Governance of a Distributed Autonomous Organization

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***Abstract*—This paper explores and analyzes the governance of a Decentralized Autonomous Organization (DAO) in the context of managing a distributed research testbed. Since the absence of a central authority gives the members complete control over the network, governance plays a significant role in the decision-making processes in any DAO. Using a decentralized payment system as a case study, this paper analyzes applicable governance models and identifies key challenges in a DAO. By examining existing governance mechanisms and their suitability for our scenario, the paper aims to outline a strong governance methodology that fulfills the requirements of the DAO and facilitate its objectives.**

***Index Terms*—DAO, Governance**

1. Introduction

Blockchain technology has gained significant popularity in recent years, revolutionizing industries by enabling secure and transparent transactions between parties. Its decentralized nature eliminates the need for intermediaries, which is the initial idea for *Decentralized Autonomous Organizations (DAOs)*. DAOs have arisen as a promising governance model, using blockchain to enable collaborative decision-making without relying on classic hierarchical structures. They give their community complete control over their rules and operations.

Defining governance for each DAO is crucial, as it depends on the specific goals and objectives of the organization. Generally, governance refers to the rules and decision-making processes that manage a DAO. These decisions can vary from simple ones, such as adding or removing members, to more complex ones, such as making major changes to the organization or its structure.

Understanding how decisions are made within a DAO and how its token economy is managed is essential for long-term sustainability.

1.1. Goal

This paper aims to investigate governance in DAOs using a decentralized research testbed as a scenario. We will analyze the most common governance models and processes that are primarily used in DAOs and evaluate their applicability to our research testbed scenario. By the end of this paper, the reader should have a better understanding of governance in DAOs and be able to choose and design the most suitable solution for each specific organization.

1.2. Outline

The paper is structured as follows:

- Section 2 includes a brief overview of the DAO testbed scenario and relevant concepts and terms in DAOs.
- Section 3 analyses the governance models and process, discussing their advantages and disadvantages in the context of the research testbed.
- Section 4 discusses the suggested methodology for our use case.
- Section 5 concludes the paper with key takeaways and an overview of future work and studies.

By following this structure, the paper systematically builds an understanding of governance, ensuring practical applicability to the research testbed scenario.

2. Background and Terminology

To understand how decentralized autonomous organizations work and what governance challenges lie underneath, we need to define some terms and concepts used in the paper. It is worth mentioning that because the governance is the main focus of the paper, the terms are simplified. Further details can be found in [1] and [2].

2.1. DAOs and Relevant Concepts

Decentralized Autonomous Organization(DAO) is a transparent organization based on Blockchain technology. The organization is managed by the members, and depending on the rules defined in the *Smart contract*s, the members can vote on the decisions of the organization.

Smart contracts are self-executing contracts with the terms of the agreement between parties being directly written into lines of code. They play a crucial role in DAOs since there is no central authority to manage the organization, and the terms of a smart contract can be very different; one of the most commonly used methodologies are token-based contracts.

Tokens are digital assets used to represent ownership of a particular asset. They can be traded with other parties and can be exchanged for other assets. It is important to note that tokens are not always the same as cryptocurrencies. Depending on the use case, tokens can be used to represent any type of asset, such as stocks, paintings or even real estate.

With the power of smart contracts and tokens, *Decentralized Application*(dAPP) can provide a platform for

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members to interact with the DAO. dApps are applications that run on decentralized networks. They follow the rules defined in the smart contracts and enable members to interact with the DAO, normally via predefined tokens.

In the managing DAOs, it is important to differentiate between *on-chain* and *off-chain* governance. On-chain governance refers to the governance processes that are proposed directly on the blockchain, and after voting, the decision is automatically executed on the blockchain. Off-chain governance, on the other hand, refers to the governance processes that are proposed outside the blockchain, for example, in forums or social media. After voting, the decision is executed manually by the members of the organization.

