# Transparent Road Tender Allocation Using Blockchain

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*Abstract -* **In our digital age, people are looking into blockchain tech to boost openness and faith in public processes. This includes government contract awards for road building where unfair methods, favouritism, and tampering often happen during bidding. Many setups using blockchain have been suggested to make contract awards clear and safe. But most of these plans end at giving out the contract and don't deal with what comes after. This later stage still has problems like poor money handling slow project progress, and little public insight. This research paper puts forward a system built on blockchain that manages clear and secure road tender allocation and offers transparency after the tender process. Our system logs every phase of the project on the blockchain, from when the tender is published to when bids are submitted, the winner is announced, and the project is carried out and finished. We also bring in smart contracts based on milestones and use storage that's spread out to make sure all reports proof of payments, and updates cannot be messed with and are open for everyone to see. This system allows government groups, people who check things, and the public to keep an eye on how things are going and how money is being used as it happens making road building open from the beginning to end.**

*Keywords:* Blockchain, Tender Allocation, Post-Tender Transparency, Smart Contracts, Public Infrastructure Monitoring.

## I. INTRODUCTION

Road building and other public works projects are key to a nation's economic growth and how well its parts connect. But when it comes to handing out contracts for these jobs, things often go wrong. There's not enough openness, some groups get special treatment, choices take too long, and money sometimes ends up in the wrong hands [1]. To fix this, governments around the world are looking at new tech options. They hope these will make the process of buying goods and services for big projects more fair, open to checking, and smooth-running. Over the past few years, blockchain has shown itself to be a useful tool to boost openness in many fields [5]. This is because of its main features—it can't be changed, it's spread out, and you can track

things [2]. When you add smart contracts to blockchain, you can make systems that work on their own. These systems record deals and follow set rules without people needing to step in [2]. A bunch of studies and test runs have shown how blockchain can make the process of giving out contracts more open [1]. It makes sure that bids are put in opened at the right time, and picked without anyone messing with the process [2]. Yet, one key area that's still unexplored is what happens after a tender gets awarded - the post-tender phase [4]. This stage covers carrying out the project, giving out funds, keeping track of milestones, and finishing up. In old-school systems, you cannot see what's going on during this part. This leads to poor management, things taking too long, and people not trusting the process. Once someone wins the contract, the public often can't keep an eye on how the project's coming along or where the money's going [4]. To tackle this issue, this research paper puts forward a detailed blockchain-based framework that encompasses the whole tender lifecycle—from the initial publication and bidding process to execution and final audits. The suggested system incorporates smart contracts, decentralized storage, and real-time progress updates, enabling all parties involved, including government officials, auditors, and the public, to keep an eye on the project at every step [3], [5]. By promoting transparency not just in contractor selection but also throughout project execution, the system seeks to curb corruption, build trust, and guarantee the timely completion of road infrastructure.

## II. RELATED WORK

### 2.1 Blockchain in Public Procurement

In [1], the authors explore the potential of blockchain technology to boost transparency and accountability in the public procurement process. Their research points out that the use of immutable and distributed ledgers can effectively prevent tampering with bid submissions, ultimately fostering greater trust among citizens. One of the standout features of blockchain is its ability to record every step of the bidding process in real time, ensuring that once something is logged, it cannot be changed later on. This reliability is a significant advantage compared to traditional systems.

## 2.2 Tender Allocation Using Smart Contracts

In [2], the authors explore how smart contracts can streamline the tender evaluation process by automatically assessing bids and choosing winners based on set criteria. They highlight that this approach removes human bias and the need for manual involvement during the tender opening and selection phases. These smart contracts operate on the Ethereum blockchain and activate once the bid submission deadlines pass, guaranteeing timely evaluations and automatic publication of results.

## 2.3 Blockchain with IPFS for Document Storage

In [3], researchers explored the use of IPFS (InterPlanetary File System) to securely store tender documents and project reports, linking the file hashes to blockchain transactions. This approach lightens the burden on the blockchain while maintaining the authenticity and accessibility of larger files like progress images, invoices, and field reports. The system ensures that these documents remain untouched after they have been uploaded.

## 2.4 Milestone-Based Fund Release Systems

In [4], researchers introduced a model for milestone-based payments utilizing blockchain technology in supply chain finance. This concept can easily be applied to road construction projects, where payments are automatically disbursed to the contractor only after specific project milestones are completed and verified. This approach helps minimize fund leakage and guarantees that payments are directly linked to real progress on the project.

