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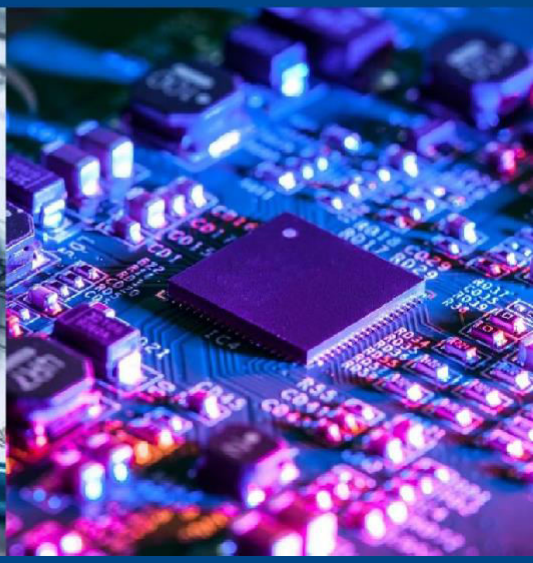

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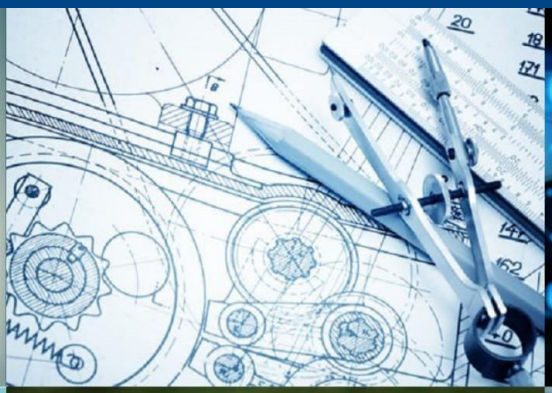

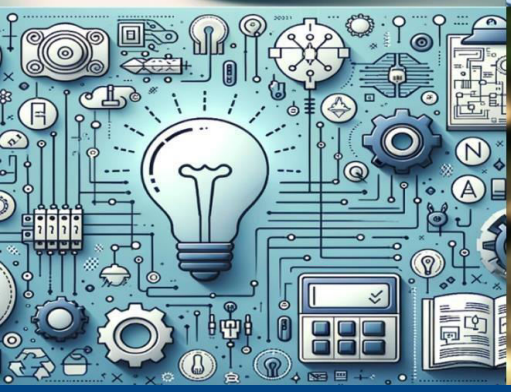

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Blockchain-Powered Crowdfunding: A Secure Smart Contract Model for Automated Fundraising

Muragesh M Adahalli[1], Chandan A[1], Channaveeranagouda[1], Gagan R N[1], Mr. Raghavendra K.[2]

U.G. Students, Department of Computer Science and Engineering, PESITM, Shivamogga, Karnataka, India[1]

Assistant Professor, Department of Computer Science and Engineering, PESITM, Shivamogga, Karnataka, India[2]

murageshadahalli8@gmail.com, chandan007685@gmail.com, channaveeranagouda2004@gmail.com, gaganarnaik123@gmail.com, raghavendrak@pestrust.edu.in

ABSTRACT: Crowdfunding has become a strong way to raise money for creative, social, and business projects. However, traditional crowdfunding platforms often struggle with issues like lack of transparency, concentration of control, and possible misuse of funds. Blockchain technology helps tackle these problems by providing decentralization, permanence, and automated fund management through smart contracts. This paper suggests a blockchain-based crowdfunding system built on the Ethereum network to improve trust and accountability between campaign creators and supporters. Smart contracts automatically handle fund distribution and ensure that donations are released only when specific project milestones are met. Donors can track project progress and get immediate refunds if campaigns do not reach set goals. The proposed system boosts transparency, reduces human error, and removes the need for middlemen. By using blockchain's distributed structure, the model creates a safe, efficient, and secure environment for public fundraising. It also supports a more dependable and inclusive financial ecosystem.

KEYWORDS: Blockchain, Crowdfunding, Smart Contracts, Ethereum, Transparency, Decentralized Applications, Fund Management.

I. INTRODUCTION

Crowdfunding has become a popular way to raise money for social, creative, and business projects. However, traditional crowdfunding platforms often rely on centralized systems. This can lead to trust issues, fund misuse, and a lack of transparency between campaign creators and contributors. Donors typically have little insight into how their money is spent after it is withdrawn, which lowers their confidence in the process and may discourage them from participating. These challenges underline the need for a crowdfunding environment that is more transparent, secure, and accountable.

