

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

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Abstract: As a key mechanism for optimizing resource allocation in the construction market, the standardization level of project bidding directly affects project implementation efficiency, the fairness of market competition, and the ultimate quality of construction projects. Against the dual backdrop of the digital economy wave and the transformation and upgrading of the construction industry, the traditional bidding model is facing deep-seated contradictions such as insufficient process compliance, a lack of supervision mechanisms, and a lag in the construction of the integrity system. These issues hinder the high-quality development of the industry to a certain extent. From the perspective of full lifecycle management of bidding, this paper deeply analyzes the typical problems currently existing and proposes systematic improvement paths from dimensions such as top-level institutional design, business process reengineering, enhanced regulatory effectiveness, and digital technology empowerment. The paper focuses on the specific application strategies of cutting-edge technologies such as big data, blockchain, and artificial intelligence in curbing bid-rigging and collusive bidding, optimizing the bid evaluation system, and establishing a closed-loop credit system, aiming to provide theoretical support and practical suggestions for building a healthy, orderly, transparent, and efficient construction market ecosystem.

Keywords: engineering projects, bidding management, standardization construction, supervision system, process reengineering

Introduction

The engineering project bidding system is a market-based transaction mechanism that selects the optimal contractor in accordance with statutory procedures. Its core purpose lies in upholding the principles of "openness, fairness, and impartiality" as well as the principle of honesty and credit, thereby achieving the objectives of controlling investment costs and ensuring project quality. Following the introduction and subsequent revision of the Bidding and Tendering Law of the People's Republic of China and its related supporting regulations, China has established a relatively comprehensive framework for the bidding system, which has achieved remarkable results in purifying market order and enhancing the efficiency of resource allocation.

Nevertheless, many pain points still emerge in practical operations: irregularities such as evading statutory bidding, conducting fraudulent bidding, and engaging in bid-rigging and collusive bidding frequently occur; the scientific rigor of the bid evaluation system remains insufficient, and improper conduct by evaluation experts leads to a situation where "bad money drives out good"; and regulatory methods lag behind the pace of market innovation. These issues not only erode the foundation of fair market competition but may also create potential quality and safety hazards, leading to economic disputes. Given this, an in-depth exploration of the standardized implementation pathways for engineering project bidding management holds urgent practical significance for maintaining order in the construction market and ensuring the successful delivery of projects.

1. Analysis of Existing Challenges in Engineering Project Bidding Management

1.1 Insufficient Compliance of Bidding Procedures and Frequent Irregularities

1.1.1 Evading Statutory Bidding and Fraudulent Practices

Some project owners resort to tactics such as breaking projects into smaller parts or splitting bid

sections to convert projects that must be subject to statutory bidding into direct contracts, thereby evading regulatory oversight. Alternatively, they may superficially follow bidding procedures while manipulating outcomes through methods such as presetting tendentious terms or pre-selecting winning bidders, resulting in a practice of "open bidding with predetermined outcomes." For instance, in certain municipal projects, the overall project has been divided into multiple sub-items each falling below the bidding threshold, leading to the selection of contractors who do not meet the required qualifications and ultimately causing risks of construction rework (see Construction Market and Bidding, 2022).

1.1.2 Bid-Rigging, Collusive Bidding, and Document Falsification

Bidders form interest alliances by agreeing on the order of winning bids or coordinating to inflate quotations, or they collude with bidding agents and project owners to obtain insider information, thereby excluding potential competitors. At the same time, some enterprises participate in bidding by forging qualification certificates and performance records or providing false supporting documents, severely disrupting the bid evaluation order. Relevant data indicate that in recent years, cases involving bid-rigging and collusive bidding have accounted for a relatively high proportion of law enforcement inspections in the construction market, representing a persistent difficulty in the governance of the bidding sector (National Development and Reform Commission, 2023).

1.2 Lack of Scientific Rigor in the Bid Evaluation Mechanism and Questioning of Its Impartiality

1.2.1 Unscientific Bid Evaluation Methods

Some projects rely excessively on the principle of "lowest price winning," while neglecting key indicators such as the feasibility of technical proposals and the contractor's performance capability. This compels winning bidders to reduce safety investments to maintain profit margins, thereby creating quality risks. For example, a bridge project experienced a safety incident during construction due to the winning bidder's excessive reduction of safety measures (see Journal of Engineering Management, 2021).

