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Not just code: a framework for community governance and management in Decentralized Autonomous Organizations

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The concept of Decentralized Autonomous Organizations (DAOs) has introduced a novel paradigm in organizational governance, characterized by more collaborative decision-making. However, the lack of established organizational frameworks for DAOs presents significant challenges to their constitution, stability, and longevity. Aiming to address this shortcoming, this paper presents a conceptual framework to guide the design of the community governance structure of DAOs. To achieve this aim, we employed two complementary methods: firstly, we conducted a systematic literature review about DAOs and community governance; secondly, we conducted an analysis of the governance methods employed by five DAOs operating in public blockchain ecosystems. The proposed framework provides a valuable tool for DAO founders, developers, and community members to design and implement effective governance structures and contributes to the understanding of DAO governance and further research.

1 Introduction

The emergence of computer networks has precipitated a paradigm shift in human organizations and interactions. A pivotal development within this trajectory was the dissemination of blockchain technology by Nakamoto (2008), presenting a foundation for novel economics and decentralized human interactions, bypassing intermediaries, and fostering new forms of human collaboration (Liu et al., 2021; Pacheco, 2019).

With its inherent attributes as a distributed ledger, blockchain presents applicability for diverse administrative functions. For example, logistics stands to gain traceability capabilities, while finance and tourism can enhance operational efficiencies and cost reduction. This capacity to support intelligent business operations across various domains ultimately enhances management and decision-making through verifiable and auditable data (Erceg et al., 2020; Pancić et al., 2023).

Decentralized Autonomous Organizations (DAOs) are a novel organizational model enabled by blockchain technology, operating as collaborative systems combining human and machine elements. DAOs are governed by rules and incentives encoded as smart contracts on a blockchain network, driving their

operation through the voluntary efforts of their community members (Anand and Chauhan, 2020; Ellinger et al., 2024).

DAOs can be deployed on public blockchains to leverage their open nature or in permissioned ones. The choice of the underlying blockchain infrastructure shapes the organization's accessibility, operational context, and governance characteristics (Santana and Albareda, 2022).

The degree of openness of the blockchain is reflected in the design of governance models and management practices. The nuances range from fully transparent and globally accessible governance on public chains to more controlled, permissioned governance structures on private or consortium chains, where stakeholder roles and rights are defined prior to participation.

For instance, consortium or private blockchains can offer distinct advantages for certain DAO implementations, such as enhanced privacy, controlled participation, and tailored performance, which are suitable for specific inter-organizational or administrative use cases (Ipert and Mauer, 2023).

DAOs operate on principles of collective action where virtual community members collaborate to establish, debate, and vote on rules governing software protocols and oversee the exchange of shared assets (Santana and Albareda, 2022). This governance model enables participants to collectively make decisions and manage organizational resources through consensus mechanisms and participative decision-making (Buterin, 2014; Wang et al., 2019).

Leveraging blockchain's transparency, immutability, and security, DAOs provide a platform for trust, collaboration, and innovation within a distributed network (Anand and Chauhan, 2020). According to DeepDAO's report (2024), DAOs are active across diverse fields, from finance to the arts, accumulating a total treasury of USD $32.5 billion in assets collectively managed by 11.3 million token holders.

DAO scholarly literature has been focusing on blockchain and smart contract code-level to address technological features such as transparency through automated rule agreements defined in code without human intervention (Singh and Kim, 2019), smart contract automatic execution, encoded rules, and the decision-making process to create a structure with decentralized control (Wright, 2023). The present study intends to discuss DAO beyond the code level.

DAOs have a significant human component, which has prompted research into diverse areas, including conflict resolution (Chen and Cai, 2023), entrepreneurial endeavors (Poeschl, 2023; Oguntegbe et al., 2023), and participatory decision-making (Augustin et al., 2023).

As presented by Amend et al. (2023), Rausser et al. (2023), and Riaza and Gnabo (2023), DAOs are a more democratic model with an innovative functional structure compared to traditional organizations. This model can offer solutions to problems related to decentralized management and stakeholder's collaboration (Ding et al., 2023).

DAOs blend on-chain smart contracts with off-chain member interactions, empowering individuals to collaborate while simultaneously addressing the critical challenge of mitigating conflicts of interest and reducing misconduct. DAOs offer a novel approach to collective decision-making and operational oversight, fostering trust and transparency (Axelsen et al., 2022; Hsieh et al., 2018).

However, DAOs also present significant challenges, including technical complexity, public misunderstanding, regulatory hurdles, and practical operational issues (Gilson and Bouraga, 2024; Wang et al., 2019). As discussed by Ding et al. (2021), since there are no conventional organizational frameworks for DAOs to deal with their community governance, they must adopt and develop ways to organize themselves as they see fit.

To address this shortcoming, this paper presents a conceptual framework to guide the design of the community governance structure of DAOs. To achieve this aim, we employed two complementary methods: firstly, we conducted a systematic literature review about governance within DAOs; secondly, we conducted an analysis of the governance methods employed by five DAOs operating in public blockchain ecosystems.

Following this introduction, Section 2 outlines the methodological approach employed in this research. Section 3 presents the synthesis of existing literature. Section 4 presents the analysis of governance mechanisms observed in the five selected DAOs. Section 5 presents the conceptual framework developed in this study, detailing its underlying logic and theoretical underpinnings. Section 6 relates the proposed framework with DAOs governance practices. Section 7 concludes this article by acknowledging the study's limitations and further research.

2 Methodological approach

This section details the methodological approach adopted for this research. Firstly, we outline the protocol followed for the systematic literature review, adhering to the established procedures of Kitchenham (2004). Secondly, we describe the analysis of governance practices within five DAOs operating in public blockchain ecosystems.

To guide the search for information, six research questions were formulated:

- RQ 1. What theoretical frameworks can guide community governance in DAOs?
- RQ 2. Who are the key stakeholders in DAO's community governance?
- RQ 3. How to increase engagement in DAO's community?
- RQ 4. What centralized elements exist in DAO's community governance?
- RQ 5. What are the voting limitations within DAO's governance?
- RQ 6. What are some common governance practices in successful DAOs?

