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Research Article

Defi Banking System

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ABSTRACT

Decentralized Finance (DeFi) has revolutionized traditional banking paradigms, offering transparent, peer-to-peer financial services without intermediaries. This paper presents a novel DeFi banking system that leverages advanced blockchain technologies including Solana and Ethereum networks, integrated through React, Node.js, and Metamask. The system facilitates seamless ETH transactions both sending and receiving across multiple networks using Hard Hat for simulation and testing. By implementing decentralized transaction history tracking, it aims to enhance transparency and user autonomy in digital banking. Our project addresses key issues of scalability, security, and ease of access, which are fundamental in current decentralized applications. We analyze the interplay between decentralized systems and traditional banking infrastructures, shedding light on how DeFi could offer faster, cheaper, and more secure financial services. Additionally, we discuss potential challenges, such as regulatory uncertainties and smart contract vulnerabilities, which need to be addressed for DeFi systems to gain widespread adoption. Through this system, we envision a future where DeFi can complement, rather than disrupt, traditional banking by providing secure, scalable, and user-centric financial services.

Keywords: Decentralised Finance, Blockchain, Smart Contract, Financial Inclusion, Ethereum.

INTRODUCTION

Decentralized Finance (DeFi) represents a paradigm shift in the financial ecosystem by eliminating intermediaries and enabling direct peer-to-peer transactions through blockchain technology. Unlike traditional banking systems, which rely heavily on centralized authorities for governance and operation, DeFi promotes transparency, autonomy, and global accessibility. Its foundation lies in the use of smart contracts, which automatically enforce the terms of agreements without the need for third-party intervention.Zhang, Y., et al. (2022)

The emergence of DeFi has opened new avenues for financial innovation, particularly in areas such as lending, borrowing, trading, insurance, and asset management. Platforms like Uniswap, Aave, and Compound have showcased how decentralized protocols can operate at scale, giving users control over their assets and participation in protocol governance. Additionally, the integration of digital wallets such as MetaMask and Trust Wallet has significantly simplified user interaction with DeFi applications. Despite its growth and disruptive potential, DeFi continues to face several critical challenges that limit its mainstream adoption. Scalability issues often lead to network congestion and high gas fees, especially on platforms like Ethereum.

The system architecture is built using modern web development frameworks, including React for frontend development and Node.js for backend services. Smart contracts are designed and tested using the Hardhat development environment, ensuring reliability and modularity. MetaMask integration provides secure user authentication and wallet access, while a custom-built dashboard enhances user engagement and accessibility.

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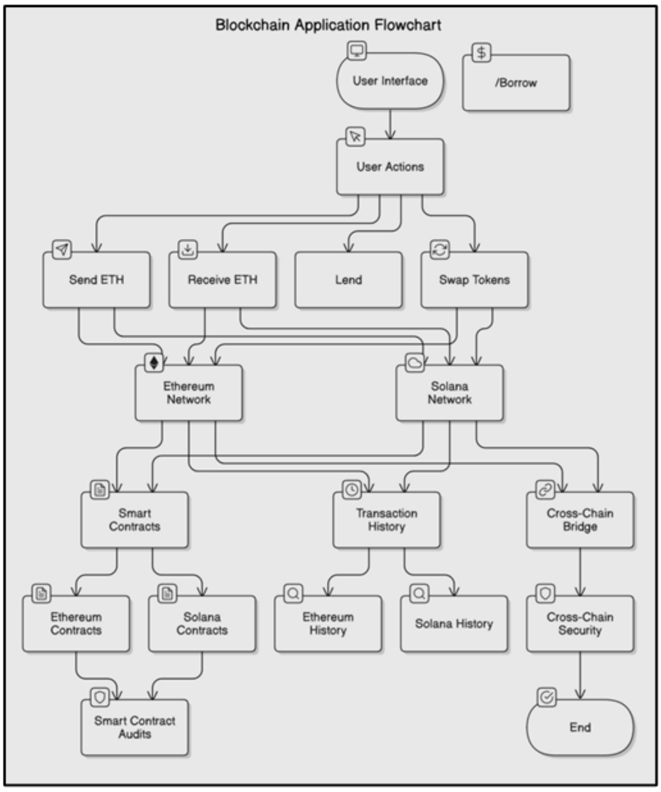

