



Zero-Ambiguity Donation Channels via NFT-Encoded Auction Provenance in Distributed Benevolence Ledgers

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ABSTRACT

The evolution of blockchain technology has introduced innovative approaches for managing digital assets and transforming fundraising models through Non-Fungible Tokens (NFTs). However, many existing charity platforms continue to operate on centralized systems that restrict transparency, limit accountability, and fail to provide donors with verifiable proof of their contributions. In such systems, donors often have minimal visibility into fund utilization, and there is no direct linkage between their contributions and any traceable digital asset. Moreover, traditional charity and auction mechanisms rely heavily on intermediaries for transaction validation, data management, and operational control, making them susceptible to data manipulation, reduced auditability, and diminished user trust, while also lacking mechanisms to encourage active participation. To address these limitations, this research proposes a decentralized charity auction framework that integrates Blockchain technology with NFTs to ensure secure, transparent, and verifiable transactions. The system is developed using the Django Web Framework and leverages Web3 Technology along with Smart Contracts to automate and manage auction processes. Each auction item is uniquely tokenized as an NFT, guaranteeing authenticity and non-replicability. Users can register as donors or auction organizers, create NFT-based auctions, and participate through bidding or direct contributions. All transactions are permanently recorded on the blockchain, and NFT ownership is automatically transferred to the highest bidder or contributor, serving as a verifiable digital proof of participation. By removing intermediaries and ensuring immutable record-keeping, the system enhances trust, strengthens security, and introduces an incentive-driven participation model, thereby improving transparency, accountability, and efficiency in modern charity and fundraising ecosystems.

Key words: Distributed Ledger Systems, Digital Ownership, Tokenized Assets, Decentralized Applications (DApps), Immutable Records, Smart contracts

1.INTRODUCTION

Charitable giving has historically served as a cornerstone of social development, enabling individuals, communities, and institutions to contribute toward humanitarian relief, healthcare support, education, environmental sustainability, and cultural enrichment. The growing digitization of financial systems has further expanded the reach of charitable activities, allowing donors to contribute across geographical boundaries with ease and speed. However, the effectiveness of these contributions is highly dependent on the levels of transparency, accountability, and trust maintained within the donation ecosystem [1]. In recent years, multiple reports and studies have highlighted increasing concerns among donors regarding the lack of visibility into how their funds are utilized, delays in fund distribution, and the absence of verifiable mechanisms to ensure that contributions reach their intended beneficiaries. This lack of trust not only discourages potential donors but also impacts the overall efficiency and credibility of charitable organizations. To address these challenges, there has been a growing interest in leveraging emerging digital technologies to enhance donation tracking, monitoring, and reporting systems.



Among these technologies, Blockchain Technology has emerged as a highly promising solution due to its decentralized, transparent, and tamper-resistant nature. BT operates as a distributed ledger where every transaction is recorded across multiple nodes, making it nearly impossible to alter or manipulate data once it has been validated and added to the chain. When combined with Smart Contracts which are self-executing programs that automatically enforce predefined rules and conditions, blockchain systems can eliminate the need for intermediaries and ensure that transactions are executed securely and efficiently. In the context of charitable donations, this means that funds can be directly transferred to beneficiaries or verified entities, while maintaining a permanent and auditable record of every transaction [2]. Such a system significantly enhances trust, as donors can independently verify how their contributions are being used, thereby fostering greater confidence and encouraging increased participation in charitable activities.

Despite these advancements, traditional donation systems continue to dominate the sector and exhibit several inherent limitations. One of the major issues is the lack of transparency, where donors have minimal or no access to real-time information regarding the utilization of their funds. This opacity makes it difficult for organizations to demonstrate accountability and build long-term trust with stakeholders [3]. Additionally, these systems often rely on centralized infrastructures that are vulnerable to cyberattacks, data breaches, and fraudulent activities, posing serious risks to both donors and organizations. Another critical challenge is the inefficiency of existing processes, which are often slow, manual, and dependent on multiple intermediaries such as banks, payment gateways, and administrative bodies. These intermediaries not only introduce delays but also impose significant transaction fees, reducing the overall amount of funds that ultimately reach the intended recipients [4]. Furthermore, traditional systems lack adaptability, making it difficult to respond quickly to urgent situations such as natural disasters or medical emergencies.