Blockchain technology offers a strong solution by providing decentralization, immutability, and secure handling of transactions through smart contracts. Unlike traditional platforms, a blockchain-based system records every financial transaction on a distributed ledger, making the process verifiable and tamper-proof. Smart contracts remove the need for third-party intermediaries and allow for automatic control of fund distribution based on set conditions. This automation minimizes the risk of fraud, builds trust, and increases accountability among all involved.

The proposed system aims to improve donation transparency by letting donors track the progress of campaigns and keep control over how funds are used. In this model, donations are held within the smart contract, and fund withdrawal requests from the fundraiser will only be processed if the donors approve them. This feature ensures that the contributed funds are used responsibly and only for valid purposes. Additionally, the platform has a three-level access structure involving the Fundraiser, Admin, and Donor, with each role having specific responsibilities to ensure reliability and fairness in the system.

The goal of this research is to create and implement a decentralized crowdfunding platform that enables secure, transparent, and donor-controlled management of funds. By integrating blockchain technology, automating smart contracts, and using role-based access, the system addresses key issues found in traditional crowdfunding. This approach promotes trust, reduces manipulation, and ensures verifiable transactions. The results show how blockchain can greatly enhance the reliability of public fundraising by building a secure and transparent donation ecosystem.

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II. LITERATURE REVIEW

Belleflamme et al. (2014) state that crowdfunding helps entrepreneurs and small businesses finance their ideas, products, and causes. Traditional crowdfunding methods are expensive, unclear, and not accessible to global investors (Mollick, 2014). Tokenization, blockchain, and smart contracts may transform crowdfunding [1].

Blockchain-based crowdfunding platforms greatly improve transparency, security, and efficiency compared to traditional platforms. They use decentralized ledgers and smart contracts to automate transactions and protect against fraud. These platforms lower operational and transaction costs, enable faster fund transfers, and allow global participation without intermediaries. Smart contracts ensure that funds are only released to project owners once they reach their goals. This boosts investor confidence and accountability. Key challenges include technical complexity, regulatory uncertainties, and the need to educate users about blockchain systems. Findings suggest that blockchain technology creates a more trustworthy and scalable environment for investors and entrepreneurs, but further research and validation are needed [2].

The use of smart contracts and Ethereum has allowed us to implement logic in the blockchain. This blockchain architecture makes the proposed system resistant to nonrepudiation attacks. Additionally, it reduces scams and fraud while increasing transparency in crowdfunded projects. It also helps product developers receive consumer feedback before development [3].

A proposed solution for smart grid (SG) systems that focuses on peer-to-peer (P2P) energy trading is called ETDeaL. This is a secure energy trading scheme based on smart contracts and implemented on a Truffle suite [5].

DAOs operate through smart contracts, which are blocks of code that execute when a specific set of conditions is met. Many blockchains currently use smart contracts. The rules of a DAO are defined by these smart contracts. Stakeholders in a DAO have voting rights and can decide on or create new governance ideas, which can affect how the organization runs [6].

The Funds-Chain study introduces a Web3-based blockchain A crowdfunding model is built on the Ethereum Sepolia test net to improve transparency, security, and decentralization in fundraising. It removes intermediaries through Solidity smart contracts that automate campaign creation, contributions, and payouts. Integration with MetaMask wallets allows direct and secure transactions between donors and creators, as well as real-time fund tracking. The system's layered architecture, which includes the UI, smart contract, and data layer, ensures reliability and scalability. By using Thirdweb deployment, a Vite.js-React frontend, and Tailwind CSS, Funds-Chain offers a user-friendly decentralized platform. Overall, it shows how blockchain can change crowdfunding by ensuring fund security, transparency, and efficiency [7].

Mukherjee et al. (2024) proposed a blockchain-based crowdfunding platform that uses smart contracts on Ethereum to improve transparency and trust between investors and project creators. This system cuts out intermediaries, making sure fund transfers happen only after funding goals are met. Their findings show reduced transaction fees, faster processing, and better security through immutability and de centralization. Smart contract automation reduces fraud and builds investor confidence. Compared to traditional platforms, blockchain offers more accountability and scalability. The study concludes that blockchain-based crowdfunding is a secure, cost-effective, and globally accessible alternative to centralized systems [8].