1.2.2 Deficiencies in Expert Management

The expert database for bid evaluation suffers from structural imbalances, with some experts lacking appropriate professional alignment or exhibiting subjective biases. A lack of transparency in the expert selection process makes it susceptible to human interference. Additionally, the absence of effective monitoring during bid evaluation sessions leads to instances of "favor-based scoring," undermining the objectivity and fairness of evaluation outcomes.

1.3 Poor Coordination of the Regulatory System and Weak Enforcement Deterrence

1.3.1 Fragmentation of Regulatory Functions

Bidding regulation involves multiple administrative departments, including development and reform, housing and urban-rural development, and transportation. This results in overlapping functions, duplicate supervision, or regulatory vacuums, while information silos between departments hinder the formation of a cohesive regulatory force.

1.3.2 Lack of Full-Process Supervision

Traditional regulatory models place a heavy emphasis on pre-approval while neglecting post-award performance monitoring, with insufficient attention given to contract execution and project implementation after the bid is won. This has led to persistent issues such as "dual contracts" and illegal subcontracting and assignment (see China Tendering, 2022).

1.3.3 Low Penalty Costs for Violations

Current regulations impose relatively lenient penalties for violations, with fines often falling short of the illegal gains obtained. Additionally, the credit joint disciplinary mechanism has not yet been fully implemented, making it difficult to form an effective deterrent. This situation creates a reverse incentive, where the cost of non-compliance is low while the cost of compliance remains high.

1.4 Insufficient Information Technology Support and Limited Management Efficiency

The electronic bidding platforms in some regions have rudimentary functions, covering only basic information dissemination without encompassing the full process. Inconsistent data standards between

platforms create "information silos," and the security of electronic bid evaluation systems requires improvement. Furthermore, the weak digital capabilities of small and medium-sized enterprises place them at a disadvantage in electronic transactions, exacerbating unfair competition.

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

2.1 Consolidating the Foundation of Laws and Regulations and Strengthening Institutional Constraints

2.1.1 Improving the Top-Level Legal Design

The revision of the Tendering and Bidding Law and its implementation regulations should be promoted, with efforts to refine the criteria for identifying behaviors such as evading bidding and bid-rigging or collusive bidding, as well as the detailed penalties for such violations, thereby significantly increasing the cost of non-compliance. The scope of definition for projects subject to mandatory bidding should be clarified, and institutional loopholes that allow for the splitting of projects to evade bidding should be closed.

2.1.2 Standardized Management of Bidding Documents

The use of standardized bidding document templates should be promoted to strictly regulate the scope of bidding, bid evaluation methods, and contract terms, while prohibiting the inclusion of discriminatory or exclusionary clauses. Key indicators such as technical parameters and qualification requirements must be quantified and clearly defined to reduce the scope for discretionary decision-making.

2.2 Innovating the Bid Evaluation Mechanism to Ensure Fairness in Review

2.2.1 Promoting the Comprehensive Evaluation Method

The practice of relying on a single price-oriented approach should be changed, and a multi-dimensional evaluation system encompassing "price, technology, credit, and performance" should be established. Weightings should be set reasonably (for example, the weighting for price should be controlled within a reasonable range) to ensure that the winning bidder possesses both technical capability and cost advantages. Practical experience has shown that the comprehensive evaluation method can effectively improve the project quality acceptance rate (Ministry of Housing and Urban-Rural Development Case Database, 2023).

2.2.2 Optimizing the Expert Management System

A dynamic assessment and exit mechanism for experts should be implemented to attract and retain highly skilled professionals. The model of "random selection plus off-site evaluation" should be promoted to reduce the risk of human interference. Audio and video technology should be utilized to record the entire bid evaluation process, creating a "sunshine review" environment.

2.3 Building a Coordinated Regulatory Framework to Achieve Full-Process Coverage

2.3.1 Deepening Interdepartmental Coordination Mechanisms

Regulatory resources should be integrated by establishing a unified bidding supervision information platform, enabling data sharing and joint law enforcement. The boundaries of departmental powers and responsibilities should be clarified to build a credit supervision network where "a single instance of dishonesty leads to restrictions in all areas." In some regions, the adoption of an "Internet + Regulation" model has significantly improved the efficiency of case investigation and handling (see China Government Procurement, 2023).

