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Decentralized autonomous organization design for the commons and the common good

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The current internet economy is characterised by a historically unprecedented bundling of private sector power over infrastructures. This situation is harmful for overcoming problems where collective action is needed, such as for governing digital commons. Organisations that run on collectively owned decentralised infrastructure are able to overcome this centralisation of power. These common decentralised autonomous organisations (DAOs) could help in fostering digitally enabled collective action. However, currently we have no clear view of how a DAO designed for commons governance would operate and be governed. By creating a conceptual prototype of a DAO governing a common, we provide a clear path of how common DAOs should mature and which tools are needed to create them. In this research, we created a governance framework for common DAOs by combining 16 works on technology for commons governance. The framework reveals that common DAO governance consists of three areas: 1) Governance structure, 2) Enabling technology, and 3) Community governance. We provide governance mechanisms that together describe an implementation of Ostrom's common governance principles in a DAO. This work is a synthesis of previous research on technology for collective action. The proposed framework aids in standardising DAO governance for the common good and may contribute to a large scale roll-out of commons DAOs.

KEYWORDS

decentralized autonomous organization, blockchain, smart contracts, commons governance, Ostrom, constitution, blockchain governance

1 Introduction

We are surrounded by common resources. Everyday, we breathe oxygen from commonly owned air, use water from common pools, utilise wooden products that come from common forests and drive to work by the shared transportation network. These, and all other common resources have two features that make them vulnerable for exhaustion (Ostrom, 1990). First, it is hard to exclude participants from them as they are public resources. Second, use of this resource is competitive and scarce; e.g., when a particular tree is used to create my table, it cannot also be used for another table.

Because of these characteristics, rational individual behaviour leads to collective demise, which is called the tragedy of the commons (Hardin, 1968). Individualistic behaviour from some or even just one stakeholder can break down the common. This mismanagement of commons is currently happening in, for example, bee population decline in the Netherlands (Biesmeijer et al., 2006). Even though all stakeholders suffer when there are fewer bees, none can take the responsibility to solve the problem alone. Only collective action can solve this major challenge.

Ostrom. (1990) empirical studies have shown that in some situations, self-management can be more effective in maintaining a collective resource over time than market privatisation or public ownership (Ostrom, 1990). Ostrom highlights how practices and rules can be useful in maintaining common pool resources and communities over time. Her famous eight principles may help communities overcome the tragedy of their commons.

At the same time, adhering to these principles is increasingly difficult a digital era. There are two principles of successful common governance that are under tension: the participation in rule making by all stakeholders and the monitoring of activities (Ostrom, 1990). These principles require shared ownership, but the applications, servers, cloud hosting, software and hardware, which we frequently use for commons governance, is owned by a single centralised institution. Almeida et al., 2020 call this the ownership problem of digital governance. The central control over the infrastructure that sustains the main platforms of collaboration commonly emerges as a point of tension and conflict (Rozas et al., 2021a). The centralised actors can prefer their own profit over common prosperity, which leads to conflicts in or demise of commons.

We define the digital architecture as the technological systems that include applications and networks, and the underlying software and hardware components that contain servers, APIs and data centres. Since our dependence on digital infrastructure for governing our society is growing, more power is handed to the central actors that own the underlying infrastructure. The more digital our common governance becomes, the more centralised it will be. In fact, the current internet economy is characterised by a historically unprecedented bundling of private sector power over infrastructures (Schrape, 2019). Hence, we must increasingly hold faith that the centralised actors will not misuse their power over the commons, or find a solution that changes the ownership of the infrastructure.

But how can we sustain the future of our commons? A possibility is a technical infrastructure that is not owned by one party. This can solve the problematic intertwinement of digitalization and infrastructure centralisation. A solution that can sustain our commons is a *decentralised* infrastructure.

Decentralisation in the context of infrastructure is a system that seeks to function independently of any social institutions (De Filippi and Loveluck, 2016). For commons it means that the technological infrastructure is owned by multiple stakeholders of which none is essential (Rozas et al., 2021a). When the infrastructure is owned by multiple or all stakeholders, governance is no longer dependent on a single infrastructure provider. Therefore, decentralised technologies offer pressure for negotiation on those holding power in the community and thereby foster permissionless innovation (Thierer, 2016). This cooperation and division of power is essential to sustainable commons (Ostrom, 1990).

On top of this decentralised infrastructure we can build decentralised applications and organisations. Decentralised Autonomous Organisations (DAOs) are cooperatives of stakeholders that run on this decentralised blockchain infrastructure. They could help create decentralised governance (Hassan and De Filippi, 2021). The centralised infrastructure ownership that challenges sustainable commons might be solved by the decentralised governance of DAOs (Bellavitis et al., 2022).

Therefore, we might be able to create sustainable commons by designing a DAO for supervising these resources.

However, there are at least three problems that hinder us from creating common DAOs. First, DAOs are still in their infancy (El Faqir et al., 2020). Second, because of DAO infancy, there is too little tooling available for DAO development (El Faqir El Rhazoui, 2021; Santana and Albareda, 2022; Wang et al., 2022). Finally, DAO use for commons governance has remained speculative (Rozas et al., 2021a), and there is currently no clear view of how a DAO designed for commons governance would operate.

In this article, we solve the third problem. Existing digital governance for commons leads to centralisation of power because of the centrally stored data and thereby control. Common DAOs create a technical solution for governing commons that is decentralised. These DAOs overcome the dependence on a central actor that can harm prosperity of the common resource.

We first collect design practices from the current academic research of both digital commons governance and DAO commons governance. Several papers already provide mechanisms or partial designs (Cila et al., 2020; Poux et al., 2020; Rozas et al., 2021a). We aggregate and standardise all their findings in a single framework and create DAO design specifications. This approach will answer our research question of: *What are design specifications of a common DAO?*

To answer this question, we first recall what other authors have written on commons governance, digital commons governance and DAOs for commons governance, in Section 2. Afterwards, we explain how we collected literature and created a framework in a structured manner in Section 3. This is followed by the introduction of the common DAO framework in Section 4. Finally, we reflect on the limitations and real life applications of common DAOs in Section 5 and conclude this research in Section 6.

2 Theoretical background

2.1 Common resources, their tragedy, and their revitalisation

Common pool resources, common resources or commons are natural or man-made resource systems that are sufficiently large as to make it costly (but not impossible) to exclude potential beneficiaries from obtaining benefits from its use (Ostrom, 1990). Given Ostrom's background as an economist, she mentions fishing grounds, groundwater basins, grazing areas, irrigation canals, and other physical, geographic or biological world examples. But commons are not limited to the physical world, and can be contained in the digital world as well (Greco and Floridi, 2004; Gunitsky, 2015; Rozas et al., 2021a).

Commons are threatened in their existence by their particular characteristics. Hardin describes what he calls the tragedy of the commons. He invites the readers to imagine a commonly owned pasture (Hardin, 1968). Every farmer on this land will try to keep as many cows as possible. A farmer profits fully from every cow and suffers only a share of the costs of overgrazing, and, within these boundaries, will try to maximise his gain. The only rational course for every farmer is to increase his herd until the inevitable occurs: system depletion.

TABLE 1 The eight principles for successful governance of commons. The principles are identified in the works of (Ostrom, 1990) and the definitions are taken from the work of (Rozas et al., 2021a).

#	Principle	Definition
1	Clearly defined community boundaries	To define who has rights and privileges within the community, for example, to use certain resources or to perform certain actions on them
2	Congruence between rules and local conditions	The rules that govern behaviour or commons use in a community should be flexible and based on local conditions that may change over time. These rules should be intimately associated with the commons, rather than relying on a “one-size-fits-all” regulation
3	Collective choice arrangements	To best accomplish congruence (Principle 2), people who are affected by these rules should be able to participate in their modification, and the costs of alteration should be kept low
4	Monitoring	Some individuals within the community act as monitors of behaviour in accordance with the rules derived from collective choice arrangements, and they should be accountable to the rest of the community
5	Graduated sanctions	Community members actively monitor and sanction one another when behavior is found to conflict with community rules. Sanctions against members who violate the rules are aligned with the perceived severity of the infraction
6	Conflict resolution mechanisms	Members of the community should have access to low-cost spaces to resolve conflicts
7	Local enforcement of local rules	Local jurisdiction to create and enforce rules should be recognised by higher authorities
8	Multiple layers of nested enterprises	By forming multiple nested layers of organisation, communities can address issues that affect resource management differently at both broader and local levels

Scholars observed the tragedy in the energy consumption of data transport where initiators only pay a fraction of the energy costs (Costenaro and Duer, 2012), in digital information systems such as Wikipedia (Curien et al., 2006), and in the common open email communication which is then flooded with commercial spam email (Pavlov et al., 2005).

