Research on the Quality Evaluation of China's Infrastructure Engineering Cost Consulting Services Based on COWA-FCE Method

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Abstract. With the development of the times, cost consultancy has gradually become an equally important professional consulting service as design and supervision, etc. It is of great practical significance to carry out service quality evaluation of infrastructure project cost consultancy for lean cost control of infrastructure projects. In this paper, a multi-dimensional three-level evaluation index system is designed based on the characteristics of infrastructure project cost consulting services, and then the service quality evaluation of an infrastructure project cost consulting is carried out based on the COWA weighting algorithm and the fuzzy comprehensive evaluation method, and the evaluation results are analysed. The evaluation results prove that the COWA-FCE method proposed in this paper has good applicability for evaluating the service quality of infrastructure engineering cost consulting services.

Keywords: COWA weight · fuzzy comprehensive evaluation method · infrastructure engineering · cost consultancy · service quality

1 Introduction

Infrastructure projects play an important role in China's engineering projects, which are related to the development of the national economy and the quality of life. There are many existing studies on service quality evaluation, but there are few studies on the evaluation of the service quality of capital construction cost consultation. Some similar studies on service quality evaluation have very important reference significance for the evaluation construction of this article. Cao Haijun et al. [1] constructed a five-dimensional service quality evaluation index system for the government data open platform, and applied TOPSIS model to conduct empirical research on the service quality of each sample platform. Xin-XinLiu et al. [2] proposed a research framework for online service quality evaluation and service improvement based on the sensitivity analysis of short-term and short-term memory networks. Ecem Tumsekcali et al. [3] established a model for evaluating the public transport system during the pandemic, modeled the evaluation model

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as a multi-criteria decision-making problem, and used the weighted sum product evaluation method under the integrated WASPAS interval-valued intuitionistic fuzzy (IVIF) environment using AHP (analytic hierarchy process). Majid Nojavan et al. [4] studied a mixed fuzzy method for performance evaluation of educational institutions based on service quality, which can effectively improve the service quality of educational institutions. S. Hemalatha et al. used SERVQUAL tool to evaluate the service quality of container terminal operators, prepare a customized questionnaire for 20 enabling factors in five dimensions of service quality, and use TOPSIS and GRP methods to evaluate the service quality of container terminals.

It can be found from the above literature research that the evaluation of service quality is concentrated in the transportation industry. The methods are mainly analytic hierarchy process (AHP) and fuzzy evaluation method. The content of evaluation is mainly the evaluation system established for customer service satisfaction and grading indicators. After comparing various evaluation methods, this paper uses COWA weighting method and fuzzy comprehensive evaluation method to evaluate the quality of cost consulting services. According to the characteristics of cost consulting services, a multi-level evaluation index system is constructed in different dimensions, and the main index weighting methods are compared and analyzed. The COWA operator weighting method is used as the index weighting method in this paper to calculate the weight of each evaluation index for the quality of cost consulting services. The main comprehensive evaluation methods are compared and analyzed, and the fuzzy comprehensive evaluation method is used to evaluate the quality of cost consulting services.

2 Evaluation Index System for the Quality of Infrastructure Construction Cost Consulting Services

The quality of capital construction cost consultation service includes multiple dimensions and involves many key points. It is very important to determine the appropriate evaluation index system. Through collecting the service content of the cost consulting unit and consulting the relevant service evaluation documents, this paper has determined the evaluation index system, as shown in Table 1, 2 and 3.

3 Evaluation Methodology

3.1 COWA Weighting Method

This paper studies the traditional commonly used weighting methods and finds that the principal component analysis method, factor analysis method and entropy method need enough actual sample data, but the evaluation indicators in this paper are mostly qualitative indicators, so it is difficult to collect the actual sample data, so the objective weighting method is not used to calculate the index weight. The analytic hierarchy process, Delphi method and TOPSIS method have strong personal subjective color. This paper has many indicators and is divided into multiple levels. The subjective judgment is easy to affect the weight results. OWA (Ordered Weighted Average) was proposed by American scholars Yager and Filev. The principle of this method is to process the sample

Table 1. Evaluation index system for the quality of infrastructure project cost consulting services

