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Performance Management Methods of Embankment Water Conservancy Projects Based on Comprehensive Evaluation Method

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The embankment water conservancy project has provided strong guarantee for agricultural development, increase of farmers' income and social stability. With the development of agricultural refinement, the comprehensive evaluation of the various benefits of embankment water conservancy project is particularly important. By constructing comprehensive evaluation method, this paper gives a comprehensive evaluation to the influence of embankment water conservancy project on economy, social and other aspects, so as to find problems in the process of embankment water conservancy project construction and post-operation management, and to give targeted improvement suggestions. This study takes an embankment water conservancy project in some county in Guangxi Province as an example and conducts analysis by introducing the comprehensive evaluation model. The study results show that, the comprehensive evaluation method can assess the embankment water conservancy project more comprehensively and systematically, which is good for the development of the embankment water conservancy project and can make the embankment water conservancy project truly promote the agricultural production and income increase and serve the people.

1. Introduction

The rapid development of agriculture in our country has greatly benefited from the embankment water conservancy projects (Vine et al., 1999; Vine, and Sathaye, 1999). The construction of embankment water conservancy projects will provide strong guarantee for the high output of agricultural products, stable production, higher income of farmers and social stability (Vine and Sathaye, 2000; Byles, 2005). However, with the increase of population in our country and the improvement of production technology, the agricultural industry is further subdivided (Newman, 2009; Choi et al., 2015), the input and output of embankment water conservancy projects are getting more attention, and its economic and environmental benefits have become important research contents (Byles et al., 2006). Much research has been done at home and abroad (Dougherty, 1998; WB et al., 1998; Wei et al., 2016; Byles et al., 2005). However, the indexes in the performance evaluation study mainly reflect the economic benefits of the project as well as specific parameters of the project such as irrigation area, channel length and water supply capacity, etc., as for whether these would really convert into benefits and bring about the increase of the output and quality of agricultural products or other impacts on the environment or society (Kelnert and Silva 1994; Whittington, 1996; Martinez, 1993), there hasn't scientific and systematic evaluation yet (Kelnert and Silva, 1994; Whittington, 1996; Martinez, 1993; Houria et al., 2017).

This paper systematically analyzes various aspects involved in the construction and operation management of embankment water conservancy project, constructs an evaluation index system, and then uses the expert scoring method and the analytic hierarchy process (AHP) to determine the index weights, based on the rating of the scores to determine the comprehensive performance results, and conducts benefit evaluation of the embankment water conservancy projects on the economics, social, environment, technology and other aspects. This study aims to promote the construction unit to establish the concept of performance, promote the people to participate in the project supervision, promote the development of embankment water

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conservancy, make the embankment water conservancy project really promote the increase in agricultural production and income, so as to serve the people.

2. Construction of evaluation index system

In order to comprehensively reflect the current status and development trend of embankment water conservancy projects, reliable data needs to be obtained to fully reflect all aspects of the subject under evaluation. Therefore, when building an evaluation index system, it should be scientific and comprehensive, with clear boundaries between indexes and not overlap each other. At the same time, it is necessary to take all aspects of the construction and operation management of embankment water conservancy projects into consideration.

According to relevant requirements of the state's performance evaluation, this paper selects evaluation contents from 5 aspects to divide into indexes and elements, the details are shown in Table 1.

Table 1: Performance evaluation indexes

Evaluation content	Index	Element
Implementation	finacial index	the availability of funds
		the accomplishment of investment
		the allocation of funds
		grant and notes
		reports and data
Economy	agricultural production	yield increasement of per mu
		cost reduction of per mu
Technology	technology of construction	construction technology and process
		quality of equipment and raw material
		selective of technology and equipment
Environment	benefit to ecology	enhancement of utilization rate of resources
		the agricultural disaster reduction ability
		improvement of farmers' living condition
		ability to resist the loss of land
Society	social stability	condition changes of cadres and masses
		the satisfaction of farmers to the construction
		the satisfaction of farmers to the mangement system after construction
		the transfer of rural labor force

3. Determination of the weight of indexes

In the process of evaluation, AHP is usually used to decompose complex system problems and analyze the elements of decomposition to give different weight, so as to accurately and reasonably evaluate the impact of different indexes on the assessment object. AHP is shown in Figure 1.