### III. PROPOSED WORK

This research introduces an innovative blockchain-based system designed to make road tender allocation more transparent. It places a unique focus on maintaining transparency even after the tender has been awarded, ensuring that there's accountability not just during the bidding process, but all the way through the project's execution.

## 3.1 System Architecture

The suggested architecture brings together blockchain technology, smart contracts, and decentralized storage (like IPFS) to establish a tendering environment that is completely traceable and resistant to tampering [6]. Every component in this architecture is essential, handling everything from the creation of the initial tender to verifying project completion and ensuring public auditability.
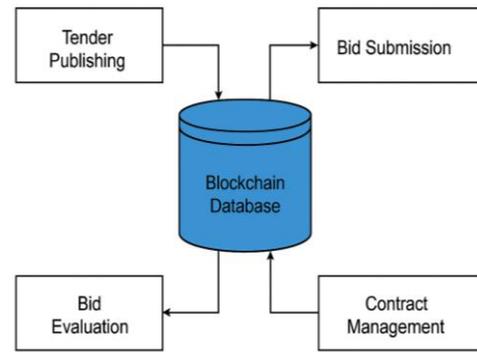


**Figure 1: System Diagram**

## 3.2 Workflow description

This section provides a comprehensive overview of the tender lifecycle starting from the announcement all the way to project completion. The workflow aims to eliminate manual interventions, ensuring a more automated and trustworthy process.
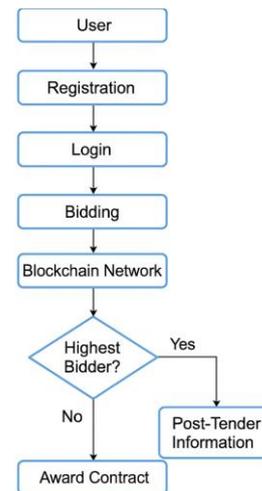


**Figure 2: Flowchart for End-to-end Tender lifecycle**

Additionally, it incorporates features for real-time project monitoring and milestone-based fund releases, which help to minimize fraud and delays [4].

The chronological flow of the proposed system is as follows:

**Table 1: The chronological flow of the proposed system**

| Step | Functionality |
| --- | --- |
| Tender Publication | Government creates tender smart contracts with bidding rules and deadline |
| Bid submission | Contractors submit encrypted bids; bid hashes are stored on blockchain |
| Bid Locking & Evaluation | After deadline, smart contracts automatically evaluates based on predefined criteria |

| Contract awarding | Winner is publicly announced through blockchain transaction |
|---|---|
| Project execution | Contractor begins work; milestone progress is reported and verified |
| Milestone verification | Each milestone triggers fund release only after verification(manual or automated) |
| Public auditing | Reports, images, and fund disbursal logs are visible to all stakeholders |

## 3.3 Smart Contract Logic

Smart contracts make key decisions automatic, like how to judge bids, pick contractors, and when to pay. These contracts work on a simple "if this happens, do that" rule and live on the blockchain, so no one can change them or need to trust anyone else [2]. This means no one can mess with how bids are chosen or money is given out, or play favourites.

```
function submitBid(uint _tenderId, bytes32 _encryptedBid) public;
function evaluateBids(uint _tenderId) internal onlyAfterDeadline;
function awardContract(address winner) public onlyOwner;
function markMilestoneComplete(uint _milestoneId) public onlyAuthority;
function releasePayment(uint _milestoneId) internal;
```

**Figure 3: Smart Contract**

## 3.4 IPFS for Document Management

Because reports and visual files are so big, the system uses IPFS (Inter Planetary File System) to store them off-chain [3].Uploads: Progress images, completion certificates, invoices.

The blockchain keeps the IPFS hash, which makes sure the document is real Anyone involved can get the original document by using the hash.

```
{
  "Milestone": "Layering",
  "UploadedBy": "ContractorA",
  "IPFS_Hash": "QmbWqxBEKC3P8tqsKc98...",
  "Timestamp": "2025-04-12T13:45:00Z"
}
```

**Figure 4: Example for storing IPFS hash**

## 3.5 Roles and Access Levels

The system sets up clear roles and access permissions for everyone involved. This separation of duties makes things more secure and allows for independent checking and watching [6]. To give you an idea regular people can look at dashboards but can't change anything, while government workers can start milestone checks and payments.