The answers to the first five research questions inform the development of the proposed conceptual framework, while the findings from the sixth question RQ6 supports it by providing descriptive evidence from real-world DAO governance examples.

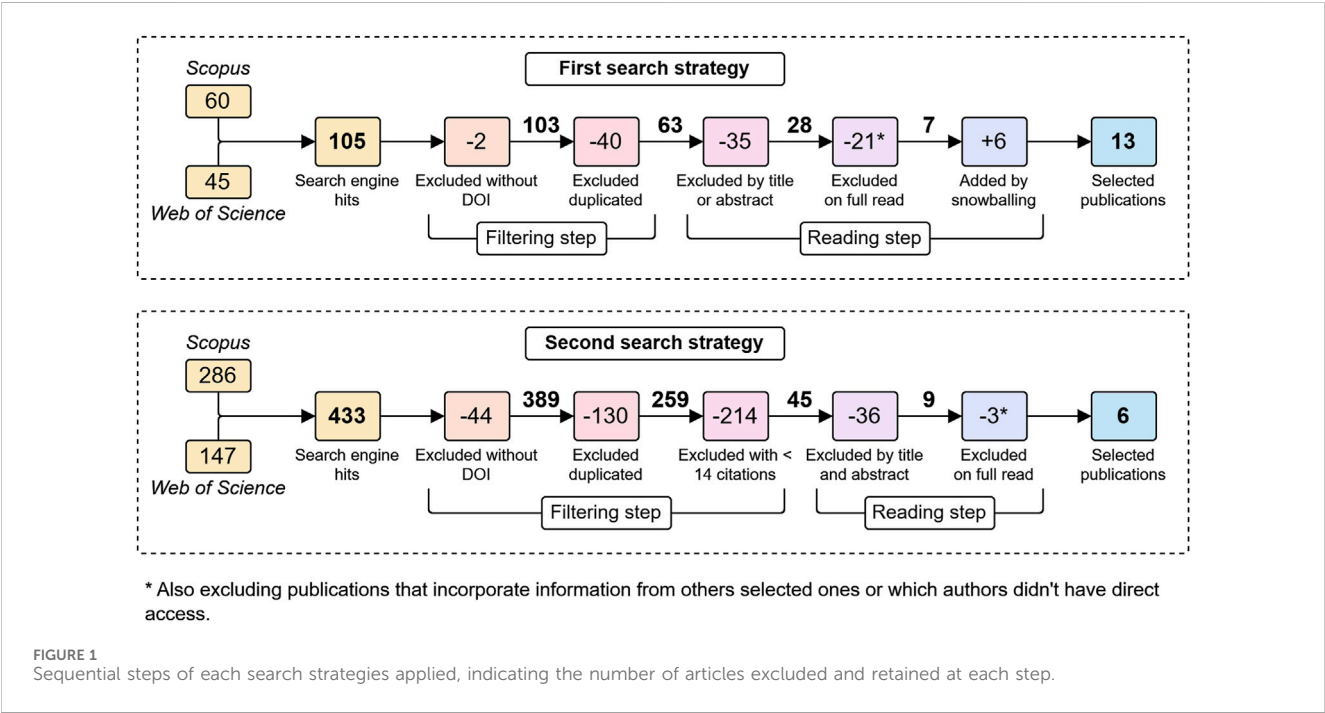## 2.1 Systematic literature review

We used Scopus and Web of Science as search platforms due to their comprehensive coverage, high quality, and reproducible

TABLE 1 Query strings used in the first search strategy.

Source	Query
Scopus	TITLE-ABS-KEY (("decentrali*ed autonomous corporation*" OR "decentrali*ed autonomous organi*ation*") AND ("governance*" OR "communit*")) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (PUBYEAR, 2023) OR LIMIT-TO (PUBYEAR, 2024))
Web of Science	(TI= (("decentrali*ed autonomous corporation*" OR "decentrali*ed autonomous organi*ation*") AND ("governance*" OR "communit*")) OR AB= (("decentrali*ed autonomous corporation*" OR "decentrali*ed autonomous organi*ation*") AND ("governance*" OR "communit*")) OR AK=(("decentrali*ed autonomous corporation*" OR "decentrali*ed autonomous organi*ation*") AND ("governance*" OR "communit*"))) AND (PY = = ("2023"OR "2024") AND DT = = ("ARTICLE") AND LA = = ("ENGLISH"))

TABLE 2 Query strings used in the second search strategy.

Source	Query
Scopus	TITLE-ABS-KEY (("decentrali*ed autonomous corporation*" OR "decentrali*ed autonomous organi*ation*") AND ("governance*" OR "communit*")) AND (LIMIT-TO (LANGUAGE, "English"))
Web of Science	(TI= (("decentrali*ed autonomous corporation*" OR "decentrali*ed autonomous organi*ation*") AND ("governance*" OR "communit*")) OR AB= (("decentrali*ed autonomous corporation*" OR "decentrali*ed autonomous organi*ation*") AND ("governance*" OR "communit*")) OR AK=(("decentrali*ed autonomous corporation*" OR "decentrali*ed autonomous organi*ation*") AND ("governance*" OR "communit*"))) AND (LA = = ("ENGLISH"))

FIGURE 1
Sequential steps of each search strategies applied, indicating the number of articles excluded and retained at each step.

results. The search was conducted in two strategies, using four search strings, two per strategy and platform.

The first search strategy was realized with the query strings presented in Table 1. These query strings seek to locate publications with the following characteristics and respective proposals:

- Classified as articles, to ensure greater rigor and quality of information;
- Written in English, given the linguistic ability of the authors and to facilitate source checking;
- Published in 2023 or 2024, to find state-of-art research;

- Containing in their title, abstract, or keywords the acronym terms of DAOs or DACs in singular or plural form and with American or British English grammar;
- With the terms "community" or "governance" in singular or plural forms.

