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MANAGING DATA IN DECENTRALIZED AUTONOMOUS ORGANIZATIONS (DAO): MAKING DECISIONS AND SHARING DOCUMENTS

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ABSTRACT: With an emphasis on decision-making and document interchange, this study examines data management procedures in Decentralized Autonomous Organizations (DAOs). Data security, dependability, and openness are essential to the efficient operation of decentralized, blockchain-based DAOs. The study looks at contemporary technologies as the basis for data management and exchange procedures, such as distributed storage systems, smart contracts, and on-chain voting systems. The capabilities and governance models of several DAO platforms are examined, pointing out current drawbacks and potential avenues for development. The study's findings provide useful information for improving DAO operations and creating fresh governance frameworks.

KEYWORDS: Data management, decision making, document exchange, smart contracts, on-chain voting, distributed storage system, decentralized governance.

INTRODUCTION

In recent years, alongside the rapid development of blockchain technology, the concept of Decentralized Autonomous Organizations (DAOs) has gained increasing relevance. Unlike traditional centralized governance structures, DAOs autonomously manage decision-making and resource allocation processes based on blockchain technology. Therefore, effective data management—namely decision making and document exchange—within DAOs is crucial for their success.

Data management in the DAO context encompasses not only secure and transparent storage of information but also its efficient utilization and distribution. Particularly, information exchange among members involved in decision-making processes has reached a new level through blockchain technology, smart contracts, and distributed storage systems. Consequently, analyzing and improving data management mechanisms to ensure DAO efficiency and reliability is a pressing task.

This article investigates how data management, particularly decision-making processes and document exchange, is organized in DAO systems using modern technologies. The study reviews existing DAO platforms and their governance mechanisms, assessing their effectiveness and security.

LITERATURE REVIEW

The concept of Decentralized Autonomous Organizations (DAO) was first proposed by Vitalik Buterin and other blockchain researchers in 2013-2014, focusing on decentralized governance and automated, transparent decision-making processes (Buterin, 2014). DAOs fundamentally rely on blockchain technology and smart contracts to enable direct information exchange and governance among participants (Wright & De Filippi, 2015)[1].

From the perspective of data management, decision-making in DAOs differs significantly from traditional organizations. The process is often carried out through on-chain voting mechanisms, ensuring transparency and immutability of decisions (Jentzsch, 2016). For document storage and exchange, distributed storage systems such as the InterPlanetary File System (IPFS) are integrated with blockchain networks (Benet, 2014).

Recent research suggests improving DAO governance efficiency by adopting various consensus algorithms and delegated voting models, which accelerate data exchange and decision-making

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processes (Hassan & Kyriakou, 2021). Popular DAO platforms (Aragon, DAOstack, MolochDAO) have been extensively analyzed regarding their governance models and data management methods (Schwartz et al., 2020).

However, existing literature offers limited in-depth analysis of data security, document exchange complexity, and challenges inherent to decentralized governance in DAOs. This article aims to fill this gap by scientifically studying these aspects and proposing novel approaches[2].

METHODOLOGY

To conduct an in-depth study of data management and decision-making processes within Decentralized Autonomous Organizations (DAOs), this research employed qualitative methods including literature review, case studies, analytical approaches, and technical explanations. These combined methodologies enable a comprehensive theoretical and practical investigation of the topic[3].

1. Literature Review

The initial phase involved extensive analysis of international scientific sources on blockchain technology, DAO governance models, and data exchange, sourced from reputable databases such as Scopus, Web of Science, IEEE Xplore, and Springer. Selected articles and books published within the last 5-7 years focused on DAO development trends, smart contract-based decision-making mechanisms, distributed storage, and data security. This review facilitated a deep understanding of technical and governance aspects and helped identify existing research gaps.

2. Case Studies

Following the theoretical review, practical examples of DAOs' real-world operation and data management processes were examined. Prominent DAO platforms including Aragon, DAOstack, and MolochDAO were studied in detail to understand their governance models and technological infrastructures. The voting process—where each member votes on proposals, smart contracts tally votes, and decisions are executed automatically on the immutable blockchain—was analyzed. Additionally, distributed storage systems such as IPFS integrated into DAO platforms were explored for secure document exchange and persistence.

3. Analytical Approach and Technical Demonstration

Based on collected theoretical and practical data, the study analyzed data management workflows within DAOs. The effectiveness of on-chain voting via smart contracts and the operational principles of distributed storage systems for document exchange were investigated. A simple on-chain voting smart contract example written in Solidity demonstrates the technical foundation of DAO decision-making (see below).

```
// SPDX-License-Identifier: MIT

pragma solidity ^0.8.0;

contract SimpleDAOVoting {

    struct Proposal {

        string description;

        uint voteCount;

        bool executed;
```

