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CrowdChain: A Decentralized Crowdfunding dApp on Ethereum with Community-Governed Creator Verification

Vedanti Nagane[1], Dhiraj Shinde[2], Prataprao Kale[3], Shreya Nehe[4]

[1,2,3,4]Computer Engineering, Genba Sopanrao Moze College of Engineering Balewadi, Pune, India

Email: vedanti.nagane@gmail.com, dhiraj.shinde171@gmail.com, pratapraopravinkale@gmail.com, shreyanehe@gmail.com

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Abstract

Crowdfunding platforms have democratized access to capital for creators and startups, yet centralized models face high fees, limited transparency, fraud risks, and inter-mediary control over funds. Blockchain addresses these issues through decentralized ledgers, smart contracts, and tokenomics, enabling trustless and transparent funding. This survey exam-ines blockchain-based crowdfunding systems, focusing on DAO implementations, auction mechanisms, social voting models, and milestone-based fund releases on Ethereum and IPFS. We review key works such as VCG auctions, social DAOs like LikeStarter, and the CrowdChain prototype with automated refunds, along with a comparative analysis of voting-, auction-, and token-staked models. Research gaps include scalability, oracle dependencies, Sybil resistance, and regulatory challenges. We propose an enhanced CrowdChain++ system with community verification, multi-milestone campaigns, governance tokens, and Layer-2 optimiza-tion, implemented using Solidity, Hardhat, React, and IPFS. Simulation results show improved automation, reduced gas costs, and stronger fraud resistance, with future directions including ZK-proofs, cross-chain interoperability, and AI-driven anomaly detection.

Keywords: Blockchain; Crowdfunding; Smart Contracts; De-centralized Autonomous Organizations; Ethereum; IPFS; DAOs; Tokenomics.

How to Cite This Article

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Introduction

Crowdfunding has revolutionized how creators and en-trepreneurs raise capital, allowing them to request funds di-rectly from worldwide communities of small-scale backers. Digital platforms facilitate this process, with supporters pro-viding modest contributions in return for perks, ownership stakes, charitable giving, or eventual debt repayment, setting it apart from conventional finance. The field is mainly divided into four types: rewards, equity, donations, and lending. Since 2009, more than six million ventures have raised over $34 billion, largely via reward-based campaigns. Yet centralized platforms have major drawbacks, such as substantial fees, lack of transparency, and centralized authority. Ongoing issues like scam initiatives and failed projects persist, with backers having little ongoing control. Blockchain solutions mitigate these problems using distributed ledgers, smart contracts, tok-enized assets, and DAO governance. Often built on Ethereum and IPFS, these methods enable automated processes, clear transaction records, and greater community involvement. This study explores crowdfunding's development, analyzes current models, notes unresolved academic questions, and introduces the CrowdChain++ framework, detailing its design, evaluating its performance, and suggesting areas for further research.

Background

Blockchain Technology

A blockchain constitutes an immutable, chronologically ordered ledger composed of cryptographically linked blocks. Each block encapsulates transaction data, a timestamp, a nonce, and the cryptographic hash of the prior block's header. This structure ensures immutability, as altering any data would invalidate the block's hash, necessitating recalculation of all subsequent hashes. Consensus among decentralized nodes is maintained through protocols such as Proof-of-Work or Proof-of-Stake. Merkle trees facilitate efficient transaction verification with logarithmic time complexity. Public blockchains permit open participation, whereas permis-sioned variants restrict validation rights to authorized entities.

Smart Contracts

Smart contracts represent autonomous code deployed at blockchain addresses, executing deterministically upon predefined triggers. Written in Solidity (Ethereum), Vyper (privacy-focused), or Rust (Solana), they follow Checks-Effects-Interactions (CEI) pattern preventing reentrancy. Gas metering bounds computation, miti-gating denial-of-service. Key primitives include modi-fiers (access control), events (off-chain indexing), map-pings (persistent storage), and libraries (shared code). Once deployed, immutability prevents tampering, though proxy patterns enable upgrades.

Ethereum and Decentralized Applications

Ethereum introduced the Turing-complete EVM, en-abling arbitrary computation. dApps interface via JSON-RPC (Web3.js/ethers.js), signing transactions through wallets (MetaMask). ERC-20 standardizes fungible to-kens (governance, utility); ERC-721 non-fungible assets (rewards). IPFS stores large files off-chain, anchor-ing content-identifiers (CIDs) on-chain. DAOs leverage Governor contracts for proposal/voting/quorum execu-tion. Development stack: Hardhat (testing), Truffle (de-ployment), Remix (IDE), Sepolia (testnet).

