

Smart Contracts for Decentralized Construction Project Bidding: Challenges and Feasibility

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Abstract

The study aims to assess smart contract solutions for centralized construction project bidding. Traditional bidding methods in construction projects can be vulnerable to fraud and collusion, leading to unfairness and tampering with information. Electronic tendering technologies have been introduced to streamline the process but rely on a centralized database, making them vulnerable to fraud, collusion, and corruption. Blockchain technology offers a decentralized approach to data management, offering a secure and transparent platform, and potentially establishing a secure and open tendering system.

The study used a mixed research approach. A structured questionnaire for the study was designed from the literature review and administered to Architects, Construction Managers, Quantity Surveyors, Contractors, Civil Engineers, and Consultants in the Wa municipality. Both purposive and snowball sampling methods were used in this study to obtain a valid and effective overall sample size. The questionnaire was disseminated through Google Forms, 81 retrieved and used for the analysis of the study. The statistical tools used for analysis are frequency, percentages, and thematic analysis.

The results indicate that there are numerous challenges in centralized construction project bidding processes, including issues related to trust, document management, time, accessibility, political influence, competition, fairness, financial aspects, interference, and coordination. 36 respondents representing 44% believed the centralized construction project bidding process was inefficient.

The majority of respondents, 74.1%, expressed a positive belief that smart contracts can effectively address the challenges identified. A substantial portion believes that smart contracts are feasible for construction project bidding, and a significant number are either neutral or very optimistic about the potential of this technology.

Keywords: Smart Contracts, Blockchain technology, Centralized Construction Project Bidding,

1.0 Introduction

The construction industry is often flawed by inefficiencies, lack of transparency, and disputes during the project bidding process. The emergence of blockchain technology and smart contracts presents an opportunity to revolutionize this process, providing a decentralized and secure platform for centralized construction project bidding (Sigalov et al 2021). The construction industry operates with diverse contract formats and standards. Several stakeholders are involved in centralized bidding processes, including suppliers, project owners, contractors, and subcontractors. Gaining broader acceptance of the technology requires building confidence and guaranteeing the security of sensitive information and transactions

within smart contracts. One of the biggest challenges in creating a uniform smart contract solution is making sure it complies with the law while accommodating different bidding scenarios. To ensure openness, efficiency, and fairness in construction project bidding, this research proposal seeks to explore smart contract feasibility to solve central project bidding challenges.

2.0 LITERATURE REVIEW

2.1 Overview of project bidding

An early and crucial stage of building projects is the construction tendering process, which takes place between the employer and bidders. Bidders submit a tender to the employer outlining their plan to finish a certain construction project (Ahmadisheykhsarmast, et al 2023). The main goal of the construction tender procedure is to award the contract to the most competitively bidder, the qualified contractor. The bidding process, as its initial stage, is typified by its ability to tackle one of the urgent practical problems that need for strong management requirements. The conventional bidding procedure depends largely on the engagement of a trusted third party and is very document-oriented. Therefore, the conventional bidding procedure does not exclude the possibility of fraud and participant cooperation.

Among the most dishonest things bidders do are offer illegal financial incentives and rig the bidding process. Offering incentives to those who could reveal the contents of proposals that have been filed or even replace them after submission is what these tactics entail. Furthermore, in order to support a certain bidder and guarantee their success in obtaining the contract, the tender organization could unjustly assess offers (Jones, 2021). The competitive aspect of the construction business can be compromised by bid rigging, injustice, insufficient bidding confidentiality, and information tampering (Anderson et al., 2018). As a result, there is an increasing need for an unchangeable, visible, traceable, and safe way to guarantee fairness from the start of the tendering process to the contract awarding stage. In recent years, electronic tendering (e-tendering) systems have emerged as online alternatives to traditional tendering processes, aiming to create an efficient and equitable bidding environment that expedites the overall process. Simultaneously, e-tendering systems reduce the administrative burden associated with bid administration tasks, leading to cost savings (Chan and Owusu, 2022). Compared to conventional tendering processes, e-tendering systems facilitate the comparison of proposals and technical data, making the process more streamlined (Abdel-Basset et al., 2018).

