

# Research on the Countermeasures to Solve the Problems of Bidding Mode of Engineering Projects Based on Blockchain Technology

Shiyun Tang<sup>1</sup>, Zecheng Wang<sup>2</sup>

<sup>1</sup>School of Management Science and Engineering, Anhui University of Finance and Economics, Anhui 233000, China;

<sup>2</sup>School of Management Science and Engineering, Anhui University of Finance and Economics, Anhui 233000, China.

## Abstract

Electronic tendering mode is the current bidding mode of engineering projects in China, which effectively solves the problems of high bidding cost and low efficiency of bidding process in traditional bidding mode. However, there are still some disadvantages, such as low degree of information sharing and poor storage capacity. As an emerging technology in the 21st century, blockchain technology has the characteristics of decentralization, smart contract, tamper-proof, openness and transparency. Its technical advantages are highly compatible with the problem solving in the implementation process of the bidding mode of engineering projects. In this paper, the existing problems of the current project bidding mode are further analyzed from the perspective of information and participants. The advantages of applying the blockchain technology to solve these problems are discussed, and targeted countermeasures to implement the blockchain technology in the project bidding process are also put forward.

## Keywords

Blockchain technology, engineering project, bidding mode.

## 1. Introduction

With the accelerating pace of economic globalization, the competitions in various industries are becoming increasingly fierce, among which the selection and application of the bidding mode of engineering projects plays an important role in the industry competition [1]. At present, the electronic bidding mode used in China has the advantages of higher transparency and lower cost, and can realize the efficient, fair, safe and low-cost bidding of engineering projects. However, it is not perfect, and the technical support and other aspects need to be developed. There are still various illegal operations, fraud and other problems, as well as information security, leakage, sharing degree, which seriously affect the fairness and fairness of the project bidding activities [2].

As an emerging technology in the 21st century, blockchain technology has the characteristics of decentralization, tamper resistance, openness and transparency, and smart contracts. Its technological advantages are highly compatible with the problem solving in the implementation of engineering project bidding mode. Introducing it into the engineering project bidding mode for application has great advantages and can solve the current problems. Great potential will be unleashed in the reform and development of future engineering project bidding models [3]. The bidding process for engineering projects involves the game and collaboration of multiple stakeholders, and its business process is in line with the characteristics of blockchain. Therefore, the research on constructing a new bidding model for

engineering projects based on blockchain technology has received increasing attention in recent years, but some of these issues still need further research.

## 2. Literature Review

Blockchain is characterized by decentralization, openness and transparency, tamper-proof, encryption time stamp and traceability, which can solve the problems of trust and consensus, and has gradually become a key technology for decentralized transaction and automated execution in financial [4], medical [5], sports [6], agricultural [7], legal [8] and other fields. In addition, based on the successful application of blockchain technology in the above fields, its application in the field of engineering project bidding will also bring new development and opportunities.

The introduction of blockchain technology into the field of engineering project bidding has attracted the attention of scholars at home and abroad. Xu et al. [9] realize the openness, transparency and traceability of the whole process by integrating blockchain technology into it; Zhang et al. [10] point out that the introduction of blockchain technology in the bidding process can greatly reduce the communication cost; Zhang et al. [11] suggest that the introduction of blockchain technology into the project bidding field helps to ensure the privacy protection and public verifiability of the project bidding. Zhu et al. [3] point out that blockchain technology is expected to promote the high-quality development of engineering projects and accelerate the transformation and upgrading of engineering management field; Hu et al. [12] believe that blockchain technology helps to improve the ability of national audit to process information, enhance the trust of the society or the public in the government; Sun [13] emphasizes that blockchain technology can solve the problem of project bidding commitment and process default transparency, improve the security of the whole process information and the traceability of quality management.

Looking at the existing research results, researchers in the field of engineering project bidding at home and abroad have gradually recognized the importance of blockchain technology in this field and are committed to exploring the application prospects of this technology in the field of engineering project bidding. However, the problems currently existing in the field of engineering project bidding in China have not been thoroughly studied and solved by using the blockchain technology. Based on the above analysis, this article analyzes the problems of the current engineering project bidding model from the perspectives of information and participants. Based on the analysis of the advantages of blockchain technology used in engineering project bidding model, targeted countermeasures are proposed to solve the problems of engineering project bidding model using blockchain technology, with the aim of providing suggestions for future researchers to apply blockchain technology in the field of engineering project bidding. At the same time, by addressing the above issues, it can promote the completion of the bidding process for engineering projects.

