

ORIGINAL RESEARCH ARTICLE

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# Smart Development Path for International Engineering Bidding and Procurement in the Context of Digital Transformation

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**Abstract:** In the context of digital transformation, the intelligent development of international engineering bidding and procurement holds significant importance. This paper first elaborates on its technological foundations, including the supportive roles of big data, cloud computing, artificial intelligence, and blockchain technology in enabling intelligence. It then explores key pathways, covering aspects such as process standardization, full lifecycle digitalization, and data-driven decision-making. Concurrently, safeguard measures are proposed, involving technical security, talent development, and mechanisms for continuous innovation. Through research in these areas, this study provides comprehensive insights and directional guidance for the intelligent advancement of international engineering bidding and procurement.

**Keywords:** digital transformation; international engineering; bidding and procurement; intelligent development; safeguard measures

## Introduction

As the digital wave sweeps across the globe, industries are actively exploring paths for digital transformation, and the field of international engineering bidding and procurement is no exception. Under traditional models, international engineering bidding and procurement face numerous challenges, including cumbersome processes, lack of information transparency, and decision-making without scientific basis. Digital transformation presents new opportunities for development. By leveraging advanced technologies to achieve intelligent progress, it can enhance the efficiency, transparency, and fairness of bidding and procurement,

while reducing transaction costs and risks. Against this backdrop, an in-depth exploration of the pathways for the intelligent development of international engineering bidding and procurement holds significant practical importance and value.

## 1. Technological Foundation for the Intelligent Development of International Engineering Bidding and Procurement

### 1.1 Big Data Technology

Data collection and integration are core components of big data technology supporting the intelligentization of international engineering bidding and procurement. This process focuses on the aggregation and



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standardization of multi-source heterogeneous data, covering various types of relevant information such as tender announcements, bid documents, supplier details, and project parameters <sup>[1]</sup>. By implementing unified data encoding and format specifications, differences in data formats and semantic inconsistencies from diverse sources are resolved, enabling effective data integration and interoperability, thereby laying a solid foundation for subsequent data applications <sup>[2]</sup>. Data analysis and mining leverage specialized algorithms to deeply process massive datasets, extracting actionable insights from fragmented and unstructured information. These techniques uncover hidden correlations, trends, and developmental patterns within the data, providing scientific support for decision-making throughout the bidding and procurement process and facilitating a shift toward data-driven decision models <sup>[3]</sup>.

**1.2 Cloud Computing Technology**

Cloud storage and computing provide efficient computational power support for the intelligentization of international engineering bidding and procurement. Through a distributed storage architecture, it ensures the secure retention and efficient retrieval of massive bidding and procurement data, breaking the capacity limitations and geographical constraints of traditional storage models. Simultaneously, leveraging robust cloud computing capabilities, it rapidly processes the vast amounts of data generated throughout the entire bidding and procurement process, enhancing data processing efficiency <sup>[4]</sup>. The cloud service model offers flexible and scalable core advantages, enabling rapid deployment and dynamic optimization of bidding and procurement platforms based on project scale changes and demand adjustments. This eliminates the need for substantial hardware investments in system upgrades, effectively reducing platform construction and operational costs. It adapts to the cross-regional, multi-scenario application requirements of international engineering bidding and procurement and supports multi-stakeholder collaborative operations <sup>[5]</sup>.

**1.3 Artificial Intelligence Technology**

The intelligent bidding evaluation system, powered by

machine learning algorithms, establishes standardized evaluation models through training and learning from historical bidding data. This enables the automation and intelligence of the evaluation process, reducing subjective biases caused by human intervention and enhancing the standardization and efficiency of bidding procedures <sup>[6]</sup>. Natural language processing technology accurately interprets the core requirements of tender documents, automatically identifies key information and compliance points in bid submissions, thereby improving the accuracy and efficiency of document review and effectively mitigating omissions and errors inherent in manual audits. Predictive analytics technology, based on historical procurement data and project-related information, constructs risk and return prediction models to precisely assess potential risks during project execution and forecast project profitability. This provides reliable references for procurement decision-making, enhancing its scientific rigor and foresight <sup>[7]</sup>.