However, the main issue with these systems is that they rely on an approved entity to supervise and manage the process, as well as a centralized third-party database. Thus, total control over the system is obtained by the third party, opening it up to possible fraud, collusion, corruption, and manipulative activities (Manzoor et al., 2021). For instance, proposals may be untimely disclosed to other participants, and the centralized database storing bidding information can be tampered with, leading to significant risks in terms of data security and traceability. Hence, the vulnerability of centralized storage of sensitive participant-related data to privacy and security breaches is significantly increased. Blockchain technologies have recently emerged as a decentralized solution to tackle these concerns by offering decentralized data storage and control. This presents a robust alternative for establishing a secure, reliable, and transparent

platform (Chenthara et al., 2020). The potential of blockchain and smart contracts in creating a secure and transparent tendering system has been explored in recent research. However, these studies have mainly focused on qualitative analysis or the development of conceptual frameworks, with proposed methods targeting specific stages of the tendering process. Limited research efforts have been dedicated to developing a secure and transparent smart contract-based tendering system, which is the primary objective of this paper (Li and Kassem, 2021). The purpose of this article is to evaluate smart contracts as a decentralized method for safe and open construction contract tendering at every level of the procedure. The suggested method would display the whole tendering process as a smart contract deployed on a decentralized public blockchain, minimizing human interaction throughout the bidding process. The main goals of the proposed decentralized tendering system are to generate trust between the relevant parties, provide transparency, and provide a strong replacement for eliminating or significantly reducing dishonesty and disruptive behaviors in the tendering process for construction projects.

2.2 Tendering practice in construction projects

The process of choosing the best qualified contractor to complete a certain building project is known as tendering. In the construction business, the conventional paper-based technique of tendering has long been in use. Nevertheless, this approach comes with a high administrative burden and is susceptible to abuse due to insufficient security and transparency safeguards (Mothibi, G.M., 2020). Therefore, the prospect of tampering with tendering information and planned collusive acts might be enabled by the traditional tendering process. Initiating and carrying out the tendering procedure is often handled by a central authority. Since of this, the conventional approach cannot completely guarantee the process's reliability since the central authority may divulge confidential information or engage in other wrongdoings motivated by self-interest (Ahmadisheykhsarmast et al.2023).

E-bidding technologies have made it possible to offer an alternative in recent years that enhances the conventional tendering process by offering an effective and practical tendering environment. E-tendering is providing bidders with electronic bidding materials and obtaining their replies via an online platform (Sithole, 2017). The construction sector would see increased efficiency, cost savings, and process acceleration with the use of e-tendering. Applying e-tendering, according to Abdullahi et al. (2022), promotes openness and makes it simple to monitor bidder progress via internal systems. Research from a number of developed countries shows that e-tendering applications can save pre-contract expenses by up to 20% (Paula, 2019). Because e-tendering platforms are centralized, process execution and control are delegated to external mediators, even if they provide significant benefits for addressing some of the previously listed problems.

Because prospective bidders must rely on the authorized organizer to verify the legality of offers, e-tendering systems present serious challenges about data integrity, security, transparency, and traceability (Ahmadisheykhsarmast, et al 2023). Furthermore, a centralized database houses the sensitive data and transaction records of the bidders taking part in the e-tendering process, raising the possibility of data loss, privacy concerns, and information manipulation (Hassija, et al 2020). Another problem with these technologies that interrupts the entire process and causes enormous financial losses is the potential for hackers to compromise the e-tendering systems. (Hassija, et al 2020).

2.3 Blockchain in construction

In the construction industry, there has been recent research exploring the potential of utilizing blockchain and smart contracts to facilitate digital transformation, promote collaboration, and strengthen trust. Blockchain technology has emerged as a groundbreaking innovation, bringing about a fundamental change in the conventional management of traditional business processes. This shift is particularly significant as traditional systems often rely on centralized structures that necessitate trusted intermediaries (Chen et al., 2022). According to Rahman et al., blockchain has the ability to address issues related to data integrity and security in centralized cloud-based information management, presenting a secure platform for the communication of sensitive data.

According to Li et al. (2021), blockchain's built-in characteristics do away with the requirement for a centralized authority. In order to motivate users of non-cryptocurrency blockchain systems to precisely verify transactions, they have also created an incentive structure (Rahman, et al 2022). According to Nawari and Ravindran (2019), sensitive BIM data maintained on a blockchain network is guaranteed to be secure and private. According to Sharma et al. (2018)'s thorough literature study, blockchain-based solutions successfully overcome the drawbacks of data encryption and processing on centralized servers utilized by Internet of Things devices. The reason for this is that the blockchain keeps an open record of all data transfers (Ahmadisheykhsarmast, et al 2023).