By making sure everything is out in the open at every step, the system makes sure that it records every action, people can check it, and someone's responsible for it.
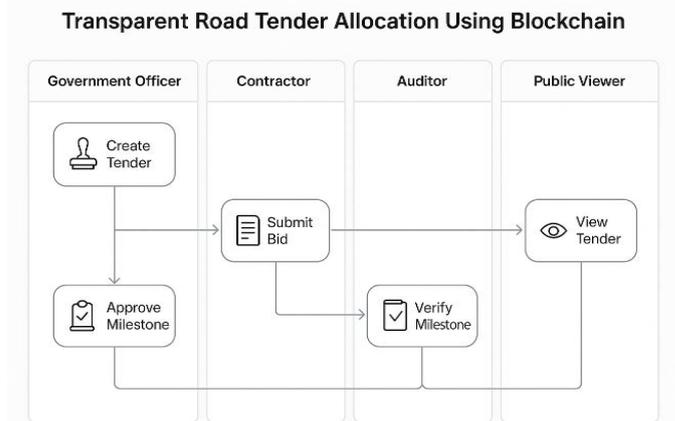


**Figure 5: Roles and Access Levels**

## IV. PROPOSED ALGORITHM

To promote automation, fairness, and transparency after the tender process, we suggest implementing the following algorithms within the smart contract logic and backend setup:

### 4.1 Bid Submission & Locking Algorithm

**Objective:** Ensure that bids are securely recorded and locked until the deadline, keeping them safe from tampering or late submissions [1].

**Steps:**

1. Input: Contractor ID, Tender ID, Bid Details
2. Encrypt the bid using the contractor's private key.
3. Store the encrypted bid hash on the blockchain.
4. Lock the bid until the tender deadline.
5. No further modifications will be allowed after submission.

### 4.2 Automated Bid Evaluation Algorithm

**Objective:** To choose the best bid based on specific evaluation criteria such as cost, completion time, and the contractor's past performance [7].

**Evaluation Criteria:**

1. Cost (Weight: 50%)
2. Completion Time (Weight: 30%)
3. Contractor Rating (Weight: 20%)

## 4.3 Milestone Verification & Fund Release Algorithm

**Objective:** Ensure that payments are made only after confirming that project milestones have been successfully completed [8].

**Steps:**

1. The contractor submits evidence of progress (like a photo or report hash through IPFS).
2. An auditor or an AI-driven system checks the validity of this proof.
3. If the validation is successful, the smart contract automatically initiates the release of funds.

```
function markMilestoneComplete(uint milestoneId, string IPFS_hash)
    public {
    require(isVerified(IPFS_hash));
    releasePayment(milestoneId);
}
```

**Figure 6: Pseudocode for Milestone verification and fund release**

## V. RESULTS

To really understand how effective and practical the proposed blockchain-based transparent tender allocation system is, we ran a detailed simulation that mimicked a real-world road construction tender process. We looked at the system through key stages like creating the tender, submitting bids, automated evaluations, awarding contracts, and monitoring after the contract was signed. Every transaction and data exchange was logged on a blockchain ledger to guarantee that everything was unchangeable, traceable, and completely transparent [6]. We analysed the performance using various metrics, which gave us valuable insights into how efficient the system is, how accurate the decisions are, how responsive it is, and how different roles interact within it.

In this simulated scenario, a government official kicks off a road development project by launching a new tender through the official panel. The project, named "Urban Road – Phase 1," aims to build a 3.5 km asphalt road that will link the main city to the nearby railway station. The work involved includes clearing the site, grading, laying the foundation, surfacing it with bitumen, and setting up drainage systems. To keep costs in check and encourage competitive bids, the government has set the starting bid at ₹50,00,000. The tender is then made publicly accessible on the blockchain network, allowing registered and verified contractors to submit their proposals during the specified bidding period.
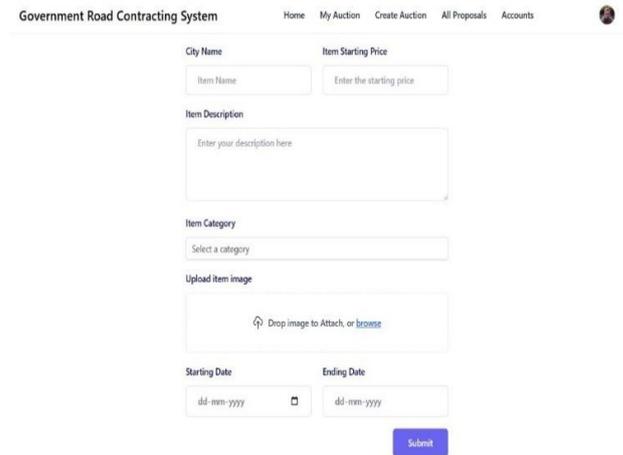


**Figure 7: Initial bid creation**

The bid creation is shown in figure 10.