There are two traditional options for overcoming the tragedy of the commons; central regulation or privatisation (Ostrom, 1990). Both approaches end the resource’s unique shared ownership model. However, a third, less obvious, approach is possible for managing common resources by employing a community of stakeholders. Elinor Ostrom shows how commons can very well be sustained by communities, if they manage to create a particular kind of governance structure (Ostrom, 1990; Linåker and Runeson, 2022).

Ostrom describes design principles that characterise robust institutions for managing common resources. After observing successful commons, she concluded that across all those commons, there are eight shared principles. Solid successful communities adhere to these eight principles. Failed communities, on the other hand, did not adhere to those principles (Ostrom, 1990).

Since its discovery, this research has become foundational within common governance literature. It provides scholars and practitioners with a solution for the tragedy. Later, Cox et al., 2010 provided these principles with an empirical validation. The eight principles are listed in Table 1. We have chosen these principles as this article’s theoretical foundation, as others have done previously (Cila et al., 2020; Rozas et al., 2021b; Hunhevicz et al., 2022; Linåker and Runeson, 2022; Poux, 2022).

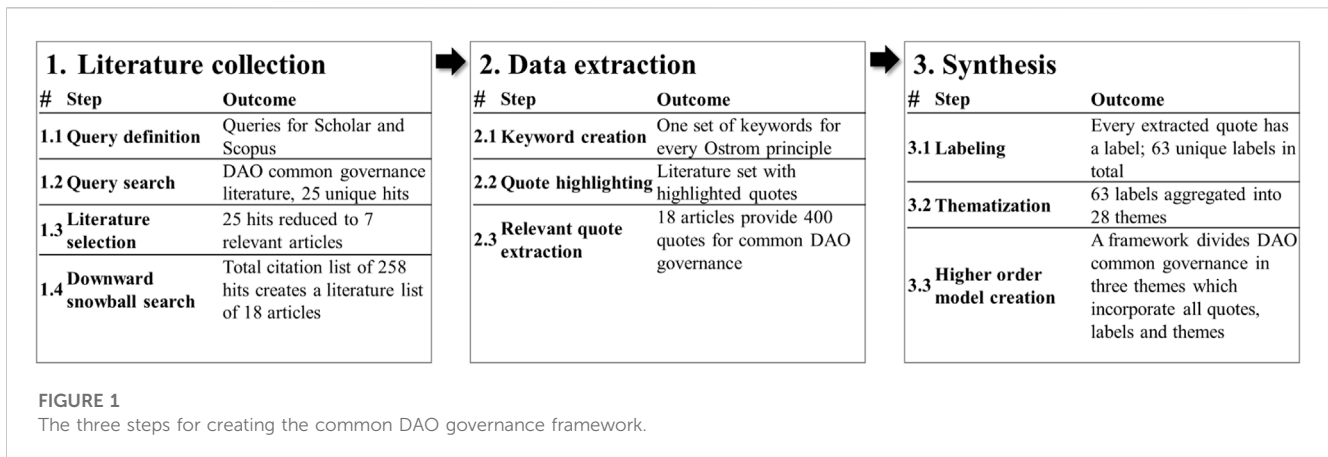
2.2 Blockchain technology and DAOs spark new interest in commons governance

In creating new organisational structures, such as decentralised organisations that govern common resources, information systems

(IS) can play a paramount role (Levy et al., 2003). The IS discipline is uniquely positioned to examine the broader implications of software development given its emphasis on the intertwining of people, process, and technology within a business and societal environment (Maruping and Matook, 2020). However, the IS investigation of commons is limited. Grant & Tan remark that it is a different kind of networked IT governance. Commons are unique because they challenge the traditional understanding of product and service delivery (Grant and Tan, 2013). They require governance that is intensive, collaborative, and often highly political with cycle times and speed of decision making longer than expected. Success depends on processes that build trust, foster collaboration, and develop relationships among entities and individual participants (Grant and Tan, 2013). Three trends within information systems that touch upon commons are the investigation of using IS for decentralisation (Mueller-Bloch et al., 2022), creating sustainability using information systems (Curto-Millet and Corsín Jiménez, 2022), and the tighter integration of community actors in digital platforms (Maruping and Matook, 2020). All three encourage combining IS with the commons and draw us to the exploration of blockchain governance.

The rise of decentralised technology created a new interest in common governance. (Fritsch et al., 2021). Davidson et al., 2016 even define blockchains as “trust-less commons in which effective rules are embedded in constitutional smart contracts that are cryptographically secure and crypto-economically implemented.” These authors remarked that the structure of these rules may be similar to the eight principles identified by Ostrom (Davidson et al., 2016). This gives rise to the hypothesis that well-governed blockchain-based communities will adhere to Ostrom’s principles.

These similarities have also been recognised by other scholars. Blockchain governance is governance where part of the decisions, votes, ownership and outcomes are registered on the blockchain or on-chain. Several articles investigate the cross-mixing potential of blockchain governance and common governance (Wright and De Filippi, 2015; Rozas et al., 2021a; Malafosse



et al., 2022). The eight principles provide guidance for successful blockchain governance. At the same time blockchain governance is a concrete application of common governance that prevents digital tragedies related to centralised infrastructure ownership. In this article we consolidate the intersection of common governance and blockchain governance by merging the already investigated similarities.

2.3 Building the bridge between common governance and blockchain governance

Nevertheless, the integration of the various components of blockchain based common governance remains unfinished. Rozas et al., 2021a; Cila et al., 2020 provide partial answers, and Hunhevicz creates a list that only partially reveals the connection between blockchains and commons (Hunhevicz et al., 2022). Furthermore, none of these authors builds a governance model for practitioners, or makes Ostrom’s principles operational for DAOs and other blockchain based communities.

With a structured method, we aim to extract more ways in which blockchain technology can implement the principles. To integrate all facets of the bridge between the fields, this article adopts the findings of the listed authors and other relevant scholars and builds the Common DAO framework.

If we succeed in building a framework that successfully interprets the Ostrom principles for decentralised technology communities, we can design DAOs that adhere to the eight principles. The governance framework provides normative interpretations on the eight principles to facilitate common DAOs. This is relevant for academics because it shows how successful common governance can be implemented in a DAO. It is relevant for society because common DAOs can help us sustain collective action and resources in a digital age. In the next section, we discuss the method that leads to a framework for designing common DAOs.

3 Research method

In this section, we discuss the method for creating the common DAO framework. This method is divided into three parts. We first

collect previous work and, afterwards extract the relevant data. The final step is combining these data into a single framework. A scheme for this method is in Figure 1.

3.1 Literature collection by query search and snowballing

To collect relevant DAO common literature, we used a twofold approach. First, we conduct a query search and afterwards a downward snowball research. This hybrid method of combining queries with snowball search is similar to (Mouroao et al., 2020). We used this combination for three reasons: first, it has a high precision of addressing relevant literature. Second, it maintains a fine balance between precision and recall (Mourão et al., 2020). Third, the novelty of the research field comes with a wide variety of used terms, which reduces the ability to rely solely on search queries. The hybrid approach overcomes this limitation. Finally, to enhance the quality of the results, we limited the findings to peer-reviewed literature, and excluded grey literature.

For the query search, the first step was designing relevant queries. To ensure the relevance of our query results to this research, we based the query components on the terms of our research question. Additionally, to maximise the literature coverage, we used the two leading search engines, Scopus and Scholar.

For Scopus, we used the query: *TITLE [(Digital OR DAO OR Blockchain) AND Commons Governance]*. For Scholar, we employed the query: *allintitle: digital commons governance OR DAO commons governance OR blockchain commons governance*. These queries yielded 25 unique results.

