Increasing Donation Transparency in Disaster Relief: A Blockchain-based Solution

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***Abstract*— The project aims to create a decentralized system for tracking donations based on blockchain technology built using ReactJS and WEB 3.0. The goal is to integrate transparency and convenience into the online donation methods. Our system offers a clear record of transactions for donors, allowing them direct interaction with the recipients, whether charitable foundations or individual beneficiaries. Smart contracts, composed in Solidity programming language, are stored on the Ethereum public blockchain, enabling automatic execution under specified conditions. Currently, blockchain technology finds extensive application across various sectors. Payments are now facilitated through this technology, ensuring transparency in the processes of donation and fund transfers. To track donations, a single database that contains all donor information, transaction history, and donation records must be established. This blockchain-based system facilitates the operations of donors, nonprofit organizations, and recipients by offering a transparent and safe platform.**

Keywords*— *Blockchain, Smart Contracts, Ethereum, Disaster Management, Donation.

I. Introduction

As a distributed, permanent, and unchangeable ledger that records crucial transactional characteristics like accountability, execution, and transparency, blockchain is an emerging technology for transactions [1]. Instead of being supervised by a single authority, these transactions are verified by a global decentralized network of computers. Each approved transaction generates a block, and those blocks are connected to one another to create a structure that has a chain-like appearance [3]. The absence of transparency leaves donors in the dark about how well their contributions are being used. The proposed system makes it possible for social organizations to manage various initiatives for charitable purposes by removing the requirement for third parties to be present at any stage of the process. [4] It operates by means of a smart contract that remains accessible to all parties while confirming and evaluating their impact. Because it's simple to keep an eye on an organization's transactions, donors' trust in these social organizations can be reestablished. When it is put into practice, it will help to build confidence between recipients and contributors who take part in charity endeavours [6].

In an effort to increase donation transparency in disaster relief, a number of alternative methods and technologies were used prior to the development of blockchain. Traditional centralized databases and audit systems were widely used among them. Donation data was kept in centralized databases, which were accessible to authorized parties but vulnerable to corruption or data manipulation because they only had one point of control. Auditing systems lacked real-time transparency and relied on recurring checks and reports from outside parties, which helped to build trust in the auditing process. Complete transparency in relief efforts was hampered by these methods' inability to provide an unchangeable and publicly accessible ledger of donation records, raising questions about the accuracy and integrity of the data. With a focus on the following major components, this system seeks to bring about significant improvements to the present donation procedure. Our technology leverages Ethereum, a decentralized and open-source blockchain with smart contract functionality, providing a transparent platform for all participants [5]. This transparency allows campaign participants to monitor transactions, preventing any misuse by intermediaries. Our solution's global reach, which allows for quick transfers of cash to any location via a peer-to-peer network, is one of its main advantages. The constraints of conventional worldwide bank transfer services are removed as a result. On the blockchain, decentralization is essential to the smooth execution of transactions. By using blockchain technology for rapid and safe processes instead of laborious ones, we change the way transactions are conducted without the need for a governing body managing transactions [7]. As money gains value, security becomes more important than ever. E-payment systems are still susceptible to hackers even with strong safety precautions like asymmetric and symmetric encryption in place [8]. Thus, it is essential to ensure improved security measures. In conclusion, our technology provides enhanced security against possible threats in e-payment systems, global reach via peer-to-peer networks, decentralized execution of transactions on the blockchain, and transparency through Ethereum's decentralized platform.

II. LITERATURE SURVEY

To guarantee effective and secure data transfer, Pour et al. [1], Sreedevi et al. [2], and Ozkan et al. [3] developed three different systems that combine blockchain technology with other technologies. Pour et al. developed a network-based model that uses an algorithm for dynamic voltage frequency scaling, blockchain technology, and the Internet of Things (IoT) to speed up response times and preserve transaction histories across the network. A web application linked to a

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distributed ledger system that houses all the organization's peers and smart contracts is the solution created by Sreedevi et al., which reduces the requirement for human involvement and the chance of human error. Using the Quorum blockchain framework, Ozkan et al. developed a system with web service and standalone smart contracts for NGO nodes that is more energy-efficient than solutions that are based on cryptocurrencies. The Web3JS library allows these two components to communicate from node to JS Back-End.

