Improvement Research of Effective Lowest Price Bid Evaluation Method of Construction Engineering Project of China

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Abstract: This paper is put forward with median value as the benchmark, via optimization and validation of the median value promote the Effective of Effective Lowest Price Bid Evaluation method, and hope it is have reference value for engineering bidding practice of China.

Keywords: effective Lowest Price Bid Evaluation method, median, mean.

1. Introduction

Effective lowest price method, which is based on the qualification review of bidders, distributes the offers of all bidders from high to low deleting the highest and lowest offers proportionally and averages the rest offers. Then, it gets rid of a certain proportion of the highest and lowest quotations and calculates the mean value of remaining quotations. On the basis of the average score, the quotations fluctuate in a certain percentage to determine the effective range. The quotations in this range are treated as being valid and the winning bidder is determined by taking the lowest quotation. In theory, this method is perfect because it saves money to the greatest degree and the tender can maximize their benefits.In practice, not only is it simple, convenient but also it requires no complex operating procedures and tender production process, which will save the transaction costs. In addition, it helps restrain corruption, reduce black-box operation, and promote firm management, which can improve project quality and firm reputation. However, due to the imperfections of the current market economy in China, there are many limitations in practice, such as the unreasonable rules of price control, the uncertainty of evaluation basis, and the excessive complexity of the list review and so on. The most important problem is that the mean value method is easily affected by dispersed values (Chen, 2011). In some illegal situations such as irrational units quotations, together-conspired bidding and contacting bidding , the calculated average price based on the mean value method will be far away from its market access quotation. Thus, how to eliminate the outliers to determine the most cost-effective corporate is of particular importance. On the basis of above, this paper analyzes the effectiveness of current effective

lowest bid evaluation method in China based on the construction of engineering project bidding market in Hefei Province. Median value method is put forward in this paper, and the coefficient of skewness and coefficient of dispersion is introduced to optimize and validate median value method in order to improve effectively the lowest bid evaluation method for reference of engineering bidding practice.

2. Empirical Analysis of Effectiveness

In order to prove the effectiveness and practicality of effective lowest price bid evaluation method, this paper collects relevant data of construction engineering project bidding from 2009 to 2014 of Hefei city,for empirical analysis of effectiveness of effective lowest price bid evaluation method .

2.1 Conceptual Model

For empirical analysis of effectiveness, three aspects of data are required: First, all quotations come from tender of all projects and the data of the winning bidder. Second, the data of project site field survey, including the data of the result of final acceptable project such as the assessment of the quality of projects and the construction period. Third, the data of final accounts price of project.

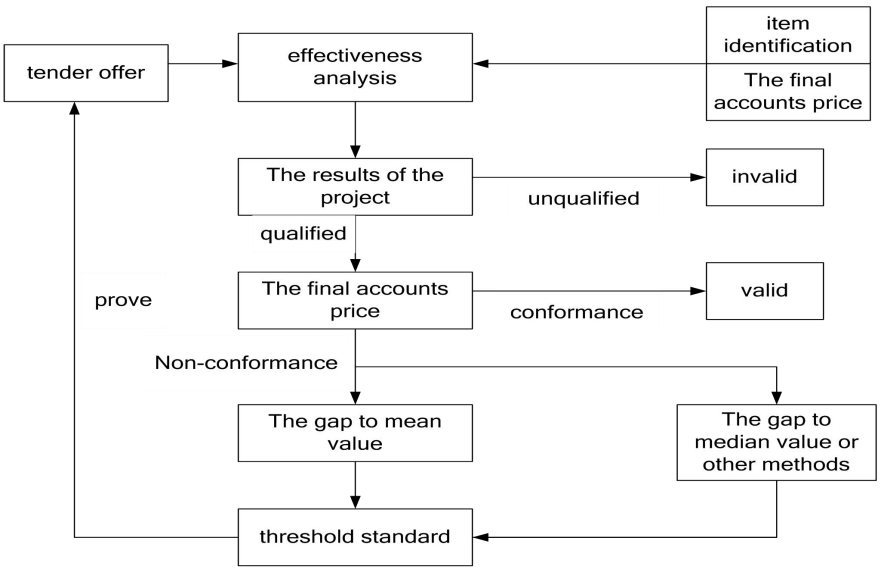

Figure 1 Conceptual Model of Empirical Analysis of Effectiveness

Based on the conceptual model, the main ideal of empirical analysis of effectiveness as follow: Firstly, if the results of the project are unqualified, in other words,the project does not meet the expected requirements or have to require more time, we can determine that the bidder does not well fulfill contract and evaluation of the work of corporate is invalid. If the identical results are qualified, we can enter the second stage. Secondly, we can make a compare between the final accounts price of the accounts department and the bid price of the bidding winner. If the two are the same price, or float in a reasonable range, it indicates that bid price of the bidding winner is valid. If the final accounts price far away from the successful bid price, we can focus on the average price gap between the final accounts price and the bid price. Due to the current evaluation methods take the average value as the baseline of bidding price, so if there is a big gap between the mean value and the final accounts price, it prove that we must adjust the current evaluation method on the setting of threshold standard, in other words, the effectiveness of lowest price is inadequate. In the

same way, we can make a compare between the final accounts price and the value calculating by the median value, or other methods so that we can verify whether the improved method is closer to the average price of market or not.