Level I index	Level II index	Level III index	Level I index	Level II index	Level III index
Performance evaluation of work	Quality of work	Reliability of audit basis	Performance evaluation of work	Achievements and Innovations	Relevant standard-setting experience
		Accuracy of work content			Experience of relevant thesis results
		Integrity of work content			Innovation at work
		Reasonableness of work content	Performance evaluation of contract fulfillment	Quality of Service	Timeliness of feedback on major issues
		Specification of work content			Speed of problem solving
		Integrity of the audit materials			Communication skills
		Accuracy of the audit process			Staff service attitude
		Accuracy of the outcome documents		Team configuration	Professionalism of personnel
		Insightfulness of the outcome documents			Professional staffing
		Standardization of results output			Staff mobility
		Degree of professionalism in opinion			Degree of organizational soundness
	Timeliness of service	Carrying out field work			Construction of office space
		Timeliness of work			
		Reasonableness of the work schedule			

(*continued*)

Table 1. (*continued*)

Level I index	Level II index	Level III index	Level I index	Level II index	Level III index
		Legal compliance of the service process			

Table 2. Results of evaluation indicator scores

Evaluation indicators	Rate the value	Evaluation indicators	Rate the value
Reliability of audit basis a_1	7.3	Legal compliance of the service process a_{15}	8.7
Accuracy of work content a_2	8.1	Relevant standard-setting experience a_{16}	7
Integrity of work content a_3	7.5	Experience of relevant thesis results a_{17}	4.7
Reasonableness of work content a_4	7.5	Innovation at work a_{18}	6.6
Specification of work content a_5	6.7	Timeliness of feedback on major issues a_{19}	8.1
Review the completeness of thematerial a_6	7.3	Speed of problem solving a_{20}	7.3
Accuracy of the audit process a_7	6.6	Communication skills a_{21}	7
Accuracy of the outcome document a_8	8.2	Staff service attitude a_{22}	6.4
Insightfulness of the outcome document a_9	7.1	Professionalism of personnel a_{23}	7
Standardization of results output a_{10}	7.2	Professional staffing a_{24}	7
Degree of professionalism in opinion a_{11}	6.9	Staff mobility a_{25}	5.5
Carrying out field work a_{12}	6.4	Degree of organisational soundness a_{26}	6.5
Timeliness of work a_{13}	6.4	Construction of office space a_{27}	6.5
Reasonableness of the work schedule a_{14}	6.5		

Table 3. Summary table for evaluation of quality of cost consultancy services for infrastructure project

Target level	Score	Dimensional level	Score
Quality of infrastructure construction cost consultancy services S	7.0295	Performance evaluation of work A_1	7.1067
		Performance evaluation of contract fulfillment A_2	6.8732

data by weighting, rearrange the maximum and minimum values, avoid the impact of extreme evaluation on the weight results, and weaken the subjective color of individuals [6] At present, this method has been applied in many research fields [7–10]. Chinese scholars have improved the data aggregation form on the basis of the ordered weighted average operator OWA, and proposed a variety of variations of the OWA operator. In this paper, the Combined Ordered Weighted Average (COWA) operator, referred to as COWA operator, is selected, and the COWA weighting method is adopted.

3.2 Fuzzy Comprehensive Evaluation Method

Because this paper selects the COWA operator weighting method to determine the index weight, while the fuzzy comprehensive evaluation method can make the qualitative indicators quantitative to build correlation with the parameters at all levels when selecting the operator and determining the membership function, and can effectively deal with the problem of the explicit extension of the key domain connotation and the best practice, to maximize the objectivity of the evaluation value. So that the evaluation results can better reflect the overall characteristics of the whole process of cost consultation service quality evaluation. Therefore, this paper chooses the fuzzy comprehensive method as the comprehensive evaluation method of the whole process cost consultation service quality evaluation.

4 Case Studies

4.1 Data Sources and Processing

In this paper, the State Grid Corporation of China's capital construction project cost consulting service was selected as a case. At first, 10 experts in the professional field were invited to grade the importance of 27 third-level indicators and the corresponding two first-level indicators. The result score was 0.5 points as the minimum unit, and the value range was 1–5. After that, the cost consulting service quality of this project is evaluated and scored according to the performance of the cost consulting team in the process of providing consulting services and the final consulting results in the infrastructure project cost consulting project through the industry survey. After the evaluation criteria are defined, the evaluation results of 27 three-level indicators are obtained from 10 insiders. The result score is 1 point as the minimum unit, and the value range is 1–9, Count the number of different scores of the same indicator to form the evaluation set corresponding to the indicator set.