2.3.2 Strengthening Full-Chain Supervision

The scope of supervision should be extended to cover all stages of tendering, bidding, bid evaluation, and contract performance: pre-event review of plans should be strictly conducted, in-process procedures should be standardized, and post-event tracking of performance should be implemented, with a focus on cracking down on subcontracting, assignment, and dual contracts. Inspections using the "dual random selection and public disclosure" method should be promoted to

enhance regulatory deterrence.

2.3.3 Improving the Credit Disciplinary System

A credit evaluation model for bidding activities should be established, incorporating violations into credit records and linking them to qualification upgrades, financial credit, and other relevant areas. A blacklist system should be implemented for entities with serious credit violations, restricting their market access, thereby fostering a market environment where compliance is rewarded and non-compliance is penalized.

2.4 Deepening Digital Application to Enhance Management Efficiency

2.4.1 Promoting Full-Process Electronification

A unified electronic bidding public service platform should be built to realize online operation of all stages, including announcement, registration, bidding, evaluation, and contracting, thereby reducing human intervention. The use of CA digital certificates should be promoted to ensure data security. Big data technology should be utilized to intelligently identify abnormal quotations and similar proposals, assisting in the detection of violations.

2.4.2 Breaking Down Data Silos

The interconnection between bidding platforms and credit, qualification, and regulatory platforms should be promoted to enable automatic data verification. Digital training and technical support for small and medium-sized enterprises should be strengthened to bridge the "digital divide" and promote fair competition.

3. Core Pathways for Empowering Bidding Standardization Through Technological Means

Addressing the aforementioned challenges, the introduction of modern technological means such as big data, blockchain, and artificial intelligence, along with the construction of a comprehensive, full-process, and all-element standardized bidding system, lies at the heart of solving these problems.

3.1 Reconstructing the Trust Mechanism with Blockchain to Create an Unforgeable Transaction Chain

The decentralized, immutable, and traceable characteristics of blockchain technology provide a novel solution to address the trust crisis in bidding activities. First, a blockchain-based electronic bidding platform should be constructed. Key data such as tender announcements, tender documents, bid documents, bid opening records, bid evaluation reports, and bid award results should be stored on the chain. Once data is uploaded to the blockchain, any modification leaves a trace and requires consensus across the entire network, fundamentally eliminating behaviors such as tampering with bid documents or forging performance records.

Second, smart contracts enable automatic execution. By utilizing smart contract technology, bidding rules can be codified. When specific conditions are met (such as the payment of a bid bond or the arrival of the deadline), the system automatically triggers corresponding actions (such as automatic bid opening or automatic refund of the bid bond), thereby reducing the scope for human intervention and ensuring rigid compliance with procedures.

Finally, blockchain facilitates supply chain finance and credit transmission. Based on credit records stored on the blockchain, financial institutions can verify enterprises' actual performance in real time, providing convenient financing services for small and medium-sized construction enterprises, alleviating their capital pressures, and promoting fair competition in the market.

3.2 Deep Mining with Big Data to Precisely Identify Bid-Rigging and Collusive Bidding

Big data technology enables multi-dimensional analysis of massive bidding data, uncovering hidden correlations and anomalous behaviors.

3.2.1 Establishing a Bidder Correlation Relationship Network

By analyzing data such as bidders' registered addresses, contact phone numbers, legal representatives, equity structures, and historical bidding records, a complex relationship network can be

constructed. Once the system identifies highly overlapping characteristics among different bidders or frequent collusive bidding behaviors, it automatically triggers an alert, prompting regulatory authorities to conduct targeted inspections.

3.2.2 Analysis of Abnormal Quotations

By utilizing statistical models and machine learning algorithms, historical quotation data can be analyzed to identify abnormal quotation patterns that deviate from market norms (such as clustered quotations or patterned price differences), thereby assisting in the detection and investigation of bid-rigging and collusive bidding practices.

3.2.3 Verification of Enterprise Qualifications and Performance

By integrating data interfaces from departments such as industry and commerce, taxation, social security, and housing and urban-rural development, the system enables automatic comparison and real-time verification of bidders' qualifications, performance records, and personnel information, leaving no room for fraudulent materials to go undetected.

3.3 Artificial Intelligence-Assisted Bid Evaluation to Enhance the Scientific Rigor and Efficiency of Review

Artificial intelligence technology can compensate for the limitations of manual bid evaluation, improving the objectivity and efficiency of the review process.

