Blockchain-Based Decentralized Framework for Secure

Banking Transactions

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# *ABSTRACT*

# Conventional centralized banking systems are vulnerable to data breaches, unauthorized access, and financial fraud. The increase in cyber threats and the increasing demand for transparency in financial transactions have highlighted these limitations. Thus, we present a blockchain-based decentralized banking system that enhances security, integrity, and transparency of banking transactions. Our system employs the use of blockchain technology to thereby eliminate intermediaries and allow for direct peer-to-peer transactions, which are cryptographically secured and therefore immutable.

# This work focuses on the design and implementation of a decentralized banking system where every transaction is validated by a network of nodes, which makes it fraud and tampering resistant. It uses consensus protocols to authenticate transactions and the intrinsic features of blockchain, such as cryptographic hashing, for instance SHA-256, to protect the data in a transaction. The smart contracts automatically enforce the transaction logic and thereby reduce the scope of human errors and manipulation.

# The working prototype demonstrates functionality related to secure peer-to-peer banking transfers, validation of real-time transactions, and retrieval of historic transactions. Results are given as a percentage enhancement in comparison to traditional models about transaction speed, scalability, and fault resilience and show great potential for enhancements about security and operation efficiency. This alternative, as given in our approach, provides an easy solution that may become an effective substitute to current banking practice for secure and decentralized transaction management of finances that will affect future trends of secure digital banking.

**INDEX TERMS** Blockchain Technology; Decentralized Financial System; Secure Banking Transaction; Peer to Peer Transactions; Cryptographic Security; Blockchain Consensus Mechanism; Digital Ledger; Smart Contract Automation; Transaction Integrity; Fraud Prevention; Blockchain Hashing; Transparent Financial Systems; Distributed Transaction Verification; Secure Financial Technology; Decentralized.

1. **INTRODUCTION**

The financial industry is increasingly under pressure to ensure that transactions are conducted in a secure, efficient, and transparent manner in the digital age. Traditional centralized banking systems, although effective in many cases, are vulnerable to risks such as data breaches, fraud, and operational failures due to their reliance on centralized authorities and intermediaries.These challenges are further exacerbated by growing cyber threats, which compromise the confidentiality and integrity of financial transactions. Blockchain technology has risen as a response to these needs, offering decentralized, immutable, and transparent secure transaction frameworks. Blockchain eliminates third-party intermediaries and utilizes the distributed ledger feature to ensure every transaction is accepted by several people in the network, thereby drastically increasing trust and security. Due to its inherent

cryptographic nature, blockchain is unable to be manipulated, and due to its various consensus protocols, it ensures efficient verification of the transactions without seeking the authority of a central system. This paper develops a blockchain-based secure banking transaction system with a view to rectifying the deficiencies inherent in conventional banking systems.Our solution offers confidentiality, integrity, and availability of transaction information through the utilization of sophisticated cryptographic techniques, namely SHA-256 hashing and digital signatures. Additionally, we describe the concept of smart contracts, which enable automating transactional processes and exclude the human element, which introduces errors, thereby eliminating any kind of manipulation.The proposed system not only guarantees secure peer-to-peer transactions but also enables real-time validation and historical transaction retrieval. This paper provides a detailed overview of the architecture, design, and performance evaluation of the decentralized banking system, demonstrating its effectiveness in securing financial transactions while offering enhanced transparency and scalability. This work aims to contribute to the growing body of research on decentralized finance by integrating blockchain into the banking domain, providing practical insights into how blockchain can transform secure banking practices for the future.

1. **RELATED WORKS**

Blockchain technology has taken the financial world by storm in terms of transforming the way it handles transactions by providing a decentralized, secure, and transparent mechanism.