There are various suggestions regarding donation systems facilitated by different blockchain frameworks. In a study by E. Shaheen et al., a novel model for tracking donations was introduced, involving multiple new participants overseeing the donation process to eliminate suspicions surrounding charity activities. This model ensures all donations are traceable within the Blockchain, providing donors with insight into the specific utilization of their funds. The implementation of this model utilized Hyperledger Composer [4]. In another study [5], the authors proposed a system where users, categorized as donors/beneficiaries, NGOs, and government entities, play vital roles within the blockchain network.

Blockchain-based solutions have been suggested by Verma et al. [6] and Singh et al. [7] to enhance drought risk management and make it easier for drought victims to receive aid. Their papers examine the main problems, criticize the current setups, and assess the state-of-the-art in blockchain-based disaster management. Benefits like secure transactions, effective resource management, and open data sharing are provided by the proposed systems. Different challenges are also mentioned, such as the requirement for scalability, vulnerability to cyberattacks, and standardization and interoperability.

In [8], the author emphasizes the significance of traceability management influenced by Blockchain Technology and shares insights from developing Origin Chain. The crucial aspect of tracing product origins throughout supply chains is highlighted to validate product authenticity and install trust among consumers. Employing smart contracts - a predefined set of rules for executing transactions - the blockchain records and tracks all transactions as state transitions, utilizing the Ethereum blockchain for this purpose. The approach used by the author is beneficial for monitoring diverse products within the supply chain. The Origin Chain system is the more secure method for product traceability compared to traditional physical systems involving quality check teams.

As to the author of [10], the blockchain makes it possible to get a decentralized transaction record that is useful for creating, approving, and sending transactions to other nodes connected to the same network. The level of security required for financial transactions is further increased by the different cryptographic hash algorithms of distinct cryptocurrencies. Financial services, healthcare services, business, and industry can all benefit from the blockchain.

A charity application today needs a system that validates itself without depending on any other system or application. Blockchains are being used as they are not restricted to a particular system and because they can independently verify the integrity and consistency of transactions. Ethereum is chosen as a platform because it is a public platform and has better scalability since, it can run 7-20 transactions per second [11].

III. PROPOSED SYSTEM

The proposed donation system on the Blockchain draws attention to several essential aspects crucial to an efficient donation platform. Our system implements measures to verify the validity of both the donors and the administrative entities through techniques and cross-checking with government databases. A number of important players, each with a distinct function, are involved in this system: donors, beneficiaries, relief organizations, and validators. Donors—individuals or groups—contribute money or other resources to disaster relief efforts. The management and distribution of aid to impacted areas is mostly the responsibility of relief organizations. The proposed approach seeks to build trust between aid organizations, recipients, and donors by ensuring a clear, traceable, and unaffected donation flow.

A. Actors and Roles

The principal players in the proposed system are as follows.

Below is an overview of the actors and their roles.

1) Donors: Individuals, teams, or organizations ready to provide funding to help after a disaster.

2) Relief Agencies: These are the organizations in charge of planning and coordinating the distribution of aid to affected areas during disasters.

3) Recipients: These are the individuals or groups affected by the disaster that need help.

4) Validators: Independent agencies or individuals in charge of verifying and validating the authenticity of financial transactions and the distribution of assistance.

B. Entities

There are several main entities in this system. Here is a description of a few of the essential entities:

1) Blockchain Platform: The decentralized ledger technology that serves as the foundation for all contribution and aid transaction data is transparent and safe.

2) Smart Contracts: Blockchain-based, self-executing contracts designed to automate and uphold the conditions of aid distribution and giving.

3) Donation Wallets: Virtual wallets for donors and relief agencies to hold, send, and receive donated funds or resources.

4) Disaster Relief Inventory: Database storing information about available resources and their distribution to affected areas.