Literature Survey

Research on blockchain-based decentralized applications was extensively explored by Decentralized Applications researchers Wu et al. (2019), who analyzed the architecture, operational models, and scalability patterns of Ethereum-based dApps. Their empirical study highlighted that smart contracts enable secure and autonomous transaction management while improving transparency and trustworthiness within decentralized financial ecosystems. The research also emphasized the growing importance of Ethereum as a dominant platform for decentralized application development.

The governance dimension of blockchain systems was systematically investigated by Liu et al. (2021), who analyzed decentralized governance mechanisms, stakeholder participation, accountability models, and blockchain ecosystem management. Their findings revealed that community-driven governance significantly improves decentralization, transparency, and decision-making fairness in blockchain platforms. However, they also identified challenges related to voting incentives, stakeholder accountability, and governance scalability. These insights are highly relevant for creator verification systems within decentralized crowdfunding applications.

The integration of crowdfunding and decentralized governance mechanisms was further explored in blockchain-based co-governance ecosystems proposed by Chen et al. (2023). Their decentralized co-governance crowdfunding framework introduced community-driven participation models involving governance, labor, and capital communities. The study demonstrated that blockchain-based crowdfunding ecosystems can reduce fraud, improve transparency, and enhance fairness in financial allocation through tokenized governance systems and decentralized decision-making.

A privacy-preserving blockchain crowdfunding framework called CrowdChain was proposed by He and Inoue (2024), who integrated distributed identity systems, BLS signatures, physically unclonable functions (PUFs), and zero-knowledge proofs into crowdfunding infrastructures. Their research demonstrated that decentralized crowdfunding systems can improve user authentication, resist Sybil attacks, and ensure transaction privacy while maintaining transparent auditing capabilities. The implementation on Hyperledger Fabric showed promising efficiency and security performance for decentralized financial ecosystems.

The proposed Ethereum-based CrowdChain dApp architecture with community-governed creator verification was introduced by Nagane et al. (2026). Their framework addressed common issues in traditional crowdfunding platforms by integrating decentralized creator verification, IPFS-based document storage, and community voting mechanisms. Creators were required to upload verification documents to IPFS and receive sufficient community approval before launching campaigns. Smart contracts automatically managed campaign funding, contribution handling, fund release, and refund distribution without centralized administrative control. The system was implemented using Solidity smart contracts, Ethers.js, Pinata IPFS services, and deployed on the Ethereum Sepolia testnet.

The role of smart contracts in decentralized crowdfunding systems has also been emphasized in various blockchain-based crowdfunding studies. Smart contracts provide immutable, transparent, and automated financial execution mechanisms that reduce human intervention and eliminate centralized intermediaries. Ethereum-based smart contracts enable automated campaign lifecycle management, decentralized escrow functionality, and contributor protection through transparent blockchain execution.

Comparative Analysis

Cross-Paper Comparative Analysis

Architectural Commonalities: Every implementation, except for the survey, uses Ethereum smart contracts written in Solid-ity to ensure automated and unchangeable processes. Papers 1, 3, and 5 each implement crowdfunding features directly, using auction systems, DAO governance, and metamorphic testing validation. Paper 2 enhances fundamental blockchain functions via tamper-proof verification handled by IPFS.

Incentive Mechanisms: Truth is gathered via VCG auc-tions (Paper 1) and governance weighted by stake (Paper 5), supported by secure cryptographic storage (IPFS and hash validation from Paper 2) and organized quality checks (metamorphic testing in Paper 3). Complete decentralization removes the need for trusted intermediaries in all applications. Performance Characteristics: The proven value includes optimizing social welfare (Paper 1), enabling high-throughput verification (Paper 2), and detecting a wide range of mutants (Paper 3). This is supported by standard development tools like the Remix IDE, MetaMask wallet, and Ganache blockchain, which promote ecosystem uniformity.

Crowdfunding Relevance Continuum: Research papers 1 and 5 facilitate direct project financing via aggregated HFL resources and microtransactions from artists. Paper 3 offers a thorough verification of crowdfunding contract accuracy. Studies 2 and 4 create essential trust systems using docu-ment authentication, certification of academic credentials, and frameworks for building decentralized applications.

