

Enhancing Construction Contract Billing through Blockchain Technology *Blockchain technology for secured billing process*

¹Mr. Yogesh Dilip Mulik, ²Dr. Sumedh Y. Mhaske

¹Student, M.Tech Construction Management, VJTI, ²Associate Professor, VJTI

¹Civil and Environmental Engineering Department, VJTI

¹Veermata Jijabai Technological Institute, Mumbai, India

Abstract— Construction projects are typically lengthy endeavors that involve significant financial transactions. Unfortunately, delays and financial difficulties often result in project setbacks and increased costs. The billing process plays a crucial role in managing the project's finances. However, traditional billing methods are time-consuming, taking nearly a month to release payments to contractors due to the need for document approval, certificate verification, and bill verification. This slow process can be quite cumbersome. To address these challenges, this paper proposes the use of blockchain technology to streamline the billing process. By implementing blockchain and utilizing the Python language, we can ensure the security of all transactions while significantly accelerating the billing process through online platforms. Additionally, this study aims to develop a storage model for maintaining payment records for future reference. To gain insights into the traditional billing process, we conducted on-site visits to three local construction sites. Based on our observations, we have created a model that allows users to view and upload necessary documents. Based on our findings, implementing blockchain technology in billing processes can lead to a significant time-saving of around 50% when compared to traditional methods. This research provides readers with a comprehensive insights into the various applications of blockchain technology in the construction industry. This study serves as a valuable resource for those interested in exploring secure billing platforms and the potential benefits they can bring to construction projects.

Index Terms— Construction; Blockchain; Billing; financial transaction.

I. INTRODUCTION

For decades, the construction industry has suffered low productivity. Building projects are well known for their massive size, extended time periods due to which they are highly complex and unpredictable. This decentralized and loosely interconnected network involves various entities with different motives, leading to issues like a lack of trust, dishonesty, and hidden information. In this regards whole industry is always searching for methods to develop culture around trust, honesty, and values.

Blockchain is emerging technology considered for the fourth industrial revolution, and many sectors are getting attracted to it. As the blockchain is decentralized system, it relies on cryptography to maintain transparency and continuous record of transactions which are shared among multiple participants. The technology also incorporates smart contracts, encoding business rules within the blockchain to be executed alongside transactions. Digital signatures are used to verify the origin of transactions, providing an added layer of security.

Blockchain's resilient design offers numerous benefits, including reduced time, complexity, and costs. It has the potential to enhance regulatory oversight and streamline banking and trading procedures. By utilizing a decentralized consensus mechanism, blockchain ensures that transactions are unchangeable and can only be updated through consensus among network peers. This eliminates the need for traditional third-party intermediaries in transactions and offers consensus and immutability regarding asset transfers within corporate networks.

Construction projects, known for their extended duration and numerous financial transactions, often face delays and financial challenges. Delays in invoice clearance, payment settlements, and disputes between clients and contractors can lead to increased project costs. The lack of solid evidence in payment-related disputes can result in unsuccessful outcomes. To solve these issues, blockchain technology is one of the best solution. Blockchain offers secure, inexpensive, and transparent platform to securely record and store all transactions. It benefits both clients and contractors by simplifying and accelerating the billing and payment process. By leveraging blockchain, the construction industry can save time and costs, promoting efficiency, security, and transparency in financial transactions.

II. NEED OF STUDY

Blockchain technology is one of the today's most celebrated technology which is making a significant impact on various fields and services. As this technology is prominent and due to its transformative potential construction industry can gain benefits from it.. However, research on blockchain applications in the Indian construction industry remains limited, creating a need for further exploration and study. Implementing blockchain in construction can revolutionize the sector by enhancing various aspects, including supply chain monitoring, contractor billing, material quality assurance, and transaction security.

Public blockchains operate on a decentralized system accessible to everyone, where anonymous users collectively update the distributed ledger. In contrast, private blockchains are utilized within specific organizations like banks, granting them full control

over the system. A hybrid blockchain combines both public and private implementations, making it accessible to a limited set of trusted and verified users with collective authority to maintain and update the network.