5) Verification Protocols: Mechanisms for validating the authenticity and validity of relief efforts and transactions.

TABLE I. shows the Structure and Attributes of the blockchain system.

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TABLE I. STRUCTURE-ATTRIBUTE TABLE

STRUCTURE	ATTRIBUTES
Donation Wallets	string Donor ID; string Contact Information; string Donation Type; int Quantity; int Value;
Blockchain	int Blocks; string Hash; int Timestamp; bool Donation Transactions;
Smart Contracts	string Conditions; string Escrow Account Details; bool Execution Status;
Verification Protocols	string Verifier ID; bool Verification Status; bool Audit Trails;

IV. Methodology

The system architecture diagram (Fig. 1.) of our proposed donation system visualizes the working of the system portraying the integration of various tools and frameworks. The system uses APIs to fetch the relevant data from the database on the blockchain and MetaMask. Each of the functions related to fetching/adding data from the blockchain use the smart contracts to efficiently automate the execution of agreement.

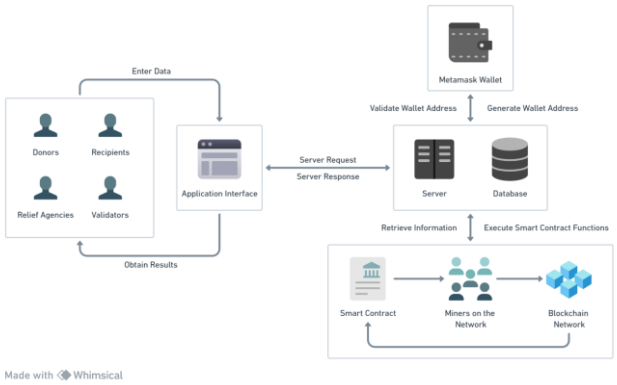

Fig. 1. System Architecture

A. Initialization Phase

The initialization step consists of deploying a smart contract and integrating it with the main system. After a smart contract is deployed onto a blockchain network, the address of the contract needs to be updated on the server that hosts it, which is the central system. To complete the interaction between the backend server and the smart contract, an update to the "Web3.py" package is also required. These are the account's public and private keys, which were needed to activate the smart contract. Since the authority is carrying out the smart contract in this specific instance, they must update this data.

B. MetaMask Registration Phase

The integration of MetaMask: To enhance the user experience, individuals are provided with comprehensive instructions and guidance on how to set up the MetaMask browser plugin.

MetaMask is an essential tool for easy wallet management and connecting to blockchain networks. Establishing Wallets: With the MetaMask plugin, users have the option to either create new Ethereum wallets directly or link their existing wallets to the platform. These wallets are essential to the management and execution of bitcoin transactions. Robust and Secure Authentication: MetaMask is used in conjunction with a strong authentication mechanism in the solution. This guarantees that the wallet account on the platform can only be accessed and controlled by the legitimate owner. This robust authentication method adds an additional layer of security to the platform. Easy Wallet Connection: After completing the setup and login processes, users can easily link their wallets to their online applications. Users can interact with the platform safely and conveniently by tracking their campaigns, contributions, and donations thanks to this seamless connection. It offers a seamless, user-friendly interface that makes interacting with the platform effective.

C. Support Campaign Creation

Campaign can be created by providing details like participant's name, a distinctive campaign title, a campaign description, an image with a link, and a reasonable donation target. To ensure fast and secure transactions, ReactJS's ethers package is used that sends the set fee to the designated administrative wallet address. Particularly, by using a percentage of the system based on the total amount of funds raised throughout the campaigns, this system indirectly helps the overseeing authority generate revenue. The smooth integration of ethers as a payment method simplifies the financial components of these campaigns, lowering associated costs and guaranteeing an open and effective fundraising environment for all stakeholders. The campaign creation form is submitted, and the related smart contract is activated on the blockchain. The smart contract needs to be made to carry out token issuance and fundraising.