## 3. Overview of the Blockchain Technology

In 2008, a research scholar named "Satoshi Nakamoto" published a foundation paper titled "Bitcoin: A Point-to-Point E-Cash System". The release of the Bitcoin White paper marked the generation of its underlying core technology--blockchain technology<sup>[14]</sup>. Blockchain is divided into narrow blockchain and broad blockchain. The former refers to the chain data structure that combines data blocks in a certain way according to the time order and ensures data security. The latter refers to the new distributed infrastructure and computing paradigm<sup>[15,16]</sup> of using blockchain data structure to test and store data, using consensus algorithm to generate and update data, using cryptography technology to ensure data transmission and sharing security, and using smart contract technology to program and process data. Its basic framework is

composed of data layer, network layer, consensus layer, incentive layer, contract layer and application layer, as shown in Fig. 1 .

The development of blockchain technology mainly includes three stages, namely 1.0,2.0 and 3.0. The 1.0 stage is mainly the application of digital currency, while the 2.0 stage is mainly the addition of the new technology of smart contract. At present, the blockchain 3.0 stage is programmable, and the emergence of blockchain technology will help the Internet to achieve from the transmission of information to the transmission of value<sup>[17]</sup>. Blockchain technology has the characteristics of decentralization, openness, transparency and so on. By implementing decentralized features to prevent data from being tampered with, the problem of trust and consensus is solved. The feasibility of applying it to the bidding mode of engineering projects is precisely based on this characteristic.

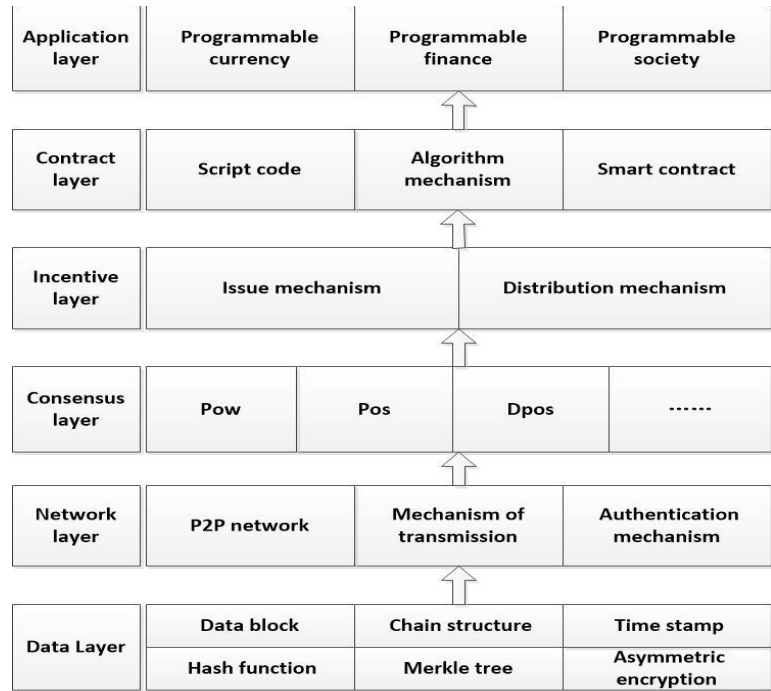


Fig. 1 Blockchain Foundation Framework

4. Problems Existing in the Current Bidding Mode of Engineering Projects

The development of information technology and the popularization of the Internet have provided a good platform and foundation for the development of electronic engineering project bidding models in China. The electronic bidding model has the advantages of saving enterprise costs, facilitating supervision and management by regulatory agencies, and improving the overall bidding efficiency [18]. Although the electronic bidding model has been widely used, there are some shortcomings in it. Below, the existing problems will be analyzed from the perspectives of information and participants.

4.1. From an Information Perspective

From this point of view, the main problems in the electronic bidding model are the issue of information security and information accuracy, the issue of low information utilization, and the issue of poor information storage capacity.

4.1.1. The Issue of Information Security and Information Accuracy

For the electronic bidding model, the technology of China's electronic bidding platform is not yet perfect. Although the information platform may set different permissions to ensure the confidentiality of information data during use, the confidentiality protection of information such as bidding documents uploaded to the information platform cannot be guaranteed <sup>[19]</sup>. In

order to win the bid, many unscrupulous enterprises may enter the bidding platform system by means of hacker technology, and maliciously tamper with or steal the bidding information in the system, resulting in issues of information security and accuracy. At the same time, due to the large number and wide range of personnel involved in the electronic bidding platform for engineering projects, there is a risk of account or password information leakage at any stage. Once leaked, it is easy for people to maliciously tamper with or steal information during the bidding process, which cannot guarantee the security and accuracy of the entire bidding process information, thereby affecting the normal progress of engineering project bidding.

#### **4.1.2. The Issue of Low Information Utilization**

At present, most regions in China have adopted the electronic bidding model, but in actual operation, most of them only utilize the platform's bidding information dissemination and publication function, without completely completing the entire engineering project bidding process through the electronic bidding platform. So, the information generated in the bidding process is unable to be shared and communicated with others, ultimately resulting in low utilization rate of the generated information and inability to fully utilize the original value of the information. This hinders the development and application of electronic bidding models.

