Research on the Standardization of Tendering and Bidding Management for Engineering Projects

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Abstract: *Standardisation is a general way of organising the allocation of resources in the construction industry, and thus it will affect the efficiency of project construction, fairness in market competition, and the overall quality of construction projects. Given the dual background of the wave of the digital economy and the transformation and upgrading of the construction industry, the traditional bidding model has many deficiencies, such as poor process compliance, a lack of supervision mechanisms, and slow construction of the integrity system. The problems mentioned above will have some effect on the high-quality development of the industry. There are now problems in the full-life management of bidding; this paper will identify the typical problems mentioned above and put forward systematic improvement directions in the areas of top-level institutional design, business process reengineering, enhancement of regulatory effectiveness and application of digital technology. The first goal of this paper is to explore how new technologies such as Big Data, Blockchain and Artificial Intelligence can be applied to solve the problems of bid-rigging and collusive bidding, improve the bid-evaluation system, build a closed-loop credit system, and provide theoretical support and practical suggestions for building a healthy, orderly, transparent and efficient construction market ecosystem.*

Keywords: *Engineering Projects, Bidding Management, Standardized Construction, Supervision System, Process Reengineering*

Introduction

A Bidding System for Engineering Projects is a type of market transaction that selects a suitable contractor in accordance with laws and regulations. First of all, we will adhere to the spirit of "openness, fairness and impartiality" and maintain the virtues of honesty and integrity to control investment costs and ensure the quality of construction projects. After the introduction and subsequent revision of the Bidding and Tendering Law of the People's Republic of China and relevant supporting regulations, China has built a relatively complete framework for the bidding system and achieved good results in regulating market order and improving the efficiency of resource allocation.

However, many problems still occur in actual operation: irregular bidding, fraudulent bidding, bid-rigging and collusive bidding are frequent; there is still a lack of scientific rigor in the bid evaluation system, and improper conduct by evaluation experts has led to a situation of "bad money driving out good"; regulatory methods are far behind the pace of market innovation. The above problems will harm the foundation of fair market competition and may also result in quality and safety hazards and economic disputes. Therefore, a particular path for the standardised implementation of bidding management in engineering projects needs to be studied in detail to maintain order in the construction market and ensure the successful completion of construction projects.

1. Analysis of Existing Problems in Engineering Project Bidding Management

1.1 Failure to follow Bidding Procedures and many irregularities

1.1.1 Avoid Statutory Bidding and Fraudulent Activities

Some project owners use the following methods to reduce the scope of regulatory supervision: they divide the projects into several small parts or conduct different rounds of bidding at various times and thus do not need statutory bidding. Alternatively, there may be a bidding process in name only, but the results are changed by adding favourable predetermined terms or by selecting the winning bidder in

advance; this is known as "open bidding with predetermined outcomes". For example, in some municipal projects, the main project has been broken down into many small items, and each is below the bidding threshold; thus, contractors who do not meet the required qualifications have been selected, and construction rework risks have arisen[1].

1.1.2 Bid-rigging, collusive bidding and document forgery

Bidders have formed interest groups to agree on which bid will be successful or have colluded to inflate the quotation; they may also be in contact with bidding agents and project owners to obtain inside information and eliminate potential competitors. At the same time, some enterprises are submitting forged qualification certificates and performance records or other false supporting documents in their bids to disrupt the order of bid evaluation. Based on the above data, in recent years, the proportion of cases involving bid-rigging and collusive bidding in law enforcement inspections of the construction industry has been relatively high, and the governance problems of the bidding sector have not been effectively solved.

1.2 Lack of Scientific Rigour in the Bid Evaluation Mechanism and Questions Raised about its Fairness

1.2.1 Unscientific Bid Evaluation Methods

Some projects are too focused on the "lowest price wins" mode and do not consider other necessary conditions, such as the technical feasibility of the proposal and the performance of the contractor. Therefore, the winning bid will be lower, and the quality of the project may be reduced. For instance, in the construction of a bridge project, the winning bidder reduced some of the safety measures, and then there was a safety accident[5].