This section suggests a new method for crowdfunding based on blockchain technology. Ethereum [12] is an open-source, public blockchain-based distributed computing platform and operating system that includes smart contract functionality. Smart contracts let us implement business logic and run on the blockchain network. Solidity is the preferred language for writing these contracts. A smart contract on the Ethereum network allows us to exchange money, share, or trade anything of value in a transparent and conflict-free way. This feature of smart contracts makes them useful in various scenarios.

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III. SYSTEM ARCHITECTURE

The design of the proposed blockchain-based crowdfunding platform uses a distributed approach that combines on-chain smart contracts with off-chain web application components. The system has three main role-based interfaces: Fundraiser, Admin, and Donor. Each role interacts with the smart contract through a web application and a MetaMask wallet.

At the center of the design is the Ethereum smart contract. It manages campaign data, donation transactions, withdrawal rules, and refund processes. All important information, such as goal amounts, deadlines, pledged funds, and contributor identities, is stored securely on the blockchain. This ensures transparency and prevents tampering.

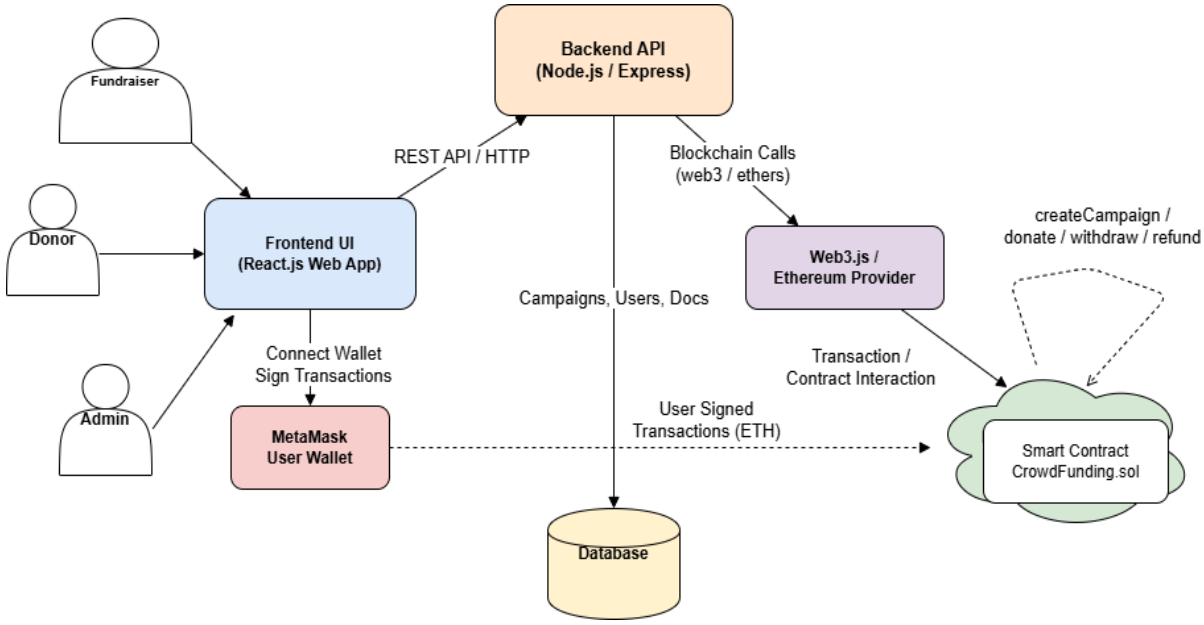

Figure 1: System Architecture

The web application layer, built with React and Node.js, handles user authentication, document management, campaign displays, and communication between the frontend and the blockchain using Web3.js. Fundraiser starts a campaign by submitting details and attaching verification documents. These details are stored off-chain, while financial information and updates about the campaign are managed on-chain. Before launching, every campaign needs to be reviewed by the admin through a dedicated dashboard. It only becomes visible to Donors after approval. Donors connect their MetaMask wallet to send cryptocurrency directly to the campaign contract, and they can track how the funds are used. To maintain donor trust, fund withdrawals require approval from the donors, ensuring that the donated funds are used transparently. through this hybrid design, the system provides secure fund transfers, clear usage of donations, and role-based control. It also removes the need for traditional centralized crowdfunding intermediaries.

IV. METHODOLOGY

The proposed system follows a structured development methodology to design and implement a secure and transparent crowdfunding platform using blockchain technology. The entire process is divided into five major phases: Requirement Analysis, System Design, Development, Testing, and Deployment.