On the other hand, due to the long-standing monopoly of engineering project bidding information resources and traditional confidentiality awareness, enterprises with information resources are subjectively unwilling to share information with other enterprises in the industry. The concept and awareness of information resource sharing have not yet formed [20]. It is prone to the phenomenon of information silos, unable to achieve comprehensive interoperability, multi-party interaction, data sharing, resource disclosure and other functions, resulting in a low level of information and data sharing, a lack of unified standardized standards, and increasing the difficulty of participants in comprehensive and accurate analysis of information data in engineering project bidding. This leads to a low utilization rate of information generated in the bidding process of engineering projects, making it difficult to showcase the value of information.

#### **4.1.3. The Issue of Poor Information Storage Capacity**

With the improvement and improvement of the electronic bidding model, there are more and more engineering project bidding activities, and each engineering project bidding process will generate a lot of information, data, and other materials. These information and data need to be archived and preserved by the electronic bidding platform. Because the capacity of each bidding document is between 300-800MB, and the archives need to be kept for at least 15 years, the number of engineering project bidding archives accumulates over time, and the required storage capacity also increases [21]. A large amount of data storage can lead to insufficient system storage capacity, ultimately seriously affecting the operational efficiency and stability of the electronic bidding platform.

### **4.2. From the Perspective of Participants**

From this point of view, the main problems in the electronic bidding model are the issue of uneven levels of evaluation experts, the issue of being not familiar with computers of operators, and the issue of inadequate inspection of supervisory personnel.

#### **4.2.1. The Issue of Uneven Levels of Evaluation Experts**

In the bidding and evaluation process of engineering projects, it is difficult to ensure the fairness, scientificity, and objectivity of the evaluation process and results if the expert members of the evaluation committee have insufficient professional knowledge reserves and uneven levels, or if the experts of the evaluation committee lack independence. Due to the inadequate professional quality level of experts in the bid evaluation committee, they may sometimes score and evaluate based on their own subjective judgment or impression. When the bidding unit bribes the experts in the bid evaluation committee, it may affect the fairness of

the bid evaluation results [22]. At the same time, if the professional ethics level of experts in the bid evaluation committee is not high, they may be bribed by bidding personnel, have abnormal private dealings with bidding personnel, and are prone to collusion and cheating between bidders and experts in the bid evaluation committee, resulting in bid evaluation results that harm the interests of the project tenderer.

#### **4.2.2. The Issue of Operators Being not Familiar with Computer**

In the bidding and evaluation process of engineering projects, many evaluation committee experts are older and have limited knowledge of computer operation technology. At the same time, many personnel engaged in the bidding industry in China have transferred from traditional engineering cost, engineering management and other majors, and are not familiar with the professional operation knowledge of computer software. In the past decade, most major universities have trained single type talents, and computer professionals are not familiar with the bidding process of engineering projects. Even worse, the salary and benefits of personnel working in the computer software industry are much higher than those engaged in engineering project bidding [23]. Therefore, many people choose to work in the computer software industry, while few are willing to choose the job of engineering project bidding management.

Due to the current adoption of a new electronic bidding model in the bidding process of engineering projects, operators need to fill in and upload key information in the bidding documents according to the table format specified by the platform. Some bidding units may not provide detailed descriptions in the platform's operating guidelines or the operation process may be "cumbersome" during the filling process. Operators may not be familiar with the filling process during the filling process, which may result in a long filling time and even errors in the information filling in the bidding documents. Some unit staff are not yet proficient in the operation process of the electronic bidding platform. If errors are found and they want to make certain modifications to a certain content, the unit staff may be unable to modify the key information of the error due to unfamiliarity with the platform operation content [24]. Therefore, if relevant operators are unable to proficiently master computer operations, it will ultimately seriously affect the bidding results.

#### **4.2.3. The issue of Inadequate Inspection of Supervisory Personnels**

The supervision mechanism of engineering project bidding has an important impact on the final bidding result. In the electronic bidding platform, it is necessary to complete the release of bidding documents, review of bidders' bidding qualifications, evaluation of bidders' bidding plans, formulation of the winning bidder, and final determination of the winning bidder. However, there is currently a lack of mature methods to complete these tasks, and the bidding process on this platform is prone to "dark box operations" [25]. In this mode, there is a lack of clear regulations on whether alternative bidding proposals and progress reports on the actual situation of bidding can be completed through the platform. At the same time, the written reporting channel for electronic bidding has not yet been opened, and there is a lack of clear operational steps and basis for how to implement it. These are all phenomena of weak supervision mechanisms in the electronic bidding mode.