2.2. Relevant Concepts in Testbed DAO

The suggested testbed DAO in [3] is built on *Algorand* blockchain. Algorand is a blockchain platform that aims to provide a decentralized, secure, and scalable platform for developers to build applications. It uses a consensus mechanism called *Pure Proof of Stake*(PPOS), which allows for fast and secure transactions on the network [1]. This Blockchain technology offers the possibility to create and manage digital assets, called *Algorand Standard Assets*(ASA),which can represent any type of fungible (like cryptocurrencies) or non-fungible (like NFTs) assets. ASA can be traded efficiently and with low fees between members on the Algorand network [1]. The paper [3] suggests using ASA as a token to represent the resources in the testbed DAO.

2.3. Testbed DAO Scenario

The rapid advancement of scientific research has led to an increasing demand for computational resources. Many research institutions operate specialized testbeds equipped with specialized hardware, such as GPU clusters, 6G testing equipment, and other resources. However, researchers often require access to resources beyond their local infrastructure, necessitating a collaborative system for resource sharing across institutions.

The bachelor thesis "Trustless Resource Sharing between Scientific Testbeds" [3] proposes a DAO to manage sharing of computational resources. This system, built using Algorand's ASA token standard, enables compensation when one institution utilizes another's resources in exchange for tokens. The technical aspects of the DAO have been implemented, but the governance aspects remain unexplored.

Governance in the context of our scenario refers mainly to the decision-making processes for research site participation and management, including adding or removing sites and determining which decisions should be centralized or decentralized.

Since the testbed DAO is mainly based on collaboration between research sites, it is important to have a governance model that encourages participation and engagement from all members.

3. Analysis of DAO Governance

Selecting a suitable governance model for the DAO is essential. Different decisions need to be made by the DAO members, and these decisions can vary widely from minor to large. Although not all members have the same voting power, the governance model should still be fair and transparent to all members. At the same time, it should not allow any member to manipulate the voting process.

3.1. Challenges

Since every single decision and change needs to be made by members themselves, it is crucial to understand the challenges that might arise in a DAO.

Significant ownership concentration in DAOs can lead to governance challenges since only a few large token holders may have the power to influence decisions. This can lead to lower participation rates from smaller token holders, which can result in Growth challenges for the DAO in the long run [4].

Conflicts of interest between various stakeholders, particularly between large and small token holders, can also arise in DAOs. To address it an approach to governance can be the "one token, one vote" model. But this can lead to strategic voting and manipulation by large token holders since there is no guarantee that all the members will participate in the decision-making process.

Parties can buy votes and bribe other members to manipulate the DAOs in their favor.

Another challenge is the lack of anonymous voting; since all the votes are recorded on the blockchain(as a part of general rule in any blockchain system), this can lead to privacy concerns for the members of the DAO. Beyond the governance challenges.

DAOs also face technical challenges such as scalability, security, and code vulnerabilities, which are out of the scope of this paper.

3.2. Voting Process

Depending on the scale and type of the DAO, the voting process might differ from one DAO to another. In this section, we will discuss the general voting process in DAOs and the different stages that are involved in it. More information about the voting process can be found in [5]. Generally speaking, the voting process in DAOs can be divided into three main stages: Proposal process, voting, and post-voting implementation.

3.2.1. Proposal Process. Unlike corporations with annual meetings and management/shareholder proposals with specific requirements, DAOs typically have a continuous proposal submission process by members. This often involves two main steps: initial discussion and "temperature check" on governance forums, followed by a formal on-chain or off-chain proposal. Some DAOs require a minimum token quorum to create proposals.

3.2.2. Voting Procedure. DAOs specify quorum requirements in their protocol, often lower than in traditional corporations(where it is usually more than 50 percent) due to a lack of voter participation. Token holders' voting power is usually determined at the creation of the proposal. Many DAOs allow members to revote their tokens. It is important to note that tokens that are used for voting are not consumed in the voting process (however, they

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might be staked, and as a result, they will not be accessible for a short amount of time),meaning that the tokens can be used for other purposes, such as trading after the voting process. Another key difference from traditional voting is the real-time transparency of individual token holders' votes in DAOs, Which means every member of the DAO is able to see the votes of the other members.