Intelligent Auxiliary Bid Screening. By utilizing natural language processing (NLP) and optical character recognition (OCR) technologies, the system automatically extracts key information from bid documents, conducts compliance reviews, and rapidly identifies omissions, errors, and inconsistencies, significantly reducing the time required for bid screening.

3.3.1 Intelligent Scoring of Technical Proposals

For standardized technical indicators, the AI can perform automatic scoring based on preset rules. For non-standardized technical proposals, the AI can assist experts in conducting similarity detection to identify plagiarized or identical proposals, and provide multi-dimensional comparative analysis reports to support experts in making more informed judgments.

3.3.2 Expert Behavior Profiling

By analyzing experts' historical bid evaluation data, an expert behavior profile can be established to identify behaviors such as tendentious scoring or abnormally high or low scores, providing data support for the dynamic assessment and removal of experts.

3.4 Cloud Computing and the Internet of Things (IoT) Collaboration to Achieve Full-Process Visualized Supervision

Relying on the powerful computing support of cloud computing and the sensing capabilities of the Internet of Things (IoT), the seamless connection between bidding activities and project implementation stages is achieved.

3.4.1 Centralized Cloud Deployment

A unified provincial or national electronic bidding public service platform should be built to achieve centralized data storage and computation, breaking down geographical limitations. The implementation of remote off-site bid evaluation should be promoted to address the uneven distribution of expert resources.

3.4.2 Real-Time Monitoring Through the Internet of Things (IoT)

The bidding system is interconnected with Internet of Things (IoT) devices at construction sites (such as video surveillance cameras, sensors, and real-name access control systems). After the bid is awarded, the system automatically tracks the attendance of key project personnel, project progress, and quality and safety data. Once any violations such as subcontracting, unlicensed affiliation, or unauthorized replacement of key personnel are detected, the system immediately triggers an alert, thereby achieving closed-loop supervision across the entire chain from "bidding" to "contract performance."

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

In 2021, a certain province initiated a standardization reform of bidding management. The main measures included: promoting "full-process electronic bidding," with over 80% of projects in the province conducting transactions online, reducing the bidding cycle by 30% and decreasing complaints related to human intervention by 55%. Blockchain technology was introduced to store bid documents on-chain and record contract performance on the blockchain, effectively curbing data tampering and fraudulent performance behaviors. The "comprehensive evaluation method" was adopted, increasing the weight of technical proposals to 30%-40%. Consequently, the proportion of projects awarded based on the lowest price principle dropped from 60% to 25%, while the project quality acceptance rate increased by 18%. An "interdepartmental joint supervision mechanism" and a big data early warning system were established. In 2022, 120 cases of bid-rigging and collusive bidding were investigated and dealt with, 45 dishonest enterprises were publicly listed on the blacklist, and the market violation rate decreased by 40%.

After the reform, the order of market competition in the province's construction sector improved significantly, with the average project cost decreasing by 8% and enterprise satisfaction increasing to 90%. This validated the effectiveness of the "institutional + technological" dual-drive model. In particular, the big data early warning system played a crucial role in identifying hidden bid-rigging and collusive bidding, successfully intercepting on multiple occasions attempts by violative groups to conceal related bidding through complex equity structures.

5. Conclusion and Outlook

The standardization of engineering project bidding management is a comprehensive systematic project that requires the coordinated efforts of institutions, mechanisms, and technologies. Current efforts should focus on core issues such as procedural compliance, bid evaluation fairness, and regulatory effectiveness. By improving the legal framework, optimizing bid evaluation, strengthening collaborative supervision, and empowering through digitalization, the principle of "openness, fairness, and impartiality" can be effectively implemented. The deep integration of technological means, particularly the trust reconstruction enabled by blockchain, the precise profiling achieved through big data, and the intelligent assistance provided by artificial intelligence, offers powerful tools to address persistent challenges in the bidding field.

Looking ahead, with the further development of new technologies such as 5G, the Internet of Things (IoT), and the metaverse, bidding management will evolve toward greater transparency, efficiency, and intelligence. Application scenarios such as remote bid evaluation via virtual reality and virtual site inspections based on the metaverse will become feasible. At the same time, it is essential to balance standardized regulation with market vitality, stimulating enterprises' innovation potential on the basis of orderly competition. In the future, international exchanges and cooperation should also be strengthened to draw on advanced international bidding management practices, align China's bidding standards with international norms, assist Chinese construction enterprises in better participating in global competition, and promote the sustainable, high-quality development of the construction industry.

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