The supervision information sources for engineering project bidding mainly include two types: one is the active filling of information by participants during the bidding process, another type is the various information collected by local public resource trading venues for bidding and tendering of engineering projects [19]. Public resource trading venues all have their own independent bidding and trading system platforms. The main problem currently is that the information exchange and exchange between the public resource trading platform and the supervision platform under the electronic bidding mode of engineering projects are insufficient, mainly due to the lack of timely sharing. The two platforms cannot achieve timely



communication, and cannot guarantee the accuracy of information submission. To a large extent, it restricts the supervision efficiency of the supervision platform and the accuracy of information extraction and inspection by the supervision department at any stage of the bidding process, resulting in inadequate supervision and inspection.

## **5. Analysis of the Advantages of Blockchain Technology in the Bidding Mode**

### **5.1. Promoting Transparent Management and Full Process Supervision of Engineering Project Bidding Information Through Structural Decentralization**

In the traditional bidding model, the release of bidding information for engineering projects is carried out uniformly by the release management center of the bidding enterprise. However, due to the consideration of local economic development by enterprises, the bidding information is often not fully released nationwide. Although the electronic bidding model solves the problem of limited scope of bidding information dissemination, there is an overly centralized problem in terms of information security and accuracy, as well as in the supervision of bidding activities. For engineering project bidding, the information involved is personally published by the bidding enterprise on the electronic bidding platform, and other participants can only understand relevant information through its publication channel. Some unscrupulous individuals are easily able to maliciously tamper with the information released by bidding companies through hacker means<sup>[26]</sup>. At the same time, the supervision of engineering project bidding activities is carried out by relevant supervisory agencies that establish relevant supervision mechanisms. During the bidding process, other participating parties cannot participate in the supervision process, and the results of engineering project bidding may be controversial. The decentralized advantages of blockchain technology can effectively solve the above problems.

The essence of blockchain is a distributed structure composed of several highly autonomous nodes that are freely connected to each other in chronological and logical order. These nodes form their own system due to their independent functions and governance mechanisms<sup>[27]</sup>. The decentralized advantage of blockchain structure can play a certain role in the bidding process of engineering projects, helping each participating entity in the bidding process achieve a point-to-point handover mechanism. Both parties can directly negotiate, implement, and supervise various matters, thus achieving the management of each task without relying on the bidding enterprise management center. Based on this advantage, blockchain technology can also enhance the information expansion function in the bidding process of engineering projects, making it possible to jointly build, share, and maintain information.

At the same time, the cryptographic encryption algorithm of blockchain technology will be deeply applied in the bidding mode of engineering projects, and the cost consumption data, business execution measures, and process supervision effect during the bidding process of engineering projects will be fully displayed to all participants in a partitioned and itemized visualization manner, achieving real-time and dynamic supervision from multiple parties. For the bidding party, these data can help them supervise the behavior of each participant. For bidders, these data can help them develop bidding plans that are more in line with engineering projects.

### **5.2. Breaking the "Data Island" and Violations of all Participants in Engineering Project Bidding Through Data Diversity and Openness**

In the traditional bidding process of engineering projects, due to geographical and time constraints, bidding companies are unable to share bidding information related to the project

simultaneously. Some illegal bidding companies collude with other companies in advance, resulting in illegal behaviors such as collusion and bidding, reducing the fairness and impartiality of the winning bid. Although the electronic bidding model has solved these problems in practical operation, many times it only utilizes the platform's bidding information dissemination and publication function, without completely completing the entire engineering project bidding process through the electronic network platform, resulting in other information generated in the bidding process being unable to be shared and communicated with others, ultimately resulting in low utilization of the generated information. The data diversity and openness advantage of blockchain technology can effectively solve these problems.

Essentially, blockchain is a public database with open, jointly utilized, and jointly supervised data [28]. Therefore, in each stage of engineering project bidding, the data openness advantage of blockchain technology helps to achieve real-time transmission of information throughout the entire stage of engineering project bidding, sharing bidding data information across the network, joint supervision and management of various nodes, and deep mining of data information value, thereby formulating more suitable bidding plans for engineering projects, while ensuring the fairness and fairness of the final results, reducing the occurrence of various violations and laws during the bidding process.

### **5.3. Improving the Reliability of Engineering Project Bidding Information and Enterprise Qualification Examination Through Whole Process Encryption and Traceability**

The traditional bidding model for engineering projects may generate a lot of information during the bidding process, and it may be necessary to refer to the information generated in previous stages at different stages. However, due to the shortcomings of the traditional bidding model, it may result in issues such as information leakage, tampering, or inability to access. Although the electronic bidding model can solve some of the above problems, it is still difficult for tendering enterprise to distinguish the authenticity of bidding companies' qualifications before the bidding starts, due to some illegal companies may falsify their qualifications. In addition, the electronic bidding model has the disadvantage of poor information storage. When too much information is generated during the bidding process, it becomes very difficult for the system to store this information, resulting in a decrease in the overall system operation speed [29]. The full encryption and traceability advantages of blockchain technology can effectively solve these problems.