During the reading step, references relevant to the topic were also included in the final selection, following a snowball practice.

The second search strategy was realized with the query strings presented in Table 2, looking for publications from years before 2023, and not only articles. These query strings seek to locate

TABLE 3 Governance aspects observed in analyzed DAOs.

| Governance aspect	Description
Governance structure	This dimension examines whether the DAO employs a hierarchical or distributed governance model
Token-holder influence	The extent to which token holders directly or indirectly influence decision-making processes within the DAO.
Community participation	Methods for community members to engage in governance activities, such as discussions, proposals, and voting
On-chain governance	The utilization of smart contracts and other on-chain mechanisms to execute and enforce governance decisions

FIGURE 2
Proposed conceptual framework to guide DAO's community governance.
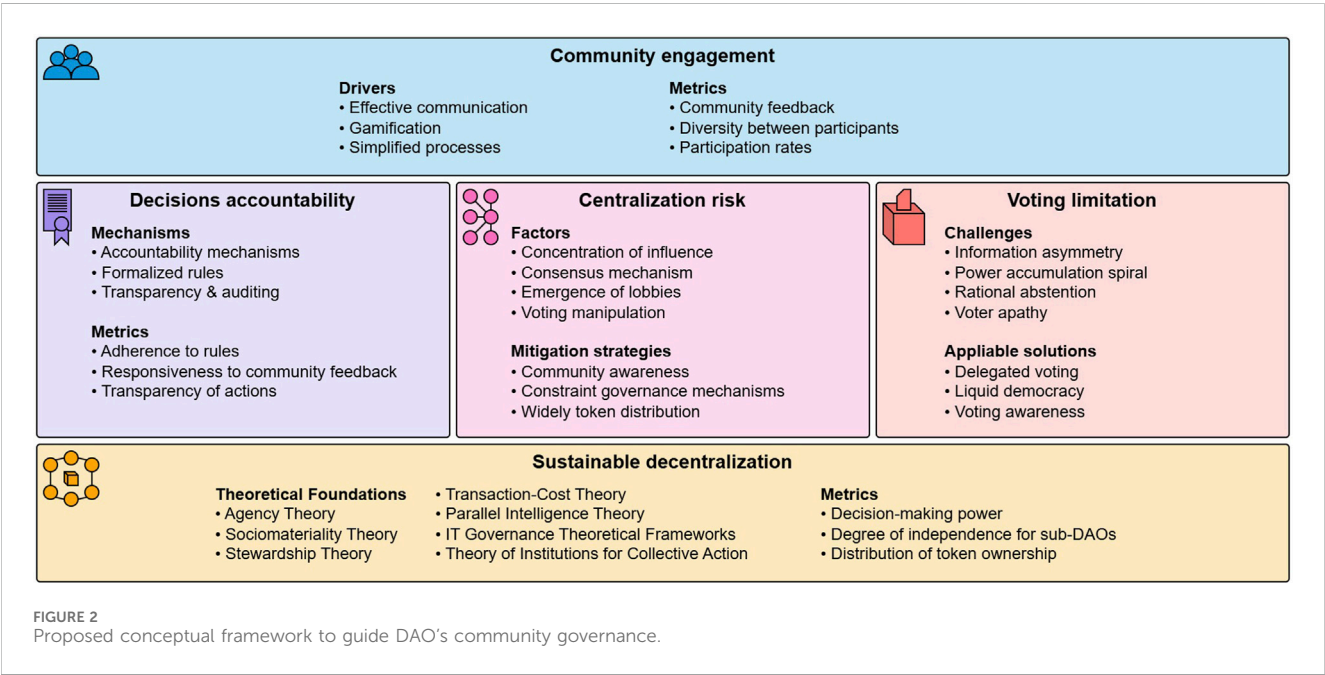
TABLE 4 Suggestions for future research.

Questions for future researchers	Source
How do the dynamics of community governance modify DAO's smart contracts and overall structure?	Alawadi et al. (2024)
How can machine learning be effectively integrated into DAOs while considering the implications for community and governance?	Wang et. at (2019)
What additional mechanisms can be implemented to encourage active shareholder participation in DAOs without compromising decentralization?	Alawadi et al. (2024)
How can specialized consensus mechanisms be designed to effectively coordinate diverse stakeholders within DAOs?	Li and Chen (2024)
How can transparent decision-making processes be developed for DAOs to ensure democratic access to information and effectively monitor decision-making procedures?	Gilson and Bouraga (2024)
How can optimized notification systems and user-friendly platforms enhance DAO governance and participation?	Gilson and Bouraga (2024)
What are the opportunities, tensions, and challenges of work created by DAOs, and how do users respond to these dynamics?	Ellinger et al. (2024)

publications with the following characteristics and respective proposals:

- written in English, given the linguistic ability of the authors and to facilitate source checking;
- containing in their title, abstract, or keywords the acronym terms of DAOs or DACs in singular or plural form and with American or British English grammar;

- with the terms "community" or "governance" in singular or plural forms.

As part of the filtering stage, publications were selected whose number of citations were equal to or greater than the sample average, in this case fourteen citations.

Each search strategy has a sequence of selection steps, as shown in Figure 1. Considering the final selection of the two search strategies, we

selected nineteen articles to answer the research questions of this systematic literature review. The raw data underlying this article will be accessible through the publisher's platform.

2.2 Analysis of governance practices in DAOs

To address RQ 6, we analyzed the governance practices of five prominent DAOs operating within public blockchain ecosystems: Arbitrum, GnosisDAO, MantleDAO, Optimism, and Uniswap. These DAOs were selected because they were among the top 10 with the highest treasury reserves, as reported by DeepDAO (2024).

Treasury reserves were chosen as selective criteria for reflecting stakeholder confidence and commitment, serving as an indicator of project viability and trust within the decentralized ecosystem. Arbitrum, for example, boasts a substantial community with over 1 million token holders and 330,000 lifetime participants, demonstrating significant engagement within its ecosystem.