1.2.2 Shortcomings in Expert Management

The structure of the expert database for bid evaluation is unbalanced, and some experts do not have professional qualifications or are biased. A lack of openness in the selection of experts is likely to be due to people. If there is no proper supervision of the bid-evaluation meeting, there will be a risk of "favouritism in scoring" and thus the fairness of the evaluation results will be compromised.

1.3 Poor Coordination of the Regulatory System and Weak Deterrence of Enforcement

1.3.1 Fragmentation of Regulatory Functions

The Departments of Development and Reform, Housing and Urban-Rural Development and Transportation are responsible for Bidding Regulations. Therefore, there are many functions, redundant supervision, regulatory gaps and information silos among the departments that prevent the building of an effective regulatory system.

1.3.2 Absence of Full-process Supervision

The old regulations were too focused on pre-approval and did not monitor the actual progress of the projects after they were approved; thus, they overlooked contract execution and implementation in the field. Therefore, there are still problems of "dual contracts" and illegal subcontracting and assignment[4].

1.3.3 Low Penalty Costs for Violations

The penalty according to the present regulations is relatively mild, and the fine amount is often lower than the illegal gains. The credit-joint disciplinary mechanism has not been fully built up and cannot handle the misconduct at present. Therefore, it will be less costly for employees to violate the policy and more difficult for the company to enforce it.

1.4 Absence of Information Technology Support and Inefficient Management

Some areas have developed simple electronic bidding platforms that can only spread basic information about the bid and not the whole process. The Data Standards are not the same everywhere, so there will be "information silos" and risks to the security of the electronic bid evaluation system. Small and medium-sized enterprises are not digitally literate and thus fall behind in the electronic era of transactions.

2. Implementation Paths for the Standardization of Engineering Project Bidding Management

2.1 Consolidate the Foundation of Laws and Regulations and Strengthen Institutional Constraints

2.1.1 Improve the Top-Level Legal Design

Amendments need to be made to the Tendering and Bidding Law and its relevant regulations, and efforts should be increased to improve the identification of behaviour such as bid suppression and bid rigging or collusive bidding; at the same time, the specific penalties for these violations should be increased significantly to raise the cost of non-compliance. The scope of the projects to be tendered should be clarified, and institutional loopholes that allow for the division of projects to avoid tendering need to be closed.

2.1.2 Standardised Management of Bidding Documents

Standardised Bidding Document Templates should be used to limit the scope of the bid, the way the bid is evaluated and the contract terms, and no discriminatory or exclusionary provisions should be included. Specify the technical attributes and qualification requirements for the key indices, make them quantitative, and reduce the margin of error.

2.2 Innovation in the Bid Evaluation Mechanism for Fairness in Review

2.2.1 Developing the Generalised Evaluation Method

The old way of decision-making based solely on price has been changed, and now there will be a multi-factor assessment system of "price, technology, credit and performance". Reasonable weights should be given to all the factors (e.g., the weight of price should be moderate), and the chosen winner should have good technology and a reasonable cost. Based on the above, we know that a general evaluation method will enhance the quality of the project.

2.2.2 Optimising the Expert Management System

Dynamically determine the needs of the experts at different times and establish an early retirement option for them. To avoid the problem of human error, we will use a model of random selection and off-site assessment. Audio-visual technology should be used to record all the stages of the bid evaluation and create a "sunshine review" atmosphere.

2.3 Building a Coordinated Regulatory System with Full-process Coverage

2.3.1 Strengthen Coordination Among Departments

Organize the regulatory resources on a single bidding supervision information platform and share data and carry out joint law enforcement. Clarify the powers and responsibilities of all departments participating in the construction of the credit supervision network, and a single case of fraud should result in sanctions across all departments. Some places have introduced an "Internet + Regulation" model and greatly improved the efficiency of case investigation and handling.

2.3.2 Enhance Full-Chain Supervision

The scope of supervision should cover all links in the tender, bidding, bid evaluation and contract implementation process; preliminary reviews of the plans need to be conducted, the procedures during this period should be standardised, and after-event performance monitoring should be carried out to curb subcontracting, assignment and dual contracts. Boost the motivation for inspection by randomly selecting some subjects and making them public knowledge.