The advantages of blockchain technology are driving its adoption in various industries, and the construction sector can benefit from several key features:

- **Transparency:** The distributed ledger's transparency is a compelling feature of blockchain technology. All network participants have access to real-time transaction records, leaving no room for errors or manipulation.
- **Security:** Blockchain promises robust security due to its interconnected nature. Each block generates a hash based on the previous block's contents, making them intrinsically linked. Attempting to hack the blockchain network is prohibitively expensive and futile since any alteration to a block taints all information within it.
- **Cost-effectiveness:** By eliminating the need for expensive physical offices and reducing commissions for financial services, blockchain streamlines financial transactions and reduces operational costs.
- **Intellectual Property Protection:** Blockchain creates a secure digital platform for safeguarding intellectual property. Through digital certification and ownership certification, artists and creators can protect their work and receive appropriate compensation upfront.
- **Fraud Prevention:** Blockchain technology combats online payment fraud through smart contracts, ensuring that currency cannot be reused for subsequent payments, eliminating corruption risks. Each transaction is digitally signed by both parties, further enhancing security.
- **Faster Transactions:** Blockchain facilitates rapid money transfers and document exchanges, saving time compared to traditional payment systems that involve third-party clearances.

By applying blockchain to the construction industry, stakeholders can monitor the supply chain more effectively, ensure accurate billing for contractors, maintain stringent material quality standards, and enhance overall transaction security. Embracing this technology will revolutionize the construction sector in India, providing a more secure and efficient digital platform for conducting business. Further research and exploration of blockchain's applications in construction will undoubtedly unlock its full potential and pave the way for a transformative future in the industry.

III. THEORETICAL FRAMEWORK OF BLOCKCHAIN

Blockchain is a sequence of blocks, which holds a complete list of transaction records like conventional public ledger. With a previous block hash contained in the block header, a block has only one parent block. The first block of a blockchain is called genesis block which has no parent block. We then explain the internals of blockchain in details. Blocks are connected through hash codes and the data in that blocks get secured.

Following are some advantages of blockchain framework:-

1. Blockchain is an append-only distributed system that is shared among participants in a business network, ensuring resilience by eliminating any single point of failure.
2. The entire historical record of an asset is permanently stored on the blockchain, providing a transparent and unalterable history.
3. Records on the blockchain are immutable and tamper-proof, instilling trust in the system, as once data is committed to the shared ledger, it cannot be modified.
4. Transactions are only confirmed and added to the blockchain when all parties involved reach a consensus through network verification.
5. Once a transaction is recorded on the blockchain, it becomes irreversible, ensuring the integrity of the data and preventing any unauthorized changes.
6. Blockchain incorporates code that executes automatically based on specified triggering events, allowing for the implementation of "if this then that" statements that computers or nodes follow autonomously.

IV. DATA COLLECTION

In this study three site visits were done to collect information about the conventional billing process carried out on actual construction sites. As we know RA(Running Account) bill is used on site for billing purpose. Conventional billing process is time consuming because it involves many procedures. First, site engineer from both the side (client and contractor) check the work done on site. Then, deduction can be made by them if required or the retention cost can be deducted. After that site engineer certify the bills by checking the attached documents and then only the bill will hand over to the client. After receiving the bill, within 15 days the payment should be done from the client side, But most of the time it gets delayed.

