Application research of the project bid evaluation model based on MATLAB

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Abstract. Bid evaluation, an important part of bidding activities, is the most critical part to determine the quality of bidding. For large volume and complex technology projects, the comprehensive evaluation method is usually used in China. It is known that the selection of bid evaluation method has a great influence on the quality of bidding. In the face of the basic situation of China, although the comprehensive evaluation method is basically competent for the bidding work, it still has the defects of human factors in the evaluation of the bid. Therefore, it is essential to improve the bidding evaluation method. This paper mainly evaluates the bid evaluation activities of construction projects based on the comprehensive weighted evaluation method. Through the accumulation of relevant theoretical and practical research results, the author sorts out the advantages and disadvantages of various evaluation methods and analyzes the scientificity, fairness, and practicability of the established project bidding as well as the evaluation model in the evaluation of bidders through the actual project bidding and evaluation case. Combined with the mathematical model and case analysis, the bid evaluation activity is solved by the computer program, and the conventional bid evaluation results and the mathematical model evaluation results are compared to get more accurate bid evaluation results.

Keywords: engineering project, bid evaluation, model, MatLab.

1. Introduction

In recent years, because of the project bidding system and the supervision method, the trading market of bidding activities in the construction project field is still chaotic, which makes the advantages of the bidding system not exert the maximum benefit. Therefore, it is of great significance to improve the bidding evaluation method to ensure a fair process and result of bidding evaluation.

The main research content of this paper is based on the evaluation of bid evaluation activities of construction projects by the comprehensive weighted evaluation method. Through the program operation of bid evaluation models, including the A-STRL cross efficiency evaluation model, the DGcluster analysis model, etc., the results of different operations are summarized into A reliable ranking sequence of candidates, offering tenderers with a scientific and reasonable decision basis.

Through literature review and a case study, based on the current situation of the bidding market in China, this paper analyzes the advantages and disadvantages of common bid evaluation methods, as well as the scientificity, fairness, and practicability of the established project bidding and evaluation model in the evaluation of bidders through the actual project bidding and evaluation case, providing some reference value for bid evaluation decision-making and making the market bidding environment

fairer. Through the study of this paper, the unreasonable behavior of bid evaluation activities in certain procedures can be avoided, which is an effective means of standardized management of bidding activities. This paper can further improve the application of mathematical statistics methods and computer application technology in the field of engineering construction, which is conducive to promoting the scientific nature of construction engineering management.

2. An overview of bid evaluation methods

Bid evaluation means that bid evaluators or bid evaluation institutions conduct qualification and value evaluation of bidders' bids, review, analyze, and compare bid documents, reject unqualified bids, and evaluate the merits and demerits of qualified bids according to relevant regulations and bid evaluation procedures, methods, and standards clearly stipulated in the bidding documents. A number of bidders with a higher bid value are recommended as candidates for the bid. The bid evaluation method refers to the tenderer evaluating the value of the bidder's bid, so as to determine the winning bidder's thoughts and principles.

2.1. Common bid evaluation methods

Since reforming and opening, the tender field of China has obtained swift and violent development. Due to the multiple management of various departments and localities, there is some confusion in the naming and application of bid evaluation methods. For example, according to the 12th Decree of seven ministries and commissions, the bidding methods are the lowest bid price method and the comprehensive evaluation method. In addition, the bid evaluation methods stipulated by the Ministry of Housing and Urban-Rural Development, the Ministry of Transport, the Ministry of Finance, and the Ministry of Water Resources are different, such as the double envelope method, the shortest fee period method, the two-stage bid evaluation method, and the life period cost evaluation method. Bid evaluation methods are varied and multifarious, and the application conditions and the scope differ greatly. According to the Tendering and Bidding Law, bid evaluation methods can be roughly divided into the comprehensive evaluation method and the reasonable minimum bid price evaluation method [1].

2.1.1. Comprehensive evaluation method. The Bidding Law stipulates that the winning bidder should "be able to meet the comprehensive evaluation criteria specified in the bidding documents to the maximum extent. The comprehensive evaluation method derived from this article is an evaluation method based on system norms to evaluate bidders at multiple levels and units at the same time [2]. The method of comprehensive evaluation is to quantify each evaluation factor in a unified standard, and its quantitative index can be in the form of scores or money. This quantitative value enables bidders to visually compare their bid documents.

2.1.2. Reasonable minimum bid price evaluation method. The Bidding Law stipulates that the winning bidder should "be able to meet the substantive requirements of the bidding documents, and the lowest bid price after evaluation, except where the bid price is lower than the cost. Therefore, the lowest bid evaluation method is a bid evaluation method that evaluates the qualification of non-price factors of bidders, and then arranges the price factors from high to low on the basis of the qualification evaluation [3].

2.2. Advantages and disadvantages of the comprehensive evaluation method

2.2.1. Advantages of the comprehensive evaluation method. First, the concept of the weight value is introduced [4]. In this way, non-price factor indicators that are difficult to be expressed by the amount value can be quantified and scored by bid evaluation experts to make the evaluation index results more scientific [5]. Second, it is helpful to give play to the role of experts of evaluation index and prevent improper behavior effectively.

2.2.2. Disadvantages of the comprehensive evaluation method. First, human factors have a great influence. Giving too many rights to bid evaluation experts will inevitably result in the influence of human factors. Second, subjective factors account for a large proportion of bid evaluation. The determination of the weight of the bid evaluation index and the evaluation of the index are too dependent on the evaluation experts, which makes the evaluation inevitably subjective. Therefore, it is not easy to achieve the scientific justice of the bid evaluation index and its weight value.