We conducted this documentary analysis by collecting information from the official websites of the selected DAOs. The subsections of Section 4 reference these websites and present a summary of the findings.

To ensure comprehensive data collection, five key aspects of DAO governance were defined to guide the information search. These key aspects, listed in Table 3, served as a structured document analysis protocol for identifying relevant data points across the selected DAOs.

3 Findings in academic literature

This section presents our findings and discussion related to research questions RQ 1 to RQ 5.

3.1 Related frameworks and theories

Considering RQ 1, the community governance of DAOs can be analyzed through several theories that evaluate different perspectives. As summarized by Santana and Albareda (2022), some of the applicable theories are:

- Agency Theory can offer ways to develop strategies to mitigate agents' self-interested behavior, which can cause governance conflicts in DAOs;
- Theory of Institutions for Collective Actions can offer ways to understand how DAOs, as peer-to-peer communities, manage shared digital assets;
- Sociomateriality Theory can offer ways to analyze the human-machine interactions that control DAO's operations.

Alawadi et al. (2024) expand the set of theoretical perspectives by presenting two other theories:

- Stewardship Theory, as the antithesis of Agency Theory, offers a perspective for analyses which conditions create more balanced interests among different DAO's stakeholders, collaborating for the joint growth of the organization;

- Transaction-Cost Theory applies to DAOs because they can reduce market costs by offering a clear contractual framework that prevents investors from misinterpreting agreements.

Beck et al. (2018) also suggest that the theoretical framework of IT governance offers valuable guidance for discussing governance within the blockchain economy, encompassing DAOs as full-digital organizations.

Ding et al. (2021) mentions Parallel Intelligence Theory as a relevant theoretical and practical framework for DAO governance, offering solutions to challenges arising from multiple decision-making agents operating in uncertain environments.

Organizational theory also offers valuable insights into the dynamics of community governance within DAOs. This theory explores how organizations function, evolve, and respond to external factors. By examining various organizational perspectives and frameworks, it can offer more understanding of DAO structure, behavior, and adaptation (ASU, 2023).

Even though DAOs are usually described as ideal for democratic governance and resource management, mistrust and questionable incentives typically drive them into practice. Instead of collective stewardship for the common good, DAOs often function as systems of checks and balances to manage potential conflicts and protect diverse stakeholders' interests, aligning more closely with traditional agency theory (Alawadi et al., 2024).

3.2 Key players in DAO community and governance

Considering RQ 2, understanding the key stakeholders involved in DAO community governance is crucial for effective decision-making and community development. DAOs introduce a novel way to work by fostering voluntary collaboration within decentralized peer-to-peer communities.

Santana and Albareda (2022) and Alawadi et al. (2024) outlined that DAO members can assume distinct roles, such as:

- Founders initiate the DAO, establishing its objectives and rules for cryptocurrency investments;
- Investors offer crypto assets, receiving DAO's tokens that grant participation in decision-making;
- Developers contribute by designing, implementing, and refining the DAO's business logic within smart contracts;
- Miners/Validators support the blockchain infrastructure by processing, validating, and storing members' transactions.

Azouvi et al. (2019) highlight the substantial influence developers hold in blockchain-based organizations. As they are responsible for translating proposals into code, they can potentially manipulate decisions to serve their own interests (Zhao et al., 2022).

3.3 Engaging the DAO community

Considering RQ 3, a thriving DAO community requires active engagement from its members. Due to the possibility of anonymous participation in DAOs, it is difficult to guarantee the engagement

and responsibility of participants (Tamai and Shoji, 2024). Malicious members can exploit the organization's reputation and community trust for their own benefit, engaging in short-term, high-risk activities to generate quick profits, potentially endangering the long-term sustainability of the DAO (Li and Chen, 2024).

Membership engagement reinforces the interests of both DAO actors and the overall organization. A robust incentive structure increases the likelihood of sustained attention and effort from co-investors, potentially deepening their commitment and engagement over time. Ellinger et al. (2024) suggest fostering a shared stake in the DAO's success by rewarding mutually beneficial activities through dual-value tokenization.

DAOs heavily rely on vesting to engage founders, contributors, and external token holders. To address the issue of members quickly selling their tokens, Davidson (2023) proposes linking vesting contracts to the token's value, not just time.

As proposed by Davidson (2023), when someone joins a DAO as a contributor and receives native tokens, these tokens aren't immediately liquidable. Instead, a vesting contract determines when and how the tokens become available for liquidation based on time or value. This approach enables an alignment of compensation with performance, encourages long-term commitment, and reflects the quality of contributions.

Gilson and Bouraga (2024) also suggest some strategies to boost member engagement, such as:

- Gamify voting: introduce rewards and competitive elements to make voting more fun;
- Simplify proposals: use plain language, visuals, and interactive formats to make proposals accessible to a wider range of token holders;
- Increase effective communication: encourage open dialogue between token holders and developers, providing clear and accessible information on DAO rules, proposals, and decision-making procedures;
- Allow plenty of time for decisions: encourage members to gather information before making decisions, aiming to balance individual desires with the collective good.

Using gamification depends on the organization's objectives, how its community interacts, and its governance rules. For instance, DAOs might use achievement badges (even as non-fungible tokens) or scoring systems that rank participants and offer prizes to top ones.

Along with these practices, Liu et al. (2022) suggest that fostering social capital, sharing capital and psychological ownership, and organizing members based on their organizational experience can increase engagement in DAOs.

Voting power has an impact on engagement. For instance, the low perceived impact of individual votes in DAOs often discourages active participation. Alawadi et al. (2024) suggest a system where voting power diminishes over time for members who are inactive in the DAO, encouraging greater participation from more active members.

3.4 Decision and governance concentration

Considering RQ 4, despite their theoretically decentralized governance, DAOs often incorporate centralized elements in their structures. According to the empirical results of Gilson and Bouraga (2024), DAO participants expressed significant concern about token concentration, considering this as a key issue within DAOs.