In light of these challenges, there is a pressing need for a more robust, secure, and transparent donation framework that can address the shortcomings of conventional systems while enhancing user trust and engagement. Blockchain-based solutions, particularly those integrated with NFTs, offer an innovative approach by combining decentralized transaction management with verifiable digital ownership. NFTs can serve as unique digital representations of donations, participation, or ownership, providing donors with tangible proof of their contributions in a secure and immutable format. This not only increases transparency but also introduces an incentive-driven model that can enhance user engagement and participation. By leveraging Blockchain Technology, Smart Contracts, and NFTs, modern donation systems can achieve higher levels of efficiency, security, and accountability, ultimately transforming the way charitable activities are conducted and perceived in the digital era [5].

2.LITERATURE SURVEY

Taherdoost, et al. [6] conducted an extensive and structured literature review on NFT-related research spanning from 2012 to 2022, with a strict focus on peer-reviewed journal publications to ensure reliability and academic rigor. Their study systematically filtered and analyzed works containing blockchain and NFT-related keywords while excluding non-scholarly sources such as media articles and dissertations. The authors provided a comprehensive classification of research themes, including technological foundations, application domains, and economic implications of NFTs. Furthermore, they identified key trends such as the rapid growth of digital asset ownership models, increasing adoption across industries, and emerging challenges related to scalability and regulation. Their findings also highlighted significant research gaps, particularly in standardization, interoperability, and long-term sustainability, making the study a foundational reference for future investigations in NFT ecosystems. Ahmed, et al. [7] proposed a blockchain-empowered decentralized philanthropic framework aimed at enhancing transparency, accountability, and trust in charitable donation systems.



Their approach eliminates the dependency on centralized intermediaries by utilizing blockchain's distributed ledger to record all donation transactions in an immutable and verifiable manner. The framework incorporates smart contracts to automate donation workflows, ensuring that funds are released only when predefined conditions are satisfied. This mechanism significantly reduces the risk of fund mismanagement and fraud. Additionally, the study emphasizes improved donor confidence through real-time tracking and auditing capabilities. Performance evaluations indicate that the system enhances operational efficiency while maintaining data integrity, making it a viable solution for large-scale social and humanitarian applications. Bellagarda, et al. [8] introduced a blockchain-enabled NFT-based application designed to mitigate fraud and establish authenticated digital identity systems. Their work extends the application of NFTs beyond digital art by integrating identity verification mechanisms within blockchain infrastructure. The system ensures that each digital identity is uniquely represented and securely stored, preventing duplication and unauthorized modifications. By leveraging decentralized verification, the framework eliminates reliance on third-party authorities, thereby improving security and user control. The study also discusses potential vulnerabilities associated with off-chain storage and proposes enhancements to strengthen the linkage between digital identities and blockchain records. Their contribution demonstrates the broader applicability of NFTs in secure identity management systems. Zhou, et al. [9] developed a sophisticated blockchain-based donation framework that integrates cross-chain supervision with verifiable credentials to ensure transparency and reliability in multi-chain environments. Their system introduces a supervisory blockchain layer that monitors transactions across different blockchain networks, thereby enabling unified tracking and coordination. Smart contracts are deployed at various stages of the donation lifecycle to enforce rules, validate transactions, and maintain consistency. The inclusion of verifiable credentials enhances identity authentication, ensuring that only legitimate users can participate in the system. The authors conducted performance evaluations comparing their framework with existing solutions, demonstrating improvements in scalability, traceability, and security. This work highlights the importance of interoperability and identity verification in modern blockchain applications.