According to Pan et al. (2022), the blockchain ensures data authenticity and immutability through decentralized information storage, increasing the effectiveness of equipment security information management. According to Fugelsang (2019), blockchain technology is a viable means of ensuring data confidentiality and privacy in the financial management of enterprises. According to Khurshid, (2020), In the blockchain-based construction business, the decentralized nature of blockchain technology and smart contract integration will speed up transaction times, cut costs, and improve transaction transparency.

2.4 Blockchain-based tendering: exploring the research gap

It is recommended that the tendering process be conducted via a decentralized, transparent, and secure platform in order to reduce the likelihood of bidder suspicion and fraud. Due to its ability to provide a decentralized consensus mechanism, blockchain technology can successfully address the issues with e-tendering systems related to security, privacy, trust, and transparency (Dutta, et al 2020). The potential of blockchain technology to develop a secure tendering process has not received much attention from research. According to Khurshid, A. (2020), blockchain technology offers a cutting-edge framework for the development of a reliable and open system of construction contract tendering Pan et al. (2022) emphasized how smart contracts might improve transparency by streamlining the bidding process by allowing bid documents to be shared according to the employer's assessment standards (Sigalov, et al 2021).

2.5 challenges in the centralized construction project bidding process.

The centralized construction project bidding process, where project owners or procurement agencies solicit bids from contractors to select the best offer, faces several challenges and limitations. Here are some of the current issues associated with the centralized bidding

process: Lack of Transparency: The bidding process can lack transparency, making it difficult for contractors to assess the fairness of the process. Without clear visibility into the evaluation criteria and decision-making process, contractors may question the integrity of the bidding process (Mahmood, 2010). Limited Competition: In some cases, the centralized bidding process may restrict competition, as only a limited number of pre-selected contractors or suppliers are invited to participate. This reduces the opportunity for other qualified and potentially more competitive contractors to bid on the project (Fourie, and Malan, 2021.) Time and Cost Overruns: The centralized bidding process can lead to delays and cost overruns. The time-consuming nature of the process, including document preparation, submission, evaluation, and negotiation, can prolong the project's start date and result in increased costs. Bid Shopping and Bid Peddling: Bid shopping occurs when a project owner discloses the lowest bid received to other contractors in an attempt to secure an even lower price. Conversely, bid peddling occurs when a contractor discloses a lower bid to the project owner after bid submission to secure the contract. These practices undermine fair competition and can lead to unethical behavior (Pishdad-Bozorgi, and Yoon, 2022). Limited Innovation and Collaboration: Centralized bidding processes may not foster innovation or encourage collaboration among contractors. The focus on lowest-price bidding often discourages contractors from proposing innovative approaches or value-added solutions that could improve project outcomes (Marinelli, and Antoniou, 2019). Qualification-Based Selection Challenges: The centralized bidding process primarily focuses on price-based selection, neglecting the importance of contractor qualifications and expertise. This can lead to contractors being selected solely based on their bid price, disregarding their experience, track record, and ability to deliver quality work (Wang, et 2019). Inefficiency and Administrative Burden: The paperwork-intensive nature of the centralized bidding process can be time-consuming and administratively burdensome for both project owners and contractors. This can result in inefficiencies and delays in the overall procurement process (McCue, 2003). Addressing these challenges requires a shift towards more transparent, inclusive, and efficient procurement practices. Introducing technology solutions, implementing qualifications-based selection methods, encouraging collaboration, and promoting fair competition are potential steps to improve the centralized construction project bidding process (Wondimu, et al 2018).

2.6 Potential benefits offered by smart contracts in addressing these challenges.

Numerous issues related to the centralized construction project bidding process may be resolved by smart contracts. (Kassem and Li, 2021). Openness and Unchangeability: A blockchain is used to hold smart contracts, which gives the bidding process immutability and transparency. All contract terms, conditions, and actions are recorded on the blockchain, creating an auditable and tamper-proof record. This enhances trust and eliminates concerns about the fairness of the process (Weingärtner, et al 2021). Increased Competition: Smart contracts can enable broader participation and increased competition in the bidding process. By utilizing blockchain-based platforms, contractors from anywhere in the world can access and participate in bids, eliminating geographical limitations. This enhances competition and increases the chances of finding the most qualified and competitive contractors (Khalfan, et al 2022). Processes that are both efficient and automated: Smart contracts automate a number of the bidding process's steps, including bid submission, evaluation, and contract award. As a result, there is less manual involvement, less paperwork, and a more efficient administration