After querying the search engines, we excluded articles that were not relevant for this research. The exclusion criteria are: 1) not available, 2) not in English, 3) not peer-reviewed, and 4) not providing design practices for digital commons governance. In this way, the number of relevant articles was reduced to seven. On these articles, we conducted the second step of literature collection, the downward snowball search. We scanned through the entire list of articles that cite these articles. It brought a combined total of 258 hits of articles. In this list, we found

TABLE 2 The dataset with the number of extracted quotes per principle. ● means more than 5 quotes extracted, ◐ means between 1 and 5 quotes extracted, ○ means no quotes extracted for this principle. Two articles did not provide any quotes for the final framework.

#	Title	P1	P2	P3	P4	P5	P6	P7	P8	Total quotes
1	Fuster-Morell. (2014). Governance of online creation communities for the building of digital commons: Viewed through the framework of the institutional analysis and development	○	●	●	◐	○	◐	○	◐	50
2	Rozas et al. (2021a). When ostrom meets blockchain: exploring the potentials of blockchain for commons governance	◐	●	●	●	●	●	◐	◐	44
3	Petersen (2022). Automating governance: Blockchain delivered governance for business networks	●	●	◐	●	◐	●	○	◐	44
4	Linåker and Runeson (2022). Sustaining Open Data as a Digital Common–Design principles for Common Pool Resources applied to Open Data Ecosystems	●	●	●	●	●	●	◐	◐	39
5	Rozas et al. (2021b). Analysis of the potentials of blockchain for the governance of global digital commons	◐	●	●	●	◐	●	◐	●	38
6	Cila et al. (2020). The blockchain and the commons: Dilemmas in the design of local platforms	◐	●	●	◐	◐	○	○	○	37
7	Hunhevicz et al. (2022). Applications of blockchain for the governance of integrated project delivery: A crypto commons approach	●	●	●	●	◐	◐	○	○	33
8	Poblet and Sierra (2020). Understanding help as a commons	◐	●	●	●	●	◐	○	◐	30
9	Dulong de Rosnay and Le Crosnier (2012). An introduction to the digital commons: From common-pool resources to community governance	◐	◐	◐	◐	◐	◐	●	●	27
10	Poux et al. (2020). Blockchains for the Governance of Common Goods	◐	●	◐	●	○	◐	○	○	18
11	Valdivia and Balcell (2022). Connecting the grids: A review of blockchain governance in distributed energy transitions	◐	●	○	○	○	◐	◐	◐	15
12	Rozas and Huckle (2021). Loosen control without losing control: Formalization and decentralization within commons-based peer production	○	◐	◐	○	○	○	◐	◐	8
13	Jain et al. (2022). Blockchain for SME Clusters: An ideation using the framework of Ostrom Commons Governance	◐	◐	◐	○	○	◐	○	○	5
14	Howell and Potgieter (2019). Governance of blockchain and distributed ledger technology projects: a common-pool resource view	○	◐	○	○	○	◐	◐	○	4
15	Almeida et al. (2020). Digital governance and the tragedy of the commons	◐	○	○	○	○	◐	○	◐	2
16	Poux et al. (2022). Maximal Extractable Value and the Blockchain Commons	◐	◐	○	○	○	○	○	○	2
17	Murtazashvili et al. (2022). Blockchain Networks as Knowledge Commons	○	○	○	○	○	○	○	○	0
18	Poux (2022). A Unified Framework for the Governance of the Commons with Blockchain-Based Tools: An Application to Customary Land Commons in Ghana	○	○	○	○	○	○	○	○	0
	Total quotes	45	122	64	57	28	42	14	28	400

11 more articles that met the aforementioned criteria. We ended the snowball search when the search on the final article provided no more new articles. Using this saturation criterion is in line with (Wohlin, 2014). Table 2 shows the overview of the literature collection, which resulted in 18 relevant papers.

3.2 Extracting data from the literature set

After collecting the set of relevant articles, we extracted all practices that display how a DAO can implement one of the eight principles. We did so in three steps, keyword creation, quote highlighting, and extraction.

In the first step of the data extraction, we established a set of keywords for every principle in Ostrom’s work. Ostrom herself provided the first set of keywords. For example, the first principle of

“clearly defined boundaries” leads to the keyword boundary. We extended the list of keywords by manually scanning four articles for additional keywords.¹ We selected these articles from the literature set based on their alignment with the research goal and we chose commons research with diverse topics. These are Dulong de Rosnay (Dulong de Rosnay and Le Crosnier, 2012), concerning digital commons, Jain et al., 2022 for SME cluster commons, Rozas et al., 2021a, for blockchain based commons, and linåker and Runeson (Linåker and Runeson, 2022) for open data commons. Complementing Ostrom-based keywords for principle one, these articles reveal that entry barrier, membership, rights, protection and stakeholders also point to relevant quotes.

¹ The overview of used keywords is available at <https://data.mendeley.com/datasets/63bnwscghw>

After having created the keyword set, the second step was highlighting all quotes in the literature set. This was done automatically in Nvivo. We let the tool scan all documents for the keywords and let it provide a highlight on every hit. This allowed for easy extraction after the highlighting.

The final step was scanning the highlights and extracting by hand the relevant practices. We followed Kitchenham & Charters' guidelines (Kitchenham and Charters, 2007), by letting two researchers do the practice adoption. We adopted every highlight that is a normative description of commons governance. We excluded highlights that do not describe commons governance or are unclear. Some quotes were a citation to another article of the list. In that case, we only mentioned the quote in the original article. Additionally, two articles did not provide any practices, and were excluded from further analysis. For research transparency, we still listed them in Table 2.

This created a data set of 400 quotes of observed commons governance, divided over eight principles.²

3.3 Data synthesis for framework creation

To turn the data points into a single framework, we adopt the thematic synthesis approach of Cruzes and Dyba. We follow their three steps: 1) labelling, 2) thematization and 3) creating a higher order model (Cruzes and Dyba, 2011).

The first step, labelling, is to create groups of similar quotes in the 400 quote data set based on their characteristics. We used a method that Cruzes & Dyba call an integrated approach, which provides freedom to interpret findings within the boundaries of an established framework. It combines deductive and inductive approaches when labelling data. The deductive element is adherence to the eight principles. As a result, every label falls within a single principle. The inductive part is that per principle, we assigned codes that reflected the emerging concepts in the data. Every data point was compared to all previously created labels and could fall in one of them. When none of the previously created labels would match the data point's content, we created a new label. In total, we created 63 labels.

In the second step, thematization, we aggregated the labels into themes. Themes are abstract entities that bring meaning and identity to a recurrent experience and its variant manifestation (DeSantis and Ugarriza, 2000). Initially, we suspected that our themes would align with the eight principles. However, we soon realised that the underlying labels concerned varied topics and a different thematization would be more clear. For example, principles 4, 5, and 6 all have underlying labels about smart contracts. Rather than having to discuss smart contracts within every principle, we chose to aggregate these labels in a different overview. We created cross-principle themes by combining labels that together form an overarching theme, such as the themes subcommunities, constitutional rules or resource monitoring.

The final step of the synthesis is the creation of a higher order model (Cruzes and Dyba, 2011). Within literature, we could not

find a division of governance by a common DAO that adequately encompasses all elements that this investigation discovered. Therefore, we created one ourselves. It divides common DAO governance into three governance areas: 1) Governance structure, 2) Enabling technology, and 3) Community governance. These three governance areas collectively contain all the themes. It provides a structured classification of all the governance elements of common DAOs. In the next section, we explain the division between these three areas, and present the entire common DAO framework.

4 Results

We use this results section to describe how a common DAO can implement the eight Ostrom principles. We present our results in the form of a framework, the common DAO framework. This results section is divided into three parts. We first describe the purpose and need for this governance framework. We make several comments on how the results can be interpreted before describing our framework. Second, we describe the governance mechanisms for DAOs that we distilled from the literature.

4.1 The purpose and content of the common DAO governance framework

The common DAO framework is a normative framework. It describes what a common DAO should do to achieve governance that maintains collective action and sustains the commons.

The framework elements are generic and normative interpretations of the Ostrom principles. When we state that a DAO should adhere to a governance element we mean: a common DAO that adheres to all the governance mechanisms described in the framework, will probably perform better than the same DAO that does not adhere to the elements. This research is based on the findings of Ostrom and the cited authors, which will later be complemented with empirical research.

In describing the framework elements, we chose a middle point between providing details of common DAO governance and being concise and relevant for all common DAOs. We have drawn a schematic overview of Common DAO governance in Figure 2. We add a definition of key concepts from this overview in Table 3. The definitions have been derived from the literature sources, and we added several synonyms that we observed.