Karaduman, et al. [10] presented a comprehensive evaluation framework for assessing blockchain systems based on critical parameters such as security, traceability, data integrity, and system scalability. Their study explores advanced cryptographic techniques, including Zero-Knowledge Proofs, to enhance privacy while maintaining transparency. Additionally, the authors examined cross-chain architectures that enable interoperability between different blockchain networks, addressing one of the major limitations of isolated systems. The proposed framework combines both quantitative metrics and qualitative analysis to provide a holistic evaluation approach. By introducing smart contract-based bridging mechanisms, the study enables secure communication between permissioned and permissionless networks. This work serves as a guideline for designing robust, efficient, and scalable blockchain solutions across various domains. Sidorova, et al. [11] analyzed the transformative impact of NFTs within the digital art and creative economy, emphasizing their role in redefining ownership and monetization models. Their study explains how NFTs function as blockchain-based certificates that guarantee the authenticity and uniqueness of digital assets. By eliminating intermediaries such as galleries and auction houses, NFTs enable artists to directly engage with buyers, thereby increasing revenue opportunities and reducing transaction costs. The research also highlights the broader implications of NFTs in democratizing access to global art markets and improving transparency in ownership transfer. However, the authors also acknowledge challenges such as market volatility, environmental concerns, and the need for improved regulatory frameworks.

Tiganoaia, et al. [12] developed a decentralized Web3-based application aimed at enhancing transparency and efficiency in educational and social donation systems. Their platform leverages blockchain technology and smart contracts to automate transactions, ensuring that all financial



activities are securely recorded and easily traceable. The system provides donors with real-time insights into fund allocation and utilization, thereby increasing trust and accountability. The authors also present implementation details, including system architecture and operational workflows, along with demonstration scenarios to validate practical feasibility. Their findings indicate that decentralized applications can significantly improve the reliability and transparency of donation ecosystems, contributing to sustainable development goals. Ramirez, et al. [13] explored the application of blockchain and NFTs in enhancing source code security and protecting digital intellectual property. Their study proposes a framework where code artifacts are tokenized as NFTs, enabling verifiable ownership and traceability throughout the software lifecycle. By leveraging blockchain's immutable ledger, the system ensures that any modification, access, or transfer of source code is securely recorded and cannot be altered retrospectively. This approach significantly reduces risks related to unauthorized usage, plagiarism, and intellectual property theft. The authors also discuss the integration of digital certificates to further strengthen authenticity verification. While the framework demonstrates strong potential in securing software assets, the study highlights challenges such as scalability, computational overhead, and the need for user-friendly adoption mechanisms in real-world environments. Sedlmeir, et al. [14] examined the critical issue of transparency in blockchain systems, particularly focusing on its implications in organizational and public-sector applications. Their research highlights that although blockchain inherently promotes openness through distributed and replicated ledgers, excessive transparency can lead to unintended exposure of sensitive information. This creates conflicts with privacy regulations such as GDPR, especially in scenarios involving personal or confidential data. The authors analyze the trade-offs between transparency and privacy, emphasizing that a balance must be achieved to ensure both accountability and data protection. They propose the adoption of privacy-preserving techniques, such as selective disclosure and advanced cryptographic methods, to mitigate these risks. Their work underscores the importance of designing blockchain systems that are not only transparent and secure but also compliant with regulatory and ethical standards.

3. PROPOSED SYSTEM

The research for Donation Verification, is designed as a decentralized web-based application that aims to enhance trust, accountability, and transparency in charitable fundraising processes. The architecture integrates blockchain technology with Non-Fungible Tokens (NFTs) to ensure that every auction and donation activity is securely recorded and can be independently verified in real time, as illustrated in Figure 1. The platform operates as an online charity auction environment where organizers can initiate fundraising campaigns by listing items or causes, while contributors can engage either by placing bids or making direct donations. Each transaction is executed through smart contracts and permanently stored on the Ethereum blockchain, ensuring that critical details such as participant identity, bid values, auction references, and transaction states remain immutable and publicly auditable.



Figure 1: Proposed system architecture.