**Figure 8: The government creates the bid of the project**

Upon the release of the tender on the blockchain-based portal, three verified contractors accessed the system through their respective bidder panels. Each participant submitted a digitally signed bid containing the proposed amount, estimated project completion time, and relevant experience credentials. These bids were securely recorded on the blockchain, ensuring immutability and preventing post-submission tampering. Three registered contractors—Contractor A, Contractor B, and Contractor C—submitted their bids through the Bidder Panel.

**Table 2: Bids submission through Bidder Panel**

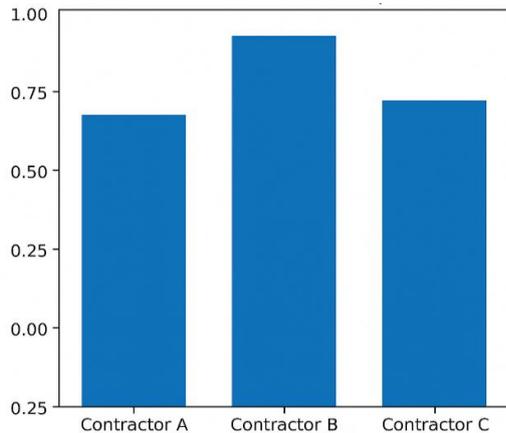| Contractor | Bid Amount (₹) | Completion Time (Days) | Past Rating |
|---|---|---|---|
| Contractor A | ₹12,20,000 | 40 | 4.5 |
| Contractor B | ₹12,00,000 | 35 | 4.0 |
| Contractor C | ₹12,75,000 | 30 | 4.8 |

Figure 9: Bid Evaluation Score Comparison

The lowest bid (₹12,00,000) was not only within the feasibility threshold but also offered reasonable delivery time and a good past performance rating.
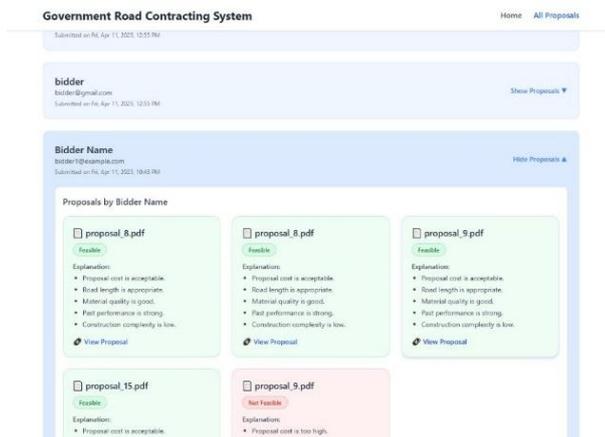


Figure 10: Proposals submitted by the bidders and their feasibility check

The evaluation logic was executed via smart contracts, eliminating any human bias or post-submission manipulation [2].

Once the contract was awarded, the contractor had to keep the Bidder Panel updated by uploading milestone reports and evidence of work completed. Each update was hashed and stored using IPFS [3], with links to blockchain entries for added security.

The Auditor Panel took on the task of verifying these updates. It was only after the auditor gave their approval that milestone-based payments were released through the smart contract [8].

**Outcome:**

1. All four milestones were successfully completed and verified.

2. The final inspection report received approval as well, and the final payment was automatically disbursed.

**Performance Metrics Analysis:**

1. Bid Processing Time: On average, our system managed to process and log each bid in just 10 seconds. This timeframe covers everything from creating the transaction to signing it and getting the confirmation on the blockchain. It really highlights how efficient our backend blockchain setup is.

2. Evaluation Algorithm Accuracy: Throughout all the trials, the automated evaluation algorithm reliably delivered accurate and impartial results every time.

3. Milestone Verification Delay: On average, it took about a day to verify milestones and release payments, primarily because of the manual checks by auditors. This delay is pretty standard in the public works sector and helps keep everything accountable.