We cannot claim completeness of this framework for three reasons. One, this is a very new field, and because of that new, yet unforeseen results can be expected. Second, we base our results on relatively few examples of digital common and DAO common governance. When, or if, commons governance using DAOs reaches maturity, we expect other problems to rise that have not been addressed in this framework. Third, managing commons is a complex multi-disciplinary field. Addressing its governance consists of many different kinds of considerations that include, but are not limited to economy, sociology, political philosophy and technology. Because of the complexity of the subject, we do not expect to have completely covered the question of governing commons.

² The full data set is available in the same Mendeley data set.

4.2 Three governance areas of common DAO governance

In this framework, we break down the entangled concept of commons governance in three areas: governance structure, technology governance, and community governance. We have defined the three governance areas as shown in Table 3, numbered 1–3.

All relevant elements and themes have been placed within a particular governance area. There are themes that could also be part of multiple governance areas, as commons governance is an intertwined science. We put the themes in the area where they appear most relevant, and evaluated with other researchers. Nevertheless, valid arguments remain to restructure parts of the framework.

4.2.1 Governance structure as the foundation of the community

The governance structure consists of rules, processes and other aspects related to governance of the decentralised community and common resource. An overview of this area is in Table 4.

The DAO structure is grounded in a foundational document, called the constitution (#5 of Table 3 and G1 in Table 4). It plays an essential role in commons governance, but also in the application of Ostrom's principles to a DAO. The constitution should define the boundaries of the ecosystem (Linåker and Runeson, 2022), and determine who is a participant and who is not (Almeida et al., 2020; Hunhevicz et al., 2022). The constitution should be created collectively, to increase the adoption and enforcement of it (Poux et al., 2020), or at least by a consortium of actors closest to the core of the community (Linåker and Runeson, 2022; Petersen, 2022). From a commons perspective, the constitution should define at least three governance aspects. First, the duties, roles and processes of monitoring (Dulong de Rosnay and Le Crosnier, 2012; Poux et al., 2020) should be defined, and it should contain access rules (Fuster-Morell, 2014). Second, the constitution should describe expected behaviour, and the graduated sanctions & escalation protocol (Dulong de Rosnay and Le Crosnier, 2012; Petersen, 2022). Finally, it should describe conflict resolution; its mechanisms, processes, rules and actors (Howell and Potgieter, 2019; Linåker and Runeson, 2022; Petersen, 2022). There are two additional mechanisms that aid in creating a stable common DAO: External recognition and the creation of subcommunities. The constitution should be recognised by a national government or a state (Dulong de Rosnay and Le Crosnier, 2012; Howell and Potgieter, 2019), which helps in legal enforcement, public discussion and recognition. It remains unclear how stateless or cross-national commons can achieve legal recognition. Finally, the constitution should allow for the creation of sub-communities, by allowing subsidiarity and governance on several levels (Rozas et al., 2021b). The constitution should leave space in its jurisdiction that can be filled at lower levels (Petersen, 2022).

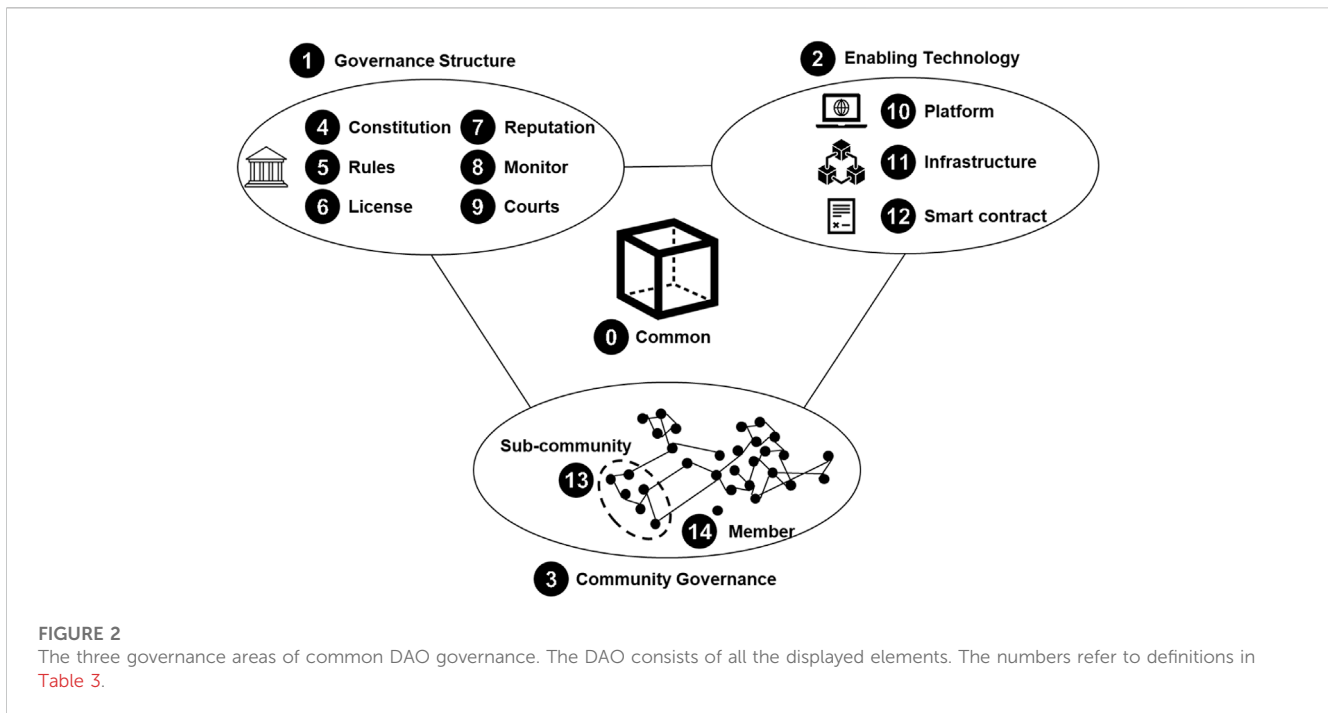
The constitution is further detailed into rules (#6 in Table 3 and G2 in Table 4). Ostrom makes a distinction between collective choice rules and operational rules (Ostrom, 1990). In this article, we take these together because the abstract nature of this

investigation limits our enquiry into operational rules. Nevertheless, the observed articles detail how the principles can be applied to DAO rules. The rules should guide member interaction with resources and be easily upgradeable, as described in (Rozas et al., 2021a; Hunhevicz et al., 2022). They should also be automatically enforced where possible and cover both on-chain and off-chain governance, as outlined in (Poux et al., 2022). The rules should incentivize all common interactions, including care tasks, conflict management, and event organisation, by creating a protocol for rewarding value-adding activities (Cila et al., 2020). The value for activities that are not yet rewarded should also be determined through a protocol (Cila et al., 2020). The rules should guide the monitoring process, including how to handle actors who use more resources than agreed or expected, and proof of information could automate monitoring while preserving privacy (Poux et al., 2020). Penalties for violations should be established, including warnings, reputation loss, capping rules, loss of privileges, access revocation, and temporary or permanent bans from the community (Dulong de Rosnay and Le Crosnier, 2012; Poblet and Sierra, 2020; Rozas et al., 2021a; Rozas et al., 2021b; Linåker and Runeson, 2022). Sub-communities should also have the ability to create rules that deviate from the standard, increasing their flexibility or allowing adherence to local legislation (Rozas et al., 2021a).

Finally, rules for particular actions should be in place. Specific rules should be implemented for creating negotiation space, assigning delicate tasks to members, revoking privileges, assigning penalties, distributing decision rights, managing accountability, incentivising tasks, creating hierarchical structures, assigning responsibilities, incentives, memberships, communication among stakeholders, decision making, and implementing a kill-switch (Cila et al., 2020; Poblet and Sierra, 2020; Valdivia and Balcells, 2022).

For achieving collective action, the governance structure of a DAO should have three types of processes: for rule design, conflict resolution, and monitoring.