A. Requirement Analysis:

In this phase, we identify the needs of the main users, donors and campaign creators. Campaign creators, or fundraisers, need a platform where they can securely launch fundraising campaigns, share campaign details, and receive funds directly into their crypto wallets. Donors need a clear and trustworthy system to verify the authenticity of campaigns before they donate. the analysis also outlines the administrator's role. The administrator verifies campaign legitimacy

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before it can go live on the platform. This stage makes sure that all functional, technical, and security requirements are clearly defined before the design phase starts.

B. *System Design:*

The design phase focuses on creating the structural and logical blueprint of the entire platform.

1. *Architecture Design:*

The system is built using a three-tier architecture, including the frontend (user interface), back end (server-side logic), and blockchain (decentralized storage and transactions).

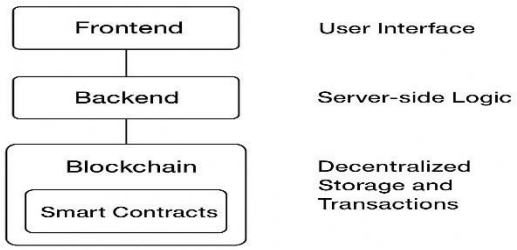

Figure 2: Architecture Design diagram

2. *UML Diagrams:*

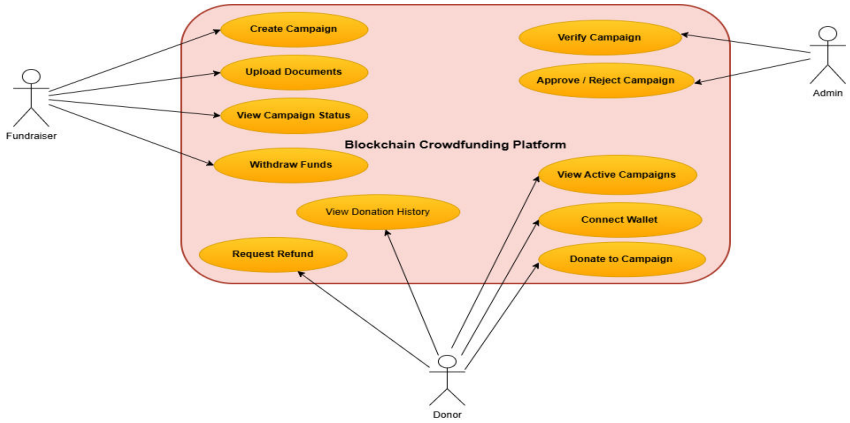

Figure 3: Use Case diagram

To model the system behavior and interactions, UML diagrams like Use Case, Activity, and Class Diagrams are created. The Use Case Diagram defines the interactions between fundraisers, donors, and admins. The Activity Diagram shows the campaign approval and donation workflows. The Class Diagram illustrates relationships between main entities like campaigns, users, and transactions.

3. *Smart Contract Logic:*

Smart contracts handle fund flow and campaign approval. These contracts make sure that funds only go to verified campaigns. All transactions are unchangeable and can be traced on the blockchain.

4. *User Interface Design:*

The UI is simple and easy to use. It lets users connect MetaMask, view campaigns, and make donations without any technical difficulties.

C. *Development:*

The development phase focused on implementing the main functional components of the crowdfunding platform and integrating blockchain features. The smart contracts were created in Solidity to handle key tasks like campaign

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creation, administrator verification, and secure fund transfers within the Ethereum blockchain. For the user interface, the frontend was built using React.js to offer a responsive and interactive experience for fundraisers, donors, and administrators. The backend used Node.js, and Web3.js enabled communication between the frontend and the blockchain network, allowing the system to manage user data, transaction requests, and contract interactions effectively. Additionally, MetaMask wallet integration was added so users could log in with their Ethereum accounts and make transactions securely, ensuring smooth interactions with the decentralized system.

D. ***Smart Contract Design and Implementation:***

The main function of the proposed crowdfunding system is managed by a smart contract on the Ethereum blockchain. This contract handles campaign creation, accepts donations, and controls fund flow without needing middlemen. This setup ensures transparency, trust, and safety for both creators and donors.

The contract keeps a detailed record of each campaign using a Campaign data model. This model stores the creator's address, campaign description, funding goal, total funds raised, and deadline. When a fundraiser sets up a campaign, these details are permanently recorded on the blockchain, so no changes or tampering can occur after creation.

