_{10}	C_{11}	C_{12}
C_9	1	1/2	2	2
C_{10}	2	1	3	4
C_{11}	1/2	1/3	1	3
C_{12}	1/2	1/4	1/3	1

(2) The characteristic root method is used to calculate the weight value of each index

A = (0.253, 0.471, 0.179, 0.096)

(3) Conduct a consistency test

$\lambda_{\max} = 4.12$, when $n = 4$, $RI = 0.9$; $CI = \dfrac{\lambda_{\max} - n}{n-1} = 0.04$, $CR = \dfrac{CI}{RI} = 0.044 < 0.10$

The judgment matrix has satisfactory consistency.

4.2.1.5 Judgment matrix of layer B4-C

(1) Pairwise comparison judgment matrix

Tab. 7. Judgment matrix of layer B4-C

B_4	C_{13}	C_{14}	C_{15}	C_{16}
C_{13}	1	3	2	2
C_{14}	1/3	1	1/3	1/2
C_{15}	1/2	3	1	1
C_{16}	1/2	2	1	1

(2) The characteristic root method is used to calculate the weight value of each index

A = (0.418, 0.109, 0.249, 0.225)

(3) Conduct a consistency test

$\lambda_{\max} = 4.046$, when $n = 4$, $RI = 0.9$; $CI = \dfrac{\lambda_{\max} - n}{n-1} = 0.015$, $CR = \dfrac{CI}{RI} = 0.0167 < 0.10$

The judgment matrix has satisfactory consistency.

4.2.2 Weight of each indicator relative to the overall target

The index system was decomposed according to the mutation series method, and the weight values were calculated by the analytic hierarchy process (AHP). The weights were arranged from large to small, and the importance of each index was finally determined. The results are shown in Tab. 8.

According to the evaluation index system established in Tab. 9, several experts were asked to score and take the average value. The data processing results are shown in Tab. 10 and Tab. 11.

There are four tertiary indicators of environmental factors, which belong to butterfly mutation:

$x_{u1} = u^{1/2} = (0.636)^{1/2} = 0.798$

$x_{v1} = v^{1/3} = (0.742)^{1/3} = 0.905$

$x_{w1} = w^{1/4} = (0.611)^{1/4} = 0.884$

$x_{t1} = t^{1/5} = (0.710)^{1/5} = 0.934$

According to the non-complementary principle:

$x = x_1 = \min(x_{u1}, x_{v1}, x_{w1}, x_{t1}) = 0.798$

In the same way, $x_2 = 0.878$, $x_3 = 0.892$, $x_4 = 0.844$

Four of the secondary indicators are butterfly mutations:

Tab. 8. Weight of each index

The primary indicators	The secondary indicators	The tertiary indicators	Relative secondary index weight	Relative primary index weight
Green project management performance evaluation index system A	Tissue factor B_1 (weight 0.181)	The attention of management C_1	0.418	0.0757
		Green institutional guarantee C_2	0.225	0.0407
		Project group level C_3	0.249	0.0451
		Green education measures C_4	0.109	0.0197
	Technical factor B_2 (weight 0.257)	Advanced construction technology C_5	0.485	0.1246
		Environment protection technology C_6	0.140	0.0360
		Safety precautions C_7	0.155	0.0398
		Energy-saving college equipment C_8	0.219	0.0563
	Management factors B_3 (weight 0.257)	Quality conformance C_9	0.253	0.0650
		Reasonable schedule C_{10}	0.471	0.1210
		Reasonable cost C_{11}	0.179	0.0460
		Security assurance C_{12}	0.096	0.0247
	Environmental factor B_4 (weight 0.305)	Effluent treatment C_{13}	0.418	0.1275
		Waste gas treatment C_{14}	0.109	0.0332
		Solid waste treatment C_{15}	0.249	0.0759
		Noise control C_{16}	0.225	0.0686

Tab. 9. Green project management performance evaluation system

The primary indicators	The secondary indicators	The tertiary indicators
Green project management performance evaluation index system	Environmental factor u	Effluent treatment u_1
		Solid waste treatment v_1
		Noise control w_1
		Waste gas treatment t_1
	Technical factor v	Advanced construction technology u_2
		Energy-saving college equipment v_2
		Safety precautions w_2
		Environment protection technology t_2
	Management factors w	Reasonable schedule u_3
		Quality conformance v_3
		Reasonable cost w_3
		Security assurance t_3
	Tissue factor t	The attention of management u_4
		Project group level v_4
		Green institutional guarantee w_4
		Green education measures t_4

Tab. 10. Three-level membership matrix of project management performance evaluation