The process for designing the above-described rules should be a collective effort (G3). The community can add new rules, or make amendments to the existing rules (Cila et al., 2020). Four phases should be present in designing rules. First, there should be a dialogue process where members can discuss how rules should be changed (Linåker and Runeson, 2022). Then follows the second phase of proposal creation (Dulong de Rosnay and Le Crosnier, 2012; Poblet and Sierra, 2020) and third, a discussion of proposals. This should include the ability to modify other member's proposals. (Dulong de Rosnay and Le Crosnier, 2012). Fourth, members vote, and the more important the decision, the higher the quorum should be (Fuster-Morell, 2014). All four phases should be transparent (Fuster-Morell, 2014; Poblet and Sierra, 2020), preferably by on-chain enforcement using smart contracts. Tools that automate the decision making process should be used, such as automatic checking whether a proposed rule conflicts with the constitution (Poblet and Sierra, 2020). Voting can be in a standard democratic way, or in flexible methods such as quadratic voting or conviction voting (Hunhevicz et al., 2022). The members should decide how tasks are carried out, as they are the closest actors and the biggest stakeholder (Rozas et al., 2021a; Hunhevicz et al., 2022). Not everyone has to participate in the



creation of every rule, only those that are affected by its outcomes (Cila et al., 2020; Poux et al., 2020; Linåker and Runeson, 2022). Experts or other elected leaders should participate or be given special voting rights in designing rules (Hunhevicz et al., 2022; Linåker and Runeson, 2022).

The DAO should have a conflict resolution process (G4) (Fuster-Morell, 2014; Linåker and Runeson, 2022; Petersen, 2022). Conflicts should be first handled on a local level, but there has to be a possibility to escalate (Rozas et al., 2021a). Members should craft clear dispute resolution strategies intended to avoid costly litigation proceedings (Hunhevicz et al., 2022). Tools should be used to standardise conflict resolution (Rozas et al., 2021a). An independent third party can act as a juror for managing conflicts (Poblet and Sierra, 2020). Finally, the community can create transparency over conflict resolution by creating two lists: first, a list of potential conflict scenarios and their resolution. This aids in transparent conflict resolution (Rozas et al., 2021a; Petersen, 2022). Second, the community should create a list of graduated sanctions that are recognised within the community (Poblet and Sierra, 2020; Linåker and Runeson, 2022). Unique to DAOs are sanctions like exclusion to voting rights, token slashes and social sanctions based on the transparent data (Hunhevicz et al., 2022).

The final process that should be designed is monitoring (G5). The articles do not provide concrete steps that should be followed. However, they do give several principles that should be incorporated. First, the common should be monitored by the community itself. Frequently, this will happen through the election of monitors (discussed in Section 4.2.3) (Linåker and Runeson, 2022). These monitors should overview the activities of individual members. Monitoring concerns both the production and extraction of resources (Linåker and Runeson, 2022). Monitoring can also be of other member activities, such as forum posts (Poblet and Sierra, 2020). Members should be able to assess if they are treated fairly (Cila et al., 2020).

Besides rules and processes, there are several other governance aspects which have to be considered. We list three aspects: external connections & legal adherence, licenses, and currency.

The common and its community should be designed with external connections in mind (G6). Public sector actors should be included in the community to ensure adherence to laws and regulations from external authorities. These actors include local government agencies, civil society, research institutions, and non-governmental organisations (Ostrom, 1990; Grafton, 2000; Cila et al., 2020). The constitution, rules, licenses, and smart contracts should all comply with legal frameworks to ensure the DAO is operating within the bounds of the law (Dulong de Rosnay and Le Crosnier, 2012; Rozas et al., 2021b; Linåker and Runeson, 2022). Not only legal frameworks should be considered, but also the digital culture, technological constraints, and standards (Fuster-Morell, 2014). To further strengthen legal adherence, the DAO structure, its constitution, rules, and smart contracts should be legally recognised. This would set the path for making smart contracts legally enforceable (Howell and Potgieter, 2019) and create flexible frameworks for decentralisation, which is currently a challenge for the DAO structure (Valdivia and Balcells, 2022).

Licenses play a crucial role in establishing a formal relationship between communities and their members (G7). These licenses define the rights and limitations of users (Rozas et al., 2021b) and the methods by which members can extract or add value to the community (Linåker and Runeson, 2022). Existing DAOs, such as dOrg, use a smart contract to show that users adhere to the constitution (van Vulpen et al., 2022). Licenses should be tailored to the specific needs of different stakeholders, by differentiating them based on factors such as commitment, financial strength, business nature, or geography (Rozas et al., 2021a; Linåker and Runeson, 2022). In some cases, specific licenses can also promote the participation of minority groups (Valdivia and Balcells, 2022). The

TABLE 3 Key common DAO concepts with their definition. The definitions are derived from the literature. The numbers refer to the schematic overview of common DAO governance.

#	Concept	Definition	Observed synonyms
0	Common	A resource that is used, owned and accessible by a community for a specific purpose	Ecosystem, resource
1	Governance structure	The system of rules and processes that direct and control the operation and management of a decentralised community and common resource	-
2	Enabling Technology	The set of independent and open-source software tools and technology that support the creation and management of a decentralised community, its governance, and common resources	-
3	Community Governance	The process of forming a social, economic, or political community and foster a sense of belonging, identity, and shared purpose among its members	Whole ecosystem governance
4	Constitution	The governing document that establishes a community’s principles and policies, governance structure, procedures, objectives and goals and defines member rights and responsibilities, scope of authority and responsibilities	Vision and goal document, Ecosystem vision, Policy, Shared mission, Social contract, Charter, Commons goal document
5	Rules	Regulations that specify the actions and interactions of the community and community members	Governance mechanisms, Norms, Policy
6	License	A mutual agreement between an individual and the community that the individual is a member and accepts the rights & duties that come with it	Contract
7	Reputation	The implicit or quantified perception of a member within the community	Trust
8	Monitor	A member or group of members responsible for monitoring the community’s and individual adherence to the constitution and rules	Administrator, Quality assurance role, Moderator
9	Courts	A group of members authorized to solve conflicts within the community	Independent body, Conflict arena, Jury
10	Platform	The hardware and software structure that enables participants to interact with the decentralised infrastructure, create and deploy smart contracts, communicate, collaborate and make decisions within the community and which provides a unified user experience	-
11	Decentralised infrastructure	An infrastructure where hosting of data, services and decision making is spread across a network of nodes, thereby eliminating the need for a central authority	-
12	Smart contracts	A self-executing blockchain script that enforces the constitution and rules of a community	-
13	Sub-community	A subset of the larger community that is defined by a particular characteristic such as geography or work	Nested enterprises, Polycentricity, Groups, sub-projects, work groups
14	Member	Individual who belongs to a community, have rights and responsibilities within it, are impacted by its decisions and actions, and contribute to its goals and objectives	Participants, Extractors, Individuals

design of licenses has a significant impact on the composition and wellbeing of the community. Therefore, they should be created with consideration for the limits of the common resource and the number of licenses should be limited to prevent overconsumption (Linåker and Runeson, 2022). Additionally, the distribution of licenses should align with natural human community boundaries (Poblet and Sierra, 2020). Unauthorised access to the resource by unlicensed individuals should not be allowed (Poblet and Sierra, 2020; Petersen, 2022). Ultimately, licenses should provide sufficient flexibility and freedom for participation, thereby fostering a positive community dynamic (Fuster-Morell, 2014).

The final governance mechanism is the currency (G8). Currencies have many uses in structuring the internal economy of the community. For common DAO governance, we observed three applications. A community currency can quantify the economic relations and activities that occur around the common (Cila et al., 2020). The DAO should, however, avoid quantifying all contributions, as that can disrupt community relations. Augmented Bonding Curves may

aid in creating stable currencies (Hunhevicz et al., 2022). Furthermore, the currency can be used to create a collective choice in the community and provide liquid voting (Rozas et al., 2021a). Finally, through currencies, common DAOs can provide members a quantified and modular access to the common resource & community (Rozas et al., 2021a; Hunhevicz et al., 2022). Other uses for the currency can be thought of, but are beyond the scope of this article.

4.2.2 Technology as the enabler of the governance structure

Technology enables members to interact with each other and with the common. Members should therefore have an application that enables interaction with the platform. The platform allows interaction with the common, pushes data to the decentralised infrastructure, and enables creation of smart contracts. The overview of normative principle interpretations is in Table 5.

The first guideline of Ostrom’s principles for the decentralised application is that it should facilitate all governance decisions,

TABLE 4 Governance structure for a common DAO.

