

Comprehensive Evaluation of Distribution Network Project Cost Management Effectiveness Based on Big Data

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ABSTRACT

Due to the particularity of distribution network, its engineering construction management is very important. According to the content and characteristics of distribution network project cost management, this paper first establishes the effectiveness evaluation index system of distribution network project cost management, comprehensive analysis method is used to establish the evaluation model, and then the effectiveness of distribution network project cost management is comprehensively evaluated by the combination of comprehensive evaluation and big data. It provides a scientific, reasonable and effective method for evaluating the effectiveness of distribution network project cost management, and also analyzes the important aspects of distribution network cost management, providing guidance for improving distribution project cost management.

Keywords: *Distribution Network Project, Cost Management Effectiveness, Big Data, Comprehensive Evaluation*

1. INTRODUCTION

Distribution network is a very important public infrastructure to serve the society, and a key link to ensure the quality of power supply, improve the efficiency of power grid operation and innovate customer service. With the development of cities, the scale and complexity of power grid construction increase, and the management of distribution network project becomes more difficult. Since 2015, the government has made a series of arrangements for the construction and renovation of the distribution network. The National Development and Reform Commission has clearly put forward the development goal of modern distribution network which is suitable for building a well-off society in an all-round way. The new round of electric power system reform requires electric power related enterprises to strengthen cost supervision, improve operation efficiency, and promote the sustainable and high-quality development of electric power industry. However, there are still some problems in the cost management of distribution network project, and the effectiveness is difficult to measure. With the wide application of big data [1-3], in this paper the effectiveness of distribution network project cost management is studied, and the management level is determined through comprehensive evaluation by big data, so as to provide guidance for distribution network project cost management.

2. ESTABLISHMENT OF EVALUATION MODEL

2.1 Cost Management Effectiveness Index System

The construction process of distribution network project mainly includes four stages: project approval, start preparation, site construction and completion acceptance. Distribution network project cost management refers to the systematic activities of predicting, calculating, determining and controlling the project cost and its variation in order to realize the expected target of distribution network project investment under the condition of existing planning and design scheme. Distribution network project has the characteristics of large investment capital, large number of projects, small size of single unit and short construction period, which brings great challenges to the cost management of distribution network project. The main work of distribution network project cost management includes feasibility study to estimate at decision stage, preliminary design estimate and construction drawing budget in the design stage, bidding price limit and list in the bidding stage, design change and visa fee in the construction implementation stage, completion settlement and final settlement in the completion stage, etc. According to the whole process cost management content of distribution network

project, and in accordance with the principle of comprehensive coverage, systematization and scientific rationality, the effectiveness index system of distribution

network cost management is formulated, as shown in the following table 1.

Table 1. Cost management effectiveness index system

The target layer	Primary index	Secondary index	Quantitative index
Comprehensive evaluation of distribution network engineering cost management effectiveness	Management effectiveness at decision stage	Research and initial integrated management	Integrated application rate of preliminary design
		Feasible estimation management	Quality of feasibility study estimate
	Management effectiveness at design stage	Preliminary design budget management	Preliminary design estimate quality
		Construction drawing budget management	Construction drawing budget quality
	Management effectiveness of bidding phase	Management of bidding Methods	Rationality of bidding method
		Bill of quantities and bidding limit price management	Correctness of preparation
		Contract signing management	Contract compliance
	Management effectiveness of construction implementation phase	Project advance payment management	Advance payment specification rate
		Progress payment management	Specification rate of progress payment
		Quantity management	Change rate of quantities
		Design change and on-site visa management	Change visa fee level
		Contract price adjustment management	Price adjustment proportion
	Management effectiveness of the completion phase	Completion settlement management	Completion settlement standard rate
		Management of financial accounts	Accuracy of financial accounts
		Cost data management	Data integrity
		Accounting supervision and management	Settlement supervision rate

2.2 Evaluation Steps

2.2.1 Analytic Hierarchy Process

The analytic hierarchy process (AHP) is one of the effective methods to determine the evaluation weight. It is particularly perfect for complicated problems that are very difficult to analyze with quantitative indexes. It divides the elements of a complex problem into interrelated and ordered hierarchies. According to the fuzzy judgment of the actual situation, the relative importance of all levels is shown, and the weight coefficients of the relative importance order of all elements are determined by mathematical method. Its specific steps include : (1) the determination of objectives and evaluation factors. (2) Use the scale method of 1-9 and its reciprocal to construct the judgment matrix. (3) Calculate the weight and check [4-8].