As outlined by Sun et al. (2024), despite aiming for decentralization, DAOs still exhibit centralized tendencies, with large token holders wielding considerable influence. This can increase the risk of collusion among key decision-makers.

As pointed by Beck et al. (2018) and Covarrubias e Covarrubias and Covarrubias (2021), the centralized allocation of decision rights during the initial development phase of DAOs may results in substantial control and decision-making authority for the initial development team. This aspect was also observed by Liu et al. (2022) in their study on the DAO "Steemit."

As pointed out by Santana and Albareda (2022), DAOs, while more decentralized than traditional organizations, often exhibit power imbalances as key figures like founders, major contributors, and developers maintain significant influence. This can lead to conflicts within the community, highlighting the limitations of DAO decentralization.

This reality is also exposed by Ellinger et al. (2024). While DAOs are often perceived as self-governance communities with commons objectives, they operate in a hybrid space between centralized and community-based governance. Decision-making power and influence within DAOs are concentrated in specific groups, revealing a complex internal structure that is neither fully centralized nor decentralized.

Another evidence of this reality is presented by Ellinger et al. (2023), which shows that one of the biggest DAOs, the MakerDAO, faces challenges in achieving decentralized governance. Despite its success as a stable coin project, internal conflicts arose due to differing member interests. To address this, MakerDAO committed to strengthening decentralization and community involvement. This experience highlights the difficulty of balancing central and decentralized structures in a DAO.

Even though in theory DAOs can be a completely decentralized entity, there is not an impediment to deliberate actions by influential members of the network that result in them taking control. As outlined by Augustin et al. (2023), when a small fraction of the members is genuinely interested in participating in the decision-making and development process, there may be a loophole for the centralization of authority and decisions.

3.5 Voting limitations

Considering RQ 5, voting is a fundamental aspect of DAO governance, but it is not without limitations. According to Tamai and Shoji (2024), DAOs face two main problems with their voting systems:

- Members who own a substantial number of governance tokens, often called "whales," have much higher decision-making power;
- Members can coordinate to manipulate votes using harmful tactics to get their way and benefit themselves.

With the objective of solving these two major problems, the authors proposed a mechanism to counter behaviors driven by

participants' short-term self-interest, called "veToken." As proposed by Tamai and Shoji (2024), this mechanism incentivizes participants to lock up their governance tokens for longer periods, increasing their voting power based on both the number of locked tokens and the duration of the lockup.

Besides this proposed mechanism, some DAOs allow token holders to delegate their voting rights, transferring them to trusted individuals or groups (Alawadi et al., 2024). This mechanism can encourage broader community participation and reduce voter apathy. However, it also poses the risk of power centralization, as a small number of representatives could potentially dominate the decision-making process (Axelsen et al., 2022).

Delegating voting rights can create a hierarchical structure within a DAO, contradicting its decentralized principles. Additionally, lobbyists can exert undue influence over voting processes, undermining democratic decision-making. DAOs should implement more inclusive decision-making frameworks, such as multi-stakeholder models, to ensure diverse representation and reduce the potential for manipulation (Alawadi et al., 2024).

Sun et al. (2024) found evidences of limitations in voting delegation practices within MakerDAO's governance polls. The way voting is delegated can significantly influence how DAOs are governed. When a small number of delegates hold a lot of voting power, it can lead to more heated debates, due to conflicting viewpoints.

Rikken et al. (2019) posit some challenges in voting systems in achieving equitable distribution of voting power. The foundational principle of "one person, one vote" is rendered problematic in conditions of anonymity or pseudonymity. Furthermore, the capacity for uninformed participation raises concerns regarding the quality of decision-making processes, a phenomenon sometimes referred to as mob rule or the tyranny of the majority.

Zhao et al. (2022) point to efficiency concerns in operational decision-making within Decentralized Autonomous Organizations (DAOs). Specifically, they argue that the inherent voting process can introduce inefficiencies when applied to routine operational decisions, which frequently necessitate rapid responses to dynamic market conditions.

4 Governance practices in DAOs

This section examines the governance aspects of five DAOs operating in public blockchain ecosystems, with a specific focus on addressing RQ 6 and considering the key aspects listed in Table 3.

4.1 Arbitrum

Launched in 2022, Arbitrum is a layer-2 blockchain operating on the Ethereum network. It employs a rollup protocol to enhance transaction speed and reduce costs while maintaining Ethereum's security guarantees.

The Arbitrum Constitution serves as the foundational framework. It outlines the core governance structure, defining

roles, responsibilities, and decision-making authorities for all entities within the ecosystem (Arbitrum, 2025).

At the core of the governance system lies the Arbitrum DAO, governed by token holders and ruled by on-chain smart contracts along with three other governance entities.

The Arbitrum Foundation, which reviews proposals and actions to ensure they align with the Arbitrum Constitution and its own Memorandum of Association. Operating under the authority of a designated Governor contract, the Foundation manages a treasury to support the ecosystem.

The Arbitrum Security Council, composed of twelve elected members, this council is responsible for safeguarding the integrity, confidentiality, and availability of the Arbitrum network. The Council possesses emergency powers, allowing it to implement critical upgrades and initiate protocol changes when necessary.

The Arbitrum Data Integrity Committee focuses on managing the data availability of Arbitrum Nova, a network designed to facilitate lower transaction costs by operating under more relaxed trust assumptions.

4.2 GnosisDAO

Gnosis is a Decentralized Finance (DeFi) ecosystem specializing in the development of critical market infrastructure for DeFi solutions. Established in 2020, GnosisDAO serves as the collective steward of the Gnosis ecosystem, leveraging its products to guide development, support, and governance decisions.

The GnosisDAO governance model is predicated on principles of transparency, broad-based participation, and inherent adaptability. GnosisDAO's governance framework is structured around a multi-stage proposal lifecycle encompassing initial community deliberation, formal articulation, and decisive on-chain execution (Gnosis, 2025).