**1.4 Blockchain Technology**

The immutability characteristic of data relies on distributed ledger and hash encryption technologies to record and solidify information throughout the entire tendering and procurement process. Any data modification triggers network-wide verification and alerts, ensuring the authenticity and integrity of tendering and procurement information and guaranteeing transparent traceability of the process <sup>[8]</sup>. Smart contract technology transforms key terms and conditions in the tendering and procurement process into automatically executable code, enabling various operations stipulated in the terms to be completed without manual intervention. This achieves automated linkage of critical stages such as tendering, bidding, and contract performance, reduces human operational errors, enhances the efficiency and standardization of the tendering and procurement process, and provides technical assurance for fairness and impartiality in international engineering tendering and procurement. To more clearly compare the roles of different technologies in the intelligent development of international engineering tendering and procurement, relevant content is shown in

**Table 1.**

Technology Type	Manifestation of Effects	Specific Advantages
Big Data Technology	Data collection and integration, analysis and mining, and visual presentation	Achieve multi-source data integration to provide a scientific basis for decision-making and reduce the difficulty of data interpretation.

Continuation Table:

Technology Type	Manifestation of Effects	Specific Advantages
Cloud Computing Technology	Cloud Storage Computing, Cloud Service Models	Deliver high-performance computing power, reduce platform construction and operational costs, and support multi-agent collaborative operations.
Artificial Intelligence Technology	Intelligent Bidding Evaluation, Natural Language Processing, Predictive Analytics	Reduce human intervention bias, enhance review accuracy and efficiency, and provide reliable references for decision-making.
Blockchain technology	Data immutability, smart contracts	Ensure the authenticity and completeness of information, achieve automated connection of key links, and guarantee fairness and impartiality.

## 2. Key Pathways for the Intelligent Development of International Engineering Bidding and Procurement

### 2.1 Process Standardization and Normalization

Process standardization and normalization is the primary prerequisite for the intelligent development of international engineering bidding and procurement. It is necessary to establish unified bidding and procurement process standards, clarify operational requirements and execution guidelines for each stage, eliminate ambiguities and operational discrepancies in process transitions, and ensure the orderly progression of the entire process <sup>[9]</sup>. Standardized tender document templates and bid evaluation criteria systems should be established to unify document preparation norms and evaluation benchmarks, reduce arbitrariness in manual operations, and enhance the standardization and consistency of the bidding and procurement process.

### 2.2 Full Lifecycle Digitalization

Full-process digitalization focuses on the online operation of various stages such as tendering, bidding, evaluation, and award, breaking the geographical and time constraints of traditional offline processes to achieve efficient and convenient implementation of bidding and procurement activities <sup>[10]</sup>. A fully functional electronic bidding and procurement platform is established, integrating core functions such as online operations, information release, and document transmission, enabling all participants to engage remotely and interact in real-time, thereby enhancing process efficiency. The application of electronic signatures and electronic authentication technologies is strengthened, ensuring the authenticity and legality of electronic documents through encryption techniques, mitigating online transaction risks, and guaranteeing the security and controllability of the bidding and procurement process.

### 2.3 Data-Driven Decision-Making

Data-driven decision-making requires the establishment of a dedicated data warehouse that integrates various types of data generated throughout the entire lifecycle of bidding and procurement, including project information, supplier data, bid evaluation records, and contract performance details, forming a complete data chain to provide comprehensive data support for decision analysis <sup>[11]</sup>. By utilizing professional data analysis tools, massive datasets undergo in-depth processing to uncover hidden business patterns and development trends, accurately identifying key pain points and optimization opportunities within the bidding and procurement process. Based on data insights, organizations can refine bidding and procurement strategies, adjust procurement plans, screen high-quality suppliers, and manage costs effectively, thereby shifting the decision-making paradigm from experience-driven to data-driven.