2.2 Empirical Analysis

There are 10 bidding projects data for empirical analysis of effectiveness in Hefei during 2010 and 2011. Items are listed in Table 1 below.

Table 1 List of Project Quality and the Accounts Price

Name of item	Winning bid price((RMB))	Accounts price((RMB))	Quality of project
Project 1	47708549.5	49435402.7	qualified
Project 2	74820318	69459023.9	qualified
Project 3	63754929.7	68107966.9	qualified
Project 4	54197168	50764463.2	qualified
Project 5	79721162.6	88131552	qualified
Project 6	458000	515595.75	qualified
Project 7	4545278.18	4620422.15	qualified
Project 8	1214596.42	1464244.91	qualified
Project 9	499000	492179.12	qualified
Project 10	83690000	84959120	qualified

From the above table data, it indicates that the quality of project by the existing effective lowest price bid evaluation method is qualified, but the winning bid price of each item (contract price) and the accounts prices are not consistent. We can calculate deviated amplitude of the price from the following accounts by comparing the winning bid price and the accounts price, as shown in Table 2 below.

Table 2 Deviated Amplitude between Winning Bid Price and Account Price

Name of item	Winning bid price((RMB))	Accounts price((RMB))	Deviated amplitude （%）
Project 1	47708549.5	49435402.7	3.62
Project 2	74820318	69459023.9	-7.17
Project 3	63754929.7	68107966.9	6.83
Project 4	54197168	50764463.2	-6.33
Project 5	79721162.6	88131552	10.55
Project 6	458000	515595.75	12.58
Project 7	4545278.18	4620422.15	1.65

Name of item	Winning bid price((RMB))	Accounts price((RMB))	Deviated amplitude （%）
Project 8	1214596.42	1464244.91	20.55
Project 9	499000	492179.12	-1.37
Project 10	83690000	84959120	1.52

We can see from Table 2, the winning bid price of project deviate the accounts price from 1.37% to 20.55%, and three of projects (No. 5, 6, 8) deviate greatly which deviate more than 10%. The other seven bid prices were within 10%.

In the following, we analysis the main reason causes of the deviated rate of 20.55% based on the Project 8 which deviates greatly. Project 8 is Outdoor overall project, which opened on October 31, 2011 in Hefei Construction Engineering Trade Center, that the winning bid price is 1,214,596.42 (RMB). The price of the audited accounts is 1,464,244.91 (RMB), which deviates 249,648.49 (RMB). There are two main reasons: (1) 100,000 (RMB) of gold reserve are deducted from the contracts. (2) 23,815.62 (RMB) of turnkey service fees are deducted from the contracts. (3) Changing part of the increase cost of 373,464.11 (RMB). From the analysis above, we can see that the main reason causing too large dispersed degree of project is design change and the confirmation of engineering change. The total quantity of the project is not enormous, and the total contract price is low. It is likely that a slight change of design and engineering that will cause the accounts prices vary too much. We can conclude that project 6 is also small-scale projects and the deviated rate is 12.58%.

We can get three conclusions from the above analysis. Firstly, the current effectiveness lowest bid evaluation method which has being implemented by the public resources trading center in Hefei can meet the basic needs of the property owners. Secondly, the winning bid price chosen by current effectiveness lowest bid evaluation method can be in accordance with the final accounts price of project basically. Thirdly, from the analysis of the two projects which have the biggest deviation accounts, we can see that the superiority of the current effective lowest price bid evaluation method is not obvious in the evaluation of the project that the total price exceed one million.

3. Risk Prevention of Effectiveness

On the analysis above, the mean value as fiducial value of current lowest bid evaluation methods can really make a role. However, by take the universality of existing deviated amplitude into consideration, the methods of bidding quotations can also be further optimized. In this paper, according to comparing the stability of the mean value and the median value in different condition, the baseline of bidding price is determined by a more reasonable and effective way.