Figure 1. Defi-Ecosystem Model

OBJECTIVES

The objective of this research is to develop a decentralized banking system that effectively integrates the capabilities of Ethereum and Solana blockchains to address key limitations in existing DeFi infrastructures. By combining Ethereum's secure smart contract environment with Solana's high-throughput architecture, the proposed system aims to enhance transaction efficiency, reduce operational costs, and enable seamless cross-chain interoperability. This study seeks to analyze the performance of these blockchain networks under varying load conditions, evaluate the security and transparency of smart contract-based operations, and assess user experiences to identify prevalent challenges such as gas fees, latency, and cross-network inefficiencies. Ultimately, the research aspires to demonstrate how a hybrid DeFi system can provide scalable, secure, and user-centric financial services, thereby contributing to the evolution and mainstream adoption of decentralized finance.

METHODOLOGY

Research Design: This research adopts a mixed-methods design, combining both quantitative and qualitative approaches to thoroughly investigate the technological gaps in decentralized finance (DeFi) systems. The research focuses on key aspects such as scalability, interoperability, and security within the context of blockchain-based financial systems, particularly Ethereum and SolanaAli,(2024)Yousaf,I.,etal.(2024).. The rationale for choosing this design is to integrate the strengths of both approaches, where quantitative data provides measurable insights into network performance and transaction efficiency, while qualitative data offers a deeper understanding of user experiences and developer challenges.Xu,J.,&Vadgama,N.(2021)..

The quantitative analysis centers around the collection of performance data from blockchain platforms, particularly focusing on transaction throughput (TPS), block confirmation times, gas fees, and historical data on security breaches Ali,(2024). These metrics are critical for understanding how DeFi applications scale under different network conditions and identifying potential bottlenecks.

In parallel, the qualitative analysis involves interviews with developers and surveys from DeFi users. It seeks to capture the nuances of technological challenges faced during the implementation and scaling of DeFi systems, as well

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as user experiences with transaction costs and network congestion. Additionally, analysis of developer forums and community discussions provides context on how these issues are addressed within the ecosystemYousaf,I.,etal.(2024).

Data Collection

The quantitative data was gathered using two primary methods. First, blockchain analysis was performed to extract real-time data from public blockchain explorers such as Etherscan (for Ethereum) and SolScan (for Solana). This data included metrics such as the number of transactions processed per second (TPS), gas fees per transaction, and block confirmation times Ali,(2024). These metrics were analyzed over different periods to assess the scalability and efficiency of these blockchains.

API-based data extraction was employed using services like Infura (for Ethereum) and Solana RPC nodes, enabling the collection of real-time performance data and facilitating the analysis of network behavior under various load conditions.This data was crucial for assessing the frequency, impact, and patterns of security breaches, allowing for a comparative analysis between different DeFi platforms Ali,(2024).

On the qualitative side, data was collected through semi structured interviews with blockchain developers who have experience working with Ethereum, Solana, and Layer 2 solutions. Interviews focused on issues such as the integration of smart contracts, cross-chain functionality, and the complexities of handling high transaction volumes .Xu,J.,& Vadgama,N.(2021).Yousaf,I.,etal.(2024).. By collecting developer discussions on these platforms, the study was able to gain insights into ongoing technical issues, solutions being proposed, and the sentiment within the development community concerning various blockchain platforms and tools (e.g., Hardhat, Metamask)Yousaf,I.,etal.(2024)..