The full encryption operation of blockchain technology not only helps to trace the entire bidding process of engineering projects, but also promotes the generation of advantages such as structural decentralization and data diversity and openness. In the bidding process of engineering projects, its full encryption and traceability features have the following advantages. Firstly, the bidding party, bidders, evaluation experts, and other participating parties provide newly added block data information and ensure the authenticity and reliability of its data information source. Secondly, asymmetric encryption technology is used to encrypt the newly added block data information, and different levels of password protection are provided according to the temporal order, logical level, and confidentiality level of the data information to ensure the security of the data information [16]. Thirdly, the alliance chain organization broadcasts the newly added block data information throughout the network, ensuring that all participants can access and review the data. After many nodes are confirmed, it can be recorded in the overall blockchain. Finally, each block in the blockchain is a complete and independent information block, which itself contains the input time, input information, and other contents of this information block. Based on this, the entire data of any block can be quickly accessed in chronological order, which is conducive to tracing and correcting problems in the bidding process of engineering projects.

#### **5.4. Improving the Fairness and Efficiency of Engineering Project Bidding and Evaluation results Through Smart Contracts**

In the electronic bidding mode, the evaluation relies on the evaluation experts. If the professional level of evaluation experts is not very high, there will be deviations when evaluating the proposals. Even if the respected experts may have the same problems as before for they are not very familiar with computer operations. The advantages of blockchain technology in smart contracts can effectively solve the above problems.

"Smart contracts are designed to facilitate the execution of contracts through computer protocols and users, so as to reduce accidents and reliance on third-party intermediaries." , pointed out by the computer scientist Nick Sabo <sup>[30]</sup>. In the smart contract blockchain system, a computer protocol code can be prepared in advance according to the bidding rules of engineering projects, so that it must meet the conditions agreed upon by all participating parties in the bidding and reach a consensus; By triggering automatic execution conditions through specific transactions, the blockchain system will automatically execute code contracts based on rules previously agreed upon by each participant. Therefore, it can be considered that a smart contract is a computer protocol that automatically executes the contract content according to the conditions of each participant, similar to the mode of a computer program "if then" <sup>[31]</sup>. The fast transmission of information in smart contracts helps improve the efficiency of engineering project bidding. Currently, based on the advantage of blockchain technology smart contracts, the entire process of engineering project bidding is placed on a single platform in the system, eliminating the addition of third-party trust centers. All participating parties are open and transparent on this platform, avoiding the review and approval process of various documents in the process, reducing time and cost consumption, and improving the efficiency of bidding work.

At the same time, in the bidding process, the smart contract automatically opens the bidding documents based on the pre-set code, and then automatically evaluates the proposals submitted by the bidders based on the pre-set code. The optimal solution can be obtained by comparing the results of the system's automatic evaluation with the results of expert evaluation. The use of smart contracts not only achieves fairness and impartiality in the bidding and evaluation results of engineering projects, but also reduces unnecessary manual procedures, greatly improving the efficiency of the engineering project bidding process.

### **6. Countermeasures for Solving the Problems of Engineering Project Bidding Mode Based on Blockchain Technology**

#### **6.1. Establish an Information Alliance Chain System**

In the blockchain operation system, a virtual information alliance chain based on consensus protocol is established to integrate information and data resources such as bidding and tendering for various tasks and activities throughout the bidding process of engineering projects, so as to make the resource allocation of engineering projects more reasonable and effective. Each node within the information alliance chain designs tasks for each stage in the bidding process of engineering projects, achieving a decentralized distributed structure <sup>[32]</sup>. On the basis of consensus agreement, information such as management and supervision of engineering project bidding tasks, information review, information exchange, and information data traceability can be stored in a timeline database, and the dispersed relevant information can be connected to the timeline database. The privacy of participants in the bidding process of engineering projects can be protected through encryption algorithms. Therefore, it can effectively solve the problem of low information utilization in the electronic bidding model.



Using blockchain technology to develop the decentralized system for project bidding, it is helpful to build a more secure, effective and credible collaborative information alliance chain system. Using blockchain distributed technology and protocol to form an effective collaboration mechanism, the value of each participant in the project bidding system can be fully recognized and encouraged, and the information communication of the project bidding process is open and transparent. Realizing information data sharing and connection in the project helps to establish the dynamic information alliance in the whole project bidding process. It can be seen from the above that the establishment of information alliance chain system can effectively solve the problems of information security and accuracy in the electronic bidding mode.