In an ideal and perfectly competitive market environment, rational quotation of the bidder is normally distributed (Song & Wei, 2011; Ishii, Takano & Muraki, 2011). In other word, the mean quotation of the bidder and the median value are the same. In practice, reasonable quotation of the bidder basically has a certain degree of deviation from the normal distribution, and tends to a Poisson distribution (Liang, 2005). In addition, in the current complex market environment, the bidder will quote some quotation totally inconsistent with the conventional sometime, named as outliers. Due to the adding outliers, the method of the average value as the value becomes undesirable. According to this condition, the article, by way of randomly generated data, respectively prove the difference of stability of the median

value and the mean value under the circumstances of between the Poisson distribution and outliers' case.

3.1 Situation of Poisson Distribution

Using Excel random number generator, 50 groups of random sequence are generated which contain 100 random samples value and are subject to $\lambda = 3$ (average instantaneous speed or density) of Poisson Distribution. Then we calculate the median value and the mean value of 50 groups of sequence. The results are shown as table 3.

Table 3 Median Value and Mean Value of Data of Poisson Distribution

NUM	1	2	3	4	5	6	7	8	9	10
Median Value	3	3	3	3	3	3	3	3	3	2
Mean Value	3.08	3.08	3.01	2.91	3.01	2.77	2.84	3.12	3.1	2.69
NUM	11	12	13	14	15	16	17	18	19	20
Median Value	3	3	3	3	3	3	3	3	3	3
Mean Value	2.97	2.95	3.21	3	2.75	2.89	3.03	3.51	3.07	2.9
NUM	21	22	23	24	25	26	27	28	29	30
Median Value	3	3	3	3	3	3	3	3	3	3
Mean Value	3.05	2.81	2.97	3.1	2.68	2.73	2.94	3.09	2.75	2.93
NUM	31	32	33	34	35	36	37	38	39	40
Median Value	3	3	3	3	3	3	3	3	3	3
Mean Value	3.18	3.1	3.11	3.09	2.78	3.01	3.24	2.88	3.04	3.08
NUM	41	42	43	44	45	46	47	48	49	50
Median Value	3	3	3	3	3	3	2.5	3	3	3
Mean Value	3.05	3.1	3.07	3.26	2.83	3.31	2.45	2.93	2.94	2.81

Calculate the tandard deviation (SD for short) of the median value and the mean value:

$SD_{\text{median value}} = 0.157$, and $SD_{\text{mean value}} = 0.184$

Due to mean value in the SD is less than median value in the SD, so,in the case of sample obeying Poisson Distribution, the median value is more stable than the mean.

3.2 Situation of Having Outliers

Using Excel to generate 50 groups of random sequence, each group has 100 samples values and samples values are in the interval [0, 1]. Adding several outliers in each group, the abnormal value random is floating in [0, 10]. Calculate the median value and mean value in each group and the results are shown as table 4.

Table 4 Median Value And Mean Value Of The Quotation With Some Outliers

NUM	1	2	3	4	5	6	7	8	9	10
Median Value	0.57	0.52	0.55	0.48	0.44	0.40	0.45	0.56	0.48	0.49

Mean Value	0.59	0.59	0.57	0.51	0.52	0.48	0.56	0.63	0.62	0.53
NUM	11	12	13	14	15	16	17	18	19	20
Median Value	0.45	0.48	0.53	0.46	0.47	0.53	0.52	0.45	0.49	0.50
Mean Value	0.55	0.63	0.62	0.66	0.55	0.70	0.67	0.64	0.61	0.75
NUM	21	22	23	24	25	26	27	28	29	30
Median Value	0.55	0.46	0.49	0.47	0.51	0.51	0.43	0.43	0.51	0.47
Mean Value	0.61	0.52	0.65	0.51	0.61	0.57	0.59	0.48	0.60	0.65
NUM	31	32	33	34	35	36	37	38	39	40
Median Value	0.55	0.48	0.50	0.57	0.49	0.45	0.43	0.52	0.60	0.60
Mean Value	0.65	0.60	0.66	0.71	0.68	0.60	0.60	0.68	0.72	0.67
NUM	41	42	43	44	45	46	47	48	49	50
Median Value	0.58	0.52	0.60	0.52	0.46	0.52	0.50	0.48	0.48	0.59
Mean Value	0.65	0.67	0.69	0.68	0.63	0.59	0.67	0.58	0.67	0.67

Calculate the standard deviation (SD for short) of the median value and the mean value:

$SD_{\text{median value}}=0.049$, and $SD_{\text{mean value}}=0.063$

As the table shows, in the case with outliers, the standard deviation of the median value is smaller than the mean value. The median value tend to be more stable than the mean after adding outliers.