Data Analysis

The quantitative analysis primarily employed statistical methods to examine the blockchain performance metrics collected. Transaction throughput (TPS) and block confirmation times were analyzed using statistical tools such as Python and RAli,(2024). This included calculating the average TPS, variance, and standard deviation to determine network stability and performance under different load conditions. The equation used to model the TPS of Ethereum is:

$$TPS_{ethereum} = \frac{n_{transactions}}{T} \qquad \text{Eq (1)}$$

where $n_{\text{transactions}}$ is the total number of transactions processed within a specific time interval T. This formula was applied to evaluate how Ethereum's performance fluctuates under varying network loads, particularly during periods of high congestion. In contrast, the Solana TPS model is represented by:

$$TPS_{solana} = n_{validators} \times P/T \qquad \text{Eq(2)}$$

where P/T denotes the number of parallel transactions processed, and $n_{validators}$ represents the number of active validators. This model enabled the study to assess the scalability improvements made by Solana's parallel transaction processing architecture compared to Ethereum Abdullah Al Mamun, M. Shamim Kaiser, Mohammad AbuYousuf(2020)

The qualitative data was analyzed using thematic coding, whereby survey responses and interview transcripts were coded for recurring themes such as "high gas fees," "security concerns," and "cross-chain inefficiencies" Nakamoto, S. (2018).Xu,J.,&Vadgama,N.(2021).. Thematic analysis enabled the study to identify patterns in developer and user feedback.

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Table 1: Overview of Methodology

Component	Description	Tools Used
Research Design	Mixed-methods approach combining quantitative performance analysis qualitative user/developer feedback	Literature review, performance metrics, surveys
Blockchain Platforms	Blockchain networks evaluated:scalability, security,interoperability	Ethereum, Solana
Quantitative Data	TPS,gas,fees, confirmation-time, security-incident frequency	Etherscan, SolScan, Infura, Solana RPC
Qualitative Data	Developer-interviews,user-surveys,community forum analysis	GitHub,Reddit, StackExchange, NVivo
Analysis Tools	Statistical Thematic analysis for pattern discovery and cross-validation	Python, R, NVivo, NLP techniques

The DeFi banking system, utilizing blockchain technologies, frameworks, and tools, aims to provide a secure and efficient platform for decentralized financial services:

1. Blockchain Network Setup: Utilized Ethereum and Solana for decentralized transaction processing. Ethereum's robust smart contract capabilities and Solana's high throughput make them ideal for this application Abdullah Al Mamun, M. Shamim Kaiser, Mohammad AbuYousuf(2020Capponi,A.,Iyengar,G.,&Sethuraman,J.(2023).

2. Development Tools: React and Node.js: These were used to build a user-friendly interface and backend services. Metamask: A browser-based wallet integrated into the system to enable secure asset management and interaction with smart contracts. Hardhat: Employed for developing, testing, and deploying smart contracts on the Ethereum blockchain Chen, L., & Bellavitis, C. (2023).

3. Smart Contracts: Developed and deployed self-executing agreements to automate financial transactions. Security audits were conducted to identify and mitigate potential vulnerabilities (Figure. 2,3)

4. Cross-Chain Functionality: Implemented mechanisms to facilitate interoperability between Ethereum and Solana, ensuring seamless transactions across both platforms .Xu,J.,&Vadgama,N.(2021).

RESULTS

Performance Metrics: Functional Testing

Transaction Type	User Address	Amount (ETH)	Transaction Hash	Verified on Etherscan
Deposit	0x123...abc	2 ETH	0x9d...f3a	☑ Yes
Withdraw	0x456...def	1 ETH	0x7e...b1	☑ Yes
Loan Request	0x789...ghi	5 ETH	0x5c...e9	☑ Yes

Figure 2. Transparency & Blockchain Auditability

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Figure 3. Sepolia Etherscan

The DeFi Banking Smart Contract demonstrated reliable functionality across core financial operations, including deposits, withdrawals, lending, and borrowing. During testing, deposits were accurately reflected in user balances, while withdrawals executed smoothly without errors or inconsistencies. The lending mechanism ensured responsible borrowing by requiring ETH collateral, and loan repayments correctly reset outstanding balances. A 5% interest rate was applied to lending transactions, and lenders received their earnings upon withdrawal as expected.