Donors can support a campaign using the donateToCampaign() function. Each donation links to the donor's wallet address, ensuring that all contributions are trackable and verifiable. The contract includes rules to stop donations after the campaign deadline, which maintains fairness and clarity in the funding process.

To protect donors, the smart contract has automatic refund features. If a campaign does not reach its funding goal by the deadline, donors can get their contributions back through the refund() function. This prevents fund misuse and builds trust in the platform. When a campaign successfully meets or exceeds its funding goal, the creator can withdraw the collected funds using the withdraw() function. This withdrawal is allowed only after the deadline and only to the creator's wallet, which stops unauthorized access to funds. The contract includes security measures to protect against common blockchain vulnerabilities.

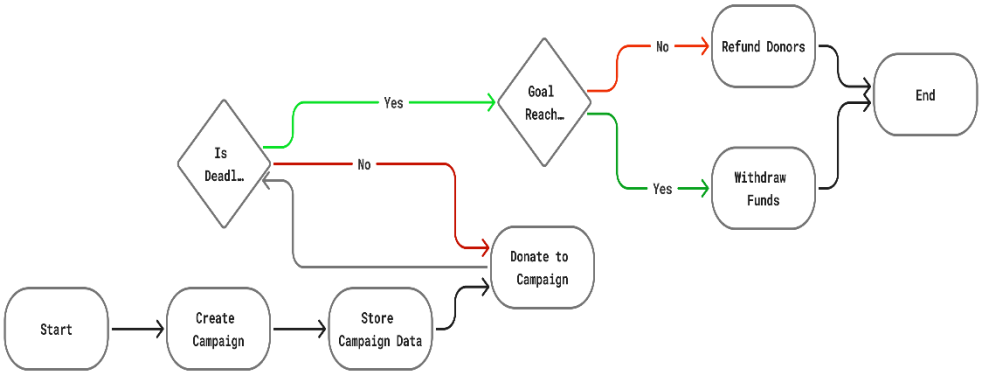

Figure 4: Smart Contract Flowchart

E. ***Testing:***

The testing phase checked that the system operates reliably, accurately, and securely across all components. We performed unit testing on the smart contracts using suitable testing frameworks to ensure the core functions worked correctly, such as campaign creation, fund transfers, and admin approval. After that, integration testing confirmed smooth communication between the frontend, backend, and blockchain layers. This ensured that data flow and transaction interactions worked as they should. We also conducted workflow simulations to test real user scenarios. This included fundraisers creating campaigns, administrators reviewing and approving requests, and donors contributing to active campaigns. These simulations showed that each user role and permission functioned properly under real-time conditions, which strengthened the overall stability and trustworthiness of the platform.

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F. *Deployment:*

Once testing is complete, the system is set up on an Ethereum test network like Sepolia or Goerli. This enables safe testing of real blockchain transactions without using actual cryptocurrency. After deployment, we monitor the system's performance, transaction speed, and usability. We collect user feedback to find areas for improvement before the final pro duction deployment.

V. RESULTS

During the testing phase, all major modules, including campaign creation, admin verification, and donor transactions, operated as expected.

1. *Campaign Creation*:

Fundraisers were able to start campaigns with details like title, goal, and deadline. Each campaign was recorded on the blockchain to ensure data could not be changed.

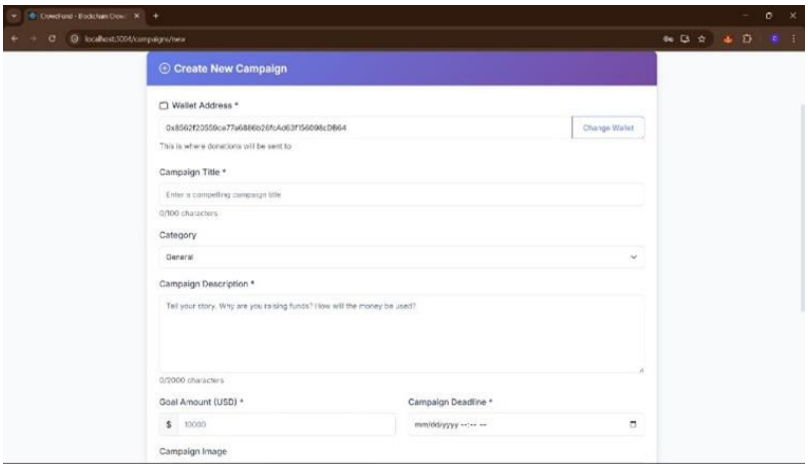

Figure 5: Fundraiser can Create the Campaign

2. *Admin Verification:*

Admins reviewed and approved campaigns successfully, making sure only legitimate projects were listed for public contribution.