4.2 Service Quality Evaluation

4.2.1 Determine Indicator Weights by COWA Operator Weighting Method

(1) Reorder the scores in descending order for each indicator to obtain the processed indicator vector.
(2) Calculate the weighted vector w

$$w = (0.0019531, 0.0175781, 0.0703125, 0.1640625, 0.2460938, 0.2460938, 0.1640625, 0.0703125, 0.0175781, 0.0019531)$$

(3) Combining the calculated values of the weighting vector w, the absolute weights of the evaluation indicators can be obtained according to equation

$$\bar{w}_1 = 3.965\bar{w}_2 = 4.617\bar{w}_3 = 4.118\bar{w}_4 = 4.117\bar{w}_5 = 4.036\bar{w}_6 = 4.535\bar{w}_7 = 3.617\bar{w}_8 = 3.427\bar{w}_9 = 3.499$$

$$\bar{w}_{10} = 4.250\bar{w}_{11} = 3.285\bar{w}_{12} = 3.091\bar{w}_{13} = 4.383\bar{w}_{14} = 3.750\bar{w}_{15} = 4.617\bar{w}_{16} = 3.259\bar{w}_{17} = 2.989\bar{w}_{18} = 3.337$$

$$\bar{w}_{19} = 4.118\bar{w}_{20} = 3.917\bar{w}_{21} = 3.741\bar{w}_{22} = 4.250\bar{w}_{23} = 4.626\bar{w}_{24} = 4.117\bar{w}_{25} = 2.841\bar{w}_{26} = 3.167\bar{w}_{27} = 3.250$$

(4) Determine the relative weights based on the absolute weights

$$a_1 = 0.0576\, a_2 = 0.0670\, a_3 = 0.0598\, a_4 = 0.0598\, a_5 = 0.0586\, a_6 = 0.0658\, a_7 = 0.0525\, a_8 = 0.0497\, a_9 = 0.0508$$
$$a_{10} = 0.0617\, a_{11} = 0.0477\, a_{12} = 0.0449\, a_{13} = 0.0636\, a_{14} = 0.0544\, a_{15} = 0.0670\, a_{16} = 0.0473\, a_{17} = 0.0434\, a_{18} = 0.0484$$
$$a_{19} = 0.1210\, a_{20} = 0.1151\, a_{21} = 0.1099\, a_{22} = 0.1249\, a_{23} = 0.1359\, a_{24} = 0.1210\, a_{25} = 0.0835\, a_{26} = 0.0931\, a_{27} = 0.0955$$
$$A_1 = 0.6694\, A_2 = 0.3306$$

4.2.2 Determination of Quality Evaluation Score by Fuzzy Comprehensive Evaluation Method

4.3 Analysis of Evaluation Results

According to experience, the quality grade corresponding to the score of the target layer is shown in Table 4.

Compared with Table 4, the quality of cost consultancy services for this infrastructure project is 7.0295, which is at a better level in terms of overall level, with a score of 7.1067

Table 4. Levels of quality

Rate the value	Quality grade
$M \geq 8$	Excellent
$6 \leq M < 8$	good
$4 \leq M < 6$	General
$2 \leq M < 4$	Poor
$M < 2$	Very poor

for performance evaluation of work and a score of 6.8732 for performance evaluation of contract fulfillment, both of which are at a better level.

From the specific three-level indicators, the accuracy of work content a_2, the accuracy of outcome documents a_8, the legal compliance of the service process a_{15} and the timeliness of feedback on major issues a_{19} scored more than 8 points and performed outstandingly, which indicates that the accuracy of the audit of the service content, the standardization of the service process and the timeliness of feedback on major issues of this consultancy in the process of cost consulting services have been recognized by the majority of the industry.

The indicators for relevant publications a_{17} and staff mobility a_{25} are less than 6 points, indicating that the consultancy's relevant publications and staff mobility are lacking and need to be further improved.

5 Conclusions of the Study

By consulting the development history of the project cost consultation, this paper studies the current situation of the project cost consultation service market, summarizes the existing characteristics and outstanding problems of the cost consultation service, and confirms the necessity of implementing the quality evaluation of the cost consultation service. The main conclusions of this paper are as follows.

(1) The evaluation index system of multi-dimensional and multi-level engineering cost consultation service is constructed.

Based on the actual situation, this paper constructs a three-level project cost consulting service quality evaluation index system including two dimensions of performance evaluation and performance evaluation. The index system covers a wide range of areas, is reasonably set, and is suitable for evaluation and analysis.

(2) Use COWA weighting method and fuzzy comprehensive evaluation method to evaluate service quality.

This paper takes the evaluation of the quality of the cost consulting service of a certain infrastructure project as an example, by inviting experts to score the importance of the indicators, making statistics on the evaluation and scoring of the various indicators of the cost consulting service by industry insiders, and combining the COWA weighting method and the fuzzy comprehensive evaluation method, comprehensively evaluating the cost consulting service of the project. After obtaining the evaluation results, the indicators were analyzed at different levels, and the analysis results confirmed the applicability of the research methods in this paper.

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