D. Donation Phase for Donors

Donors are given an easy-to-use interface for campaign exploration, which makes navigation effortless. Donors can explore and learn about a variety of campaigns on this easy-to-use platform. The platform makes donating easier for users by incorporating campaigns that fit their values and interests. Donors feel confident by the optimized donation process. Donors can select their campaign and donation amount can be send at the beginning. Transaction confirmation is simple and straightforward using MetaMask wallet. Security and transparency are maintained using smart contracts that executes and records donations on blockchain. Security and accuracy of each campaign's financial record is maintained using smart contract.

V. Implementation

Security, transparency and traceability have been offered by the system design using blockchain technology.
Web 3.0 is used for database administration and control that provides solid foundation. Blockchain ensures that the donations records stored on the blockchain remains unchangeable.
The System user friendly interface is developed using ReactJS and Tailwind CSS ensuring smooth experience and responsive design.

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Hardhat.config.js file in backend for smart contract construction and execution which is supported by JavaScript. Fig. 2. presents a flow diagram of the online application which helps with the identification of user needs, goals and pain points. It streamlines the project development by ascertaining the stages of donation creation.

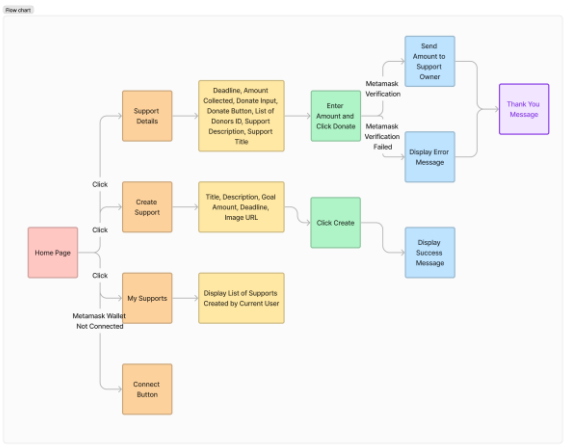

Fig. 2. User flow Diagram

The architecture of the system is based on the decentralization and immutability inherent in blockchain technology. Third Web's database securely stores and manages donations through the use of controllers that control access and uphold system integrity. Donors and recipients may browse the system with ease thanks to the engaging user experience provided by Tailwind CSS and React. Concurrently, the JavaScript-driven backend, utilizing Hardhat.config.js, facilitates the development and implementation of smart contracts, ensuring the smooth and independent operation of transactions inside the system.

The website of the donation tracking system intended for disaster relief is easy to use.

Fig. 3. shows every campaign that is currently running to aid with disaster assistance. Visitors can choose from a variety of campaigns here, along with matching donation levels, pictures of disasters that illustrate the reason, and descriptions that highlight the urgency and impact of each initiative.

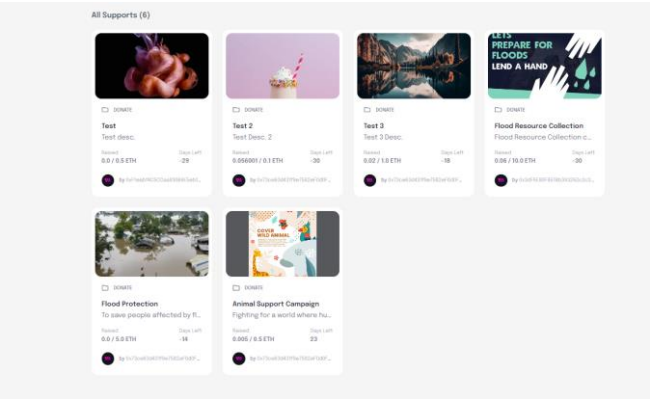

Fig. 3. Support Page

Fig. 4. Represents the creation of new campaigns. Users fill in essential campaign details such as campaign titles, desired donation amounts, disaster images to capture attention, and comprehensive descriptions outlining the essence and significance of each cause.