of duties, which decreases processing time and increases efficiency (Triana et al 2020). **Enhanced Security and Trust:** Smart contracts are extremely safe since they make use of decentralized storage and cryptographic encryption. Because blockchain technology is decentralized, it is impossible to change or modify contract conditions without agreement. As a result, contractors, project owners, and other stakeholders have greater trust (Secinaro, et al 2021). Smart contracts can be customized and self-executing. They can be programmed with particular terms, conditions, and assessment standards. This makes it possible for contracts to be modified to meet the particular needs of every bidding procedure. Additionally, once the necessary criteria are met, smart contracts can automatically carry out prescribed operations, eliminating the need for manual involvement and the possibility of human error (Ciotta, et al 2021). **Increased Collaboration and Innovation:** Smart contracts can facilitate collaboration and incentivize innovation in the bidding process. Contractors can propose value-added solutions or innovative approaches directly within the contract code, creating an environment that encourages contractors to differentiate themselves based on their expertise and creativity (Winch, G.M., 2009).

Transparency in Contractor Qualifications: Smart contracts can integrate reputation systems or verification mechanisms that validate and record contractor qualifications and past performance on the blockchain. This ensures that contractors are selected not only based on price but also their qualifications and track record, enhancing the overall quality of the bidding process (Pishdad-Bozorgi and Yoon, 2022). By leveraging the benefits of smart contracts, the centralized construction project bidding process can become more transparent, efficient, secure, and inclusive. It promotes fair competition, reduces administrative burdens, and fosters collaboration and innovation among contractors, ultimately leading to improved project outcomes (Campbell, 2017).

2.7 Evaluate the feasibility, effectiveness, and usability of the proposed smart contract solution

The feasibility, effectiveness, and usability of a smart contract solution in the context of the centralized construction project bidding process depend on several factors (McNamara and Sepasgozar, 2021).

2.7.1 Feasibility

Implementing smart contracts in the construction bidding process is technically feasible. Blockchain technology and smart contract platforms are readily available and have been successfully utilized in various industries. However, feasibility also depends on factors such as the availability of skilled developers, infrastructure requirements, and compatibility with existing systems or processes (Hamledari and Fischer, 2021)

2.7.2 Effectiveness

Smart contracts can be highly effective in addressing the challenges of the centralized construction project bidding process. The transparency and immutability provided by blockchain technology reduce the risk of fraud and increase trust among stakeholders. By

automating and streamlining processes, smart contracts can significantly reduce administrative burdens, processing time, and associated costs (Wu, et al., 2021). Contract execution accuracy and efficiency are increased by the ability to personalize contracts and add predetermined actions. Better project outcomes may also result from the enhanced competition, teamwork, and creativity that smart contracts promote (Li and Kassem, 2021).

2.7.3 Usability

A smart contract solution's usability is influenced by things like accessibility, ease of use, and system integration. Although developing smart contracts may necessitate technical expertise due to their coding foundation, attempts can be taken to design user-friendly interfaces for stakeholders who may lack familiarity with blockchain technology or coding (Nanayakkara, et al 2021). The availability of user-friendly smart contract platforms and tools can facilitate adoption and usability. Integration with existing systems, such as procurement or project management software, is also crucial to ensure a seamless user experience (Ko et al 2016). It's important to note that the successful implementation of a smart contract solution requires collaboration and cooperation among project owners, contractors, and other stakeholders. Clear communication, education, and training initiatives may be necessary to ensure that all parties understand the benefits and processes associated with smart contracts (Harris et al 2021).

Overall, when properly designed and implemented, smart contract solutions have the potential to be feasible, effective, and usable in addressing the challenges of the centralized construction project bidding process. However, careful consideration should be given to the specific requirements, resources, and readiness of the construction industry stakeholders before adopting and implementing such solutions.

3.0 METHODOLOGY

3.0 Introduction

This category discusses the approach adopted to achieve the position and goals of the study. Questionnaire design, Respondents and Information collection; and data discovery Interpretation.

3.1 Research Method

A mixed-method research approach was employed in this study, as allows researchers to use multiple sources of data to validate and corroborate their findings. The descriptive research strategy was chosen to align with the study's objective. Survey research methodology was utilized, as it involved collecting data from a sample of the study population.