## **6.2. Use Smart Contracts to Automatically Execute Business**

Contracts are the foundation of blockchain technology, and information flow is the core of actual tasks in the bidding process of engineering projects. The structure of contracts is used to deconstruct actual tasks, encode relevant task processes, rules, and other contents in the bidding process of engineering projects onto blockchain, and achieve information sharing among all parties. By pre formulating rules, protocols, and other contents through smart contracts, engineering project bidding tasks are decomposed. Smart contract technology is used to code the activity rules and protocols of various bidding tasks into the blockchain system and achieve automatic execution, achieving the goal of reducing resource allocation costs [33]. At the same time, smart contracts are used to encode and automatically execute task rules during the bidding process of engineering projects, ultimately determining the evaluation results. In this process, various information data in the blockchain system are used to carefully calculate and obtain the final evaluation results based on the evaluation criteria. Blockchain technology solidifies the authenticity and fairness of the evaluation results. This can avoid affecting the fairness and authenticity of the bidding and evaluation results of engineering projects due to the uneven level of evaluation experts or the unfamiliarity of operators with computers.

For the service commitments uploaded by bidders to the system during the bidding process of engineering projects, by using the smart contract function to compare with the actual situation, the unmet service commitments are converted into digital scores and recorded in the bidder's credit points, to avoid the situation where the bidding enterprise's qualification review fails.

Therefore, this strategy can effectively solve the problems of poor information storage capacity, uneven evaluation expert level, and unfamiliarity of operators with computers in the electronic bidding mode.

## **6.3. Upload File Information on the Chain**

During the bidding process of engineering projects, the bidding party stores the bidding documents in the bidding system, which generates a unique corresponding hash value. The information alliance chain system automatically reviews it. If it passes the review, it indicates that the chain has been successfully uploaded, and the platform will automatically publish the bidding documents. Otherwise, it is necessary to modify the files and follow the above steps again. Through this online operation and the use of blockchain technology's timestamp function, it can ensure that the information in engineering project bidding documents cannot be falsified or tampered with by illegal elements, and also ensure the security of the file content throughout the entire engineering project bidding process (see Figure 2).

During this process, the bidder needs to complete the design of the bidding plan according to the content of the bidding documents released by the platform, encrypt important information in the bidding plan, and then upload it to the platform. After successfully uploading the scheme, the system utilizes blockchain technology to automatically timestamp each bidder's uploaded scheme and store the hash value generated by the bidding scheme to ensure the security and authenticity of important information in the scheme. At the same time, utilizing blockchain

technology's overall distributed ledger function, any tampering with the bidding scheme will be recorded. In the subsequent system automatic verification, the bidding plan will be automatically judged invalid, ensuring the fairness of the final evaluation result [34]. In addition, the use of blockchain technology helps to better maintain the bidding market environment. Supervision units collect bidding information from past bidding enterprises, organize it and convert it into digital credit score tables, and publish them to the public through the platform, to avoid malicious phenomena such as collusion and bidding by bidders during the bidding process of engineering projects.

Therefore, the measure of linking file information can effectively solve the problem of inadequate supervision and inspection by supervisory departments in the electronic bidding model.