3.3 Optimization and Validation Median Value Method

From the analysis above, the median value is more stable than the mean, based on effective lowest price bid evaluation method. On this basis, we consider the influence of coefficient of skewness and coefficient of dispersion to optimize the median value.

Coefficient of skewness is first proposed by TJ. Cole [5], and is to describe the statistics of data distribution form or the overall value of the distribution of symmetry. Compared with normal distribution, deviated degrees of zero indicate the data distribution form is the same as the degree of skewness of normal distribution. Deviated degrees bigger than zero indicate the data distribution form compared with the normal distribution is deviated or right, which has a long tail on the right side. Right side has more extreme value. Deviated degrees smaller than zero indicate the data distribution form compared with the normal distribution is negative or left, which has a long tail on the left side. Left side has more extreme value. The bigger of the absolute value of deviated degree, the greater degree of skewness in the distribution form. Specific calculation formula of deviated degrees is:

$$Skewness = \frac{1}{n-1}\sum_{i=1}^{n}\left(x_i-\bar{x}\right)^3 \Big/ SD^3 \tag{1}$$

In order to eliminate the influence of discreted degree measure caused by difference in the size of the data value and measuring unit, computing coefficient of dispersion is needed. Coefficient of dispersion is also called the coefficient of variation. It is ratio of the standard deviation and its corresponding average data and is used to measure relative indexes of discreted degree of data. If coefficient of dispersion is big, the discreted degree of data in the

group is big. If coefficient of dispersion is small, the discreted degree of data in the group is small. If coefficient of the standard deviation is V_σ, the calculating formula is $V_\sigma = \sigma / \overline{X}$.

On the basis of the median value, optimizing steps are as follow. Firstly, a set of median values data are calculated, as a benchmark. Secondly, calculate the coefficient of dispersion of this set of data, and the result after percentage is treated as weight of basic value. Finally, calculate the deviated degrees of this set of data, and base on the situation which bigger than zero or less than zero as the case of changes of direction for weight assignment. Calculating formula is:

$$W = \begin{cases} M * (1 + V_\sigma * 100\%), S \geq 0 \\ M * (1 - V_\sigma * 100\%), S \prec 0 \end{cases} \quad (2)$$

W is the ultimate value, M is the median values of the set of data, and S is partial degrees.

For empirical analysis of the measuring method after verified and optimized, this paper collected the bidding data of *project 3* of Hefei city. Budget of this project is 87.2093 million (RMB) and controlling price is 86.0849 million (RMB). Its contain 12 effective bidding enterprises, and each price of bidder is shown as table 5.

Table 5 Quoted List of The Bidders

Company of bid	Quotation of bid（controlled price 86.08494636 million）	Decline of controlled price（%）
Company 1	61762541.95	28.25%
Company 2	63754929.68	25.94%
Company 3	72880718.01	15.34%
Company 4	66188888.88	23.11%
Company 5	71385215.00	17.08%
Company 6	77416329.00	10.07%
Company 7	63937456.87	25.73%
Company 8	64377722.15	25.22%
Company 9	72977196.15	15.23%
Company 10	64227700.45	25.39%
Company 11	59181835.88	31.25%
Company 12	54783264.25	36.36%

First of all, according to each bidder quotation, we can calculate the median value, discreted degree, standard deviation and mean of this set of the quotation. The calculated: the median value M=64302711 , discreted degrees $S = 0.1508$,standard deviation $\sigma = 5080710.74$, the mean $\overline{X} = 66072816.52$, calculate coefficient of dispersion $V_\sigma = \sigma / \overline{X} = 0.0769$ based on standard deviation and the mean value. Due to the discreted degrees is 0.1508 bigger than zero, using the formula $W = M * (1 + V_\sigma * 100\%), S \geq 0$. Thus we can calculate the final value of W is 69247039 .00 (RMB). The table 2 shows that the final price is 68107966.90 (RMB). We can see that the bid prices determined by optimized methods is better than the original bid price (63754929.7 RMB) and also is closer to the final account price.

4. Conclusion

This paper uses the method of empirical analysis, verify scientific validation of effectiveness of effective lowest price bid evaluation method, and proposes the median value as the

baseline of bidding price and improve effective lowest price bid evaluation method by calculating the coefficient of skewness and discrete coefficient of median value method. From the validation of data, it indicated that this method is feasible. The median value method improves the objectivity of process of evaluation and the accuracy of scaling which is vital to construction projects bidding practices. In addition, using effective lowest price bid evaluation method reasonably also need to fulfill the following requirements: First, preparing a list of the amount of high-quality projects. Second, reviewing the qualifications and price of bidders. Third, issuing risk assessment report by professional risk analysis from the third party.

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