Application of Comprehensive Evaluation System for Government Ecological Audit using Computational Intelligence Algorithms

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Abstract. Government ecological audit has a major influence on our sustainable economic and social development. The comprehensive evaluation of government ecological audit becomes increasingly important as the deterioration of ecological environment. Thus, it is great significance to set up scientific evaluation system of government ecological audit. Firstly, a present condition of government ecological audit is discussed, and a computational process is used to make the evaluation system more integrated. Secondly, a practical evaluation system of government ecological audit is presented to establish the model in comprehensive evaluating process. Then, an evaluation example of government ecological audit is proposed by using computational intelligence algorithms of analytical hierarchy process (AHP). Finally, some policy recommendations are made to strengthen the establishment of evaluation system for government ecological construction performance audit in this paper.

1. Introduction

As economy and society develops, people require more for government's high ability of ecological protection. With the destruction of ecological environment, government ecological audit is of great urgency to ensure the sustainable development of human beings. At present, China government is extending the investment of ecological audit departments by exploring new auditing methods and theory. The main functions of government ecological audit include ecological economic supervision, identification, evaluation and responsibility[1]. Moreover, the accountability of ecological audit should develop with the government responsibility expansion to the maximum extent. Government ecological audit can provide guarantee for the environment fund running because it needs a great amount of resources to construct the Eco-environment and to control industrial pollution. Thus, the changes of ecological environment shall be analyzed first for the future evaluation system of government ecological audit[2]. China government audit should change direction to ecological auditing because of the efficiency problem of the government funds usage and ecological environmental protection. It is imperative to change separation between government and ecological audit in face of auditing information distortion. The backward in ecological auditing theory and technic is an important factor of the formation of evaluation risk in a great extent[3].

On the other hand, building a harmonious ecological audit system and the implementation of comprehensive evaluation has practical significance. In order to evaluate local leading cadre economic...
responsibility audit, the department of government ecological audit ought to organize the audit system to improve the performance audit work. To analyze and study evaluation system of government ecological audit is necessary to improve the systematic structure and comprehensive ecological benefit\[4\]. In order to realize the sustainable development of economy and environment, a comprehensive evaluation system of government ecological audit should be made available on time\[5\]. The key countermeasure is the view of government ecological audit that regards ecology as basic evaluation basis and the ecological benefit as the objective. Moreover, the way of perfecting government ecological audit evaluation liability to investigate the mechanism of our country from correlation environmental protection system\[6\]. The evaluation system based on computational intelligence algorithms of AHP method and ecological audit theory was elaborated in this paper.

The paper is organized as follows. The approved evaluation system of government ecological audit based on AHP approach is described in Section 2. And the framework and computation steps of AHP theory are demonstrated in the next. In Section 3, an illustrative example of government ecological audit in China is provided in order to assess the science and rationality of comprehensive evaluation system. At last, this paper makes some useful conclusions through the analysis about the realistic data and the calculating results.

2. Comprehensive Evaluation System of Government Ecological Audit

The importance of evaluation of government ecological audit was presented, and the evaluation system and the evaluation process were demonstrated by AHP approach. Comprehensive evaluation of government ecological audit to achieve the accurate evaluation results is a dynamic process, so we must establish a more scientific and reasonable index system to describe this evaluation process. A scientific evaluation system is to get most ecological economic benefit \[7\]. The government ecological economic value was estimated tentatively with ecological resource quality indicators and main ecologic function. In this paper, an evaluation process of AHP approach is shown in Figure 1.

![Evaluation process of AHP approach](image)

**Figure 1.** Evaluation process of AHP approach

More, AHP is a computational intelligence algorithm with qualitative analysis and quantitative analysis. Based on the effect of expert group, AHP model has high efficiency and practice. The comprehensive evaluation system of AHP was built based on quantitative analysis and ecological audit evaluation of system process\[8\]. Because of AHP modification of no-consistency judgment matrixes
with automatic computer implementation, it has been applied extensively in a lot of professions[9].

Referred to the government ecological audit assessment framework, this study assesses the ecological economic value in China based on ecological audit theory and AHP approach. Next, this study briefly presents the basic steps and sequencing theory in solving real problems by AHP approach[10].

(1) Construction of judgment matrix in various levels

The AHP method of pairwise comparison of factors to establish a pairwise comparison matrix by taking two factors \( H_i \) and \( H_j \) each time, using \( a_{ij} \) to represent the ratio of influence of \( H_i \) and \( H_j \) to \( Z \), using \( A = (a_{ij})_{n \times n} \) represents all the comparison results, saying that \( A \) is a pairwise comparison judgment matrix between \( Z \)-A. If the ratio of \( H_i \) and \( H_j \) to \( Z \) is \( a_{ij} \), then the ratio of \( H_j \) to \( H_i \) on \( Z \) is \( a_{ij} \), then the ratio of \( H_i \) to \( H_j \) on \( Z \) was shown in the following:

\[
A = (a_{ij})_{mn}, a_{ij} > 0, a_{ij} = 1/a_{ij}
\]

(1)

Then, the evaluation system is more impersonal and comprehensive if results of many factor contrast scale were used. And the factor contrast scale is shown in Table 1.

| Number | The meaning of the abbreviation                      |
|--------|------------------------------------------------------|
| 1      | Representing two factors is of equal importance      |
| 3      | The former is slightly more important than latter    |
| 5      | The former is obviously more important than latter   |
| 7      | The former is more important than latter             |
| 9      | The former is more important than latter             |
| 2, 4, 6, 8 | Represents the median of adjacent judgments     |

(2) Ordering single level with synthetic level

If the maximum eigenvalue \( \lambda_{\text{max}} \) of judgment matrix \( A \), then the corresponding eigenvector is:

\[
\omega = (w_{11}, w_{21}, \ldots, w_{n1})^T
\]

(2)

(3) Performing consistency check

Combined with AHP questionnaire towards experts, the index weight and check the consistency of data was calculate in the following:

\[
CI = \lambda_{\text{max}} / (n - 1)
\]

(3)

(4) Calculating the value of \( RI \)

In order to calculating the value of \( RI \), we can get the complete data structure.