Governance structure	#	Normative principle interpretation
Constitution	G1.1	The constitution defines the boundaries for the common (P1)
	G1.2	The constitution is created by the entire community (P3)
	G1.3	The constitution describes the rights and processes of monitoring (P4)
	G1.4	The constitution describes the sanctions and escalation protocol for violations (P5)
	G1.5	The constitution describes conflict resolution mechanisms (P6)
	G1.6	The constitution is legally recognized by governmental authorities (P7)
	G1.7	The constitution allows for the formation of sub-communities (P8)
Collective choice and operational rules	G2.1	Create specific operational governance rules (P2)
	G2.2	Establish rules for how the community interacts with the platform and the common (P2)
	G2.3	Ensure that all interactions with the common are properly incentivized (P2)
	G2.4	Set concrete policies for monitoring (P4)
	G2.5	Set concrete sanctions for violations (P5)
	G2.6	Create flexibility in rules for subcommunities (P8)
Processes for rule design	G3.1	Let the members participate in the creation of rules (P3)
	G3.2	Establish appropriate dialogue processes for changing rules (P3)
	G3.3	Ensure that rule design matches the commons (P2)
	G3.4	Create participation in rule execution (P3)
Processes for conflict resolution	G4.1	Establish a conflict resolution process (P6)
	G4.2	Let an independent third party acts as a jury (P6)
	G4.3	The community collaboratively developed a graduated sanctions list (P5 &P6)
Processes for monitoring	G5.1	The common is monitored by the community (P4)
	G5.2	Monitor the impact of rules on the common resource (P4)
External connections & Legal adherence	G6.1	Ensure engagement with public actors by periodic contact (P7)
	G6.2	Integrate public actors into the common (P7)
	G6.3	Ensure the adherence to legal framework of the governance rules (P7)
	G6.4	The common is integrated in its virtual spheres, digital culture, and legal frameworks (P2)
Licenses	G7.1	Determine who can become a member of the community (P1)
	G7.2	Licenses should describe the members that participate in the DAO (P1)
	G7.3	The license describes the relationship between members and the common (P2)
	G7.4	The permissions and rights per user are configured in the platform (P1)
Currency	G8.1	A common currency structures interaction with the common and the community (P2)
	G8.2	The currency facilitates the establishment of a collective choice (P3)
	G8.3	Use tokens to determine the boundaries of the community (P1)

processes, and rules (T1). It must also show which members can access the resource and which rights they possess (Petersen, 2022). The decentralised application should be used to provide additional transparency. Rules for governance, monitoring, management, administrative procedures and maintenance protocols should all be published to the blockchain (Poux et al., 2020), in part encoded in smart contracts.

The decentralised application should provide data to aid the governance processes of monitoring and conflict resolution (T2). Transparent records and oracles complement existing community data, making it accessible to monitors and perhaps even the community as a whole (Rozas et al., 2021b; Hunhevicz et al., 2022; Petersen, 2022). Data monitoring, including metadata and API calls, should be automated and aided by tooling (Rozas et al., 2021a; Rozas

et al., 2021b; Linåker and Runeson, 2022). Automatic monitoring can also support adherence to legal requirements such as AML and KYC (Petersen, 2022). In conflict resolution, the technology should provide the jurors with an overview of the actions of the conflicting members. This can be a scanned overview of forum posts and transaction histories (Rozas et al., 2021a; Petersen, 2022). Petersen predicts that transparency in transaction history will reduce the number of conflicts (Petersen, 2022).

The decentralised application should provide members with easy access to the resource (T3). According to Morell (Fuster-Morell, 2014), members should have various ways to access the platform. Furthermore, the platform should be open to various types of members as stated by (Jain et al., 2022). Communities should consider the diversity of its member base in providing access to both young and older organisations and balance between different types of technology. To accommodate the members, asynchronous participation should be facilitated (Fuster-Morell, 2014).

A decentralised application for DAOs should prioritise the availability of information for its community members (T4). This ensures that all members are kept informed and have access to necessary information (Jain et al., 2022). One way to achieve this is through the creation of a forum for discussion and engagement within the community. Discord and Slack are frequently used online forum tools. A forum can also serve as a platform to discuss and resolve conflicts, as the first step of conflict resolution is often a public discussion (Dulong de Rosnay and Le Crosnier, 2012). By holding discussions in the open, community members can hold each other accountable and ensure respect of the rules. Moreover, the use of polls and voting in the forum can aid in decision-making and help to engage the community in finding solutions to conflicts (Fuster-Morell, 2014; Hunhevicz et al., 2022).

The creation of sub-communities (T5) is a crucial aspect of the DAO's decentralised application design and is both a constitutional and technical aspect. From a technical standpoint, the application should provide modular access to resources and allow for the division of work into smaller, manageable chunks that can be spread across sub-communities (Fuster-Morell, 2014). The technical configuration can lead to flexible nesting, as demonstrated by Poblet (Poblet and Sierra, 2020), who showed how geographic proximity leads to automatic division in sub-communities. To ensure that sub-communities can effectively use their own tooling, a community should design its application to be flexible and accommodate sub-projects within other commons (Rozas and Huckle, 2021). However, if the facilitation of sub-communities is lacking, the risk of forking increases. Forking allows the community to move the project elsewhere and puts pressure on the members with more power to act in a responsible and legitimate manner (Fuster-Morell, 2014). This encourages leaders to distribute and limit power (Rozas and Huckle, 2021). The transparent nature of blockchain provides sub-communities with more possibilities to fork the project, but the question remains whether this is an action that a community should encourage (Rozas et al., 2021b). Ultimately, while communities must be open to internal-sub groupings, there may be scenarios where division into independent commons with a narrow focus is more suitable (Linåker and Runeson, 2022). Further investigation of the effect of forking on communities is beyond the scope of this article.

Both the application and the blockchain infrastructure should facilitate the codification of governance mechanisms into smart contracts, which bring automatic and tamper-proof execution of governance rules (T6). Smart contracts provide transparency and decentralised enforcement of rules in five areas of common governance.

1. Smart contracts are a powerful tool for regulating access rights to the common and the behaviour of members (Poux et al., 2020; Petersen, 2022). They can encode boundaries, roles, and choices (Poux et al., 2020). The license can be signed on-chain and automatically give predefined rights using smart contracts (Hunhevicz et al., 2022; Petersen, 2022).
2. Smart contracts can also be used to govern community member interactions with the common resource (Cila et al., 2020; Jain et al., 2022). They can automate payments and enforce a standardised format for negotiations (Cila et al., 2020) and tokenise the value of the common resource (Jain et al., 2022). Formalising appropriation and provision rules in smart contracts ensures adherence to the agreements (Hunhevicz et al., 2022).
3. Smart contracts can replace manual monitoring (Rozas et al., 2021a) and add automatic rule violation recognition (Rozas et al., 2021a). They can monitor whether members carry out behaviour in line with the constitution (Rozas et al., 2021b), monitor transaction values for values outside the expected range (Petersen, 2022), and establish systematic monitoring of regulatory compliance (Petersen, 2022).
4. Smart contracts can automate sanctions (Rozas et al., 2021b) and encode them transparently within the community. The escalation path may also be supported by smart contracts (Rozas et al., 2021b).
5. Smart contracts can reduce the need for conflict resolution by providing transparent contractual agreements (Petersen, 2022). They can standardise the procedures for dispute resolution (Poux et al., 2020) and reduce disagreements by on-chain dispute resolution contracts (Hunhevicz et al., 2022; Valdivia and Balcell, 2022).

These five applications show how smart contracts contribute to a stronger governance structure by creating transparency and immutability. Other uses can be thought of as well, but were not observed in the articles.

4.2.3 Community governance

Finally, there are aspects of DAO common governance that are related to the governance of the community itself. The community has unique characteristics that have to be prepared for successful governance. It consists of nurturing a culture, establishing roles and facilitating sub-communities. The overview is in Table 6.

To build a thriving common DAO, the culture within the community must be prepared for decentralised governance (C1). The demands placed upon participants in a decentralised and self-organised community are bigger than in a centralised organisation. Hence, a culture that fosters participative behaviour needs to be nurtured. Community members should exhibit a willingness to engage in negotiation and discussion, fostering an environment that supports collaboration (Cila et al., 2020). To strengthen the culture, a set of norms should be established by the community and accepted by its members, with the community showing a willingness to abide by self-defined rules (Cila et al., 2020; Poblet and Sierra,

TABLE 5 Enabling technology for a common DAO.