Prospective proposals are first introduced as informal drafts within the community forum, fostering an environment for open dialogue and iterative feedback. This preliminary phase of collective discussion ensures that evolving proposals resonate with the diverse perspectives and address the multifaceted needs of the stakeholder community.

The DAO's governance process is organized into three distinct phases: the origination and iterative refinement of novel proposals, the subsequent formalization of promising concepts through the standardized Gnosis Improvement Proposal (GIP), and the final on-chain voting phase.

The GNO token plays a pivotal role within this ecosystem, empowering stakeholders with voting rights, underpinning network security through staking mechanisms, and aligning economic incentives across the decentralized platform. The community of GNO token holders exercises governance over the development, funding, and overall direction of the Gnosis ecosystem.

4.3 Mantle

Launched in 2023, Mantle Network is an Ethereum Layer 2 scaling and lower cost blockchain solution in comparison to Ethereum. The governance of the ecosystem is made by the governance-focused DAO called Mantle DAO, which is its sub-DAO structure, enabling

specialized governance for core contributor teams, topical committees, voting delegation, and budget lines.

The Mantle DAO governance model embodies a hybrid approach that joins decentralized, community-led decision-making with agile, sometimes off-chain, implementation. It stands as an example of how DAOs can balance rigor and flexibility, ensuring that strategic and technical changes are both thoroughly deliberated and efficiently executed (Mantle, 2024).

Mantle's decision-making power lies directly with $MNT token holders. They control major strategic levers such as launching new product lines, altering tokenomics, approving spending, and modifying governance parameters.

Changes to the network are formalized through Mantle Improvement Proposals (MIPs), which function similarly to statutes or corporate policies, allowing stakeholders to debate, improve, and eventually solidify the proposal before it moves to a formal vote.

After the initial discussion phase, proposals are put to an official vote on the Governance Module. Token holders then use their voting power to ratify or reject proposals. This step ensures that every significant decision reflects the collective will of the community and maintains transparency in the decision-making process.

Once approved, proposals are implemented either through automated on-chain code execution or via off-chain methods led by a core contributor team. Many implementations occur off-chain, highlighting a flexible approach that adapts to the nature of the proposed changes and the operational realities of the organization.

4.4 Optimism

Established in 2022, Optimism is an Ethereum Layer 2 blockchain for hosting decentralized applications encompassing a wide spectrum of crypto activities. The Optimism ecosystem employs a multi-layered approach that aims to balance the interests of token holders with broader community considerations.

The governance of the Optimism ecosystem is managed by the Optimism Collective, a governance-focused DAO that governs the protocol and its ecosystem, empowering community participation in decision-making. Along with the Optimism Collective, there are two distinct sub-DAOs (Optimism, 2024).

The Token House represents the token holders and is responsible for protocol upgrades, treasury management, and oversight of project directors. It operates through a delegated-voting system, incorporating non-binding committees to enhance decentralization and streamline decision-making.

The Citizen House, comprised of appointed and elected members, oversees funding, allocating grants to projects based on their ecosystem impact. Membership in the Citizen House is denoted by democratic voting and is legitimized by non-fungible tokens.

4.5 Uniswap

Established in 2019, Uniswap is a decentralized exchange operating on the Ethereum blockchain. It facilitates the trading of ERC20 tokens through a set of immutable smart contracts, prioritizing censorship resistance, security, and user self-custody.

The governance of Uniswap embodies a multi-stage process intended to foster collaborative protocol development involving diverse stakeholders. This structured approach facilitates decision-making through sequential phases encompassing public discourse, community sentiment assessment, and on-chain voting (Uniswap, 2024).

This phased method incorporates inherent checks and balances designed to ensure evaluation of proposals, mandating thorough debate and establishing voting thresholds aimed at reflecting substantial and broad-based consensus.

The Uniswap governance ecosystem incorporates several key procedural elements. The Governance Forum serves as a platform for discussions, collaborative development, and the incorporation of community input. Furthermore, tools such as Agora and Tally play a significant role in streamlining the proposal submission and voting processes, enabling participants to track the evolution of governance proposals and exercise their voting rights.

5 Proposed framework

The proposed framework posits that DAO governance hinges on five dimensions: sustainable decentralization, decision accountability, centralization risk, voting limitation, and community engagement. In this section we describe the five dimensions of the framework illustrated in Figure 2.

5.1 Sustainable decentralization

This dimension considers the theoretical foundations and measurable metrics that underpin sustainable decentralization within DAOs.

Agency Theory outlines aligning incentives among stakeholders to mitigate potential conflicts of interest; Sociomateriality Theory highlights the interplay between social, technological, and material factors that shape DAO governance outcomes; and Stewardship Theory emphasizes the ethical responsibility of key stakeholders in fostering a sustainable and accountable ecosystem.

As a prominent component of the Theory of Institutions for Collective Action, the Institutional Analysis and Development (IAD) framework, developed by Ostrom (2007), can contribute as an analytical tool for understanding how communities manage common-pool resources.

Applying the IAD framework to DAOs allows for a granular analysis of their governance structures. The DAO itself can be viewed as an "action arena" where stakeholders (actors) interact to manage shared digital assets and make collective decisions. The framework can offer a systematic method for examining the formal and informal rules that govern these interactions.

To measure the degree of decentralization can be used: the distribution of token ownership (e.g., through the Gini coefficient), the decentralization of decision-making power (e.g., accessibility of proposal initiation and voting), and the autonomy of sub-DAOs.

DAOs can strive towards a sustainable level of decentralization that fosters community ownership, minimizes the risk of

centralization, and maximizes the benefits of decentralized governance.

5.2 Decision accountability

This dimension emphasizes transparency, responsibility, and rule-abiding decision-making within the DAO. It focuses on establishing mechanisms to track decisions, ensure accountability for actions, and maintain a prominent level of transparency and auditability.

A robust governance framework is essential for achieving decision accountability. This includes a well-defined constitution, a code of conduct, and a comprehensive set of rules that guide decision-making processes, outline member roles and responsibilities, and establish consequences for rule violations.