This decentralized framework removes reliance on centralized authorities or intermediaries, thereby minimizing risks related to fraud, data manipulation, and mismanagement of funds. The system is implemented using the Django web framework for backend operations and Web3 technology for seamless blockchain communication. It is connected to a local Ethereum network where smart contracts, developed using Solidity, are deployed and executed to manage core functionalities. These contracts automate essential processes including user enrollment, auction creation, bidding operations, and donation validation, ensuring secure and tamper-proof execution of all activities. Users can register under different roles such as Auctioneer or Donor/Bidder, where auctioneers are responsible for initiating and managing fundraising events, defining categories, and monitoring collected funds, while donors can explore ongoing auctions, participate actively, and verify their contributions through blockchain-backed transaction records. The platform is designed with a user-friendly interface that simplifies interaction while maintaining robust blockchain-level security in the background. By integrating decentralization, NFTs, and immutable transaction logging, the system guarantees traceability, security, and verifiability of every contribution, ultimately strengthening donor confidence and establishing a scalable, transparent model for modern digital philanthropy.

3.1 ETHEREUM BLOCKCHAIN

Ethereum is a decentralized blockchain platform that enables execution of smart contracts through the Ethereum Virtual Machine (EVM), as illustrated in Figure 3. Users initiate transactions via wallets or decentralized applications (DApps), which are broadcast across a peer-to-peer (P2P) network. These transactions are validated and temporarily stored in a mempool before being selected by validators. Using the Proof of Stake (PoS) mechanism, validators propose and finalize blocks containing the transactions. The EVM executes contract logic and updates the global state, maintained as a Merkle-Patricia Trie. The finalized data is stored immutably on-chain and can be accessed via JSON-RPC or Web3 APIs.

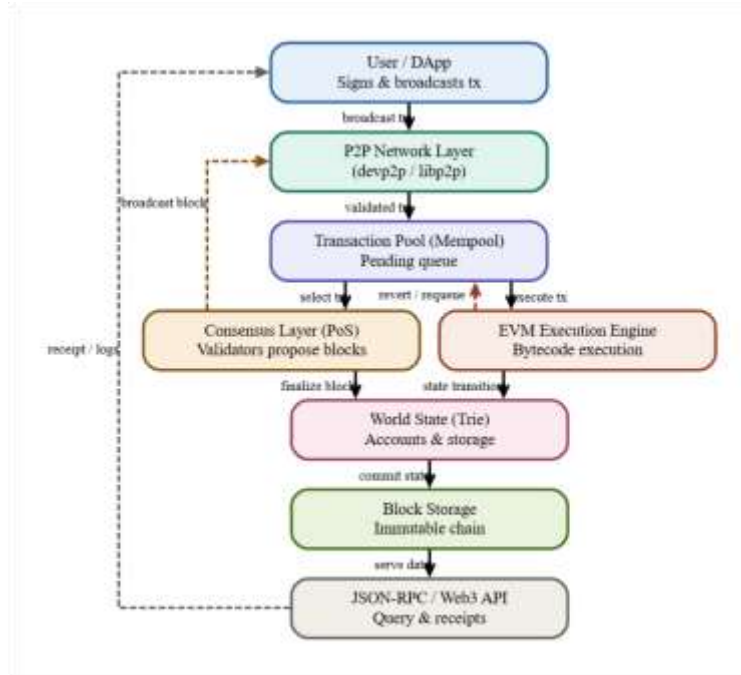


Figure 3: Internal Workflow of Ethereum.

Transaction Creation & Broadcast: In this step, the user or decentralized application (DApp) initiates a transaction by specifying details such as recipient address, value, and optional smart contract data. The transaction is then digitally signed using the user’s private key, ensuring authenticity and non-repudiation. Once signed, the transaction is broadcast to the Ethereum peer-to-peer network, where it becomes visible to multiple nodes for further processing.

2. Network Propagation & Mempool Entry: After broadcasting, the transaction is propagated across the P2P network using gossip protocols, allowing it to reach a large number of nodes efficiently. Each node performs basic validation checks such as verifying the digital signature, checking account balance, and ensuring correct nonce usage. If the transaction passes validation, it is stored in the mempool (transaction pool), where pending transactions are queued and often prioritized based on gas fees.