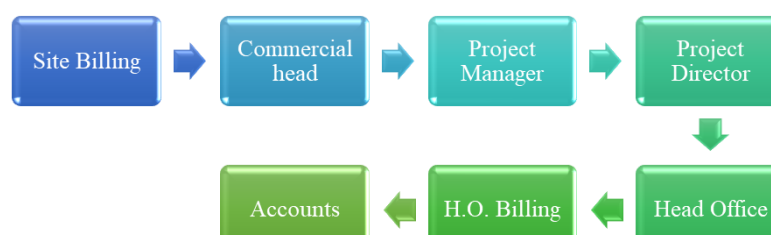


Figure 1 : Bill approval process

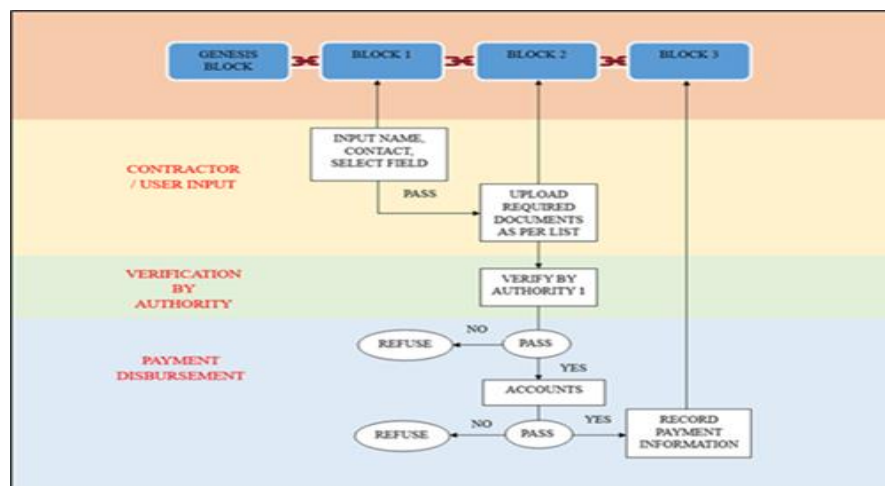


Figure 2 : Methodology

Figure 1 shows the detailed procedure of the billing process, it shows how the bills or invoices goes through under the various authorities. The process is done with hierarchical order. As the bill reaches to the account department, within 15 days the payment should be done. Sometimes due to insufficient or wrong documents the bills get rejected, in this case the payment gets delayed.

V. METHODOLOGY

In this study literature of well-known and authorized publications were studied. Blockchain framework is base of this study. Python language is used to develop this blockchain model. Python is open source so one can create little prototypes to hone our abilities. Programmer can select from variety of resources and plugins for blockchain development. Because python is dynamically typed programming language. It is likewise object oriented and is largely utilized in blockchain development, machine learning, and artificial intelligence.

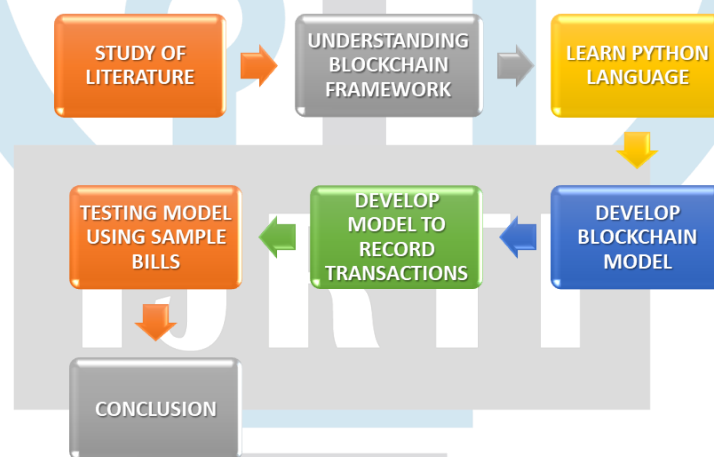


Figure 3 : Methodology for billing to construction contractor using blockchain

As fig. 2 shows, first the literature were studied thoroughly. Blockchain framework is studied and model is developed. Knowledge about the coding is essential for developing blockchain model. Also model is developed to record transaction details. At the end, model is ready to use. After developing model it is tested using sample bills.

The detailed methodology is illustrated in fig. 3 shows the execution of the actual blockchain. Figure shows the various stages involved in the process. The code generates blocks required to store data entered by the user such as name and contact details. Then user need to upload the documents required for successful execution of the bills. The next block stores the uploaded documents. This is the first stage of the process which is User input. Then the uploaded documents reviewed by the verifying authority and can make comment on it. Also verifying authority need to accept or reject the document according to requirement. Then the data and document is forwarded to next block where the document will be reviewed by the payment authority and the payment can be done. The payment disburses to contractor through NEFT/RTGS/Cheque and then authority can input the data in payment form to store the payment details for future purposes.

