# Construction of a Sustainable Development Evaluation Model for Hydraulic Engineering Projects Based on Association Rules and Big Data

Jing Zhao[1], Xiuqian Yang[2*]

[*]Corresponding author's e-mail: 17102225@qq.com

School of Hydraulic Engineering, Guangxi Vocational College of Water Resources and Electric Power, Nanning Guangxi 530023, China[1]
School of Information Engineering, Guangxi Vocational College of Water Resources and Electric Power, Nanning Guangxi 530023, China[2]

**Abstract.**The current conventional water conservancy project sustainability evaluation model mainly uses principal component analysis to select suitable evaluation indicators, which leads to poor evaluation due to the lack of analysis of the relevance of evaluation indicators. In this regard, a sustainable development rating model for hydraulic Engineering projects based on association rules and big data is proposed. The rating index system is built in a hierarchical way, and association rules are constructed by mining frequent item sets, and the importance of evaluation indexes is analyzed using association rules, and different weight values are assigned to the indexes. The evaluation of sustainable development of hydraulic Engineering projects is realized by calculating the comprehensive rating index. In the experiments, the proposed model was verified for evaluation accuracy. The experimental results show that the sustainable development evaluation model constructed by the proposed method has a small error value of the evaluation index of the model and has a high evaluation accuracy.

**Keywords:** Association rules; Big data technology; Water engineering; Sustainable development; Evaluation models

## 1. Introduction

The evaluation of the sustainability of hydraulic Engineering projects can not only provide a positive reference for the construction of the same type of hydraulic Engineering projects, but can also accurately predict the actual level of development of the current hydraulic Engineering projects, so that the shortcomings in the management and operation of hydraulic Engineering projects can be identified and optimized and improved, thus continuously improving the actual effectiveness of hydraulic Engineering projects [1]. At the same time, the water conservancy project long-term development evaluation results can also provide reliable information for decision makers to help them make further decisions on the development of hydraulic Engineering projects, not only to improve the level of project investment decisions, but also to help the decision-making department to continuously optimize the decision conclusions and improve the reliability of the decision results.However, due to the lack of reasonable analysis and discussion of evaluation indicators in the process, each evaluation indicator has the same degree of importance to the final evaluation result, thus affecting the

ICBBEM 2023, May 19-21, Hangzhou, People's Republic of China

DOI 10.4108/eai.19-5-2023.2334258

final evaluation effect [2-3]. In this regard, this paper analyzes the importance of evaluation indexes by constructing association rules, so as to give different weight values to each index and achieve accurate evaluation.

## 2. Hydraulic engineering sustainable development evaluation index system construction

Based on the analysis of the above principles of evaluation indexes, the long-term development rating index system of hydraulic Engineering projects is shown in Table 1, which includes three levels of indicators, namely, total evaluation index, main evaluation index and group evaluation index.

**Table 1.** Evaluation system for sustainable development of hydraulic projects

| Tier 1 Indicators | Secondary Indicators | Indicator Number | Tertiary Indicators |
|---|---|---|---|
| Sustainable development level of water engineering | Water Security | A1 | Water supply penetration rate |
| | | A2 | Popularity of piped water |
| | Water management security | B1 | Popularity of water self-governance management |
| | | B2 | Rate of water projects meeting standards |
| | | B3 | Project completion rate |
| | Water resources security | C1 | Effective irrigation rate |
| | | C2 | Drainage water utilization rate |
| | | C3 | Guarantee rate of water supply sources |
| | | C4 | Rate of unified water resources management |
| | Water Environmental Protection | D1 | Total Pollutant Discharge Control Rate |
| | | D2 | Soil erosion control rate |
| | | D3 | Water supply water quality standard rate |
| | Water science and education development | E1 | Degree of water informationization |
| | | E2 | Contribution rate of water resources science and technology |
| | | E3 | Professional and technical personnel allocation ratio |

## 3. Analysis of the importance of sustainability evaluation indexes of hydraulic Engineering projects based on association rules

Association rules can analyze the correlation between different things. After constructing the evaluation index system for development of hydraulic Engineering projects, this paper uses association rules to analyze the importance of the constructed evaluation indexes in order to improve the evaluation accuracy and to determine the weight of the indexes to achieve objective evaluation. [4-9]. The first step is to mine the frequent items set to construct the association rules for the evaluation indexes of long-term development of hydraulic Engineering projects.

First of all, the set of frequent items of water resources engineering sustainability evaluation index is mined, for which the minimum support degree and the minimum confidence degree are calculated, and the specific formula is shown formula (1-2).

$$Supper(A,B)_{\min} = \frac{|D_{A\cup B}|}{D} = P(A\cup B) \tag{1}$$

$$Confinence(A,B) = \frac{|D_{A\cup B}|}{D_A} = P(B|A) \tag{2}$$

Where, $Supper(A,B)_{\min}$ represents the minimum support, $D_{A\cup B}$ represents the number of tuples in which both evaluation indicator A and evaluation indicator B appear, $D$ represents the total number of tuples in the set of evaluation indicators, which can be used to characterize the representativeness and importance of the association rules. $Confinence(A,B)_{\min}$ $D_A$ represents the number of tuples containing only Evaluation Indicator A.