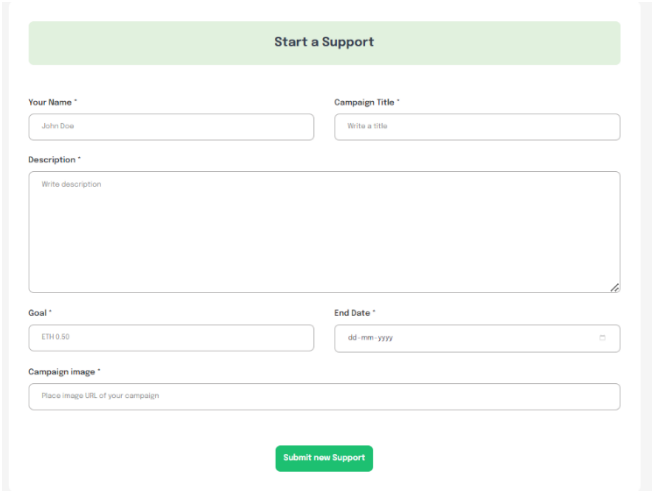

Fig. 4. Create Support Page

Fig. 5. Represents the support description page where donators can see the description about the campaign and can donate the amount from this page.

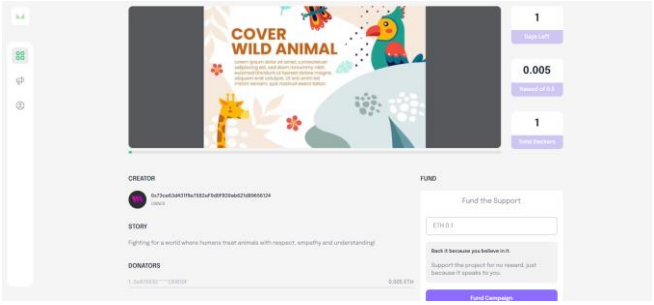

Fig. 5. Support Description Page

Utilizing this combination of technologies results in a donation platform that fosters trust and accountability. Blockchain ensures every donation is verifiable and unchangeable, while Third web handles the database and controllers, ensuring data integrity. React and Tailwind CSS combine to deliver an aesthetically pleasing and user-friendly interface, while the JavaScript-based backend, utilizing Hardhat.config.js, provides the necessary infrastructure for smart contract execution, ensuring the reliability and security of the donation process. A list of donors is visible for transparency of total donations done, where the IDs have been hidden to ensure privacy of the donors. The Deployed Project currently works on a Test Network. This system design embodies transparency, reliability, and user accessibility in fostering a robust donation ecosystem.

Four functions were developed within the .sol file throughout the project's implementation phase to handle the construction of supports, handling donations, obtaining donor data, and gaining access to a list of generated supports. Together, these features make it possible to create supports, make donations easier, get donor information, and see a list of all the supports that is available in the system.

Struct Support contains all the attributes a Campaign has. 'address' is a reserved keyword which is a 20-bit value helps us to store the Ethereum Address, 'uint256' on the other hand is unassigned in which stores the numbers which are non-negative.

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Mapping in solidity is used to form a key value pair so that we can access everything in the struct we made previously. 'public' means the values can be accessed publicly. The Global variable 'numberOfSupports' is declared which keeps track of the number of campaigns made.

The createSupport function (Fig. 6.) enables the creation of new disaster campaign instances within the system. It takes in parameters such as the owner's address, title, description, target amount, deadline, and image associated with the support. Once the function is called, it ensures that the deadline for the support is set in the future, then initializes a new campaign instance with the provided details, increments the count of supports, and returns the index of the newly created support.

```
function createSupport(address _owner, string memory _title, string memory _description, uint256
_target, uint256 _deadline, string memory _image) public returns (uint256) {
    Support storage allsupport = allsupports[numberOfSupports];

    require(allsupport.deadline < block.timestamp, "The deadline should be a date in the future.");

    allsupport.owner = _owner;
    allsupport.title = _title;
    allsupport.description = _description;
    allsupport.target = _target;
    allsupport.deadline = _deadline;
    allsupport.amountCollected = 0;
    allsupport.image = _image;

    numberOfSupports++;

    return numberOfSupports - 1;
}
```

