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RESEARCH PAPER

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A BLOCKCHAIN-BASED FRAMEWORK FOR ENHANCING TRANSPARENCY AND TRACEABILITY IN CHARITY DONATIONS

Saleha Mariyam, Suraj Singh, Faraaz Ahmad Khan, Khizr Anis
Department of Computer Science, Integral University Lucknow,
Uttar Pradesh, India

***Abstract*:** The increasing reliance of non-profit organizations (NPOs) on technology has created an opportunity to enhance transparency and trust in charity donation processes. Traditional donation systems often lack transparency, raising concerns about misuse and inefficiency. This study proposes a Blockchain-Based Frame- work for Enhancing Transparency and Traceability in Charity Donations, lever- aging Ethereum's public-permissioned blockchain to ensure secure, immutable, and traceable transactions. By utilizing smart contracts and distributed ledger technology, the framework enhances donor trust by enabling real-time tracking of donations from the point of contribution to their final allocation. A hybrid qualitative evaluation confirms the system's effectiveness in mitigating fraud, eliminating intermediaries, and increasing accountability. The proposed approach offers a scalable and secure solution to modernizing charity donations, addressing long- standing concerns regarding financial transparency and donor confidence.

***Keywords*:** Charity, Donation, Traceability system, Blockchain, Trust, NPOs, IPFS, BBDT, Dapps.

INTRODUCTION

Charity donations represent a social solidarity approach used to promote cooperation, improve the economic and social status of communities, and enhance relationships among all members of society [1]. Yet, the charity donation process involves the circulation of huge amounts of money, 70% of which has been donated by individuals, which means that it needs to be closely monitored and controlled [5].
More specifically, charity donations are made, managed, and received by various parties in- volved in the donation process, which is typically managed by non-profit organizations (NPOs) as part of their efforts to achieve both humanitarian and social objectives. These NPOs principally depend on government support and financial contributions made by individual donors [**1**]. However, as many NPOs operate in complex environments, it can prove difficult to track where the financial support they receive ultimately ends up [**9**]. Moreover, NPOs generally need to use some of the donations they receive to cover their operating costs [**6**]. As a consequence of such issues, donors often lack knowledge of the intended recipients, where their donations actually go, and how their donations are spent [5].

1 BACKGROUND

1.1 Blockchain Technology

Blockchain is an emerging technology that has been the subject of significant research interest in recent years [11] due to its decentralized, secure, and transparent nature. It is a distributed ledger technology (DLT) that records transactions across a network of computers in a way that ensures the data is immutable and tamper-proof. The first and most well-known application of blockchain is Bitcoin, a cryptocurrency developed in 2008 by an anonymous entity known as Satoshi Nakamoto [7]. Since then, blockchain has evolved beyond cryptocurrencies and is now being applied in various domains, including finance, healthcare, supply chain, and governance [2].
Key Features of Blockchain Blockchain technology is characterized by several key features that make it suitable for applications requiring transparency, security, and trust:

1. **Decentralization**: Unlike traditional centralized systems, blockchain operates on a peer-to-peer network where no single entity has control over the entire system. This decentralization eliminates the need for intermediaries, reducing costs and increasing efficiency [4].
2. **Immutability**: Once a transaction is recorded on the blockchain, it cannot be altered or deleted. This immutability ensures the integrity of the data and prevents fraud [1].
3. **Transparency**: All transactions on the blockchain are visible to all participants in the network. This transparency builds trust among users and ensures accountability [9].
4. **Security**: Blockchain uses cryptographic techniques to secure transactions and con- trol access to the network. Each block contains a cryptographic hash of the previous block, creating a chain that is resistant to tampering [7].
5. **Consensus Mechanisms**: Blockchain networks rely on consensus mechanisms to validate transactions and maintain the integrity of the ledger. The two most common consensus mechanisms are Proof of Work (PoW) and Proof of Stake (PoS). PoW requires participants to solve complex mathematical problems to validate transactions, while PoS selects validators based on the number of tokens they hold [8].

Applications of Blockchain Blockchain technology has found applications in various sec- tors, including:

1. **Finance**: Blockchain is widely used in the financial sector for applications such as cross-border

payments, smart contracts, and decentralized finance (DeFi). It reduces transaction costs, increases transaction speed, and eliminates the need for intermediaries [10].