### 2.4 Collaborative Ecosystem Construction

Building a collaborative ecosystem requires strengthening cooperation among multiple stakeholders, including tendering entities, bidders, and regulatory agencies, establishing efficient communication mechanisms and collaborative models to break down information barriers between parties and enhance the collaborative efficiency of the entire tendering and procurement process <sup>[12]</sup>. It is essential to promote the integration of tendering and procurement platforms with external resources such as financial institutions and logistics companies, consolidating supporting services like financing and logistics distribution to improve the tendering and procurement service system, thereby providing comprehensive support for international engineering tendering and procurement activities. An open and shared tendering and procurement ecosystem should be established to facilitate the efficient flow and optimal

allocation of various resources, achieving win-win outcomes for all parties involved.

### **3. Safeguard Measures for the Intelligent Development of International Engineering Bidding and Procurement**

#### **3.1 Technical Security Safeguards**

Technical security assurance serves as the core support for the steady advancement of intelligent international engineering bidding and procurement. It is essential to strengthen the construction of cybersecurity protection systems by employing various protective measures, such as encryption technologies, firewalls, and intrusion detection, to defend against various types of cyber attacks, prevent security risks like data breaches and tampering, and ensure information security throughout the entire bidding and procurement process<sup>[13]</sup>. A comprehensive data backup and recovery mechanism should be established, utilizing methods like off-site backups and multi-copy storage to securely retain data across the entire lifecycle of bidding and procurement. In the event of system failures, data loss, or other emergencies, this mechanism enables rapid data recovery, ensures the normal progression of operations, and avoids disruptions to the continuity of the bidding and procurement process due to data issues. Regular system security assessments and vulnerability repairs should be conducted, leveraging professional security technical teams to thoroughly identify potential security risks during system operation, promptly address vulnerabilities, optimize protection strategies, and continuously enhance the overall security performance of the system, thereby fortifying the technical security defensive line for intelligent development.

#### **3.2 Talent Team Development**

Building a talent team is the core driving force for promoting the intelligent development of international engineering bidding and procurement. It is essential to focus on cultivating interdisciplinary talents, creating a professional team that is not only familiar with bidding and procurement processes and industry development patterns but also proficient in information technology, equipped with data processing and intelligent technology application capabilities, to meet the diverse demands of intelligent development<sup>[14]</sup>. Strengthening digital skills training for in-service personnel, tailored technical training and business guidance should be

provided in line with intelligent development needs, enhancing the overall digital literacy and practical skills of the team, and facilitating rapid adaptation to intelligent work modes. Actively recruiting external high-end talents, absorbing professionals with international perspectives, mastery of cutting-edge technologies, and advanced management experience, will enrich the talent pool, provide solid intellectual support for intelligent development, and drive the continuous improvement of intelligent bidding and procurement standards.

#### **3.3 Continuous Innovation Mechanism**

A sustained innovation mechanism is crucial for the long-term intelligent development of international engineering bidding and procurement. It is essential to guide enterprises in increasing research and development investment, focusing on core areas such as the application of smart technologies, platform optimization, and service innovation. This will drive technological innovation and product upgrades, develop intelligent technologies and tools tailored to international engineering bidding and procurement scenarios, and enhance the relevance and effectiveness of intelligent applications<sup>[15]</sup>. Establishing a collaborative mechanism involving industry, academia, research, and application will promote in-depth cooperation among enterprises, universities, and research institutions. By integrating resources from all parties, it will facilitate the transformation of scientific and technological achievements into practical applications, deeply integrate cutting-edge technologies with bidding and procurement operations, and overcome technical bottlenecks in intelligent development. Closely tracking international technological trends and industry developments will enable timely understanding of new technologies, methods, and models in the field of intelligence. By aligning with the actual needs of international engineering bidding and procurement, intelligent development strategies can be flexibly adjusted to ensure they remain relevant to industry realities and maintain vitality<sup>[16]</sup>.

### **Conclusion**

The intelligent development of international engineering bidding and procurement is a systematic and long-term endeavor, supported by a robust

technological foundation, guided by clear key pathways, and ensured by safeguard measures for steady and orderly progress. By implementing critical pathways such as process standardization and full lifecycle digitalization, along with safeguards in technical security and talent development, the transition of international engineering bidding and procurement toward intelligence can be effectively advanced. This not only enhances the quality and efficiency of bidding and procurement but also strengthens the overall competitiveness of international engineering projects, promoting healthy and sustainable development in the field.

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