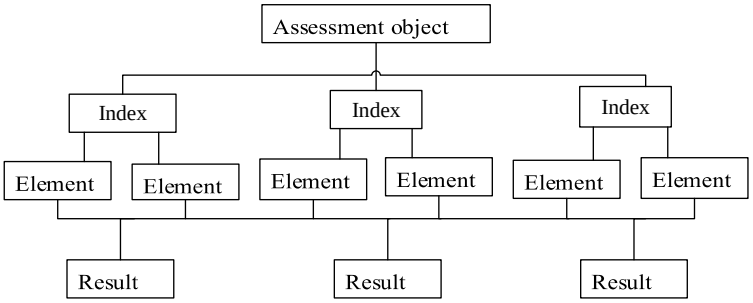

Figure1: Structural diagram of AHP

3.1 Construction of judgment matrix

Set the weight of B_i in *A* as $\omega i = \omega(B_i)$, marked as ω=($\omega 1, \omega 2, \omega 3$), T is weight vector.

Table 2: Importance of $B_i$compared with B_j

Degree of importance of B_i and B_j	$f(B_i/B_j)$	$f(B_j/B_i)$
B_i and B_j are of equal importance	1	1
B_i is slightly importance than B_j	3	1
B_i is obviously important than B_j	5	1
B_i is severely important than B_j	7	1
B_i is absolute important than B_j	9	1
The importance between each level	2，4，6，8	1

Set $b_{ij} = \frac{f(B_i/B_j)}{f(B_j/B_i)}$ (i, j = 1,2,3) (1)

Then the judgment matrix is:

$$B = \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{bmatrix} \quad (2)$$

By obtaining B's maximum eigenvalue and the corresponding eigenvector $\mathrm{X} = (x_1, x_2, x_3)^T$, the qualitative question is turned into a quantitative question. After normalization processing we can get the weight vector x_1^*, x_2^*, x_3^*, where $X_1^* = {X_i}/{\sum_{j=1}^{3} X_j}$ $(i = 1,2,3)$.

3.2 Rationality of the matrix

By introducing the degree of incompatibility $CI = {\lambda_{min} - n}/{n-1}$, the rationality of the matrix is judged.
At that time when $CI = 0$, B is exactly the same, *C(B)* is close to 0, the consistency of *A* is satisfying.

3.3 Calculation of evaluation index weight

Invite five experts to determine the importance of each index, and then use Matlab to find the eigenvalues and eigenvectors of the elements to determine the weight of the indexes.

3.3.1 Evaluation of target weight

The order of evaluation of target weight is: economy = society> environment> implementation> technology, the judgment matrix is:

$$B = \begin{bmatrix} 1 & 1/5 & 3 & 1/3 & 1/5 \\ 5 & 1 & 7 & 2 & 1 \\ 1/3 & 1/7 & 1 & 1/6 & 1/7 \\ 3 & 1/2 & 6 & 1 & 1/2 \\ 5 & 1 & 7 & 2 & 1 \end{bmatrix} = (0.0781, 0.3427, 0.0385, 0.198, 0.3427)$$

3.3.2 Weight of the elements

The indexes include the financial index under the implementation performance; the agricultural production under the economy performance; the technology of construction under the technology performance; the benefit to ecology under the environment performance; and the social stability under the society performance.

(1) Implementation performance

The importance of the elements under the financial index is: the availability of funds> the accomplishment of investment>the allocation of funds>grant and notes>data and reports.
B11=(0.4567,0.3064,0.1407,0.058,0.0382)

(2) Economy performance

For the elements under the agricultural production index, the yield increasement of per mu and the cost reduction of per mu are equally important.

(3) Technology performance

The elements under construction technology index are all equally important.

(4) Environment performance

The importance of elements under the benefits to ecology index is: enhancement of utilization rate of resources> the agricultural disaster reduction ability> improvement of farmers' living condition> ability to resist the loss of land.

$$B_{41} = (0.6396, 0.2063, 0.0938, 0.0602)$$

(5) Social benefits

The importance of elements under the social stability index is: condition changes of cadres and masses> the satisfaction of farmers to the construction> the satisfaction of farmers to the mangement system after construction> the transfer of rural labor force.

$$B_{51} = (0.5222, 0.1998, 0.1998, 0.0781)$$

3.3.3 Compatibility test

By calculating the consistency coefficient CR of each index matrix, we can get following results in the table:

Table 3: Coefficient of consistency of each index matrix

matrix	CR	matrix of assessment object	CR	Matrix of index	CR
Final target	0.0009	Implementation	0.0001	usage of fund	0.0010
		Economy	0.0042	agricultural production	0.0002
		Technology	0.0001	technology of construction	0.0001
		Environment	0.0000	benefit to ecology	0.0018
		Society	0.0001	Social stability	0.0001

As can be seen from the table, all CR are less than 0.1. Therefore, the compatibility of index matrix is good, the results can be used for further calculation.

3.3.4 Calculation of the combination weight

The weight of each evaluation index is shown in Table 4.