2.2.2 Fuzzy Comprehensive Evaluation Method

The method of fuzzy comprehensive evaluation is to construct grade fuzzy subset first, then quantify the fuzzy index of the evaluated thing, and synthesize each index by using fuzzy transformation principle. The result of fuzzy comprehensive evaluation is a vector containing rich information, which is more scientific and reasonable. It can not only represent the object accurately, but also can be further processed to obtain more useful information [9-10].

The factors of the object and the theory domain of evaluation grade is determined.

(2) After constructing graded fuzzy subsets, the evaluated objects should be quantified one by one from each factor, and fuzzy relation matrix can be obtained:

$$R = \begin{bmatrix} R & | & u_1 \\ R & | & u_2 \\ \dots & & \dots \\ R & | & u_p \end{bmatrix} = \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1m} \\ r_{21} & r_{22} & \dots & r_{2m} \\ \dots & \dots & \dots & \dots \\ r_{p1} & r_{p2} & \dots & r_{pm} \end{bmatrix}_{p,m} \quad (1)$$

(3) This paper uses AHP to determine the relative importance order among evaluation indexes.

(4) Fuzzy comprehensive evaluation results and analysis

The fuzzy comprehensive evaluation result of all evaluated object is obtained by combining weight vector and fuzzy relation matrix with appropriate operator.

$$u = \{u_1, u_2, \dots, u_6\} = \left. \begin{array}{l} \text{Management effectiveness at decision stage,} \\ \text{Management effectiveness at design stage,} \\ \text{Management effectiveness of bidding phase,} \\ \text{Management effectiveness of construction implementation phase,} \\ \text{Management effectiveness of the completion phase} \end{array} \right\} \quad (3)$$

3.1.3 Determine the Grading Theory Domain of Comments

To determine the grading theory domain of comments is to establish the evaluation set v .

$$v = \{v_1, v_2, v_3, v_4\} = \{\text{Very good, Good, Average, Poor}\} \quad (4)$$

3.1.4 Calculation of Index Weight

The weight of the primary index and the secondary index is obtained by AHP. The 1-9 scale method was adopted and the judgment matrix was calculated according to the arithmetic mean value after scoring by 10 technical and economic experts, as follows:

$$S = \begin{bmatrix} 1 & 0.33 & 2 & 0.2 & 0.2 \\ 3 & 1 & 2 & 0.2 & 1 \\ 0.5 & 0.5 & 1 & 0.33 & 0.2 \\ 5 & 5 & 3 & 1 & 2 \\ 5 & 1 & 5 & 0.5 & 1 \end{bmatrix} \quad (5)$$

3. COMPREHENSIVE EVALUATION OF COST MANAGEMENT EFFECTIVENESS BASED ON BIG DATA

3.1 Determine Index Weight

3.1.1 Determine the Evaluation Object Set

$$P = \{\text{Distribution network engineering cost management effectiveness}\} \quad (2)$$

3.1.2 Construct Evaluation Factor Subset

The ranking results of analytic hierarchy process have excellent consistency. It means taht the distribution of weight coefficients is quite effective, and the final weight is: $A = (0.08, 0.16, 0.07, 0.43, 0.26)$.

Then construct the judgment matrix of each secondary index, calculate the maximum characteristic root and consistency test, and get the reasonable weight coefficient. Finally, the weight of each index is shown in the following table 2.

According to the comprehensive weight of secondary index, engineering quantity management, design change and on-site visa management are the most important, while bidding management and contract signing management are the least important. Therefore, the cost management should focus on strengthening the process management and design change and on-site visa management in the construction implementation stage.