Enabling technology	#	Normative principle interpretation
Alignment with governance	T1.1	The platform should facilitate all governance decisions, processes and rules (P3)
	T1.2	The platform creates an overview of common governance (P1)
	T1.3	Use the blockchain infrastructure for making governance transparent (P2)
Data	T2.1	Monitoring data is visible for the community (P4)
	T2.2	Data is automatically monitored by the community (P4)
	T2.3	Data is automatically used in the conflict resolution process (P6)
Access to the common	T3.1	The platform provides access to the common resource (P2)
	T3.2	The platform facilitates collective choice agreements (P3)
Community participation forum	T4.1	Communication channels ensure member access to accurate and relevant information (P1)
	T4.2	The forum is used to solve conflicts (P6)
Facilitate sub-communities	T5.1	Ensure sub-communities have technological autonomy (P8)
	T5.2	Allow for the forking of sub-communities (P8 & P3)
	T5.3	Create modular access to commons for division across sub-communities (P8)
Smart contracts	T6.1	Smart contracts determine access rights, roles and boundaries for the common (P1)
	T6.2	Smart contracts for governance participation of the common are in place (P2)
	T6.3	Smart contracts for automatic monitoring are in place (P4)
	T6.4	Smart contracts for automated sanctions are in place (P5)
	T6.5	Smart contracts for contractual obligations are in place (P6)

2020). The culture is best nurtured by physical meetings (Fuster-Morell, 2014). Physical meetings should be localised and adapted to the members’ preferences, allowing for greater engagement and participation (Rozas and Huckle, 2021). Furthermore, these events should be easily reproducible and spreadable, promoting the growth and expansion of the community (Rozas and Huckle, 2021). Finally, the DAO should aim to make participation accessible to everyone who wishes to participate, regardless of their technical skills or physical abilities (Fuster-Morell, 2014).

Next to the culture, the common DAO should assign roles to perform particular tasks in the community (C2). Without giving members certain permissions and rights, the common can become an anarchy (Ostrom, 1990). Two roles can be observed in thriving commons: jury members and monitors. The jury is an independent body that serves as a neutral ground for conflict resolution (Linåker and Runeson, 2022). A part of the members should take part in this body, which should be a common space where conflicts can be resolved (Jain et al., 2022). The jury is aided by the tamper-proof transaction history provided by smart contracts. The jury should represent all member groups (Linåker and Runeson, 2022) and publish verdicts on-chain (Rozas et al., 2021b). There should also be a process to remove a jury member in case of misbehaviour (Rozas et al., 2021b). Finally, jury members should rotate for impartiality (Linåker and Runeson, 2022). The other role, the monitors are members that track the community’s and its members’ behaviour and adherence to rules (Linåker and Runeson, 2022). Monitors should be elected by the community and be accountable to all members (Ostrom, 1990). They should be well-connected in the

community (Linåker and Runeson, 2022). Monitors should investigate resource production and extraction (Linåker and Runeson, 2022). Finally, monitors should supervise smart contracts and algorithmic decisions (Cila et al., 2020) and have monitoring tools (Poux et al., 2020).

The facilitation of sub-communities is the final aspect of community management (C3). The overarching community may set boundaries, such as geographical boundaries or a division into working groups or projects to create sub-communities (Fuster-Morell, 2014; Rozas et al., 2021b). Flexibility in management layers can nurture the creation of natural governance, as recognised by (Valdivia and Balcell, 2022). Sub-communities should have a certain degree of independence from the overarching community. This allows for independent coordination, monitoring, verification and transfer of value and resources (Rozas et al., 2021a). Community standards can support this cooperation (Dulong de Rosnay and Le Crosnier, 2012).

A hierarchy of juries is another important factor in creating subsidiarity between layers (Rozas et al., 2021b). Mini courts aided by smart contracts for tamper-free transaction histories could rapidly resolve conflicts (Hunhevcz et al., 2022). These local courts should have the ability to escalate to a central entity (Dulong de Rosnay and Le Crosnier, 2012; Linåker and Runeson, 2022).

Adhering to local jurisdiction is easier for local nodes, which can be facilitated by creating national associations per country within the community (Rozas et al., 2021a). Rules that have proven effective in one sub-community should be transferred to similar sub-communities (Poblet and Sierra, 2020).

TABLE 6 Community governance for a common DAO.

Community governance	#	Normative principle interpretation
Culture	C1.1	Nurture a culture for decentralised governance (P2)
	C1.2	Provide equal participation opportunities for all member (P3)
Roles	C2.1	Elect members into juries (P6)
	C2.2	Elect members as monitors for the resource (P4)
Subcommunities	C3.1	Create boundaries that divide the community into sub-communities (P8)
	C3.2	Ensure interoperability between sub-communities (P8)
	C3.3	Create a hierarchy of courts to solve conflicts (P6)
	C3.4	Ensure that local nodes adhere to local jurisdiction (P7)

5 Discussion

While we are writing this article, several scholars have expressed their scepticism about DAOs. For example, the empirical analysis of Feichtinger et al., 2023 shows that existing DAOs do not live up to their promises. They are characterised by a high degree of centralised ownership, high costs for on-chain transactions, and many pointless transactions. Furthermore, one of the essential features of a DAO, its tamper-proof voting system, may not be as safe as originally envisioned. In fact, Park et al. state that blockchains do not solve existing security risks of online voting, and may introduce additional problems (Park et al., 2021).

We are not sure whether these criticisms address the technical execution of the current generation of decentralised technology or whether they address fundamental issues that should end this decentralised technology research field. To support the case of the former, in writing this article, we did not observe a fundamental barrier why DAOs cannot make a major contribution to commons revitalisation. We substantiate this claim by discussing the results of this research, their implications for theory and practice, the limitations of these results and ultimately, the directions for further research.

5.1 Results of this study: three areas of DAO governance and the governance framework

Several other frameworks already describe governance practices for DAOs. Kondova & Barba already provide a sketch of a governance structure (Kondova and Barba, 2019). The mechanisms of Hunheviz et al. and the affordances of Rozas et al. clarify governance mechanisms for Common DAOs already. Furthermore, the DAO canvas already concretely shows the issues that practitioners face.³

To complement these findings, this framework explicitly lists the requirements a common DAO should meet to create collective action, and thereby bring together a community towards a

common purpose. By deducting normative principles for common DAOs, we can much more concretely describe the application of DAOs than the aforementioned articles.

But once its value becomes clear, we have to define prerequisites for achieving that value. A common DAO has to nurture governance in three areas to create collective action. The governance structure, the enabling technology and the community governance together determine a DAO's ability to build a community. For this moment, we leave aside a final determinant, legal considerations. These will be addressed in the final section of this discussion.

We aid common DAOs in designing their three governance areas by providing the normative principle interpretations. A DAO that adheres to the normative interpretations will be able to design its three governance areas well. Once the structure is set, the technology in place and the community prepared, a common DAO has the ability to successfully govern a common.

5.2 Implications for theory and practice

Putting DAOs and blockchains at the service of the common good has three implications for theory. First, it offers an answer to the prevalent scepticism about blockchains. Blockchains have been lauded as no longer needing third parties to execute, verify and settle transactions (Halaburda, 2018). However, the need for trust is not removed, but relocated. Instead of the third party, we now have to trust the community network to collaborate and facilitate interactions. If we lose the trust and sense of community, we lose the benefits of decentralisation, as de Filippi shows (De Filippi, 2019). Therefore, not wanting to risk losing the advantages of decentralised technology, means that its applications have to bring a community together. But applications that bring a community together must share a collective goal, the good in common. Therefore, if an application does not set a common goal for a common resource then blockchains and DAOs are useless.

We suspect that the framework of this article can be applied by any community ready for technology to create collective action. We thereby exclude resources that lack a clear community collaboration, resources that are not commons, and resources where digital technologies have no purpose. This is similar to (Bettega et al., 2022). For all other common resources, a DAO may offer a solution in creating an adequate governance structure enabled by

³ The DAO Canvas is a result of the collaborative work by members of the Genesis DAO: <https://daocanvas.webflow.io/>

technology. In many cases, financial or practical reasons may still hinder the application of the DAO, but these remained beyond the scope of this paper.