3.2.3. Post-Voting Implementation. : On-chain votes are automatically executed by smart contracts upon passing, often with a "timelock delay" for security. Off-chain votes (e.g. via Snapshot) typically require a trusted core team or multisig setup to implement the changes on-chain, introducing an element of centralization.

3.3. Voting Models and Strategies

In recent years, various governance models and strategies have been developed to address the challenges of DAO governance mentioned in the Analysis section. These models seek to improve decision-making processes, encourage active participation, and ensure the health of decentralized systems. Below, we explore some of the key voting models used in DAOs.

3.3.1. Token-based Quorum Voting. In token-based quorum system, voting power is directly proportional to the number of tokens held by a participant. Each token represents one vote, and decisions are made based on the majority of votes cast. Depending on the quorum requirement, a certain percentage of tokens must be in favor of the decision for it to be valid.

This approach is straightforward and easy to understand, making it accessible for participants [6]. Token-based quorum voting is the simplest and most basic voting model in DAOs. However, it can lead to centralization, as large token holders may dominate decision-making processes.

3.3.2. Quadratic Voting. Quadratic voting is a voting mechanism which allows parties to express not just their vote but also the intensity of their vote. Instead of a simple one-vote-per-person or one-token-one-vote system, the cost of casting additional votes on a proposal increases quadratically. This means that while individuals can vote multiple times, each additional vote becomes exponentially more expensive.

The primary goal of quadratic voting is to reduce the power of large token holders and promote more democratic decision-making. For example, if the cost of one vote is one token, then casting two votes costs four tokens, three votes cost nine tokens, and so on. This prevents wealth-based manipulation and ensures that only strongly supported proposals gain traction [5].

3.3.3. Conviction Voting. Conviction voting is a dynamic model where participants continuously allocate their votes (in this case, tokens) to proposals over time. Instead of a one-time vote, the voting power of a proposal increases as more participants commit tokens to it for a longer period. The longer tokens remain staked on a proposal, the more "conviction" it accumulates, making it more likely to be accepted.

This approach encourages sustained support and prevents short-term speculative voting. A proposal that receives steady, long-term backing is prioritized over one that receives sudden but fleeting support. This model aligns governance with the real commitment of stakeholders rather than short-term advantage seekers [5].

3.3.4. Tenure-Based Voting (Vote-Escrow). Tenure-based voting, also known as vote-escrow, ties voting power to the duration for which tokens are held or locked. Members who stake their tokens for a longer period gain greater voting influence, incentivizing long-term commitment and reducing short-term speculative behavior.

The key idea behind vote-escrow is to reward long-term investors and contributors over transient participants. For instance, a user locking tokens for one year might receive one vote per token, while a user locking tokens for four years could receive four votes per token. Contrary to conviction voting, where the age of the proposal matters, the age of the tokens plays the major role in vote-escrow [5].

3.3.5. Reputation-Based Voting. In reputation-based voting, a participant's voting power is determined by their contribution history, expertise, or past decisions within the DAO. Instead of relying solely on token holdings, this model assigns weight to votes based on the trust and reliability of the voter within the ecosystem.

The main objective of reputation-based voting is to ensure that governance decisions are influenced by experienced and credible participants rather than just wealthy token holders. For example, a researcher who has actively contributed to the DAO over several years may have more voting power than a newcomer with many tokens but no prior engagement.

This approach incentivizes responsible participation and helps maintain decision-making quality. Since trust between parties and the party's reputation is the measure of voting power, consistent communication is necessary [5].

3.3.6. Contribution-Based Voting. Contribution-based voting rewards participants with voting power based on their involvement in the DAO's ecosystem. Instead of token ownership being the primary determinant, voting rights are allocated based on contributions such as code development, governance participation, content creation, or research efforts.