Table 2. Weight of cost management effectiveness index

The target layer	Primary index	Weight	Secondary index	Comprehensive weight
Comprehensive evaluation of distribution network engineering cost management effectiveness	Management effectiveness at decision stage	0.08	Research and initial integrated management	0.03
			Feasible estimation management	0.05
	Management effectiveness at design stage	0.16	Preliminary design budget management	0.08
			Construction drawing budget management	0.08
	Management effectiveness of bidding phase	0.07	Management of bidding Methods	0.01
			Bill of quantities and bidding limit price management	0.04
			Contract signing management	0.02
	Management effectiveness of construction implementation phase	0.43	Project advance payment management	0.03
			Progress payment management	0.03
			Quantity management	0.12
			Design change and on-site visa management	0.13
			Contract price adjustment management	0.11
	Management effectiveness of the completion phase	0.26	Completion settlement management	0.13
			Management of financial accounts	0.06
			Cost data management	0.04
			Accounting supervision and management	0.04

3.2 Fuzzy Comprehensive Evaluation Based on Big Data

3.2.1 Construct Fuzzy Judgment Matrix Based on Big Data

The model established can evaluate the cost management effectiveness of provincial or municipal distribution network projects. Constructing fuzzy judgment matrix based on big data mainly includes three processes.

The first is to collect data through process documents, existing databases, direct reporting, or other channels with scribe data collection tools, web crawler technology, and data sensing technology. The second is

to store and process the data, and establish a standard database through data screening, supplement, deletion of redundancy, standardization, etc. Based on Map Reduce programming model, H Base database and HDFS distributed file system, Hadoop massive data processing platform is adopted to realize data management and storage and provide basic guarantee for data analysis and evaluation. The third is to analyze and mine the data. Descriptive statistics and correlation analysis can be used to make statistical analysis of the evaluation of secondary quantitative index, and visualization technology can also be used to show the evaluation of secondary indicators in charts. Finally, the fuzzy judgment matrix is constructed and the final evaluation conclusion is drawn, shown in the following Fig 1.

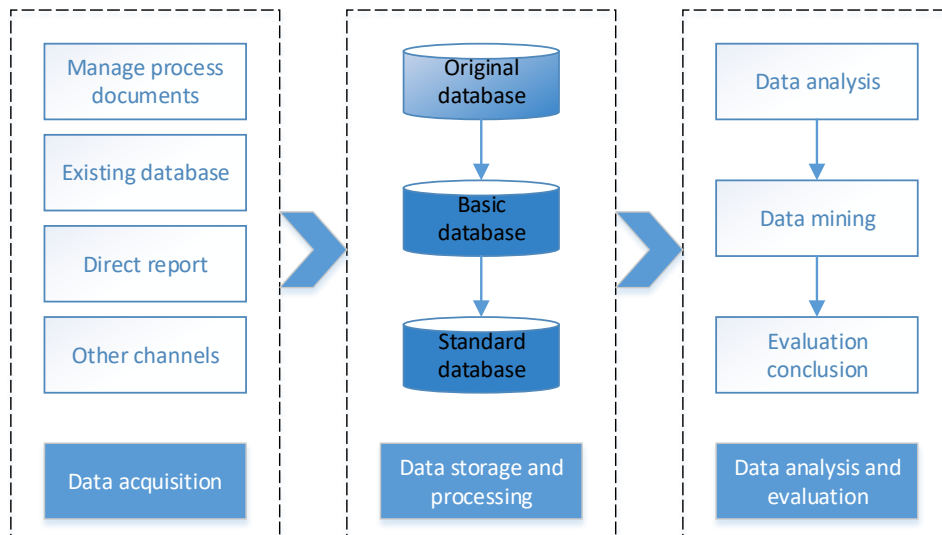


Fig 1. Fuzzy Comprehensive Evaluation Based on big data

3.2.2 Comprehensive Evaluation

On the basis of the comprehensive weight of the secondary index and the single factor fuzzy evaluation judgment matrix, the weighted average method is adopted to get the comprehensive evaluation results, and then based on the maximum membership criteria, judge the effectiveness of distribution network project cost management.

4. CONCLUSIONS

According to the content and characteristics of distribution network project cost management, this paper establishes the evaluation index system of distribution network project cost management effectiveness, including the management effect at the decision-making, design, bidding, construction implementation stage and the completion stage. The effectiveness evaluation model of distribution network project cost management is established by comprehensive analysis method, and then the comprehensive evaluation of distribution network project cost management effectiveness is effectively realized by using big data through data acquisition, data storage and processing, data analysis and evaluation and other processes. This paper establishes a scientific and reasonable evaluation model of distribution network project cost management effectiveness. It also analyzes the important aspects of distribution network cost management, that is, engineering quantity management and design change and on-site visa management. In view of the above management, it is necessary to further standardize the content, responsibility and process of the key links of construction management, prevent the occurrence of risks, and constantly improve the level of standardization of management, so as to achieve good management effects.

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