Results and discussions

The study conducted has successfully created a secure blockchain model that ensures the smooth processing of billing transactions. By utilizing blockchain technology, transparency is brought to the construction billing process through an unalterable ledger of transactions. This guarantees that all billing activities are documented and accessible to relevant parties, significantly reducing the likelihood of fraud, disputes, or mistakes. By studying blockchain frameworks, one can gain insight into implementing transparency and improving accountability in the billing process. This study has developed a secure blockchain where data is stored. A blockchain is series of blocks that contains record of transactions, similar to a traditional public ledger. Each block in the blockchain has a reference to the previous block through a hash value in its header, establishing a single parent-child relationship. In this study blocks which has created are named as User1, block and payment. As per the functionality of the blockchain these blocks are interlinked with each other using it's hash code.

Figure 4 : Interconnection between blocks

The above figure shows how these blocks are interlinked with each other through hash code and the data gets secured in it. By studying blockchain framework, one can learn about the security features and best practices for safeguarding billing information and preventing unauthorized access. Studying this blockchain will help you identify opportunities for cost and time savings and optimize the billing process accordingly.

VI. LIMITATIONS

Despite of blockchain's numerous benefits and security features, blockchain technology also comes with certain limitations in this study:

1. **Code Modification Complexity:** While the blockchain network is secure, customizing the code to meet specific requirements can be challenging. Users need coding knowledge to make necessary updates, which may pose a barrier for those without technical expertise.
2. **Cumbersome Block Identification:** During the payment initiation process, authorized individuals must input the block_id, which can be a cumbersome task. However, referencing previously stored data can ease the identification of the next payment block_id.
3. **Single Contractor Upload:** The user form currently allows only one contractor to upload documents and details at a time, lacking the functionality for multiple concurrent logins.
4. **Limited Document Tracking:** Presently, the existing coding does not offer document tracking functionality. However, this feature can be added through necessary updates in the system.

VII. FUTURE SCOPE

The future potential of blockchain in construction billing is promising, offering numerous advancements to the industry. With blockchain's transparency and automation, billing processes can be streamlined, minimizing disputes, errors, and fraud. Real-time updates enable contractors to access accurate and timely payment information.

To improve the login process, a model can be developed to store contractor details for future use, simplifying login and document uploads. Enhancing the code to segregate user data will facilitate efficient verification.

A tracking model can be implemented, allowing contractors to monitor uploaded documents and their payment status securely through their login.

As blockchain technology continues to evolve, its application in construction billing for contractors is likely to expand, offering efficiency, transparency, and enhanced security. Contractors must stay updated on blockchain developments to explore opportunities for implementing it into their billing workflows effectively.

VIII. CONCLUSION

Blockchain technology holds transformative potential for the construction industry, especially in billing and payments. By leveraging its transparency, security, and automation, construction contractors can streamline processes, reduce disputes, and improve overall efficiency. However, successful implementation requires planning, coordination, and openness to technological advancements. Embracing blockchain will create a more efficient and trusted ecosystem for construction billing.

Construction projects are time-consuming and financially complex, often facing delays due to payment issues. Late invoices and disputes between clients and contractors further complicate matters, leading to increased costs and project disruptions. Blockchain offers a secured model for contractor billing, ensuring data integrity through interconnected hash codes. This heightened security eliminates the need for time-consuming documentation, facilitating smoother billing processes.

The study proposes integrating blockchain into the billing process, which can lead to significant time and cost savings. Automation, transparency, and enhanced efficiency reduce manual labor, minimize errors, and expedite payment cycles. By analyzing blockchain frameworks, opportunities for cost and time optimization can be identified, improving billing processes professionally.

Comparing traditional billing to blockchain billing, the study reveals potential time savings of up to 50% if contractor documents meet requirements. Utilizing MS-project software for analysis, the comparison highlights the efficiency of blockchain-based billing systems. Embracing this technology will undoubtedly revolutionize billing and payments in the construction industry, fostering a more transparent, secure, and efficient ecosystem for all stakeholders involved.

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