## 4. Water conservancy project long-term development evaluation model construction

By combining the hierarchical analysis method and the construction principles of long-term development indicators, the evaluation indicator system is constructed by selecting suitable evaluation indicators and completing the importance analysis of the evaluation indicators, and then combining the evaluation indicators. On the basis of this paper, the weights of each evaluation indicator are assigned by combining the association rules, and the results of the evaluation indicator weights obtained are shown in Table 2.

**Table 2.** Table of evaluation index weights

| Secondary indicators | Weight allocation value | Tertiary Indicators | Weight allocation value |
|---|---|---|---|
| Water Security | 0.24 | Tap water penetration rate | 0.3 |
| | | Drinking water quality standard rate | 0.3 |
| | | Flood control and drainage project | 0.4 |

| | | | |
|---|---|---|---|
| | | standardization rate | |
| Water management security | 0.16 | Popularization rate of water self-governance management | 0.46 |
| | | Standard rate of hydraulic Engineering projects | 0.26 |
| | | Project completion rate | 0.28 |
| Water resources security | 0.25 | Effective irrigation rate | 0.3 |
| | | Drainage water utilization rate | 0.25 |
| | | Guarantee rate of water supply sources | 0.25 |
| | | Rate of unified water resources management | 0.24 |
| Water environment protection | 0.20 | Total pollution discharge control rate | 0.21 |
| | | Soil erosion control rate | 0.26 |
| | | Water supply source water quality standardization rate | 0.28 |
| Water science and education development | 0.15 | Degree of water informatization | 0.46 |
| | | Contribution rate of water resources science and technology | 0.2 |
| | | Professional and technical staffing ratio | 0.4 |

According to the above evaluation index weight values, the evaluation index of long-term development of hydraulic Engineering projects is calculated, and the specific calculation formula is shown formula (3).

$$N = \sum_{i=1}^{n} a_k N_k = \sum_{i=1}^{n} a_k \sum_{i=1}^{mk} b_{ki} X_{ki} \quad (3)$$

$N$ represents the development level evaluation indicator, $N_k$ represents the evaluation indicator when the evaluation indicator is K, $n$ represents the total number of evaluation indicator elements, $a_k$ represents the weight value of the second level evaluation indicator and the third level evaluation indicator, $b_{ki}$ represents the weight value of the third level evaluation indicator under the second level evaluation indicator, $X_{ki}$ represents the evaluation indicator of the third level evaluation indicator under the second level evaluation indicator, $m$ represents the number of the third level evaluation indicator under the second level evaluation indicator. The number of evaluation indicatores under the second level evaluation indicatores. The evaluation indicatores of the five second-level indicators are calculated according to the above formula, and then the comprehensive evaluation indicator is weighted as shown formula (4).

$$N_{total} = \frac{N_1 + N_2 + N_3 + N_4 + N_5}{m} \quad (4)$$

$N_1, N_2, N_3, N_4, N_5$ represents the evaluation indices for each of the five different secondary evaluation indicators, and $N_{total}$ represents the overall evaluation indicator. In order to accurately evaluate the sustainability of water resources projects, in addition to calculating the overall evaluation indicator, this paper also sets different evaluation criteria for the development stages of water resources projects. In this paper, the evaluation results are divided into five levels from the initial financing stage to the final completion stage according to the overall evaluation indicator, as shown in Table 3.

**Table 3.** Classification criteria for the evaluation level of long-term development of hydraulic Engineering projects

| Water Resources Engineering Development Grade | Comprehensive evaluation index |
|---|---|
| Financing stage | ≤0.25 |
| Initial stage | 0.2-0.40 |
| Development Stage | 0.40-0.65 |
| Mature stage | 0.65-0.80 |
| Realization Stage | ≥0.80 |

By substituting the calculated comprehensive evaluation indicator for the level of development of hydraulic Engineering projects into the above classification criteria, the different comprehensive evaluation indices are matched with the evaluation levels to obtain the development stage of the long-term development level of the water conservancy project under study, thus completing the evaluation of the level of development of hydraulic Engineering projects.

## 5. Experiment and analysis

### 5.1. Experimental preparation

In order to prove that the water resources engineering sustainability evaluation model based on association rules and big data proposed in this paper is better than the conventional water resources engineering sustainability evaluation model in terms of practical evaluation effect, after the theoretical part of the design is completed, an experimental part is constructed to test the practical evaluation effect of this model. In order to ensure the effectiveness of the experiment, two conventional water resources engineering sustainability evaluation models were selected for comparison, namely, the fuzzy evaluation model and the principal component analysis based model.

The experimental object is a water conservancy project in a certain area, and the technical parameters of different items under the water conservancy project are retrieved as the original data set for this experiment. The main component of the hydraulic project is the diversion type adjustable hydropower station. The main generating units of the hydropower station are the turbine and generator, and the specific technical parameters of the two units are shown in Table 4.