(5) Computing conformance ratio

We have completed the steps required to create an index system. The conformance ratio of \( CR \) is defined below.

\[
CR = CI / RI
\]

(4)

Where \( CR < 0.1 \), it is accepted that the consistency of the judgment matrix is acceptable.

(6) Ordering comprehensive evaluation index

The weight value of each index in this layer can be calculated in following formula.

\[
\omega_x = w_{x1} / \sum_{i=1}^{n} w_{i1}, x = 1, 2, \ldots, n
\]

(5)
Besides, we can investigate the comprehensive evaluation index through the analysis of various influence factors and the weight value of each index.

3. Application
The emphasis of this study is put on dividing evaluation index of government ecological audit, establishing the evaluation system and the process for quality level of any single factor. The index system for evaluating the effects of government ecological audit in China as an example was discussed in this study. The comprehensive evaluation system of government ecological audit is shown in the following. The comprehensive evaluation system of government ecological audit is shown in Figure 2.

![Comprehensive evaluation system of government ecological audit](image)

**Figure 2.** Comprehensive evaluation system of government ecological audit
Moreover, the evaluation system of ecological audit system performance was presented by the analysis of different influence factors. So, the evaluation system of government ecological audit combining with the facts of China was established. In addition, this paper evaluates the government ecological audit sustainability based on AHP model. It found out the way to evaluate the government ecological system by the operation of the audit management procedure. Next, the first-level and second-level target relative important degree and weight value can be calculated based on AHP structure judgment matrix. The relative important degree and weight value is shown in Table 2.

**Table 2.** Relative important degree and weight value

|   | A      | B      | C      | D      | E      |
|---|--------|--------|--------|--------|--------|
| A | 1      | 1      | 1/2    | 4      | 1      |
| B | 1      | 1      | 2      | 9      | 1      |
| C | 2      | 1/2    | 1      | 7      | 3      |
| D | 1/4    | 1/9    | 1/7    | 1      | 1/5    |
| E | 1      | 1      | 1/3    | 5      | 1      |

Then, the complementary judgment matrices can be calculated with a group preference matrix.

$$A = \begin{pmatrix}
1 & 1 & 1 & 1 & 1 \\
1 & 1 & 1/2 & 4 & 1 \\
1 & 1/2 & 2 & 9 & 1 \\
2 & 1 & 1/2 & 1 & 7 \\
1/4 & 1/9 & 1/7 & 1 & 5/1 \\
1 & 1 & 1/3 & 5 & 1
\end{pmatrix}$$

(6)

The largest eigenvalue and its eigenvector were computed.

$$\lambda_{max} = 5.3001$$

(7)

The start feasible basic was determined by using main element in according to AHP theory.

$$W = (-0.3628, -0.6043, -0.6082, -0.0735, -0.3576)^T.$$  

The value of index weight of $CI$ was calculated:

$$CI = \frac{\lambda_{max} - n}{n - 1} = \frac{5.3001 - 5}{5 - 1} = 0.0750$$

(8)

Where $n=5$, $RI = 1.12$.

Then, the consistency ratio of $CR$ can be calculated in the following:

$$CR = \frac{CI}{RI} = \frac{0.0750}{1.12} = 0.0670$$

(9)

Where $CR<0.10$, so the judgment matrices have consistency.

Next, the weight of each evaluation index was given as:

$$\omega_i = \frac{w_i}{\sum_{i=1}^{n} w_i} = \frac{-0.3628}{2.0064} = 0.1808$$

(10)

So similarly, we can get the following results.

$$\omega_A = 0.3012, \omega_B = 0.3031, \omega_C = 0.0367, \omega_E = 0.1782$$

(11)

Based on AHP, the mutual weight and total weight of each index can be calculated in similar ways.
Figure 3. The arrangement graph of comprehensive evaluation index system

So, we can make the decision-making more scientific and accurate by using the comprehensive evaluation system of government ecological audit which is shown in Figure 3. Based on Figure 3, we can get the result that the third evaluation indicator is resource environmental dispute ($C_4$) is the maximal influencing factor layer, then is misuse rate ($C_2$) and surface water quality ($B_3$).

4. Conclusions
Based on computational intelligence algorithms, an evaluation system of government ecological audit information sources was presented in this paper. According to the approved evaluation of index system of the AHP approach combined with the actual data situation, the advantages comprehensive evaluation system of government ecological audit was presented in this paper. Moreover, the evaluation system and method of government ecological audit was analyzed by using literature study and computational intelligence algorithms. The research of this study has a positive effect to promote the government ecological audit evaluation system in accordance with the actual circumstance. Furthermore, the approved computational intelligence algorithms of AHP method can be also used to the evaluation of measured data for other government ecological audit system.

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