Fig. 6. createSupport() Pseudo Code

The donateToSupport function (Fig. 7.) simplifies the process of donating to a specific disaster campaign. It accepts an ID corresponding to the campaign and records the amount sent with the transaction. Upon receipt of a donation, it updates the campaign by appending the donator's address and the donated amount to respective arrays within the support instance. It transfers the donated amount to the owner of the support and, upon successful transfer, increments the total amount collected for that particular campaign.

```
function donateToSupport(uint256 _id) public payable {
    uint256 amount = msg.value;

    Support storage allsupport = allsupports[_id];

    allsupport.donators.push(msg.sender);
    allsupport.donations.push(amount);

    (bool sent,) = payable(allsupport.owner).call{value: amount}("");

    if(sent) {
        allsupport.amountCollected = allsupport.amountCollected + amount;
    }
}
```

Fig. 7. donateToSupport() Pseudo Code

For a given campaign, the getDonators function (Fig. 8.) obtains data about the donors and the quantity of each donation. It receives an ID for support as input and output arrays with contributors' addresses and contribution amounts.

```
function getDonators(uint256 _id) view public returns (address[] memory, uint256[] memory) {
    return (allsupports[_id].donators, allsupports[_id].donations);
}
```

Fig. 8. getDonators() Pseudo Code

All created support instances can be retrieved using the getSupports function (Fig. 9.). Iterating through the current supports, it copies each instance into the array as it generates an array to hold instances of the Support struct. When it's finished, it returns this array with all the support instances that are available, giving users a thorough overview of all the campaigns that have been built within the system.

```
function getSupports() public view returns (Support[] memory) {
    Support[] memory allSupports = new Support[](numberOfSupports);

    for(uint i = 0; i < numberOfSupports; i++) {
        Support storage item = allsupports[i];

        allSupports[i] = item;
    }

    return allSupports;
}
```

Fig. 9. getSupports() Pseudo Code

Together, these features create a system that allows for the creation of campaigns, the donation of funds to these campaigns, the retrieval of donor and donation information, and the acquisition of an exhaustive list of all supports. This promotes accountability and transparency in the management of blockchain-based disaster relief donations.

VI. Results

The System has been deployed using Web 3.0 and ReactJS. The system uses the benefits of blockchain into disaster management to solve the problem of donation in disasters campaign. The benefits of blockchain include traceability, transparency, enhanced security, reduced reliance on a central authority, network efficiency, and a marked decrease in corruption. Smart Contracts have been used in this system to automate the process of donation such that the donations have been directly transferred to the relief camps.

Automated and trustless transactions allow the donations to go directly to the authorized charities and this optimizes the impact of each contribution.

Using blockchain technology, Contributions can be tracked by the contributors and make sure that donations are transferred to the correct campaigns. This feature ensures that transparency remains in the system. Possibility of fraud or poor management reduces in the system while trust between donors and recipients is maintained.

Used of alternate technologies like Centralized databases have been greatly reduce because of blockchain technology. Blockchain uses decentralized feature and ensures ledger is unaffected to data manipulation and enhances information integrity.

Blockchain's intrinsic transparency helps in continuous monitoring and donation verification which the makes the system easier to handle and reporting processes that are necessary for centralized systems. Problems associated with centralized databases have been addressed by the system offering effective, secure and more transparency for handling donations for disaster relief.

Technical challenges like MetaMask, cryptocurrency and device inconsistency will expand the scope of the project and enhance the suggested solution.

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VII. Conclusion

The Donation Tracking System, which is based on the Ethereum blockchain, facilitates donation tracking and provides details on the expenditure of this money. The system enables participants to transfer ethers instantly to one another without the need for an intermediary by utilizing the use of blockchain technology and smart contracts. It only takes donations in ETH, guaranteeing the uniqueness of every transaction and making blockchain tracing easier. These methods, which exhibit a high degree of honesty and transparency, have the capacity to foster cooperation and trust, which will promote donations and enhance the standing of charity.

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