2. **Healthcare**: Blockchain is being used to secure patient records, track pharmaceuticals, and manage clinical trials. Its immutability and transparency make it ideal for ensuring data integrity and patient privacy [2].
3. **Supply Chain**: Blockchain enables end-to-end traceability in supply chains, allowing businesses to track the movement of goods from origin to destination. This transparency helps reduce fraud, improve efficiency, and ensure compliance with regulations [3].
4. **Governance**: Governments are exploring blockchain for applications such as voting systems, land registries, and identity management. Blockchain's transparency and security can help reduce corruption and increase trust in public institutions [6].

Blockchain in Charity Donations In the context of charity donations, blockchain technology offers several advantages. It enables real-time tracking of donations, ensuring that funds reach their intended recipients. Smart contracts can automate the donation process, reducing the need for intermediaries and minimizing the risk of fraud. Additionally, blockchain's transparency and immutability build trust among donors, encouraging more contributions to charitable causes [5].

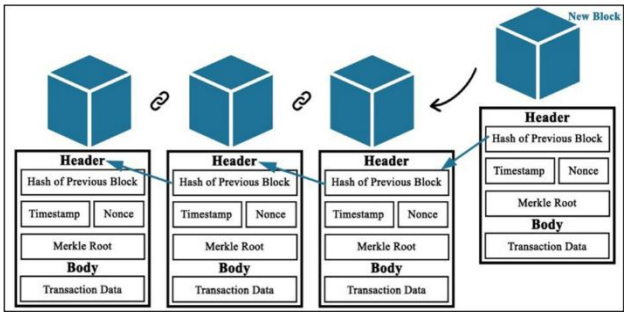

Figure 1: Structure of blockchain.

PROPOSED FRAMEWORK

1.2 Blockchain-Based Donation Traceability (BBDT) Framework

The proposed BBDT framework involves three different parties: the donor, the needy party, and the trustee. The framework uses a public-permissioned blockchain to build a new charity donation traceability system. The identities of the participants are guaranteed to achieve an authoritative, accountable, and unmodifiable system. The system uses a cryptocurrency wallet to generate public and private addresses for each party involved in a transaction. The public key is the identity of every party within the network, without prejudice to their personal identity [**7**].

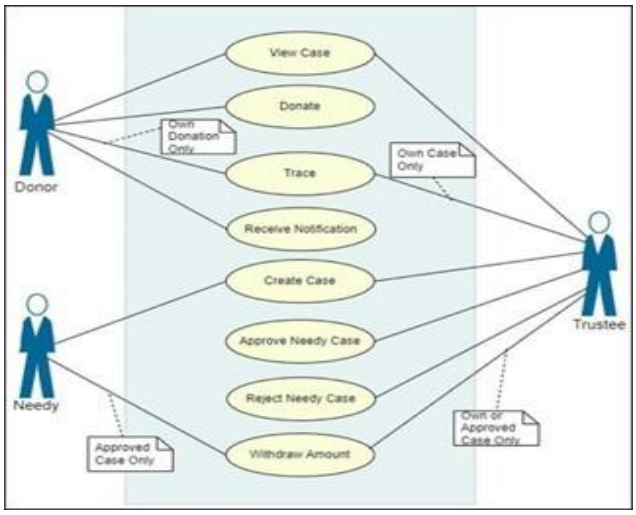

Figure 2: Proposed BBDT framework.

1.3 System Architecture

The proposed framework utilizes blockchain technology by building a public-permissioned Ethereum chain and writing smart contracts using the Solidity language. The system integrates several different components to provide the required functionalities. The architecture is divided into on-chain and off-chain components. The on-chain components include the smart contract, while the off-chain components include user interfaces developed by ReactJS, hosted and de- centralized storage such as the Inter Planetary File System (IPFS), and other components used to notify donors after cases have been completed.

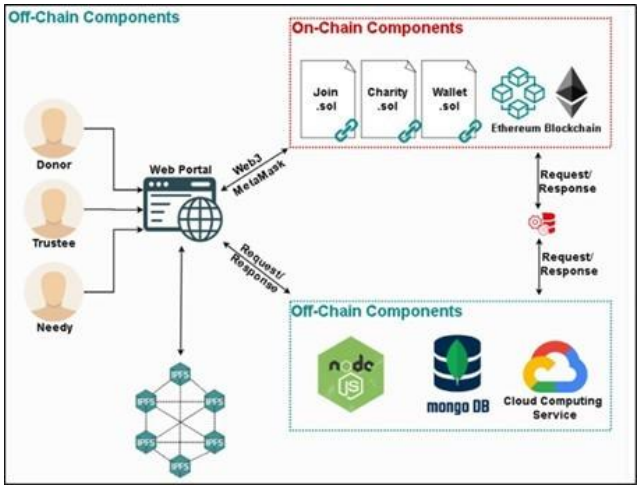

Figure 3: System architecture of the BBDT framework.