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```
}
Proposal[] public proposals;
mapping(address => mapping(uint => bool)) public hasVoted;
address public admin;
constructor() {
    admin = msg.sender;
}

modifier onlyAdmin() {
    require(msg.sender == admin, "Only admin can perform this action");
    _;
}
function createProposal(string memory description) public onlyAdmin {
    proposals.push(Proposal({
        description: description,
        voteCount: 0,
        executed: false
    }));
}
function vote(uint proposalIndex) public {
    require(!hasVoted[msg.sender][proposalIndex], "You have already voted");
    require(proposalIndex < proposals.length, "Invalid proposal index");
    hasVoted[msg.sender][proposalIndex] = true;
```

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```
        proposals[proposalIndex].voteCount++;
    }
    function executeProposal(uint proposalIndex) public onlyAdmin {
        Proposal storage proposal = proposals[proposalIndex];
        require(!proposal.executed, "Proposal already executed");
        require(proposal.voteCount > 0, "Not enough votes");
        // Actions to be performed when executing the proposal
        proposal.executed = true;
    }
    function getProposalCount() public view returns (uint) {
        return proposals.length;
    }
}
```

This code example illustrates:

- The admin creating proposals.
- DAO members voting on proposals.
- The admin executing approved proposals.

This technical demonstration enriches the article's scientific level by elucidating DAO data management and decision-making from a technical standpoint.

4. **Research Limitations**

Although the study employs qualitative methodology, certain limitations exist. Only three well-known DAO platforms were analyzed as case studies, limiting the scope of platform diversity. Furthermore, the research relies on existing scientific literature and open resources, possibly excluding rapidly evolving technologies[4].

DISCUSSION AND RESULTS

Decentralized Autonomous Organizations (DAOs) differ fundamentally from traditional organizations due to their decentralized governance and automated decision-making mechanisms. This section presents a comprehensive analysis of DAO data management, decision making, and document exchange. Real-world practices of popular DAO platforms are examined in terms of efficiency, security, and transparency, highlighting existing challenges and proposed solutions.

1. **Analysis of DAO Data Management and Decision-Making Processes**

DAO data management significantly diverges from centralized administrative control by storing and managing data in a decentralized manner, ensuring transparency and immutability. The critical

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component of data management is the decision-making process, frequently implemented through on-chain voting. Members cast votes recorded on the blockchain, with smart contracts tallying votes and automatically executing decisions. This approach guarantees immutability, transparency, and reliability (Jentzsch, 2016; Hassan & Kyriakou, 2021).

Advantages of on-chain voting include:

- **Transparency:** Every vote is recorded on the blockchain, preventing alterations or forgery.
- **Equality:** Each member's vote is accurately counted, reducing bias.
- **Automation:** Smart contracts automate decision enforcement, minimizing human errors.

However, on-chain voting also has drawbacks:

- **Scalability:** Voting in DAOs with many members burdens blockchain networks and causes delays.
- **Participation:** Low member engagement can deteriorate decision quality.
- **Complexity:** Technical complexity of proposals may confuse voters, leading to suboptimal decisions[5].

For data exchange and document management, distributed storage systems like IPFS are widely used. Documents are not stored directly on the blockchain but via cryptographic hashes on-chain, allowing secure and persistent storage off-chain[6][7].

2. **Analysis of Popular DAO Platforms**

The governance and data management mechanisms of Aragon, DAOstack, and MolochDAO platforms were deeply analyzed.

- **Aragon** automates DAO governance via on-chain voting and smart contracts, providing modular tools for managing documents and data. It offers customizable decentralized governance models with high transparency and reliability but may face usability challenges due to technical complexity.
- **DAOstack** implements delegated voting (holographic consensus), enhancing vote allocation efficiency and speeding decision-making. It supports decentralized architecture and integrates with various decentralized applications (dApps). Despite its scalability and performance, DAOstack encounters occasional consensus difficulties and reduced voter participation.
- **MolochDAO** features a lightweight and fast governance system within the Ethereum ecosystem, facilitating quick proposal decisions with a focus on security and efficiency. It is easier to manage and resource-efficient but has limited scalability and integration compared to other platforms.

3. **Existing Challenges and Recommendations**

Key challenges identified in DAO systems include:

- **Technical complexity:** Smart contracts and blockchain technologies can be difficult for many users, hindering decision-making.
- **Security issues:** Vulnerabilities in smart contracts may threaten DAO operations.
- **Low participation:** Member disengagement reduces governance efficiency.
- **Scalability:** Large-member DAOs face network congestion and delays[8],[10].

Recommendations to address these challenges include:

- **Education and support:** Providing training resources to familiarize members with blockchain and smart contracts.
- **Security audits:** Regular code audits and enhanced security protocols.
- **Incentive mechanisms:** Implementing tokens or other motivators to encourage active participation.
- **Consensus improvements:** Refining delegated voting and other algorithms to alleviate scalability issues[9],[10].

CONCLUSION

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DAO data management and decision-making processes, built upon blockchain and smart contract technologies, differ significantly from traditional governance systems. Their efficiency and reliability depend on technological infrastructure and member engagement. Analysis of popular platforms highlighted DAO strengths and weaknesses while identifying challenges and solutions. Future DAO development requires technological innovation and enhanced user education. Ongoing research in these areas remains essential.

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