3. Transaction Selection & Execution: Validators select transactions from the mempool, typically prioritizing those with higher gas fees to maximize rewards. These selected transactions are included in a candidate block and executed within the Ethereum Virtual Machine (EVM). The EVM processes each instruction in the transaction or smart contract bytecode step-by-step, ensuring deterministic execution across all nodes and generating the resulting state changes.

4. Consensus & Block Finalization: Once transactions are executed, validators participate in the Proof of Stake (PoS) consensus mechanism to agree on the validity of the proposed block. Validators attest to the correctness of the block, and through consensus protocols, the block is finalized. Finalization ensures that the block becomes immutable and cannot be altered, providing strong guarantees of data integrity and trust.

5. State Transition & Storage: The execution of transactions leads to updates in the global state, including account balances, contract storage, and other relevant data. These changes are represented using a Merkle-Patricia Trie, which allows efficient verification and storage of state data. The updated state root is committed to the blockchain and stored in block headers, ensuring consistency across all nodes in the network.



6. Data Access & Feedback: After block finalization and storage, the blockchain data becomes accessible through JSON-RPC or Web3 APIs. Users and applications can query transaction receipts, event logs, and current state information. This step completes the interaction cycle by providing feedback to the user, confirming transaction success or failure and enabling further interactions with the Ethereum network.

4. IMPLEMENTATION DESCRIPTION

The implementation of this research connecting Django to the blockchain using Web3, creating dynamic views for both Auctioners and Bidders/Donors, handling real-time transactions, and maintaining a synchronized front-end that reflects verified blockchain data. This design guarantees trustless interactions, enabling participants to confidently contribute to charitable causes without relying on intermediaries.

Blockchain Integration using Web3

- The system connects to the Ethereum blockchain using Web3(HTTPProvider('http://127.0.0.1:9545')) to establish communication with the local node.
- The smart contract interface is initialized by loading ABI from JSON using `json.load(file)['abi']` for function access.
- The deployed contract is accessed using `web3.eth.contract(address=contract_address, abi=contract_abi)` for interaction.
- Transactions are executed on blockchain using `contract.functions.saveBid(...).transact()` ensuring immutable storage.
- Transaction confirmation is obtained using `web3.eth.waitForTransactionReceipt(tx_hash)` to verify successful execution.
- Default account is set using `web3.eth.defaultAccount = web3.eth.accounts[0]` for transaction signing.
- Read operations are performed using `.call()` such as `contract.functions.getUserCount().call()` for data retrieval.
- This integration ensures decentralized and tamper-proof data storage.

User Registration and Authentication

- User registration checks duplicate entries by iterating blockchain data using for user in `usersList` before storing new users.
- New users are registered on blockchain using `contract.functions.saveUser(...).transact()` to ensure secure storage.
- User login is validated by comparing credentials using `if email == ulist[2] and password == ulist[3]`.
- User role is identified using `ulist[4]` to differentiate Auctioner and Bidder/Donor access.



- Dynamic page rendering is handled using `return render(request, page, context)` after authentication.
- User session tracking is managed using a global variable `username` for maintaining login state.
- Invalid login attempts are handled by returning error messages using `return render(request, 'UserLogin.html', context)`.
- This module ensures controlled access to system functionalities.

Auction Creation and Management

- Auction details are collected from forms using `request.POST.get('t1')` for processing user input.
- Date formatting is standardized using `datetime.strptime(date, "%d-%m-%Y").strftime("%Y-%m-%d")` before storage.
- Auction IDs are dynamically generated using `str(len(auctionList) + 1)` to ensure uniqueness.
- Auction data is stored on blockchain using `contract.functions.saveAuction(...).transact()` for persistence.
- Transaction receipts are fetched using `web3.eth.waitForTransactionReceipt(tx)` for confirmation.
- Auction records are cached locally using `auctionList.append([...])` for quick access.
- Auction creation is restricted to authorized users based on role checking logic.
- This module enables decentralized auction management.