2.3.3 Strengthening the Credit Discipline System

A credit evaluation model for bidding activities should be built to record violations in the credit history and link them to upgrades in qualifications, financial credit, etc. A blacklist will be set up for individuals and enterprises with serious credit violations to prevent them from participating in the market and to encourage others to maintain good credit by punishing non-compliance.

2.4 Optimisation of Management Efficiency Through Deep Digitalisation

2.4.1 Promote Full-Process Electrification

A single electronic bidding public service platform should be constructed to carry out all-round online operations at any time for announcements, registration, bidding, evaluation, contract, etc., and reduce the need for human intervention. Due to the risk of the data, we will use CA Digital Certificates. Big Data technology will automatically find the unreasonable quotation and the corresponding proposal that do not comply with the regulations.

2.4.2 Breaking Down Data Silos

Strengthen the links among the bidding platform, the platforms for credit, qualification and regulation, etc., to achieve automatic data verification. Improve the digital training and technical support for small and medium-sized enterprises (SMEs) to reduce the "digital divide" and promote fair competition.

3. Ways to Promote Standardisation of Bidding via Technology

To solve the problems mentioned above, big data, blockchain and artificial intelligence are new types of technologies that can be used, and at the same time, a full-process, all-element standardised bidding system will be established to deal with these problems.

3.1 Rebuild the Trust Mechanism on the Blockchain and Create an Unchangeable Transaction Chain

Blockchain is distributed, decentralized, immutable and transparent, so the problem of trust in bidding activities can be solved. First, we will construct a blockchain-based electronic bidding platform. The main data of the tender announcement, tender documents, bid documents, bid opening records, bid evaluation reports and bid award results need to be stored on the chain. After the data has been added to the blockchain, it cannot be altered; therefore, it is impossible to modify the bid documents or falsify the performance data after the fact.

Second, the smart contracts are self-executing. A smart contract will be employed to execute the bid rules. When a certain condition is met (for example, the submission of a bid bond or the approach of the deadline), the system will automatically perform the corresponding operation (such as opening bids or refunding the bid bond) to reduce the need for human intervention and ensure strict compliance with procedures.

Blockchain has developed supply chain finance and credit transmission. Based on the credit information in the blockchain, financial institutions will know the real financial situation of a company at any time and offer reasonable-interest loans to help small and medium-sized construction enterprises reduce their capital requirements and enjoy fair competition.

3.2 Deep Mining of Big Data for Accurate Identification of Bid-rigging and Collusive Bidding

Knowing the whole, we can examine the particular parts to find out why there are differences.

3.2.1 Building the Bidder Correlation Relationship Network

Based on the data of registered addresses, contact phone numbers, legal representatives, equity structure and past bid records for bidders, a large network of relationships has been built. If the system finds that many of the bids are too close or there are indications of collusion among bidders, it will notify the authorities for investigation.

3.2.2 Analysis of Abnormal Quotations

Statistics and machine learning can be applied to analyse historical quotation data and find abnormal patterns in the quotations that are significantly different from the market conditions, such as clustered quotations or regular differences in prices, in order to help detect and investigate cases of bid-rigging and collusion in bidding.

3.2.3 Verification of Enterprise Qualifications and Performance

Integrate the data interfaces of all departments, such as industry and commerce, taxation, social

security, housing and urban-rural development, etc., to automatically compare the qualifications, performance records and personnel information of bidders in real time and prevent the use of fraudulent materials from going unnoticed.

3.3 AI-Assisted Bid Evaluation to Improve the Scientificness and Efficiency of Review

Artificial intelligence technology can address the problems of manual bid evaluation and improve the fairness and efficiency of the review.

Intelligent Auxiliary Bid Screening. Use Natural Language Processing (NLP) and Optical Character Recognition (OCR) to automatically extract the necessary information from the bid documents, check if it meets the conditions, and notify you promptly of any missing items, errors or inconsistencies.