3.2 Questionnaire design

The research study used primary sources for data collection, creating both open and closed-ended questionnaire. A piloting procedure involved a Senior Lecturer, industry professionals, and respondents to assess its suitability. After approval, all respondents confirmed the questionnaire's suitability, demonstrating its effectiveness in addressing the study's objective. Two non-probability sampling techniques were used: purposive and snowball. Out of 81 questionnaires were returned, indicating a high response rate. The study was administered using Google Forms.

3.3 Data Discovery Interpretation

Following the retrieval of the questionnaires, the quantitative data were organized and prepared for coding using the IBM SPSS software, specifically version 26 of the Statistical Packages for Social Sciences (SPSS). Subsequent data analyses and interpretation were conducted using this software. Descriptive analytical tools, including simple frequencies, mean scores, and standard deviation, were utilized to analyze the received data in this study. The qualitative data was analyzed using thematic analysis.

3.4 Ethical Considerations

The research ensured the full anonymity of both individuals and organizations involved in the study. Prior to commencing the research, explicit consent was obtained from all research participants, demonstrating a commitment to ethical standards. Throughout the study, a high level of respect was maintained for the dignity of the research participants.

4.0 RESEARCH FINDINGS

4.1 Socio-demographic data

There are 81 individuals in total. Among them, 6 individuals are female, which accounts for 7.4% of the total. The majority, 75 individuals, are male, making up 92.6% of the total. The total sample size is 81 individuals. The majority, 48 individuals (59.3%), hold a Bachelor's Degree. A smaller proportion, 6 individuals (7.4%), have a Higher National Diploma. 27 individuals (33.3%) have a Master's Degree.

The largest group, consisting of 30 individuals (37.0%), has 1-5 years of experience. There is another group of 6 individuals (7.4%) with 11-15 years of experience. 30 individuals (37.0%) have 6-10 years of experience. A smaller group of 3 individuals (3.7%) has less than 1 year of experience. 12 individuals (14.8%) have more than 20 years of experience. The largest group, consisting of 45 companies (55.6%), falls in the category of companies with 1- 10 employees. There's another group of 9 companies (11.1%) with 101-500 employees 12 companies (14.8%) have 11-50 employees. 15 companies (18.5%) belong to the category of companies with 51-100 employees. There are several categories, including "Architectural," "Construction Company," "Consulting Firm," "Engineering Firm," and "Government Agencies. "The majority, 33 individuals or businesses (40.7%), are associated with Government Agencies. 27 individuals or businesses (33.3%) are related to Construction Companies. Consulting Firms account for 9 individuals or businesses (11.1%). There are 6 individuals or businesses (7.4%) in the "Architectural" and "Engineering Firm" categories, respectively

4.2 Overall efficiency of the current centralized bidding process in Ghana

Table 4.1 Overall efficiency of the current centralized bidding process?

	Frequency	Percent
Efficient	24	29.6
Inefficient	36	44.4

Neutral	18	22.2
Very Inefficient	3	3.7
Total	81	100.0

Source: field data, 2023

The findings regarding the effectiveness of the centralized bidding procedure are summarized in the table. The table shows that out of 81 respondents, 44.4% considered the procedure to be ineffective, indicating potential issues or limitations. On the other hand, 29.6% of respondents found the procedure to be effective, suggesting that it meets their expectations and operates efficiently. A smaller percentage, 22.2%, held a neutral position, possibly indicating uncertainty or recognition of both advantages and disadvantages. Only 3.7% of respondents described the process as extremely inefficient, highlighting serious concerns.

Table 4.2 Current challenges in the centralized construction project bidding process in Ghana

Theme	Specific Challenges Mentioned
Trust and Transparency	Lack of trust
	Distance and transparency is a challenge
	Power holders influence the bidding process
Document and Information Management	Bidders ignoring to provide key attached document
	Limited bidders' availability during the opening process
	Delay in receiving information
Time-Consuming Process	I think it is time-consuming
	Time constraints, laborious process
	Time-consuming
Accessibility and Availability	Distance and transparency are a challenge
	Limited bidders' availability during the opening process
	Time and cost of traveling to the employer to buy and submit bid documents
Political and Bureaucratic Influence	Power holders influence the bidding process
	Political influence affecting competition
	Bureaucracy
Competition and Fairness	Is very competitive
	Discrimination
	Delay in progress of work
	Fairness
	Lack of proper competitive bidding

Financial and Resource Challenges	Source of finance to secure contract
	With the correction of contractor work
Interference and Coordination	Interference of politicians
	Poor coordination in the bidding by different stakeholders
Positive Responses	I actually do not face any challenge
	Hardly I have ever faced any challenges
	N/A
Specific Processes Mentioned	National Competitive Tendering process
	Tenders

Source: field data, 2023

The lack of trust in the bidding process is a significant concern. Bidders may be apprehensive about the fairness and integrity of the process, which can undermine their confidence (Li, et al. 2019; Mahmood, , 2010). Issues related to document submission, the availability of key information, and the efficiency of the process are highlighted. Bidders face challenges when key documents are not provided or when information is delayed (Ahmadisheykhsarmast et al., 2023).