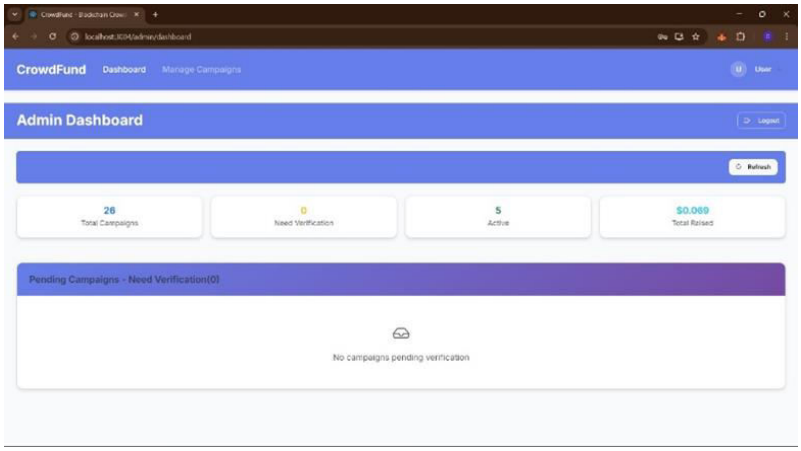

Figure 6: Admin Verification before Publishing the Campaigns

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3. *Donation Process:*
Donors contributed funds through MetaMask wallets. Each transaction was verified on the Ethereum test network.

4. *Smart Contract Automation:*
The system released funds to campaign creators automatically once the funding goal and deadline conditions were met. If the goals were not reached, the system successfully refunded donors' wallets.

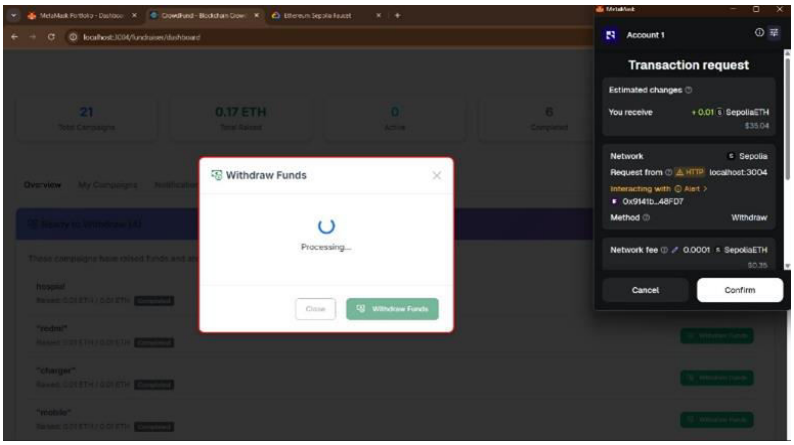

Figure 7: Metamask Wallet Integration

The outcomes confirm that blockchain integration improves trust and transparency in crowdfunding. Each transaction was permanently stored on the blockchain, preventing manipulation and ensuring donor accountability. The smart contract automation reduced the need for human involvement, minimizing risks and delays. Additionally, compared to traditional crowdfunding plat forms, this decentralized approach reduced reliance on a central authority, lowering transaction fees and preventing fund mismanagement. The test results also showed that users could verify transaction details on their own, boosting confidence and system reliability.

Overall, the system proved efficient in managing donations, campaign approvals, and fund releases. It demonstrates how decentralized applications (DApps) can transform financial collaboration by ensuring fairness, transparency, and security in public fundraising.

VI. CONCLUSION

This research shows that blockchain can effectively tackle major challenges in traditional crowdfunding, especially the lack of transparency and trust in fund management. By using smart contracts, the system eliminates intermediaries and ensures that funds are released only when the campaign conditions are met. Donors can check every transaction on the blockchain, which cuts down on fraud and boosts trust in the fundraising process. The results indicate that the de centralized approach improves data security, accountability, and fairness. Campaign creation, donation, verification, and fund withdrawal processes were successfully managed without manual oversight. Overall, the system offers a more depend able and transparent crowdfunding model and demonstrates how blockchain can support trustworthy and efficient financial collaboration in real-world situations.

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