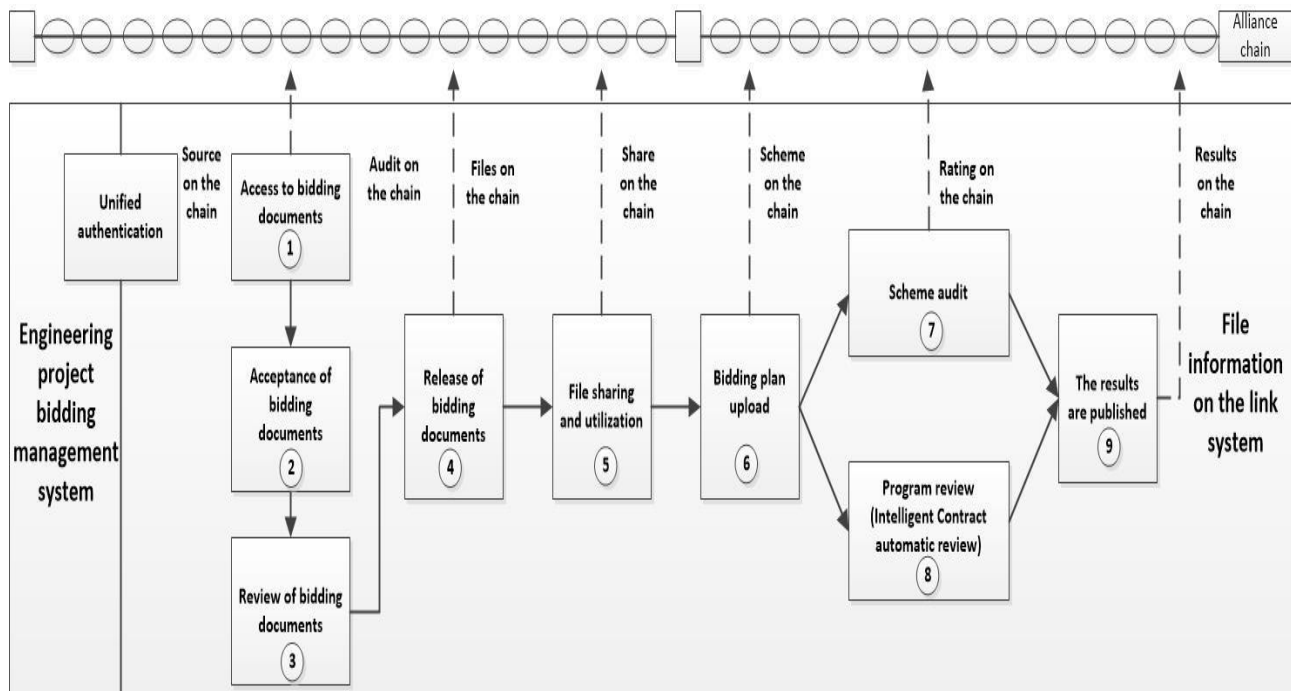


Fig. 2 The Process of Uploading File Information on the Chain

## 7. Conclusion

As an important component of China's new infrastructure, although there are still some technical and institutional deficiencies that need to be addressed, the potential of blockchain to solve the problem of engineering project bidding mode cannot be ignored. In response to the problems of difficult information traceability and low level of information sharing in the current engineering project bidding model, the engineering project bidding management model based on blockchain technology can create an information alliance system, achieve full process supervision, and fully leverage the traceability, information sharing, information tampering and leakage characteristics of blockchain technology to ensure the continuous, stable, and healthy development of the engineering project bidding field. Blockchain technology, as an emerging technology in the 21st century, is an inevitable trend to promote the healthy development of the entire industry by applying it to bidding activities. It is also an urgent requirement to solve prominent problems in the bidding field and respond to national calls. Blockchain technology will undoubtedly bring new opportunities and development to China's engineering project bidding model.

## Acknowledgements

This work was supported in part by the Natural Science Foundation of the Higher Education Institutions of Anhui Province of China under Grant KJ2021A0485; in part by the Philosophy and Social Science Planning Project of Anhui Province of China under Grant AHSKF2021D31; and in part by Graduate Research and Innovation Fund of Anhui University of Finance & Economics under Grant ACYC2022156.

## References

- [1] B. Hu: Research on Bidding Theory and Method in the Era of Big Data (MS., SouthWest JiaoTong University, China 2016), p.101.
- [2] Y.W. Wang, Y.Q. Chen: Research on the problems and countermeasures of enterprise bidding, file management, China Archives, (2010) No.6, p.36-37.
- [3] L. Zhu, H. Liang, T. Tang, et al: Blockchain enables railway: application prospect and typical case analysis, Journal of the China Railway Society, Vol. 44 (2022) No.9, p.79-86.
- [4] Y.K. Zhang, Y.X. Chen: Blockchain and financial markets stability: real action or conceptual hype? Journal of Beijing Technology & Business University(Social Sciences), Vol. 38 (2023) No.3, p.39-52.
- [5] L. Zhang, M.X. Ma, J. Du, et al: Research on the application and development trend of blockchain technology in the medical field based on bibliometry and indexing statistics, Journal of the China Society for Scientific & Technical Information, Vol. 40 (2021) No.9, p.962-973.
- [6] X.Y. Ya, Y.Y. Liu, B.C. Cao: Copyright protection of sports events network based on blockchain technology, Journal of Wuhan Sports University, Vol. 56 (2022) No.7, p.46-52.
- [7] Y.L. Lu, L.H. Yin, X. Yu, et al: Research on the construction of agricultural science data management scenario model based on blockchain, Information Science, Vol. 40 (2022) No.9, p.20-25,37.
- [8] Z.W. Cui: Blockchain Finance: Innovation, risk, and its legal regulation, Oriental Law, Vol. (2019) No.3, p.87-98.
- [9] D. Xu, Q. Yang: The systems approach and design path of electronic bidding systems based on blockchain technology, Electronics, Vol. 11 (2022) No.21, p.3501.
- [10] Y.H. Zhang, J. Li, D. Zheng, et al. Privacy-preserving communication and power injection over vehicle networks and 5G smart grid slice, Journal of Network & Computer Applications, Vol. 122 (2018) , p.50-60.
- [11] Q. Zhang, Y. Yu, H.L. Li, et al. Trustworthy sealed-bid auction with low communication cost atop blockchain, Elsevier Science Inc, Vol. 631 (2023) , p.202-217.
- [12] Y. Hu, Y.P. Kuang, Z.L. Zhu: The application of blockchain technology in national audit -- is based on the perspective of technology trust, Auditing Research, Vol. 231 (2023) No.1, p.39-47.
- [13] J.R. Sun: The application of blockchain technology in national audit -- is based on the perspective of technology trust, Construction Economy, Vol. 41 (2020) No.7, p.112-117.
- [14] Nakamoto S. Bitcoin: a peer-to-peer Electronic Cash System[EB/OL]. (2021-10-19)[2022-04-18]. <https://bitcoin.org/en/bitcoin-paper>.
- [15] S.J. Wei, W.L. Lv, S.S. Li: Summary of the typical security issues of blockchain public chain applications, Journal of Software, Vol. 33 (2022) No.01, p.324-355.
- [16] O. Bai, Y.Y. Yang: Research on the Application of Blockchain Technology in the Comprehensive Management of Network Security. Proceedings of the 2019 Internet Security and Governance Forum (Shandong, China, November 7-26, 2019). Vol. 41, p.112-117.
- [17] S. Mei, D. Jang, H.G. Lou: The application research of blockchain technology in the field of construction engineering, Construction Economy, Vol. 40 (2019) No.11, p.5-8.
- [18] Z.Y. Bai, P. Wang, T.Y. Zhang: Analysis of the system dilemma and outlet of electronic government procurement in china, Study & Practice, Vol. 393 (2016) No.11, p.79-85.