**Table 4.** Technical parameters of hydropower units

| Water turbines | | Generators | |
|---|---|---|---|
| Model | HL 190-LJ-142 | Model | SF17.5-10-200 |
| Quantity | 2 | Quantity | 2 |
| Rated output power | 18.23MW | Rated capacity | 17.5MW |
| Rated flow rate | 17.25m3 /s | Rated voltage | 10.12KV |
| Rated speed | 600r/min | Rated speed | 600r/min |

### 5.2. Analysis of test results

The comparison standard selected for this experiment is the evaluation accuracy of different models for the long-term development level of hydraulic Engineering projects, and the specific measurement index is the error value of the evaluation index obtained by different rating models, the lower the value represents the higher the evaluation accuracy of the model, the specific experimental results as Figure 1.

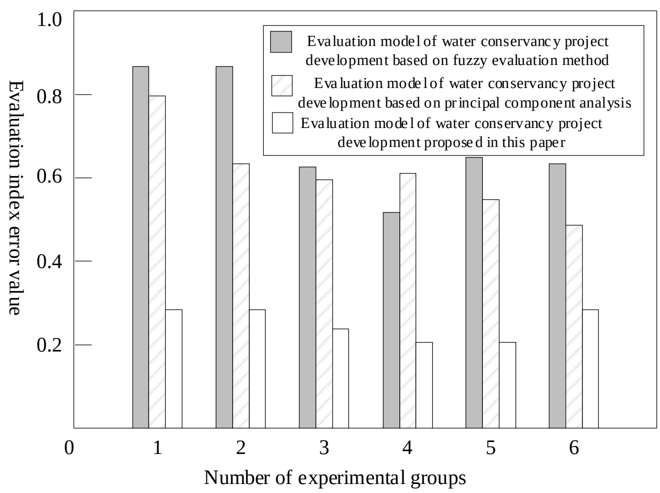


**Figure 1.** Evaluation index error comparison results

As shown in Figure 1, the above experimental results show that the evaluation accuracy of different evaluation models differs when evaluating sustainability for different water conservancy project data. It is obvious from the numerical comparison that the evaluation index error value of the proposed association rule-based and big data-based long-term development rating model for hydraulic Engineering projects is significantly lower than that of the two conventional methods, with the lowest evaluation error value not exceeding 0.3%. In contrast, the evaluation model composed of two conventional methods is significantly less accurate in evaluating the long-term development level of hydraulic Engineering projects, with the lowest error value above 0.8%, which proves that the evaluation model proposed in this paper is more advantageous in terms of evaluation accuracy.

## 6. Conclusion

In this paper, a new long-term development rating model for hydraulic Engineering projects is proposed by combining association rule theory and big data technology to address the problem of poor diagnostic accuracy of conventional fault diagnosis models for building lightning protection systems. The evaluation index system is constructed by analyzing the construction principles of sustainability indicators and the specific evaluation requirements. On this basis, the importance of the evaluation indicators is analyzed using association rules, and the weights of the evaluation indicators are set. The evaluation model proposed in this paper has been proved to have higher rating accuracy and can be applied in the actual water conservancy project evaluation research work.

## References

[1] Rajasoundaran S, Prabu A V, Routray S, et al. Secure routing with multi-watchdog construction using deep particle convolutional model for IoT based 5G wireless sensor networks[J]. Computer Communications, 2022, 187:71-82.

[2] An Y, Zhou H . Short term effect evaluation model of rural energy construction revitalization based on ID3 decision tree algorithm[J]. Energy Reports, 2022, 8:1004-1012.

[3] Fu H . Optimization Study of Multidimensional Big Data Matrix Model in Enterprise Performance Evaluation System[J]. Wireless Communications and Mobile Computing, 2021, 2021(2):1-12.

[4] Tong C, Zhang Y, Zhou M, et al. Online Monitoring Data Processing Method of Transformer Oil Chromatogram Based on Association Rules[J]. IEEJ Transactions on Electrical and Electronic Engineering, 2022, 17(3):354-360.

[5]M Bannae-Sharifian, Arasteh H, Jabari F, et al. A biogas-steam combined cycle for sustainable development of industrial -scale water-power hybrid microgrids: design and optimal scheduling[J]. Biofuels, Bioproducts and Biorefining, 2022, 16(1):172-192.

[6] Liu X, Liu H, Wan Z, et al. Study on evaluation index system of sustainable development of mine water resources based on PSO-AHP model and fuzzy comprehensive evaluation[J]. Journal of Intelligent and Fuzzy Systems, 2021(4):1-12.

[7] Goss D . Writing for Clean Water and Sanitation: Accelerating Momentum Toward the UN Sustainable Development Goals Through Action Research[J]. Prompt A Journal of Academic Writing Assignments, 2021, 5(1):42-53.

[8] Wang X, Wang Z, Jia J, et al. Quantitative evaluation of sustainable development ability of deep buried geothermal water coupled with key index factors[J]. Energy Sources Part A Recovery Utilization and Environmental Effects, 2021(6):1-18.

[9] Wu A, Chen C . Mining Positive and Negative Association Rules of Relational Data in Distributed Database[J]. Computer Simulation,2021(5)344-347,352.