Auction Browsing and Filtering

- Auction data is retrieved from blockchain using `contract.functions.getAuctionCount().call()` to determine total records.
- Individual auction details are fetched using indexed calls like `contract.functions.getAuctionName(i).call()`.
- Auction validity is checked using custom logic in `checkDate(start_date, end_date)` for active filtering.
- Date comparison is performed using `datetime.strptime(...).date()` to ensure correct validation.
- Only active auctions are displayed using conditional checks like `if date_status:`.
- Dynamic content generation is handled using string concatenation for HTML tables.
- Users can navigate to donation page using links like ``.
- This module ensures users view only relevant auctions.



Donation and Bid Processing

- Donation details are captured using `request.POST.get('t3')` and transaction type using `request.POST.get('t6')`.
- Current transaction date is recorded using `str(datetime.now().date())` for logging.
- Blockchain transactions are executed using `contract.functions.saveBid(...).transact()` for immutable storage.
- Transaction confirmation is handled using `web3.eth.waitForTransactionReceipt(tx)` for reliability.
- Bid data is stored locally using `bidList.append([...])` for faster retrieval.
- User input is processed only after form submission using `if request.method == 'POST':`.
- Transaction results are displayed using `return render(request, 'UserScreen.html', context)`.
- This module ensures secure donation and bidding operations.

Participation Tracking and Analytics

- Bid data is filtered based on auction ID using condition `if blist[0] == auction_id`.
- Total donation amount is calculated using `amount += float(blist[2])` for aggregation.
- Bid details are displayed dynamically using string-based HTML rendering.
- Auctioners can select auctions using dropdown populated via `for i in range(len(auctionList))`.
- Participation data is retrieved from locally stored bid list for efficiency.
- Results are displayed using `return render(request, 'AuctionerScreen.html', context)`.
- This module provides transparency in donation tracking.
- It helps auctioners monitor fundraising performance effectively.

Smart Contract Data Retrieval

- User data is retrieved using `contract.functions.getUserCount().call()` for total records.
- Individual user details are accessed using `contract.functions.getPersonname(i).call()`.
- Bid and auction data are similarly fetched using respective contract functions.
- Loop-based extraction is implemented using `for i in range(0, count)` for iteration.
- Retrieved data is structured into lists using `usersList.append([...])`.
- This approach minimizes repeated blockchain calls during runtime.
- Data is reused across multiple views for efficiency.



- This module ensures synchronization between blockchain and application.

Transaction Validation and Date Handling

- Auction validity is verified using a custom function `checkDate(start_date, end_date)`.
- Dates are converted into comparable format using `datetime.strptime(...).date()`.
- Current date is obtained using `datetime.now().date()` for validation.
- Conditional checks like `if current >= start and current <= end` ensure valid participation.
- Invalid auctions are filtered out before displaying to users.
- Input data is validated before processing blockchain transactions.
- This prevents incorrect or out-of-range operations.
- This module ensures logical consistency and data integrity.

5.CONCLUSION

This research demonstrates a meaningful advancement in applying blockchain technology to modernize charitable donation systems through a Django-based decentralized framework. The platform successfully integrates a local Ethereum environment, such as Ganache, with smart contracts to support secure user registration, auction management, bidding, and transaction verification, ensuring immutability through blockchain receipts. Its consistent user interface and clearly defined role-based workflows for auctioneers and bidders reflect a well-structured design approach. However, certain limitations affect system performance, including reliance on local blockchain setups that may introduce concurrency challenges and restrict scalability. Security concerns arise due to inadequate measures such as plaintext password handling and lack of protections like Cross-Site Request Forgery (CSRF) and input validation. Additionally, the absence of real-time data synchronization can lead to outdated information, impacting user experience. Performance and reliability can be improved by adopting efficient backend handling techniques, optimizing smart contract execution, integrating secure payment mechanisms, and enhancing error handling for Web3 interactions.

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