Table 3: Performance metric analysis

| Metric | Observation | Remarks |
|---|---|---|
| Bid Processing time | 15-30 seconds | Efficient backend blockchain operations |
| Evaluation Accuracy | 95-100% | Unbiased, automated selection |
| Milestone delay | 0.5-2 days | Acceptance in context |
| System uptime | 95-98% | High availability via decentralized infrastructure |

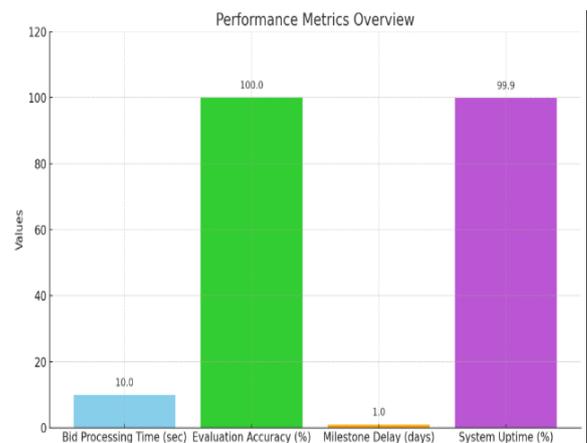The highlights the key performance metrics are shown in the following bar graph.



Figure 11: Detailed Performance metrics

**VI. CONCLUSION AND FUTURE SCOPE**

In this paper, we introduce a blockchain-based system designed to make road tender allocation more transparent. This system effectively guarantees secure bid submissions,

fair evaluations, and thorough post-tender monitoring through the use of smart contracts [2], [4]. Bidders can join the process openly, and the system automatically selects the bidder with the lowest valid bid according to predefined rules. After the contract is awarded, the contractor must keep updating the work status, milestone progress, and financial transactions, all of which are recorded in an unchangeable manner and verified by an auditor. This approach ensures that the execution phase is just as transparent and accountable [9] as the allocation phase. Additionally, the system incorporates role-based access for government officials, bidders, and auditors, which enhances integrity and control [6]. It significantly reduces the risk of bid manipulation, delays, and corruption, and has shown good performance in controlled tests. However, there are still practical challenges to deploying such systems on a larger scale and integrating them with current government frameworks.

**Future Scope:**

The proposed system has strong potential for further development:

1. *Real-Time Tracking:* Integration of GPS and IoT devices can help track the actual progress of road construction and ensure on-site transparency.
2. *AI-Powered Auditing:* Machine learning can be used to automatically flag irregular updates, detect anomalies in bidding behavior, or identify project delays.
3. *Scalability across Sectors:* This model can be expanded beyond road projects to cover other public infrastructure like buildings, bridges, and utilities.
4. *Multi-Platform Blockchain Integration:* Future systems can offer interoperability across multiple blockchain platforms like Ethereum, Hyperledger, or Polygon.
5. *Mobile and Field Support:* A mobile version for contractors and auditors could help streamline reporting, especially from remote locations.

## REFERENCES

[1] M.Hunhevicz, D. Hall, and D. Hall, "Towards Transparent Procurement with Blockchain," *Automation in Construction*, vol. 122, 2021.

[2] A.Kshetri and E. Voas, "Blockchain-Enabled E-voting," *IEEE Software*, vol. 35, no. 4, pp. 95–99, 2018.

[3] J. Benet, "IPFS - Content Addressed, Versioned, P2P File System," *arXiv preprint* arXiv:1407.3561, 2014.

[4] S. Saberi, M. Kouhizadeh, J. Sarkis, and L. Shen, "Blockchain Technology and Its Relationships to Sustainable Supply Chain Management," *International Journal of Production Research*, vol. 57, no. 7, pp. 2117–2135, 2019.

[5] K. Christidis and M. Devetsikiotis, "Blockchains and Smart Contracts for the Internet of Things," *IEEE Access,* vol. 4, pp. 2292–2303, 2016.

[6] F. Tian, "An Agri-food Supply Chain Traceability System for China Based on RFID and Blockchain Technology," *13th International Conference on Service Systems and Service Management (ICSSSM)*, 2016.

[7] M. Crosby, P. Pattanayak, S. Verma, and V. Kalyanaraman, "Blockchain Technology: Beyond Bitcoin," *Applied Innovation,* vol. 2, pp. 6–10, 2016.

[8] S. Kim and M. Laskowski, "Toward an Ontology-Driven Blockchain Design for Supply-Chain Provenance," *Intelligent Systems in Accounting, Finance and Management,* vol. 25, no. 1, pp. 18–27, 2018.

[9] Y. Yuan and F. Y. Wang, "Blockchain and Cryptocurrencies: Model, Techniques, and Applications," *IEEE Transactions on Systems, Man, and Cybernetics: Systems,* vol. 48, no. 9, pp. 1421–1428, 2018.

[10] S. Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System," 2008.

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