Indicator	Environmental factor (u)				Technical factor (v)			
	u_1	v_1	w_1	t_1	u_2	v_2	w_2	t_2
An average score of experts	0.636	0.742	0.611	0.710	0.772	0.715	0.715	0.632
The mutation series code of the tertiary index	x_{u1}	x_{v1}	x_{w1}	x_{t1}	x_{u2}	x_{v2}	x_{w2}	x_{t2}
The mutation series of the tertiary index	0.797	0.905	0.884	0.934	0.878	0.894	0.915	0.912
Indicator	Management factors (w)				Tissue factor (t)			
	u_3	v_3	w_3	t_3	u_4	v_4	w_4	t_4
An average score of experts	0.812	0.710	0.772	0.678	0.712	0.702	0.720	0.730
The mutation series code of the tertiary index	x_{u3}	x_{v3}	x_{w3}	x_{t3}	x_{u4}	x_{v4}	x_{w4}	x_{t4}
The mutation series of the tertiary index	0.901	0.892	0.937	0.925	0.844	0.889	0.921	0.939

DOI - 10.29974/JTAE.202106_67(2).0006

Tab. 11. Total membership and secondary membership of project management performance evaluation

Indicator	Environmental factor (u)	Technical factor (v)	Management factors (w)	Tissue factor (t)
Value of secondary index (minimum)	0.797	0.878	0.893	0.844
The mutation series of the secondary index	0.892 (x_u)	0.957 (x_v)	0.972 (x_w)	0.967 (x_t)

Tab. 12. Weight of each index

The primary Indicators	The secondary indicators	Relative secondary index weight	The tertiary indicators	Relative primary index weight
Green project management performance evaluation index system A	Tissue factor B_1 (weight 0.0809)	0.1363	The attention of management C_1	0.0110
		0.2132	Green institutional guarantee C_2	0.0172
		0.3969	Project group level C_3	0.0321
		0.2536	Green education measures C_4	0.0205
	Technical factor B_2 (weight 0.2129)	0.2546	Advanced construction technology C_5	0.0542
		0.4739	Environment protection technology C_6	0.1009
		0.1676	Safety precautions C_7	0.0357
		0.1038	Energy-saving college equipment C_8	0.0221
	Management factors B_3 (weight 0.2803)	0.2359	Quality conformance C_9	0.0672
		0.4597	Reasonable schedule C_{10}	0.1289
		0.1425	Reasonable cost C_{11}	0.0400
		0.1577	Security assurance C_{12}	0.0442
	Environmental factor B_4 (weight 0.4259)	0.1123	Effluent treatment C_{13}	0.0478
		0.4179	Waste gas treatment C_{14}	0.1780
		0.2029	Solid waste treatment C_{15}	0.0864
		0.2670	Noise control C_{16}	0.1137

$x_u = u^{1/2} = (0.798)^{1/2} = 0.893$
$x_v = v^{1/3} = (0.878)^{1/3} = 0.957$
$x_w = w^{1/4} = (0.892)^{1/4} = 0.972$
$x_t = t^{1/5} = (0.844)^{1/5} = 0.967$

Again according to the non-complementary principle:

$x = \min(x_u, x_v, x_w, x_t) = 0.893$

The total mutation membership function value of the management performance of the green project is 0.893. After the management performance rating evaluation, the project has a high level of grading interval division, indicating that the management performance of the project is good. At the same time, according to Tab. 11, it can be seen from the analysis of second-level index evaluation that the mutation level of environmental factors is the lowest, and this weak link needs to be improved.

4.3 Case 2 Project overview

This paper takes Fujian Electromechanical Building as the second case to verify the application of the method. Fujian Electromechanical Building is located in Jin 'an District, Fuzhou, with a total floor area of 43755.40 square meters, a floor area of 4618.8 square meters, 25 floors above ground, a floor area of 30,542 square meters, and three floors underground, with a floor area of 13213.4 square meters. Relevant data were collected and AHP and variation series were used to evaluate the performance of rural green project management.

4.3.1 Determine the weight by AHP method

The judgment matrix was constructed and the characteristic root method was used to calculate the weight value of each index, and the weight was arranged from large to small. The results are shown in the table below.

The consistency test was carried out on the judgment matrix under the four indicators of environmental factors, management factors, technical factors and organizational factors respectively. The consistency ratio was all less than 0.1, so the test was passed.