Transparency is crucial for building trust within the DAO. Public access to financial records, decision-making logs, and code repositories allows community members to verify the legitimacy of actions and identify potential irregularities.

Furthermore, on-chain voting records provide an immutable record of decision-making, enabling the verification of individual votes and the identification of potential voting irregularities. Reputation systems and robust dispute resolution processes can also enhance accountability by incentivizing responsible behavior and ensuring fair resolution of conflicts.

To assess the effectiveness of decision accountability mechanisms, some metrics can be used. These metrics include the frequency of rule violations and the consistent enforcement of penalties, the public availability of information and the ease of access to relevant data, and the incorporation of community feedback into decision-making processes.

By effectively implementing these mechanisms and regularly monitoring these metrics, DAOs can enhance decision accountability, build trust within the community, and ensure the long-term sustainability and success of the organization.

5.3 Centralization risk

Decentralization is a cornerstone of DAOs, aiming to distribute power and decision-making across a broad community. However, centralization risks can undermine this principle, leading to vulnerabilities and potential exploitation. This dimension focuses on identifying and mitigating these risks, ensuring the DAO remains truly decentralized and resilient.

Centralization risks can manifest in various forms within a DAO. For instance, a concentration of voting power among a small group of token holders can enable them to manipulate governance outcomes, compromising the interests of the broader community.

Similarly, reliance on a few key developers or core contributors can create single points of failure, making the DAO vulnerable to their actions or potential exit. Additionally, centralized control over critical infrastructure, such as the DAO's treasury or communication channels, can be exploited for malicious purposes.

To mitigate these risks, DAOs can implement a range of strategies. Token distribution mechanisms can be designed to encourage wider token ownership and prevent excessive concentration of voting power. This can be achieved through airdrops, community grants, or token vesting schedules.

A significant factor contributing to power concentration within DAOs stems from the very consensus mechanisms that underpin the blockchains they operate on. Proof-of-Work (PoW) and Proof-of-Stake (PoS), the most prevalent consensus mechanisms in public networks, both inherently carry centralization issues. This inherent centralization can directly undermine DAO's core objective of distributed governance, as stakeholders favored by the chosen consensus mechanism can exert undue influence over decision-making processes.

Proof-of-Work can result in the centralization of power among a few large-scale mining operations or pools that possess the computational resources necessary to dominate the block-creation process. While Proof-of-Stake can lead to a "rich-get-richer" effect, where stakeholders with larger token holdings have a greater chance of validating transactions and earning rewards, accumulating more tokens and, consequently, more voting power.

Furthermore, fostering a diverse and inclusive community can ensure that a wide range of perspectives are considered in decision-making processes. Decentralized governance mechanisms, such as multi-signature wallets, can distribute control over critical functions, reducing the risk of single points of failure. Finally, transparent, and open-source development practices can enhance community trust and reduce the potential for malicious actors to exploit vulnerabilities.

By proactively addressing centralization risks, DAOs can strengthen their governance structures, enhance their resilience, and ensure that decision-making remains truly decentralized and aligned with the interests of the broader community.

5.4 Voting limitation

A critical aspect of DAO governance is ensuring fair and equitable participation in decision-making processes. However, several challenges can hinder effective voting within DAOs.

Voter apathy, characterized by low turnout and disengagement, can undermine the legitimacy of governance decisions. This apathy can stem from several factors, including the perceived complexity of governance processes, the lack of clear incentives for participation, and the feeling of insignificance in influencing collective outcomes.

Furthermore, information asymmetry can significantly impact voting outcomes. Unequal access to information and resources among voters can create an uneven playing field, where some individuals are better informed and equipped to make informed decisions than others. This can lead to situations where well-informed actors manipulate or exploit less-informed voters.

The concept of rational abstention further complicates the voting landscape within DAOs. In situations where the perceived impact of an individual vote is negligible, rational actors may choose to abstain from voting altogether, leading to low voter turnout and potentially suboptimal outcomes.

To address these challenges, several solutions can be explored. Delegated voting mechanisms allow token holders to delegate their voting power to trusted representatives, potentially increasing participation and improving decision-making efficiency. Liquid

democracy, a hybrid approach, combines direct and delegated voting, allowing individuals to choose whether to vote directly or delegate their power, providing greater flexibility and potentially increasing overall participation.

It's also relevant to consider that there is an inherent difficulty of rectifying power imbalances within an established DAO governance structure may warrant consideration, though it is a topic not extensively explored in the reviewed literature. Once the initial token distribution and voting mechanisms are defined, altering the system to foster a more equitable distribution of voting power becomes challenging, particularly if a trend towards centralization emerges.

Participants who benefit from the existing power disparities are unlikely to approve proposals that would dilute their voting power. This resistance can entrench a centralized governance, perpetuating inequalities in the decision process as one or more actors may consistently oppose measures aimed at achieving greater power equity.

Finally, robust education and awareness campaigns are crucial to fostering informed and engaged voters. By educating voters on the importance of participation, the consequences of their voting decisions, and the intricacies of DAO governance, DAOs can empower their community members to make informed and responsible choices, strengthening the legitimacy and effectiveness of their governance structures.

5.5 Community engagement

A vibrant and engaged community is the lifeblood of any successful DAO. This dimension focuses on fostering active and meaningful participation from all stakeholders. Effective communication channels, such as clear and accessible forums, social media groups, and regular updates, are crucial for keeping the community informed and engaged.

Furthermore, incorporating gamification elements, such as rewarding active participation, recognizing valuable contributions, and introducing playful challenges, can incentivize community members to actively contribute to the DAO's success. Streamlining processes, such as simplifying proposal submission, voting procedures, and decision-making mechanisms, reduces barriers to entry and encourages broader participation.

Key metrics for assessing community engagement include participation rates, such as voter turnout, proposal submission rates, and forum activity. Additionally, tracking the diversity of participants and ensuring representation from different stakeholders, demographics, and skill sets is crucial for fostering inclusivity and ensuring a well-rounded perspective. Monitoring community sentiment through sentiment analysis of forum discussions and social media mentions provides valuable insights into the overall health and morale of the community.