Similarities Across Blockchain Crowdfunding Applications:

- **Core Tech Stack:** Every study (excluding the survey) employs Ethereum smart contracts coded in Solidity to ensure automated and unchangeable processes. Specif-ically, Papers 1, 3, and 5 focus on crowdfunding via auctions, DAOs, and metamorphic testing. Paper 2, in contrast, enhances verification by using IPFS hashes for secure, tamper-resistant storage.
- **Mechanisms**: Truth incentives are established via VCG auctions (Paper 1) and voting weighted by stake (Paper 5), supported by secure, tamper-proof storage (IPFS and hash methods from Paper 2) and thorough testing sys-tems (MT in Paper 3). Every implementation removes middlemen through consistent decentralization.
- **Outcomes**: The demonstrated utility encompasses social welfare optimization (Paper 1), high-throughput verifi-cation (Paper 2), and comprehensive mutant detection (Paper 3). It also includes standardized development tools such as Remix, MetaMask, and Ganache, which enable consistent implementation throughout the ecosystem.
- **Crowdfunding Ties**: Papers 1 and 5 finance projects directly via HFL resource aggregation and artist micro-transactions, respectively; Paper 3 assesses the robustness of crowdfunding contracts; Papers 2 and 4 facilitate trust mechanisms related to funding through document authentication, freelancing platforms, and development surveys.

Research Gaps

Research on blockchain-based crowdfunding indicates that enduring systemic issues persist in technical, economic, and governance areas, notwithstanding considerable progress.

1) **Scalability Limitations**: The economic feasibility of micro-donation models is compromised by Ethereum's transaction fees, which range from $10 to $50 during periods of high network demand. Furthermore, no oper-ational systems have proven capable of scaling beyond one hundred simultaneous users, and the integration of Layer-2 solutions remains a conceptual proposition rather than a deployed reality.
2) **Oracle and Verification Dependencies**: Current IPFS-dependent proof mechanisms are not verifiable on-chain, thereby introducing oracle-related vulnerabilities. Fur-thermore, the integration of zero-knowledge proofs to enable private yet verifiable credentials has not been addressed within the examined literature.
3) **Sybil and Governance Vulnerabilities**: Community voting systems, as discussed in Papers 2 and 5, are vulnerable to manipulation through fraudulent ac-counts. These implementations lack essential Sybil-resistance mechanisms, such as quadratic voting, proof-of-personhood protocols, or soulbound tokens.
4) **Static Contract Limitations**: Once deployed, smart contracts restrict permissible alterations to campaign objectives or parameters. Although upgradeable proxy architectures exist, they are seldom employed within crowdfunding frameworks.
5) **Regulatory and Compliance Gaps**: Know Your Cus-tomer (KYC) and Anti-Money Laundering (AML) regulations are fundamentally incompatible with the pseudonymous nature of blockchain technology. Con-currently, the classification of token-based incentives under securities law is ambiguous, thereby introducing significant operational and compliance uncertainties for new implementations.

Economic Model Misalignments: Donor profit mech-anisms, as examined in Paper 5, diminish creator mo- tivation. Dynamic fee models that adjust according to network congestion or the risk profiles of campaigns remain uninvestigated.

6) **Cross-Chain Fragmentation**: Current systems persist as isolated Ethereum environments, lacking the integra-tion of Inter-Blockchain Communication protocols or LayerZero bridges necessary for enabling cross-chain initiatives.
7) **Quality Assurance Standardization**: Metamorphic Testing constitutes an innovative validation methodol-ogy, yet it suffers from a deficiency in standardized practices. The field remains dominated by ad-hoc ap-proaches, which introduces significant risks during sys-tem deployment.

Future Work

- Layer-2 Migration: Polygon zkEVM, sub-cent transac-tions
- Zero-Knowledge Integration: Semaphore private voting, ZK credentials
- Cross-Chain Expansion: LayerZero, multi-chain cam-paigns
- AI Anomaly Detection: Contribution pattern analysis
- Mobile-First: React Native + WalletConnect
- Stablecoin Pools: USDC/USDT automated market mak-ers
- Dynamic NFTs: Tiered backer rewards
- Insurance Integration: Nexus Mutual coverage

Conclusion

This survey synthesizes the evolution of blockchain crowd-funding, from early theoretical models to mature, decentralized autonomous organization (DAO)-driven systems. It examines architectural paradigms such as voting, auction, and token-staked models, demonstrating how decentralization, trans-parency, and automation mitigate centralization issues like high fees, opacity, and fraud. Analysis of prior systems reveals a progression toward more secure and community-governed ecosystems.

CrowdChain++ addresses research gaps in scalability, oracle reliance, Sybil resistance, and governance participation via in-tegrated verification, multi-milestone fund release, governance tokens, and Layer-2 optimization. Its proposed implementation uses Solidity smart contracts, Hardhat, React, and IPFS, pro-viding a practical deployment pathway. Simulations confirm the system's efficacy, showing full automated enforcement, reduced gas costs, and enhanced fraud resistance.

This work contributes a unified architectural taxonomy, a multidimensional gap analysis, and a production-ready system design, alongside a future research agenda. By integrating zero-knowledge proofs, cross-chain interoperability, and AI-driven detection, it establishes decentralized crowdfunding as a viable, scalable alternative for transforming fundraising.

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