- [19] P. Liang, Y.M. He, Y.Z. Chao: Analysis on the present situation of electronic bidding in china, Reform & Opening, Vol. 17 (2014) No.7, p.13-15,39.
- [20] X.L. Han: Research on the development of hainan E-Government under the background of the reform of the system of administrative examination and approval system -- take hainan government affairs service center as an example, E-Government, Vol. (2014) No.5, p.87-92.
- [21] W.L. Zhang: Problems existing and standardized exploration of bidding files in colleges and universities, Research & Exploration in Laboratory, Vol. 37 (2018) No.7, p.301-303,322.
- [22] W.M. Sun: The significance, problems and countermeasures of the standardization of electronic bid evaluation under the condition of information technology --take the bidding of beijing construction projects as an example, Studies in Dialectics of Nature, Vol. 32 (2016) No.9, p.55-59.
- [23] C.Y. Li: Exploration of the new mode of trusted authentication of bidding electronic archives based on blockchain technology --take sinopec material bidding electronic documents single set of archiving pilot as an example, China Archives, Vol. (2022) No11, p.70-71.
- [24] Y.N. Wang: Exploration of the electronic bidding method for mining enterprises, China Mining Magazine, Vol. 29 (2020) No.S2, p.142-144.
- [25] G. Wu: Comparative Analysis of electronic bidding and electronic reverse auction for bulk procurement, Modern Management Science, Vol. (2009) No.1, p.87-89.
- [26] Y.S. Tan: Blockchain-based iot Identity Security Authentication System (MS., Guangdong University of Technology, China 2022), p.74.
- [27] Y. Wang, T.H. Yang, W.H. Wang: Blockchain applicability analysis and architecture design research in engineering construction management, Engineering Journal of Wuhan University, Vol. 54 (2021) No.S1, p.139-143.
- [28] Q. Sun: The application of blockchain technology in the bidding and bidding tracking audit of state-owned enterprises, Communication of Finance & Accounting, Vol. (2021) No.7, p.130-133,138.
- [29] Y.N. Liu, Y.P. W: Research on the application path of blockchain technology in archives management, China Archives, Vol. (2020) No.9, p.28-31.
- [30] D. Wang, Y.Y. Cheng: Application of smart contract in government procurement bidding: path, difficult problem and legal response, Journal of Beijing Jiaotong University(Social Sciences Edition), Vol. 21 (2022) No.3, p.137-146.
- [31] W.H. Yang, H. Wang, W.N. Liu: The application concept of blockchain technology in engineering project management, Construction Economy, Vol. 41 (2020) No.S1, p.141-143.
- [32] Y. Hu: Research on the application mechanism and framework of blockchain technology in the national audit -- take the audit of government-subsidized housing project as an example, Journal of Hunan Agricultural University(Social Sciences), Vol. 24 (2023) No.2, p.86-92.
- [33] Z.Y. Yang: Application and countermeasures of the new technology of electronic bidding, Construction Economy, Vol. 41 (2020) No.S1, p.271-273.
- [34] Y.H. Li: Research on judicial execution innovation based on blockchain technology, Journal of Northwest Minzu University(Philosophy and Social Sciences), Vol. (2022) No.2, p.76-86.