Table 4: Weight of performance evaluation index of farmland water conservancy project

assessment object	weight	index	weight	element	weight
Implementation	0.0780	finacial index	0.05858	the availability of funds	0.0269
				the accomplishment of investment	0.01805
				the allocation of funds	0.0081
				grant and notes	0.0033
				reports and data	0.0023
Economy	0.03426	agricultural production	0.0401	yield increasement of per mu	0.020
				cost reduction of per mu	0.020
Technology	0.0386	technology of construction	0.0256	construction technology and process	0.0085
				quality of equipment and raw material	0.0085
				selective of technology and equipment	0.0084
Environment	0.1979	benefit to ecology	0.1486	enhancement of utilization rate of resources	0.0945
				the agricultural disaster reduction ability	0.0306
				improvement of farmers' living condition	0.0138
				ability to resist the loss of land	0.0088
Society	0.3426	Social stability	0.2857	condition changes of cadres and masses	0.1490
				the satisfaction of farmers to the construction	0.0570
				the satisfaction of farmers to the mangement system after construction	0.0570
				the transfer of rural labor force	0.0224

3.3.5 Test of consistency of combination

According to the calculation formula of consistency of combination, by using Matlab software we can calculate to get CR(2)=0.0011,CR(3)=0.0043,CR(4)=0.00046,CR(s)=0.0058<0.1, which are in line with the requirement of consistency.

4. Rating of evaluation

This paper uses four levels evaluation, with 4,3,2,1 corresponding to excellent, good, medium and poor. Calculate the comprehensive performance index:

$$\mathrm{K} = \sum_{i=1}^{36} \overline{\omega}_i P_i \tag{3}$$

Where, P_i represents the score of each evaluation index, according to the obtained scores, we can determine the rating for the evaluation target.

Table 5: Hierarchical List of accomplishment of performance

level	excellent	good	medium	poor
score	>3.5	[3.5,2.5)	[2.5,1.5)	<1.5

5. Test of evaluation model

According to the constructed evaluation system, the model test was carried out with the water-saving project of embankment water conservancy project in a county in Guangxi Province.

5.1 Project overview

The total irrigation area of this project is 260km^2. The actual irrigated area is 130,000 mu, and the proportion of agricultural population in the irrigated area to the total population is 65%. The main channel length is 107km, the anti-lining reconstruction is 33km; 330 canal structures and 249 were renovated. 1 reinforced drain, about 2km long. Adding 10 sets of inlet flow meter and 1 set of controlling system. 2 new management rooms were built. Investment budget is 23 million yuan, the Central Government allocates 34% of the total funds, and the provincial finance allocates 28% of the funds, the rest is financed by the county finance and the beneficiary townships.

5.2 Performance Evaluation

5 experts were invited to give scores, the arithmetic average of each item is taken as the final score for each index, then according to formula 3, we calculate this project's performance evaluation comprehensive index as: 3.4976, which is basically excellent. The evaluation of indexes is shown in the following table:

Table 6: Results of evaluation

		implementation	economy	technology	environment	society
$\sum \overline{\omega}_i P_i$		0.2932	1.022	0.1338	0.7609	1.2877
analytic	scoring	3.7542	2.9822	3.4753	3.8429	3.7575
$\sum \overline{\omega}_i P_i / \overline{\omega}_i$						
analytic scoring		excellent	good	good	excellent	excellent

As can be seen from the above table, during the process of implementation, this project can use various funds, purchase equipment and complete the project according to the plan, the project's implementation performance is excellent. In addition, the project has had satisfactory results in improving the ecological environment and enhancing social services. However, there is still room for improvement in economic and technical benefits. After reviewing the data and researching, it is found that the project still has some deficiencies in reducing the production cost. The agricultural planting environment has little impact on the farmers' income. Therefore, we still need to actively carry out the adjustment of agricultural structure and improve the actual output efficiency of the agricultural industry.

6. Conclusion

Based on systematic analysis of the characteristics of embankment water conservancy project, this paper comprehensively considers the engineering technology, implementation process and economic input in the project implementation process from the perspective of project construction cycle management. At the same

time, it also takes into account the project's influence on ecological environment and social benefits to construct the comprehensive evaluation system. Expert scoring method and AHP were used for determine the weight of each index so as to give systematic evaluation of the embankment water conservancy project. The method was applied to embankment water conservancy project in a county in Guangxi province. The study concluded that:

(1) The index selected by this evaluation method covers the whole process of project construction and operation, including both qualitative indexes and quantitative indexes, and the content evaluated is more comprehensive and practical, which can give more comprehensive and systematic evaluations to the embankment water conservancy project.

(2) By using example, we test the constructed evaluation system, the evaluation results can reflect the influence of the project on the project area after its completion and point out the key points that need further improvement and enhancing.

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