Tab. 13. The mutation membership function value

The secondary indicators	The tertiary indicators	An average score of experts	The mutation series of the tertiary index	The mutation series of the secondary index
Environmental factor u	Effluent treatment u_1	0.71	0.843	0.913
	Solid waste treatment v_1	0.83	0.911	
	Noise control w_1	0.78	0.833	
	Waste gas treatment t_1	0.80	0.894	
Technical factor v	Advanced construction technology u_2	0.78	0.833	0.913
	Energy-saving college equipment v_2	0.82	0.906	
	Safety precautions w_2	0.80	0.894	
	Environment protection technology t_2	0.85	0.922	
Management factors w	Reasonable schedule u_3	0.81	0.900	0.940
	Quality conformance v_3	0.88	0.938	
	Reasonable cost w_3	0.78	0.883	
	Security assurance t_3	0.84	0.917	
Tissue factor t	The attention of management u_4	0.85	0.922	0.948
	Project group level v_4	0.79	0.889	
	Green institutional guarantee w_4	0.87	0.933	
	Green education measures t_4	0.91	0.954	

4.3.2 Abrupt progression method for management performance evaluation

According to the evaluation index system established in Tab. 9 and the value of the abrupt transition membership function was calculated, the results were shown in Tab. 13.

After the management performance rating evaluation, the green project management performance corresponds to [0.75,1], indicating that the project has a high level of grading interval division and good management performance.

4.4 Suggestions

In this study, the performance evaluation of rural green project management was taken as the target layer, the index system was decomposed by the progressive mutation method, and the index weight was calculated by the analytic hierarchy process.Secondly, according to the evaluation index system, take the average of experts' scoring results and follow the principle of "large, medium and small". The better the performance, the greater the value.Based on the performance evaluation results of rural green project management, this paper proposes the following suggestions and measures:

(1) According to the calculated comprehensive performance results, the score of management factors was the highest, indicating that the project management factors performed well, and management factors had obvious effects on the performance improvement of rural engineering projects. Among the three-level indicators, progress management contributed the most to the performance improvement of engineering projects, while the contribution of security was the least. Therefore, it is necessary to raise awareness of the importance of green project management from the perspective of project organization and management. According to the implementation results of green project management in rural engineering, green project management in rural engineering can effectively reduce pollution and waste in the process of project implementation and ensure construction quality. Therefore, it is necessary to learn and master the basic theories and requirements. In addition, relevant activities should be carried out in combination with project practice. The staff of the enterprise should realize the importance of green project management in rural engineering and must master relevant science and technology to achieve the required level of green project management in rural engineering.

(2) According to the results of performance evaluation, environmental performance evaluation is the

lowest, but environmental factors have the greatest impact on the performance improvement of a rural green project, so to achieve good rural green project management performance must be based on the creation of a friendly environment. The project itself is also an integral part of the social environment. The whole project team should attach importance to green, learn from green, promote the social impact and benefits of green project management, create a green atmosphere, attach importance to the social impact of projects, and establish a good corporate culture. Besides, green project management of rural projects should advocate the sustainable development of project organizations, reduce noise, safety hazards, and other negative social impacts, to achieve the purpose of protecting the environment and saving resources

(3) The results show that green technology and organization management play a decisive role in improving the performance evaluation of rural green engineering projects. Only by strengthening the research and development of green technology and green materials and gradually promoting them, strengthening the guarantee of green system and measures of green education can the performance of rural green engineering project management be really improved.

5. Conclusions

As an emerging industry of China's construction industry, green project management has become the mainstream product of China's future development of the construction industry, it can make the green project better achieve social and economic benefits. Based on the four aspects of organizational factors, technical factors, management factors, and environmental factors, this paper constructs a green project management performance evaluation index system in line with China. Green project management, as a key link and important means of project management, adopts the method of analytic hierarchy process (AHP) and mutation progression method to carry out evaluation research and carries out the comprehensive evaluation with examples. Judging from the evaluation results, the method is feasible. The evaluation model established in this paper can reflect the comprehensive level of green project management in rural engineering, strengthen the weak links in project management, and provide a basis for improving the management performance of green sustainable development. At the same time, based on the analysis of this paper, some measures have been put forward to improve the performance evaluation of green project management.

The project management system is characterized by complexity and multiple targets, so there are many influencing factors involved in the performance evaluation of green project management. The research done in this paper is exploratory, but there are also shortcomings. In consideration of the operability of the study, the selection of indicators fails to take all factors into consideration, which is subjective. In addition, green project management of domestic rural engineering is in its infancy, and respondents' understanding of green project management is limited, which will have a certain impact on the research results.

The primary contribution of this study is identifying a set of rural engineering project green management performance evaluation index system based on the AHP and mutation progression methods. The AHP methods were introduced into rural engineering green project management performance evaluation index weight，which has objectivity, and overcome subjectivity. The mutation progression theory was applied to the evaluation of green rural engineering project management and green engineering project management level, which determine its strengths and weaknesses. Our findings suggest combining these three methods to better solve the challenges of green engineering project management performance evaluation. Findings from this study will be further explored in future works since conclusions are drawn on only a few cases to foster better management and evaluation strategies.

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收稿日期：民國 109 年 08 月 14 日
修正日期：民國 110 年 03 月 05 日
接受日期：民國 110 年 04 月 01 日