However, it is relevant to consider that there is the risk of disconnecting quantitative metrics and meaningful engagement. While valuable for tracking engagement, metrics must be carefully designed and interpreted to ensure they reflect genuine engagement. This involves reinforcing their connection with qualitative factors, such as the substance of proposals, the depth of discussions, and the actual implementation of community-driven initiatives.

By prioritizing community engagement, DAOs can cultivate a thriving ecosystem where members feel valued, empowered, and motivated to actively contribute to the collective success of the organization.

6 The conceptual framework on the selected DAOs

This section relates governance practices of the analyzed DAOs with the proposed framework focusing on four key dimensions: decision accountability, centralization risk, voting limitation, and community engagement.

6.1 Decision accountability

Accountability is maintained through a combination of codified rules, transparent processes, and automated execution. In Arbitrum, accountability is codified within its constitution and enforced through smart contracts, with specific powers delegated to its Security Council, which operates based on the DAO's constitution.

GnosisDAO fosters transparency via open forums and a multi-stage proposal system, where approved proposals are executed automatically on-chain, creating an immutable record. Mantle employs a primarily off-chain process where token holders vote on formal proposals, which are then implemented by a core contributor team, and its treasury is secured by a multi-signature safe.

Optimism uses a 3-week proposal cycle with extensive discussion; the Optimism Foundation executes approved proposals but retains the right to reject or modify them with a public explanation if they present security risks or are misaligned with the DAO's objectives.

Uniswap utilizes a structured, multi-stage governance process that includes inherent checks and balances, employing tools such as governance forums and on-chain voting with executable code for direct implementation.

6.2 Centralization risk

Mitigating the concentration of power is crucial for the long-term viability of a DAO. Arbitrum's Security Council is identified as a potential point of centralization; however, this risk is mitigated by the DAO's overarching power to alter or eliminate the Council's authority.

GnosisDAO distributes influence among its token holders by making its token fundamental to both governance and economic alignment. Conversely, Mantle exhibits centralization risk due to its dependence on a core team for implementation and its high proposal and voting thresholds, which tend to favor large token holders.

Optimism directly addresses the risks associated with token-based plutocracy through its bi-cameral system. The Citizen House,

with its one-person-one-vote mechanism and its power to veto certain proposals, establishes a more balanced distribution of power.

The Uniswap foundation has demonstrated a commitment to enhancing the protocol's neutrality, indicating an active effort to address and mitigate potential centralization factors.

6.3 Voting limitation

DAOs must implement mechanisms to address challenges such as voter apathy and the disproportionate influence wielded by large token holders. To combat voter apathy, Arbitrum permits token holders to delegate their voting power to more active members of the community.

GnosisDAO seeks to cultivate more informed voting by means of a multi-phase proposal process designed to refine concepts prior to a final vote. In the Mantle ecosystem, users are required to delegate their voting rights to participate, and since voting power is proportional to token holdings, influence is concentrated among larger holders.

Optimism's Token House allows for delegation and enforces significant participation thresholds. Furthermore, its Citizen House provides an alternative voting channel for funding public goods, thereby expanding participation beyond token weight.

Uniswap maintains high thresholds for submitting and passing on-chain proposals, which creates a substantial barrier for smaller holders and concentrates power among large delegates.

6.4 Community engagement

The sustainability of a DAO is dependent on active and meaningful community participation. Arbitrum cultivates engagement through its governance forum and Discord community, framing the participation of delegates as a significant responsibility.

GnosisDAO promotes collaboration through open dialogue on its forum and other social channels, with a proposal process structured to integrate iterative community feedback. Similarly, Mantle utilizes its Discourse forum as the principal channel for community discussion and feedback before a formal proposal is put to a vote.

In Optimism, the Governance Forum is central to the process, ensuring comprehensive discussion. Its Citizen House model also uniquely engages individuals based on their shared values and contributions.

Uniswap engages its active community through its Governance Forum and via initiatives led by its Foundation, such as builder programs, to stimulate growth and active participation.

7 Conclusion

Blockchain technology has revolutionized how we approach digital innovation and governance, and the emergence of DAOs has highlighted the need to carefully consider the potential obstacles of decentralized governance to build sustainable and thriving decentralized communities.

Although many articles consider DAO from the blockchain and smart contracts aspects, what we consider the "code level," this article sought to address organizational aspects of DAOs, going beyond the level of functionalities and technical characteristics. In this sense, we hope to bring theoretical and practical contributions to the business level.

This study contributes to the growing body of knowledge on DAOs and their role in community governance. The findings contribute to the theoretical understanding of DAOs with the identification of DAOs governance aspects organized in the framework Figure 2. To practitioners, it provides a valuable tool for DAO founders, developers, and community members to design and implement effective governance structures.

While significant academic attention has been directed towards the technical contributors, investors, and governance token holders of DAOs, the role of clients of DAOs remains understudied. Unlike traditional organizations, DAOs do not operate with conventional client definition. In decentralized ecosystems, such as those focused on investment or protocol governance, participants are often better characterized as contributors or stakeholders rather than clients in a commercial sense.

To guide future research on community governance in DAOs, Table 4 presents a series of future research recommendations gleaned from the reviewed literature.

This work is not completely free of biases and limitations. Our database selection potentially excludes articles not indexed within those sources, and, despite a systematic method for literature review, subjective interpretations cannot be eliminated.

We acknowledge that snowballing in systematic literature reviews may still be limited by relying solely on randomized searches, which can introduce selection bias. Future research should explore diverse methodologies, interdisciplinary approaches, and larger article samples to address this issue.

The authors' decision for only English-language publications restricts findings on a global scale. DAOs are a worldwide phenomenon with a diverse user base; their adoption and related discussions can extend to other languages in future studies.

This study did not address cybersecurity risks that could significantly influence DAO's community governance, particularly overlooking the inherent vulnerabilities within smart contracts that underpin its business logic and decision process.

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