This model encourages active engagement and rewards meaningful contributions to the organization. A developer who contributes to maintaining the testbed infrastructure receive additional voting power compared to a passive token holder. By tying governance power to active participation, this model ensures that decision-making remains aligned with the DAO's long-term success [5].

4. Discussion

As mentioned in [5], we need to differentiate between an internal and external governance model. Since there are more researchers from different institutions involved in the DAO, There needs to be an internal governance

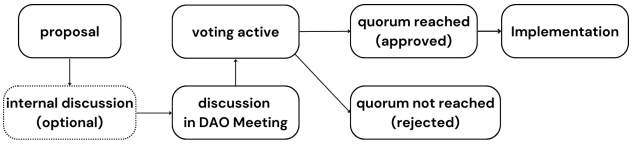

Figure 1: Proposal Process

system in each institution, which is responsible for token distribution and internal decisions.

The external governance model is responsible for the overall governance of the DAO, where each institution is an entity in the DAO and can vote on the decisions that affect the whole DAO. The paper [3] suggests that the internal governance model should be centralized, to simplify the governance of the DAO. This discussion focuses on the external governance model.

Most of the DAOs implement a hybrid governance system which consists of on-chain and off-chain governance models. Usually, the bigger the DAO gets, the more it leans towards off-chain governance; although our testbed DAO is not that big (since in our DAO, the only entities are the testbeds), the off-chain governance model is still recommended. Since essential decisions are made by the testbeds, such as adding or removing other members, it is important to have a model that is more flexible and allows discussions.

Figure 1 shows the suggested hybrid proposal process in our use case. The off-chain section of the process consists of two steps, internal and exteranl discussion. Upon creating a new proposal, it will be discussed fist internally in each organization (Since different organization have different internal governance model, this step is optional, but still recommended). Afterwards the external discussion takes place, where the representatives of the organizations discuss the Proposal. This debates can be done in the form of periodic meetings and, in urgent cases, in the form of emergency meetings. After the off-chain discussion, the on-chain voting phase will begin. Any proposal that reaches the required quorum will be finalized and executed on-chain via smart contracts.

Each voting model offers unique advantages and trade-offs, depending on the goals of the DAO. Token-based quorum voting is straightforward but can lead to centralization if a few large holders dominate decision-making. While quadratic voting enhances democratic participation, conviction voting prioritizes long-term commitment. Vote-escrow and reputation-based voting ensure governance stability by rewarding long-term stakeholders and trusted contributors, while contribution-based voting promotes engagement. A well-designed governance system may incorporate multiple strategies to balance fairness, decentralization, and efficiency within a DAO. Since in our use case, we aim to implement a governance model that encourages active participation and commitment, the Contribution-Based Voting model may be particularly suitable. By rewarding participants based on their contributions to the research testbed, we can incentivize ongoing engagement and ensure that governance decisions reflect the interests of dedicated stakeholders [7].

5. Conclusion

Selecting the right governance model for the DAO can be a very challenging task, and there is no one-size-fits-all solution. Depending on the scale, purpose, and type of the DAO, different governance models and strategies can be used. Two main focuses in the design of a governance model should be the proposal process and the voting process.

In the proposal process, the DAO should have a clear and structured process for submitting and discussing proposals. The transparency of the votes might seem concerning at first glance, but in the long term, it leads to open discussions and a more democratic decision-making process.

Unevenly distributed voting power among the members of the DAO, which is a characteristic of many DAOs, can seem like a challenge for the DAO governance at first. However, since each DAO has its unique characteristics and goals, leveraging the voting power of desired members can be an advantage for the DAO. In our use case, the members with the most contribution to the DAO have the voting power advantage.

Another aspect that should be considered is the tokenomics of the DAO. Future work should analyze the best tokenomics method for your use case and answer questions such as how tokens should be created, managed, and distributed. Token distribution is a very important aspect of our DAO, as there are always new testbeds joining and leaving the network, it also needs to be clear how to prevent inflation and deflation of the tokens.

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