3.3.1 Intelligent Scoring of Technical Proposals

According to the above rules, the AI will automatically grade the standardised technical indicators. Artificial intelligence can be employed to find similarities in the similarity analysis of non-standardised technical proposals and detect plagiarised or identical proposals; in addition, multi-dimensional comparison reports will also be provided to help users make more informed choices.

3.3.2 Expert Behavior Profiling

Based on the history of expert bid evaluations, an expert behaviour profile will be built to find any bias in scoring or other abnormal behaviour, and supporting data will be used for dynamic evaluation and dismissal of experts.

3.4 Collaboration of Cloud Computing and Internet of Things (IoT) for Full-process Visualized Supervision

With the good computing support of cloud computing and the sensing ability of the Internet of Things (IoT), close links have begun to be formed between bidding activities and project construction.

3.4.1 Centralized Cloud Deployment

A single platform for electronic bidding services should be set up at the provincial or national level to centralise data and processing, and geographical restrictions need to be lifted. Given that the distribution of experts is uneven, we will increase the use of remote off-site bid evaluation.

3.4.2 Real-time Monitoring of the Internet of Things (IoT)

Many IoT devices in the construction area have been connected to the bidding system, such as Internet of Things (IoT) video surveillance cameras and sensors, real-name access control systems, etc. The system will automatically record the attendance of the main project team, project progress, quality and safety information, etc., after winning the bid. If there are any such violations, such as subcontracting, unlicensed affiliation or unauthorised replacement of key personnel, an alarm will be issued immediately to achieve closed-loop supervision of the entire chain from "bidding" to "contract performance".

4. Case Study: Standardisation Reform of Bidding Management in a Certain Province

In 2021, a certain province began to regularise the reform of bidding management. First, promote full-process electronic bidding; now, more than 80% of the projects in the province are conducted online, the bidding cycle has been reduced by 30%, and complaints about human interference have dropped by 55%. Blockchain technology is used to store the bid documents on the chain and record the results of the contract in an unchangeable way. Therefore, the proportion of weight given to the technical proposal was increased to 30%-40%. Therefore, the proportion of projects chosen by the lowest-price rule fell from 60% to 25%, and the acceptance rate for project quality increased by 18%. Joint supervision of the department and the Big Data early warning system has been established. In 2022, there were 120 cases of bid-rigging and collusive bidding that had been investigated and handled; 45 dishonest enterprises were added to the blacklist, and the proportion of market violations fell by 40%.

After the reform, the order of market competition in the construction sector of the province improved significantly, and as a result, the average project cost fell by 8% and enterprise satisfaction

reached 90%. Therefore, it was decided to take a joint "institutional and technological" approach. In fact, the big data early warning system has found some hidden cases of bid-rigging and collusive bidding, and several times it has also discovered that the violating group has made efforts to conceal the related bidding through complex equity structures.

5. Conclusion and Outlook

Standardisation of engineering project bidding management is a problem of the whole system and therefore requires the participation of institutions, mechanisms and technology. The problems with the current work are procedural uniformity, fairness in bid evaluation and a lack of regulation. Strengthen the legal system, improve bid evaluation, enhance joint supervision, empower the people through digitalisation, and so on, to promote the ideal of openness, fairness and impartiality. Now all kinds of technology have been introduced to solve the long-standing problems in the bidding field, such as using blockchain to restore trust, building accurate profiles based on big data, providing intelligent assistance with artificial intelligence, etc.

In the future, with the development of new technologies such as 5G, the Internet of Things (IoT) and the Metaverse, bidding management will be more open, efficient and intelligent. In the future, both the remote bid evaluation and the virtual site inspection will be in virtual reality and the Metaverse. At the same time, we need to regulate the market in an orderly way and promote the innovation of enterprises through healthy competition. In the future, we should also increase international exchanges and cooperation to learn about advanced overseas bidding management practices, align China's bidding standards with international norms, help Chinese construction enterprises participate better in the global competition, and promote the sustainable and high-quality development of the construction industry.

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