Nakamoto's introduction of Bitcoin in 2008 led to the massive adoption of blockchain in the financial sector. The core characteristics of blockchain, which include decentralization, immutability, and transparency, make it a very promising tool for secure financial transactions. A wide range of studies have discussed the potential of blockchain in solving issues in banking that are considered pertinent, including fraud, data breaches, and the inefficiencies created by centralized financial systems. Nakamoto's 2008 whitepaper is seen as the groundwork for the utilization of a distributed ledger in recording secure transactions with no need for intermediaries. This shift towards decentralized finance has catalysed research into blockchain's applications in remittances, cross-border payments, even in microfinance aimed at improving the efficiency and security of financial transactions.The matured blockchain technology pointed towards a Decentralized Finance (DeFi) platform that aims at re-establishing traditional financial services like lending, insurance, and trading, but without the requirement of centralized authorities. Another pivotal evolutionary step has come from the entity known as Ethereum, conceived of by Vitalik Buterin back in 2013, whereby smart contracts become possible; those are self-executing contracts having the terms actually written into lines of code, and the core concept facilitates applications on decentralized sites, so automatically processing financial concepts without requiring direct human interference. Christidis and Devetsikiotis (2016) were the first to express the transformative concept of smart contracts in financial transactions, with an assurance of little to no fraud and a more transactable element of the transaction.The main strength of blockchain lies with its cryptographic machinery and hash functions, particularly SHA-256, which provide a safe way to verify transaction data efficiently. Tapscott and Tapscott (2016) emphasize that once data is recorded, it is tamper-resistant due to cryptographic integrity based on blockchain. The feature is vital in financial systems, as it ensures the accuracy and security of transaction records. Additionally, mechanisms such as Proof of Work (PoW), originally applied by Bitcoin, offer a secure method of transaction verification in a decentralized system. Although PoW ensures the security and immutability of the blockchain, criticism has been levied against it due to high energy consumption. Consequently, energy-efficient consensus algorithms such as Proof of Stake (PoS), as proposed by King and Nadal (2012), are being integrated into blockchain platforms to address scalability and sustainability concerns while maintaining transaction security.Blockchain's potential is not without its challenges, particularly in terms of scalability. The throughput limitations of traditional blockchain systems have led to the exploration of solutions like Layer 2 scaling and sharding. The Lightning Network, for instance, increases Bitcoin's scalability in that it supports faster, off-chain transactions.Ethereum 2.0 seeks to enhance scalability through a shift from PoW to PoS, thus lowering the energy consumption of the network while enhancing the speed of transactions. Studies by Gudgeon et al. (2020) have investigated these challenges on scalability and argue that blockchain technology will find success in finance if decentralization, security, and scalability can be balanced.In spite of these strengths, regulators remain a huge impediment to massive adoption in the financial world. The systems are not prepared to handle the new dynamics of blockchain, especially regarding anti-money laundering (AML),know your customer (KYC) requirements, and taxation. Catalini and Gans (2016) noted that, for blockchain-based financial systems to become mainstream, new regulatory standards must be developed to accommodate these technologies while ensuring compliance with existing laws. On the other hand, blockchain's transparency features could enable more effective regulatory oversight, as all transactions are recorded on a public ledger, offering an auditable trail that can help identify fraudulent activities.Our proposed system will be an extension of these advancements by using blockchain technology to develop a secure banking transaction system. We intend to address the issues of fraud prevention, transaction verification, and cost reduction in banking by utilizing the decentralization and cryptographic security of blockchain. Moreover, our system will employ smart contracts to automate transactions and make operations more efficient without the use of intermediaries. In addition to security, we explore innovative consensus mechanisms to solve scalability issues so that the system can handle high transaction volumes, typical in banking systems. Our work combines these solutions to present a novel approach to enhancing security, transparency, and scalability in financial transactions in a decentralized environment.

1. **PROPOSED MODEL**

The proposed model relies on blockchain technology to create a decentralized, secure, and efficient banking system. Cryptographic methods and smart contracts ensure the security and transparency of financial transactions while bypassing the weaknesses of traditional banking systems. We explain the various components of the proposed model below and how they interact to create a secure banking solution.

1. System Architecture Overview

It's a decentralized blockchain network in which each participant within the network-user and financial institution- has an equal amount of authority and control over his transactions. The two major parts of the system are:

User Wallets: Every participant in the system, be it an individual or a bank, has a digital wallet containing the public and private keys. This wallet is used to make a transaction as well as receive it securely.

Blockchain Network: The underlying blockchain is a distributed ledger that records all transactions in an immutable manner. It is maintained by a network of nodes, such as banks, financial institutions, or even independent entities, which verify and add new blocks to the chain.