2 IMPLEMENTATION

The proposed system is implemented using Ethereum blockchain, smart contracts, and de- centralized storage. The system allows donors to trace their donations in real-time, ensuring transparency and trust. The implementation details are as follows:

Table 1: Features of blockchain-based charity donation systems.

Function	Description
Account registration	Donor, needy party, charity organizations
Make donation	Donor

Generate a certificate	Donor
Request help	Needy party
Notify donor	–
Add conditions to donation	Donor

3 RESULTS AND DISCUSSION

The proposed BBDT framework was evaluated through a series of test cases to assess its effectiveness in ensuring traceability, transparency, and security in charity donations. The results indicate that the system successfully eliminates intermediaries, reduces fraud, and enhances donor trust. Donors were able to track their donations in real-time, and all transactions were immutable and transparent.

Algorithm 1: Trustee and needy individual's functions

```
If needy status == APPROVED
    function createCaseByNeedy()
    Input: _description
        Assign values to case variables(e.g. caseId,
        description)
        Change case status to PROCESSING
        emit createCaseByNeedyLog(nextCaseId,
        msg.sender, trustee, block.timestamp);
    End function
else
    Revert
If trustee status == APPROVED
    Function createCaseByTrustee()
    Input: _description, _targetAmount, _caseEvaluation
        Assign values to case variables(e.g. caseId,
        description, targetAmount);
        Change case status to EVALUATED;
        Evaluate the case (e.g. medium, or high, or
        critical);
        emit createCaseByTrusteeLog(nextCaseId,
        _needy, msg.sender, block.timestamp);
    End function
    Function approveCase()
    Input: _caseId
        Require Case status is PROCESSING
        Assign values to case targetAmount;
        Change case status to EVALUATED;
        Evaluate the case (e.g. medium, or high, or
        critical);
        emit approveCaseLog(_caseId, needy,
        msg.sender, block.timestamp);
    End function
    Function rejectCase()
    Input: _caseId, _targetAmount, _ caseEvaluation
    Require Case status is PROCESSING
    Change case status to REJECTED;
    emit rejectCaseLog(_caseId, needy, msg.sender,
    block.timestamp);
    End function
else
    Revert
```

Figure 4: Results of the BBDT framework evaluation. The discussion highlights the potential of blockchain technology to revolutionize charity donation processes by addressing long-standing issues such as lack of transparency, misuse of funds, and donor distrust. The proposed framework provides a scalable and secure solution that can be adopted by NPOs worldwide.

4 CONCLUSION

Blockchain-based traceability solutions have been shown to offer great utility within the charity sector. Nevertheless, to date, the charity sector in general and NPOs in particular have generally been overlooked with regard to the adoption of blockchain technology [**5**], even though the charity sector is no less important than the healthcare or supply chain sectors. While some relevant studies can be found in the literature, real-world implementations of blockchain traceability solutions remain rare [**3**].

This study has proposed a framework for implementing a blockchain-based charity donation system designed to enable the traceability and transparency of the charity donation process. In addition, a web-based system has been implemented based on the proposed framework to test its applicability and efficiency. Several positive features of the proposed system have been successfully implemented, such as the ability to create a case, accept or reject a case, donate, receive a notification, and trace donations. During the design and development of the system, many tools and software were utilized to connect the off-chain components to the on-chain components in order to structure the final system. The actual system developed featured easy- to-use navigation portals and interfaces, and it was able to authenticate parties who wished to use it. In addition, the privacy and anonymity of all the parties were preserved using a security solution designed to prevent reentrant attacks. Many tests' cases were executed in an effort to evaluate the proposed system, which indicated that it was efficient in allowing the traceability of charity donations.

Overall, the findings of this study demonstrate blockchain to be a suitable technology for use in the charity sector, where it can be adopted to replace traditional traceability methods that fail to meet the involved parties' requirements or address the prevailing problems of centralized operation [**5**]. The proposed framework facilitates the tracing of charity donations in real time until they are received by the intended recipients through a secure and trustworthy environment that utilizes immutable transactions to ensure the integrity of the charity donation process. It also enables all the parties to be incorporated in a decentralized manner so that they can con- tribute to creating and donating to charity projects. Moreover, the framework provides visibility and meets the parties' requirements with regard to transparency and security. All charity do- nations are processed in a high-transparency environment, and coupled with the ability to trace the donations in real time, this enhances all the parties' trust in the charity donation process.

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