Managing the decentralisation is crucial for blockchain integrity and a key factor if blockchain is to fulfil its promise of removing trusted third parties (Mueller-Bloch et al., 2022). We complement the findings of Mueller-Bloch et al. who investigated decentralisation of decision-making power by providing a holistic perspective of decentralised governance. Sustainability of a common is much more a strategic concern than the result of a process of resource accumulation within projects (Curto-Millet and Corsín Jiménez, 2022), which we saw reflected in the integral requirements that the framework calls for. Commons are driven by small actors, which often lack resources to adopt complex information systems (Levy et al., 2003). The current complexity of adopting DAOs therefore brings an impasse. Namely, the benefactors of decentralised governance, small stakeholders, are unable to adopt the technical infrastructure needed to ensure decentralisation. We hope that ongoing development can commodify DAOs and thereby enable adoption by SMEs and individuals. This would bring another new form of collaboration enabled by digital platforms (Maruping and Matook, 2020), ready to be investigated by IS scholars.

For DAO building communities, adherence to the principles of this article aids them to create collective action. These principles can be applied in a top-down or a bottom-up approach. Although top-down designs may be structured and efficient, they come with the risk of not being adopted by the community. Therefore, Clohessy & Acton, and Lustenberger et al. state that without a widespread distribution of knowledge, and a bottom-up approach, the implementation of a blockchain based system will likely not succeed (Clohessy and Acton, 2019; Lustenberger et al., 2021). The only way to create collective action in a DAO is through sharing of best practices and a bottom-up approach built on cooperative knowledge production, conclude (Alessie et al., 2019). We therefore remark the tension of designing an apparent top-down governance structure, which can only become effective when adopted bottom-up. Progressive decentralisation could be a third way to create a community, and has been described by (Miller, 2020).

For practitioners, the results of this paper have two implications. First, the governance areas and their normative principle interpretations can help DAO practitioners to reflect whether their governance adequately covers all three areas. If not, they can use the interpretations to build a stronger governance for their DAO. Second, for innovative practitioners eager to use decentralised technology to solve societal challenges, the playground example shows how collective action can be facilitated through technology. This can help to identify other situations where a DAO can help. To give further guidance in identifying common resources that can be managed by a DAO, we soon publish an article where we detail the resource types that are well-suited for DAO governance.

5.3 Limitations of this research

In carrying out this research, we made several choices that come with limitations. In this section, we address five limitations of this research approach, and list the mitigating measures we adopted.

We evaluated the validity of our method for measuring DAO commons governance and considered other potential research methods. However, given the nascent nature of DAOs for commons governance, none of the current methods sufficed, and we designed a systematic approach to identify articles and extract relevant data. We used a query and snowball search to identify previous findings, and ensured the query aligned with our research question.

Secondly, while some of the articles address the specific context of DAOs, most of the literature focuses on the broader topic of digital commons governance. Therefore, it may not be entirely accurate to generalise all the findings to DAOs. Despite this limitation, we have chosen to interpret all the results within the context of a DAO. We believe that if a principle applies to an information system, it should also apply to a DAO. Hence, we can leverage the insights from digital commons literature to extract common principles for DAOs.

Third, once the articles were selected, we had to extract the findings. Incorrect extraction harms the construct validity of the framework (Sjøberg and Bergersen, 2021). We mitigated this with automatic quote highlighting and manual selection & extraction similar to the work of Marshall & Brereton (Marshall and Brereton, 2013). This design enabled data extraction in an objective and standardised structure. From the created lists of all mentions of a principle, we could extract the quotes that made a normative claim about common DAO governance. This prevented the data set from becoming cluttered.

Fourth, we had to merge the data points into a single framework. Incorrect merging harms the quality of the delivered artefact. We mitigated this by following a structured process. We adopted the process of labelling, thematization, and higher-order model creation to iteratively integrate all elements in the model. The method is derived from (DeSantis and Ugarriza, 2000). During the synthesis, we realised that adherence to the eight Ostrom principles was too rigid and that a simpler model would be possible. Instead, we built the model comprising of the three governance areas. The simpler model came with the consequence of manual interpretation where every data point would fit. However, the simplicity of the outcome was worth the sacrifice to strict procedural rigidity.

Finally, several parts of this method required manual activity by the researchers. Manual labour may harm the reliability of this research as it introduces subjectivity. We standardised and structured the research as much as possible. We still required manual activity in selecting articles from snowballing, extracting the concepts, creating higher-order themes, and fitting the themes in the three governance areas. To ensure reliability and mitigate researcher bias, we took five measures. A) The used standardised methods have been meticulously followed in the process. B) We published the concepts that we identified as synonyms in Table 3. C) We extracted data following the predefined structure of Ostrom's principles, which minimised our interference in selecting quotes. D) Every step was done by two researchers, which reduced subjectivity (Kitchenham and Charters, 2007). E) The overview of the data collection and synthesis can be reviewed and validated, as it is available on Mendeley.⁴

⁴ <https://data.mendeley.com/datasets/63bnwscgwh>

5.4 Research field observations and suggestions for future research

During this research, we made two observations that can help the research field mature. Table 3 shows that there is a wide variety of definitions in this research field. Many terms require further definition. For example, it is not clear what the role of a constitution is or what is defined by infrastructure in the context of common DAOs. We brought together the various terms that are used in the article set, standardised them, and provided a definition. Our provided sketch of definitions can be used for further work, but we await further research towards standardising those terms. Rikken et al. already carried out similar work to create a standard definition for DAOs (Rikken et al., 2021).

Secondly and more integral to this work, the process of establishing a community through a DAO, and the accompanying decentralisation, is not yet realised. The only article worth mentioning here is the work of which is a description of the process of setting up a single DAO (Schot et al., 2022). DAO launch research would integrate the social, technical and organisational activities and order them. The articles in scope did not provide any guidance on these processes, because, apparently, our research field has not described these processes yet.

Next to these two observations, we make five proposals for further research based upon the findings of this work.

1. Investigating the common resource itself. Investigating which resources lend themselves for common governance through a DAO helps to clarify the importance of this field. This could be investigated by a literature search for characteristics that determine whether resources are suitable for common DAO governance, followed by interview validation with scholars.
2. Investigating the governance structure. Two proposals arise, about design and process. The first opportunity for further research is how common resources should be governed effectively in a DAO: which roles are essential; the hierarchy within the organisation; how monitoring and jury interplay in this; and whether the governance has a democratic or aristocratic election process. This can be answered by an investigation in existing organisation theory, followed by validation with the existing DAOs.
3. The second opportunity for further research is the process of realising the DAO governance structure. Building decentralised governance comes with complex questions of designing both rigidity and flexibility, selecting technology and filling roles. The process and the subsequent phases need to be clear before DAOs can launch (van Vulpen et al., 2022). Discovering the strategy for deploying the governance structure of a DAO could be investigated by first interviewing successful commons, and subsequently interviewing the few existing common DAOs such as TEC.
4. Researching the enabling technology. Although Baninemeh et al., 2021 compared the various DAO platforms in general, we still need an investigation of the entire technical infrastructure for DAO creation. This could be realised by an experiment of launching a common DAO, and reporting the selection of technology and infrastructure.
5. Finally, clarifying the legal possibilities of deploying DAOs is an opportunity to better understand how DAOs can integrate in the

world. These include the legal obligations for token models, spreading liability among members and DAO taxation.

6 Conclusion

While financial uncertainty and volatile crypto currency exchange rates make us desire for stable, sustainable, and more independent financial structures, we use this article to pose the research question: *what are design specifications of a common DAO?* We answered that question by creating the common DAO framework.

We provided a double answer to the research question in the form of a governance overview and a set of normative principle interpretations. These results guide scholars and practitioners in creating collective action through decentralised organisations.

DAOs can make a major contribution to commons revitalisation by adhering to the normative principle interpretations in three governance areas: governance structure, enabling technology, and community governance. However, for this to happen, further developments of all areas is needed.

The proposed common DAO design uses decentralised infrastructure to strengthen building efforts. Furthermore, it contains safeguards for both individualism and statism. Thereby, it may help us to strengthen communities and preserve common resources. Further research can investigate the launching process of DAOs, clarify the legal possibilities, and deepen the three governance areas for a common DAO. Our research will continue with clarifying the types of resources that are fit for common governance using a DAO.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Author contributions

PV: Conceptualization, Investigation, Methodology, Writing—original draft, Writing—review and editing. SJ: Writing—review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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