Bidders often express concerns about the time-consuming nature of the bidding process. This can be burdensome and may discourage potential participants (Chan et al. 20220: Pishdad-Bozorgi, and Yoon, 2022). Potential bidders may encounter obstacles due to accessibility concerns, such as physical distance and restricted availability during the opening procedure. There is additional mention of travel expenses for obtaining and submitting bid paperwork (Chan et al., 20220). Political influence and bureaucracy are identified as challenges. This suggests that political interference and bureaucratic red tape can affect the fairness and integrity of the bidding process (Hassija et al. 2020).

The competitive nature of the bidding process is acknowledged, but it is also associated with concerns about discrimination and fairness. Participants express worries about the fairness of the process and potential biases (McCue, 2003).

Some bidders face financial challenges in securing contracts, and there may be the need for corrections that can impact costs. These financial aspects can be hurdles for some participants (Chan et al. 20220). The interference of politicians and poor coordination among different stakeholders can lead to inefficiencies and create challenges in the bidding process. A few respondents express that they do not face any challenges or have rarely encountered issues. This suggests that experiences may vary among participants. Some respondents mention specific processes like the "National Competitive Tendering process" and "Tenders." These may have unique challenges associated with them.

In summary, the results indicate that there are numerous challenges in centralized construction project bidding processes, including issues related to trust, document management, time, accessibility, political influence, competition, fairness, financial aspects, interference, and coordination. Addressing these challenges is crucial for enhancing the efficiency, transparency, and fairness of the bidding process and ensuring that it remains accessible to a wide range of participants. For those participating in the bidding process as well as stakeholders in the construction industry, this analysis offers insightful information. Overall efficiency of the current centralized bidding process?

4.1 Potential benefits offered by smart contracts in addressing these challenges.

Table 4.3 Potential benefits offered by smart contracts in addressing these challenges

Theme	Specific Benefits/Impacts Mentioned	Frequency
Increased Transparency	Increased transparency	41
Reduced Disputes	Reduced disputes	13
Faster Contract Execution	Faster contract execution	29
Cost Savings	Cost savings	33
Improved Trust among Stakeholders	Improved trust among stakeholders	39
It makes all key players (stakeholders) take things seriously	It makes all key players (stakeholders) take things seriously	5
Other (please specify)	Other (please specify)	3
Improved Accountability in the process	Improved accountability in the process	8

Source: field data, 2023

Thematic analysis reveals that respondents emphasize several key benefits and impacts related to the concept of smart contracts in construction project bidding: **Increased Transparency:** The most frequently mentioned benefit is the increased transparency in the bidding process, which enhances fairness and trust (Li et al. 2021). **Faster Contract Execution:** Many respondents highlight the advantage of faster contract execution, which can lead to project efficiency and reduced delays. **Cost Savings:** Cost savings are a prominent theme, as smart contracts can streamline processes and reduce administrative expenses (Fugelsang, 2019). **Improved Trust among Stakeholders:** The concept of smart contracts is associated with improved trust among stakeholders, which is essential for successful project collaboration (Secinaro, et al 2021).

Reduced Disputes: Respondents recognize that smart contracts can help reduce disputes, leading to smoother project implementation (Ciotta, et al 2021). **It makes all key players (stakeholders) take things seriously:** Some respondents note that smart contracts encourage all key stakeholders to take their roles and responsibilities seriously, which can lead to a more responsible and efficient process.

Other (please specify) and Improved Accountability in the process: There are a few additional comments, including suggestions that go beyond the provided categories. In summary, the majority of respondents acknowledge the positive impacts of smart contracts in construction project bidding, with a strong focus on transparency, faster execution, cost savings, improved trust, and reduced disputes. These findings suggest that smart contracts are seen as a promising solution for addressing challenges and enhancing the overall bidding process in construction projects.

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