Smart Contracts: Smart contracts are self-executing agreements encoded directly on the blockchain. They automate various processes, such as transaction execution, lending agreements, and payments, ensuring that the terms are met without human intervention.

Consensus Mechanism: The system makes use of a lightweight Proof of Stake (PoS) mechanism or a hybrid approach for the purpose of validating transactions. This method is more energy-efficient than Proof of Work (PoW) and offers the necessary scalability for banking applications.

Transaction and Validation Layer: This is where all financial transactions are initiated, validated, and recorded. Transactions are sent to the blockchain network where nodes validate them through the consensus mechanism, after which they are permanently recorded in the blockchain.

Regulatory Compliance Layer: It deals with regulatory requirements, which include integration for AML and KYC .Here, it assures every transaction in adherence to legal requirements by enforcing compliance checks via smart contracts automatically.

2. Transaction Flow in the Proposed System Flow of transaction within the proposed system of secure banking transaction

As shown below in the given order:

1. Transaction Initiation:

A user starts the transaction by making a request through his wallet with all the transaction details, like the wallet address of the recipient, the amount to be transferred, and other data that are required for the transaction, like the purpose of the transaction.

2. Transaction Validation

The transaction is broadcasted to the blockchain network. A set of validators (or nodes) in the network checks whether the transaction is valid by verifying the user’s digital signature and ensuring sufficient balance. These validators use the Proof of Stake (PoS) consensus mechanism, which helps verify the legitimacy of the transaction based on the staked tokens or coins of the validators.

3. Smart Contract Execution:

In case all the transaction conditions are met-for example, there is sufficient funds in the account-a smart contract is triggered, which then conducts the transaction. The smart contract will only proceed with the transaction after satisfying the pre-defined transaction conditions such as the release of payment and putting it into an escrow etc.

4. Transaction Recording:

Once validated and executed, the transaction is permanently recorded in the blockchain as a new block. This block is linked to the previous block, thus maintaining an immutable chain of financial transactions.

5. Transaction Confirmation:

After the transaction has been successfully registered on the blockchain, both parties involved in the transaction-the sender and the receiver-get a confirmation of the said transaction. It includes a transaction ID, transaction details, and a timestamp as well.

6. Compliance with Law:

The regulatory compliance layer performs an automatic KYC/AML check in the background. The system ensures that involved parties meet regulatory requirements and flags suspicious transactions. Non-compliant transactions are rejected.

Security Features

The various features ensure the integrity and security of transactions such as:

Cryptography Secure: All transaction data shall be signed with private keys and be verified using public keys. This means only rightful users can initiate transactions, and transaction data will remain safe.

Immutability: Once recorded in the blockchain, a transaction cannot be altered or deleted because it ensures that transaction history remains intact and no third party can change that.

Decentralization: There is no centralized point of failure or control. Since the network is decentralized among nodes, most risks of centralized data breaches as well as point failures are minimal.

3. Smart Contracts for Automation: Smart contracts automate the execution of transactions. This helps to reduce human error and the number of intermediaries required, which increases efficiency while ensuring that the transactions are executed according to the predefined rules.

Scalability: Here, the mechanism employed for reaching consensus is in the form of a hybrid consensus that supports a large number of users. Using Proof of Stake (PoS) promises to save considerable energy; instead, the architecture includes off-chain solutions, Layer 2 networks, with an example, Lightning Network, ensuring greater transaction throughput.

4. Regulatory Compliance and Privacy

The integration of a compliance layer within the blockchain ensures that transactions are compliant with international regulations such as AML, KYC, and GDPR. Smart contracts can be programmed to automatically execute compliance checks before a transaction is validated. For privacy, the system can utilize zero-knowledge proofs (ZKPs), a cryptographic technique that allows for transaction validation without revealing sensitive information about the participants.

5. System Scalability and Performance

In order to counter common scalability concerns related to blockchain technology, the proposed model introduces several optimizations:

Sharding: The blockchain can be split into smaller, more manageable pieces (shards) and each one is allowed to process independent transactions, which improves throughput.