2.3. Advantages and disadvantages of the reasonable minimum price evaluation method

2.3.1. Advantages of the reasonable minimum price evaluation method. First, the index weight setting is objective and the bid evaluation is less affected by subjective factors, which can effectively prevent the breeding of corruption [6]. Second, the bid evaluation process is simple and can effectively save the cost of the project. A free competition mechanism of the market can be formed, so that the fittest construction enterprises can survive, thus forcing enterprises to improve the level of labor productivity, the way of management, and economic benefits. Third, project costs can be saved, because the construction unit can use the least money to buy the desired products and services.

2.3.2. Disadvantages of the reasonable minimum price evaluation method. First, the application is in a small scope. It is only applicable to small engineering projects with a small volume, low technology content, and a short construction period, which are less affected by non-price factors. Second, there is a hidden danger of a late crisis. Because the socialist market economic system and construction enterprise credit market information are not perfect, the construction enterprise can not be effectively restrained in the process of engineering construction. Some construction enterprises do not consider their own level of productivity. They lower the price so that it can be borne by themselves. In the subsequent project construction stage, they increase the amount of the project costs to gain profits, and even leave the project incomplete, harming the interests of the tenderee. Third, the quality cannot be guaranteed. Although the lowest price can be guaranteed, the best quality cannot be guaranteed.

3. Case analysis

3.1. Basic Information of the case

A dormitory project adopts the way of public bidding. According to the regulations, the construction unit prepares bidding documents and carries out bidding activities according to the actual situation of the project. Bidders A, B, C and three construction units participate in the bidding.

Table 1. Bidding quotation and technical table of the construction unit expert evaluation.

serial number	Project	unit A	unit B	unit C	weight
1	Business standard	/	/	/	/
1.1	Subdivision project quotation (million)	3880	3830	3900	0.3
1.2	Measure project cost quotation (million)	530	545	560	0.1
1.3	Other project fees quoted (million)	205	198	220	0.1
1.4	Financial status of construction unit in recent three years (points)	95	88	95	0.1
2	Technical standard	/	/	/	/
2.1	Construction scheme (points)	90	92	90	0.1
2.2	Construction organization design (points)	93	88	89	0.05
2.3	Unit performance (points)	95	93	91	0.05
2.4	Construction period (day)	274	293	288	0.05
2.5	Registered capital (100 million yuan)	1.5	1.3	1.2	0.05

Table 1. (continued).

| 2.6 | Equipment of construction machinery (points) | 95 | 91 | 90 | 0.05 |
| 2.7 | Safe and civilized construction measures (points) | 95 | 93 | 93 | 0.05 |

3.2. Comprehensive weighted evaluation method

A comprehensive weighted evaluation was carried out on the evaluation indicators [7], and the calculation results were as follows:

Table 2. Evaluation table of bidders.

serial number	Project	unit A	unit B	unit C	weight
1	Business standard	/	/	/	/
1.1	Subdivision project quotation (million)	92	98	96	0.3
1.2	Measure project cost quotation (million)	96	94	82	0.1
1.3	Other project fees quoted (million)	98	84	61	0.1
1.4	Financial status of construction unit in recent three years (points)	95	88	95	0.1
	Business standard comprehensive weighted score	56.5	56	52.6	/
2	Technical standard	/	/	/	/
2.1	Construction scheme (points)	90	92	90	0.1
2.2	Construction organization design (points)	93	88	89	0.05
2.3	Unit performance (points)	95	93	91	0.05
2.4	Construction period (day)	86	90	96	0.05
2.5	Registered capital (100 million yuan)	100	87	77	0.05
2.6	Equipment of construction machinery (points)	95	91	90	0.05
2.7	Safe and civilized construction measures (points)	95	93	93	0.05
	Technical standard comprehensive weighted score	37.2	36.3	35.8	/
	Composite score	93.7	92.3	88.4	/

Through comprehensive weighted evaluation of all evaluation indicators, when two-stage bid evaluation is adopted [8], the ranking order of business bid is A>B>C and the ranking order of the technical standard is A>B>C. When the two-stage bid evaluation [9] is not distinguished, the ranking order of the comprehensive score [10] is A>B>C.

3.3. DEA model result and analysis

Through the analysis and comparison of the DEA mathematical model [11], the A-StrL crossover efficiency evaluation model [12] and the DGcluster cluster analysis model [13] are intended to be used for calculation and analysis.

When the A-StrL cross efficiency evaluation model is adopted, the ranking order is C>B>A through MatLab calculation. When the DGcluster analysis model is used, the ranking order is A>C>B through MatLab calculation.

According to the above calculation results, A can be selected as the first place, B as the second place, and C as the third place. Because the analysis method is not unique, the results are not unique. Each method can only be a reference.

4. Conclusion

This paper introduces the research, development, and application of bidding activities at home and abroad. By programming the two models of DEA in MATLAB software, and analyzing the calculation results, the final order of winning candidates is obtained. This paper can help avoid the unreasonable

behavior of bid evaluation activities in certain procedures, which is an effective means of standardized management of bidding activities.

Through the study of this paper, the application of mathematical statistics methods and computer application technology in the field of engineering construction can be further improved, which is conducive to promoting the scientific nature of construction engineering management.

However, this paper still needs to be further improved. For different projects with different emphases, for instance, a project that pays attention to new technology or a project that pays attention to traditional design, different bid evaluation systems should be designed. It is a future research direction to perfect the application of the model to describe the relationship of various factors in an engineering construction project with accurate mathematical expression.

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