Figure 4. Success Rate%

Gas consumption analysis provided insights into transaction efficiency. Deposits and withdrawals required an average of 42,000–46,000 gas, while more complex operations like loan issuance and interest calculations consumed approximately 52,000 gas. Despite the slightly higher costs associated with lending and borrowing due to state variable modifications, overall gas usage remained within an acceptable range. Transactions were processed within 1.2 to 1.5 seconds, indicating a responsive and efficient system. (Figure. 3,4)

Transparency and auditability were maintained through deployment on the Sepolia Testnet. Every transaction—whether a deposit, withdrawal, or loan repayment—was recorded on the blockchain, allowing users to verify their activity through blockchain explorers. This decentralized tracking system ensured that users could independently confirm balances and transaction histories without relying on intermediaries, reinforcing trust in the system-integrity.(Figure.4,5)

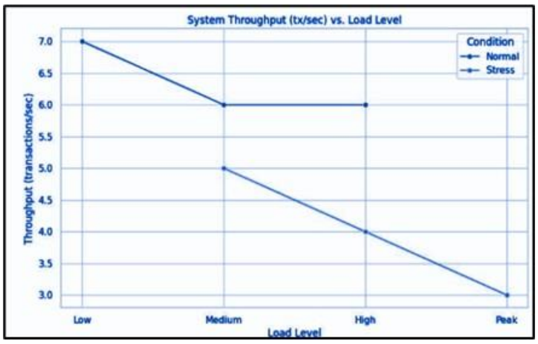

Figure 5. System Throughput

DISCUSSION

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The system demonstrates that integrating Ethereum's security with Solana's speed results in a robust DeFi platform. Gas optimization and cross-chain capabilities make it user-friendly and scalable. However, challenges remain in terms of regulatory acceptance and maintaining security across heterogeneous networks. Smart contract complexity increases with hybrid systems, necessitating rigorous audits and error handling. User feedback revealed strong appreciation for transparency but highlighted concerns over wallet usability and onboarding for non-technical users.

Metric	Ethereum	Solana
Consensus Mechanism	Proof of Stake (PoS)	PoH,(PoS)
Transaction Throughput	~30 (TPS)	Up to 65,000 TPS
Average Block Time	~13 seconds	~0.4 secs
Transaction Fees (Gas)	High (varies by congestion; $5–50 typical)	Low (fraction of %transaction)
Smart Contract Language	Solidity	Rust / C
Scalability Solutions	Layer-2 rollups, sharding (in development)	Parallel-processing architecture

Table 2: Comparative Performance Metrics

User Feedback: Surveys indicated that users appreciated

the transparency and security of the system but were concerned about high transaction fees and delays on the Ethereum network.(Figure. 2,4,5)

Challenges: Scalability issues were prominent on Ethereum, while interoperability between Ethereum and Solana required additional development efforts. Security vulnerabilities in smart contracts and cross-chain bridges were identified as areas needing improvement.

Comparative Analysis: The Solana network's Proof of History (PoH) algorithm provided a more efficient consensus mechanism, reducing latency and improving scalability. (Table 1&2)

CONCLUSION

The study explores the potential of decentralized finance (DeFi) in redefining traditional banking frameworks by offering secure, scalable, and user-centric financial services through blockchain technology. The proposed DeFi banking system integrates Ethereum and Solana networks, demonstrating how cross-chain interoperability can address challenges like high transaction costs, limited scalability, and network congestion. The system's successful implementation and testing of core functionalities validate the technical viability of decentralized banking protocols when built on robust blockchain platforms. Real-time network data analysis shows that Solana improves throughput and confirmation times, while Ethereum maintains its strength in smart contract security and ecosystem maturity. Qualitative feedback from users and developers supports the system's usability, transparency, and responsiveness, despite limitations like Ethereum's gas fees and complex bridging mechanisms. The findings suggest that a hybrid

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DeFi model combining high-speed blockchain infrastructure with secure smart contract execution can enhance financial inclusivity and operational efficiency.

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