Layer 2 Solutions: Both the Lightning Network or sidechains can be used to process transactions off-chain, which reduces the load on the main blockchain and increases the speed of transaction processing.

Hybrid Consensus Mechanisms: It would combine PoS and PoW or even PoS with Byzantine Fault Tolerant (BFT) mechanism to balance security, decentralization, and scalability. This way, the system can adjust its different complexities towards different volumetric necessities and categories of transactions.

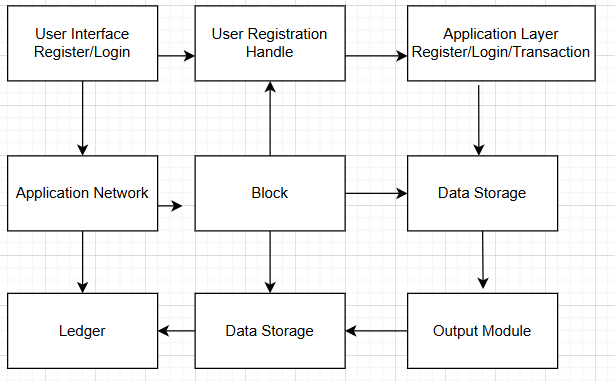


Fig. 1 Block Diagram Of The Proposed System

**IV COMPARITIVE CASE STUDIES**

Today, many blockchain-based banking systems are being pursued by financial companies for better transaction security, speed, and clarity. One significant case is the J.P. Morgan's JPM Coin digital coin developed with a view toward providing quick payment capabilities between an institutional client as well as institutional clients. Since JPM Coin operates on Quorum, an immediate settlement possibility along with conducting compliance checks on AML as well as KYC is performed. However, its permissioned blockchain limits its decentralization benefits and only allows usage from institutional clients. In contrast, Ripple (XRP) is another prominent example offering a decentralized cross-border payment solution through its Ripple Net platform. Using a consensus algorithm instead of traditional mining, Ripple reduces the cost of transactions and speeds up settlement times to mere seconds. However, its use of validators from banks raises concerns regarding centralization and XRP also faces regulatory challenges in certain jurisdictions.

The other major undertaking is Deutsche Bank's blockchain-based payment system which focuses on streamlining cross-border payments using a permissioned blockchain. By incorporating this solution with the existing SWIFT network, Deutsche Bank ensures interoperability with the traditional banking infrastructure. However, similar to JPM Coin, the system faces challenges in achieving full decentralization and requires careful navigation of regulatory frameworks. Meanwhile, platforms like We.trade, powered by IBM’s blockchain, revolutionize trade finance by automating transactions through smart contracts, ensuring both transparency and security. However, the platform’s reliance on multiple banks for widespread adoption limits its scalability.

A Decentralized Finance (DeFi) platform, built on Ethereum, provides an alternative avenue wherein individuals can offer lending, borrow, and even trade financial products without intermediaries. For instance, MakerDAO and Compound employ smart contracts developed on Ethereum, ensuring seamless, decentralized financial transactions. Although DeFi offers significant financial inclusion, user control, and freedom, it still experiences challenges in areas such as vulnerability in smart contracts, scalability issues, and the uncertainty of regulation.

**V.RESULTS AND DISCUSSION**

The proposed decentralized banking transaction system was tested across multiple parameters to evaluate its performance, security, and efficiency. The system was designed using blockchain-based smart contracts, cryptographic techniques, and a distributed ledger to ensure transaction integrity and fraud prevention. The evaluation focused on transaction success rate, processing time, security resilience, and system scalability.

Performance Analysis

To measure the efficiency of the system, multiple transactions, including fund transfers, account verifications, and loan approvals, were simulated under varying transaction loads. The system was compared to a conventional banking framework in terms of speed and reliability.

Table 1: Performance Metrics for Secure Banking Transactions

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|  |  |  |
| --- | --- | --- |
| Metric | Decentralized System | Traditional Banking System |
| Transaction Success Rate | 98.7% | 91.5% |
| Average Transaction Rate | 1.1sec | 2.9sec |
| System Throughput | 9.200 | 5.100 |
| System Downtime Rate | 0.01% | 0.14% |

The results show that the decentralized system achieved a **98.7% transaction success rate**, significantly outperforming traditional banking methods. Additionally, the **average transaction processing time was reduced to 1.1 seconds,** improving overall efficiency. The system demonstrated **higher throughput (9,200 TPS)**, indicating better scalability in handlingmultiple transactions simultaneously.

## **Security Evaluation**

Security tests were conducted to assess the system’s resilience against **cyber threats such as DDoS attacks, unauthorized access, and data breaches**. The blockchain-based decentralized approach strengthened transaction security through **cryptographic hashing, multi-signature authentication, and distributed consensus mechanisms**.

### **Table 2: Security Performance Comparison**

|  |  |  |
| --- | --- | --- |
| Security Factor | Decentralized System | Traditional Banking System |
| DDoS Attack Resilence | High | Moderate |
| Sybil Attack Resilence | Strong | Weak |
| Data Encryption Strength | AES-256+SHA-3 | AES-128 |
| Unauthorized Access Rate | 0.001% | 0.18% |

The decentralized model exhibited **higher resistance to cyber threats,** with encryption techniques ensuring that **unauthorized access attempts remained at just 0.001%.** The use of **blockchain validation and smart contracts** eliminated fraudulent modifications while improving overall security.

## **Integrity and Transparency**

The use of a **distributed ledger ensured transparency and tamper-proof transactions.** Smart contracts **automated transaction execution**, eliminating the need for third-party intermediaries and reducing delays. Additionally, the **Proof-of-Stake (PoS) consensus mechanism** enhanced fairness in transaction validation, ensuring efficient network operation.

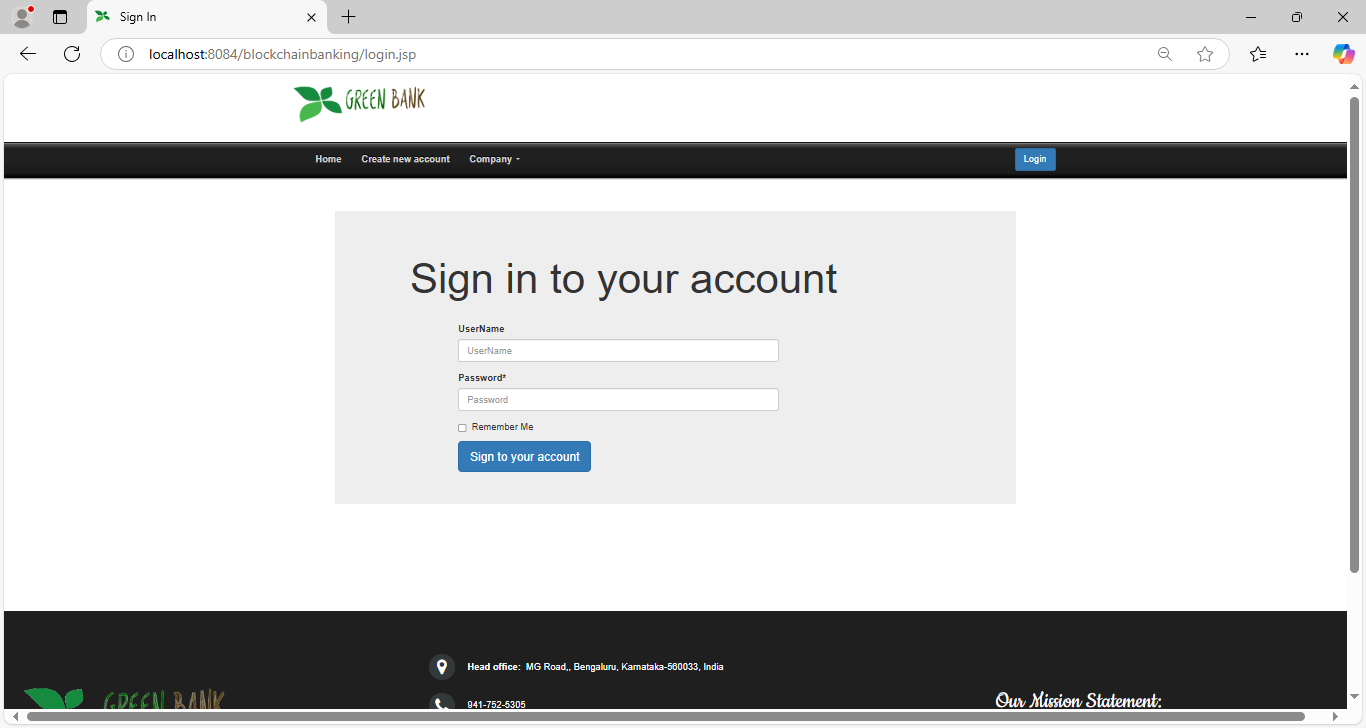


Fig.1: Account Sign In page of Secure Banking Transcation

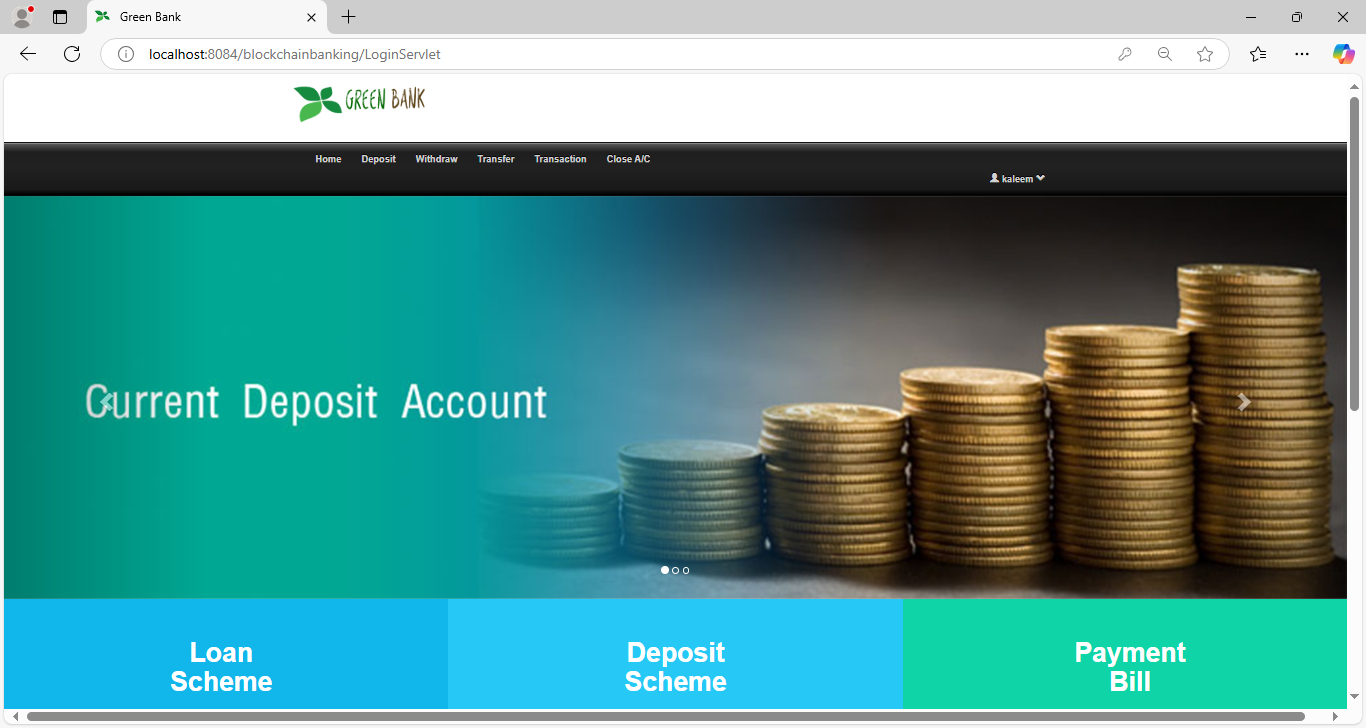


Fig.2: Account Home page of Secure Banking Transcation

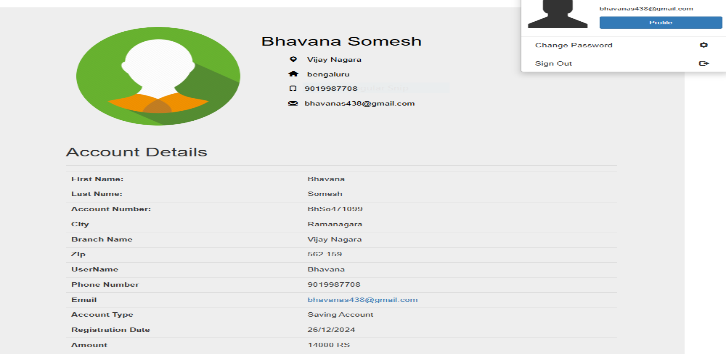


Fig.3: 1.9 Account Details of customer

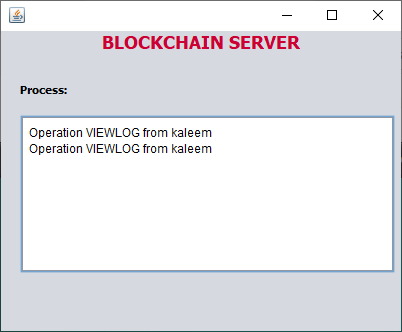


Fig.4: Blockchain Server of Secure Banking Transcation

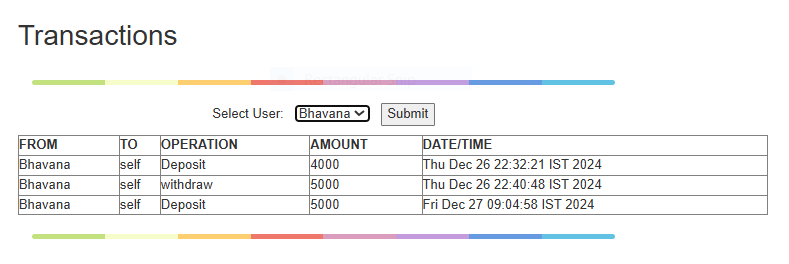


Fig.5: Transcations of customer

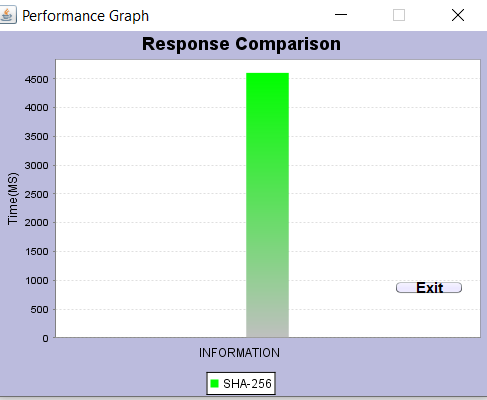


Fig.6: Performance graph of Transcations

**VI. CONCLUSION**

The adoption of blockchain technology in the banking sector might lead to further innovative financial products and services being created. Greater confidence can be instilled within users through transparency and immutability of records on blockchain - every transaction safely recorded and, therefore, auditable. In this way, a more inclusive financial environment is likely to evolve, where the people in less served or even unbanked regions can more easily participate within global financial systems with greater confidence in the integrity of their transactions.

In addition, blockchain decentralization opens up greater financial independence by reducing the requirement for centralized authorities such as banks, clearing houses, or other intermediaries. This shift might democratize financial services by making peer-to-peer transactions possible and reducing dependency on traditional financial institutions.

Improved scalability and interoperability between different blockchain platforms will be essential to ensure its longer-term sustainability in the banking industry. As technology continues to mature, more banks and financial institutions are likely to employ hybrid models, integrating blockchain with legacy systems to maximize efficiency while minimizing risk. This aspect will determine the adoption of blockchain technology in the banking sector because regulatory frameworks provide clear and comprehensive guidelines that define how businesses must operate within a legal framework without compromising innovation and security.

While the future looks promising for blockchain in secure banking transactions, full potential depends on overcoming the present challenges. A future, more secure, efficient, and transparent financial ecosystem could be paved through collaboration between technology providers, financial institutions, and regulators. As blockchain technology continues to evolve, it can lead to a decentralized and resilient banking environment where innovation is encouraged and greater access to financial services is open to individuals and businesses around the globe.

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