In collaboration with the
Wharton Blockchain and
Digital Asset Project

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Decentralized Autonomous Organizations: Beyond the Hype

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Foreword

Aiden Slavin
Project Lead, Crypto Impact
and Sustainability Accelerator,
World Economic Forum, USA

Kevin Werbach
Professor of Legal Studies and
Business Ethics and Director,
Blockchain and Digital Asset
Project, Wharton School,
University of Pennsylvania, USA

Innovation has always driven organizational coordination. From the rise of the joint-stock company in the seventeenth century, the development of limited liability in the nineteenth and the proliferation of the internet in the twentieth, novel structures and technologies have, throughout history, profoundly altered the way humanity organizes work. Today, blockchains, digital assets and related technologies are changing human coordination at a quicker rate than before, creating both opportunities and challenges.

Worldwide, entrepreneurs are hitching the power of distributed ledger technology to a new form of coordination, decentralized autonomous organizations (DAOs), to deploy resources, coordinate activities and make decisions communally. By empowering members to propose, vote on and effect changes to an entity, DAOs enable communities to work collectively towards achieving shared goals, often without top-down, hierarchal management.

Although centralized governance has made possible the creation of some of the most powerful enterprises in history, centralization comes at a cost. With a small minority in charge, centralized entities tend to make decisions opaquely and concentrate power at the top. The overheads of centralized management can be significant. Moreover, centralized organizations may overemphasize narrow goals at the expense of broader societal considerations.

By contrast, DAOs aspire to operate without conventional centralized intermediaries or institutional structures. DAOs may offer a way to democratize the management of organizations and direct effort towards a wide variety of goals, including prosocial ends. Likewise, DAOs have the potential to realize gains in transparency, accountability and more relative to traditional organizational structures, including corporations. Yet practical challenges of governance, cybersecurity and power concentration, combined with regulatory uncertainty and fragmentation, could lead to further hacks, privacy issues and inequality.

Since DAO innovation is evolving rapidly and is primarily led by the private sector, it is vital for policy-makers and regulators to stay engaged. Harnessing technologies for effective coordination requires more than just innovation. For DAOs to realize their full potential, recent innovations must be combined with evidence-based, fit-for-purpose policy and governance informed by public-private collaboration focused on ensuring that DAOs are developed and managed in a manner beneficial to society at large.

This joint World Economic Forum and Wharton School of the University of Pennsylvania publication aims to shed light on this topic, offering a foundation for policy-makers, regulators and senior business leaders to understand the DAO ecosystem. Forthcoming publications from this collaboration will provide policy frameworks for evaluating DAOs, principles-based approaches for governing DAOs and reflections on early experiments in leveraging DAOs for social impact.

Throughout history, any tool that meaningfully improved organizational coordination eventually became widespread, sparking dramatic economic and social changes. Only time will tell whether DAOs will join this list. It is our hope that this report helps realize the benefits of this emerging form.

Executive summary

❝ Open-source software, blockchain technology, economic incentives and programmable smart contracts have the potential to offer greater transparency, trust, adaptability and speed.

In recent years, decentralized autonomous organizations (DAOs), entities that use blockchains, digital assets and related technologies to direct resources, coordinate activities and make decisions, have experienced explosive growth. According to the analytics service DeepDAO, in 2021 the total value of DAO treasuries surged fortyfold, from $400 million to $16 billion, and the number of DAO participants increased by 130 times from 13,000 to 1.6 million.[1] As DAO innovation has largely been led by the private sector and DAOs are being developed for an increasingly wide variety of purposes, it is critical that policy-makers, regulators and senior executives develop a nuanced understanding of these entities.

DAO proponents assert that the novel organizational form can address the limitations of centralized governance, offering a way to democratize management and direct efforts towards a wide variety of aims, including prosocial goals. Open-source software, blockchain technology, economic incentives and programmable smart contracts have the potential to offer greater transparency, trust, adaptability and speed over traditional organizational forms such as corporations. At the same time, DAOs face challenges of scalability, engagement, cybersecurity, privacy and regulatory uncertainty. Questions remain about whether DAOs fulfil their vision of decentralized governance in practice.

To equip policy-makers, regulators and business leaders to develop nuanced, fit-for-purpose approaches to DAOs, this report provides an overview of the DAO landscape, explores DAOs' advantages and disadvantages compared to traditional organizational structures and offers a breakdown of some of the key risks they face. Forthcoming publications developed from this international collaboration among academics, legal practitioners, DAO entrepreneurs, technologists and crypto experts will offer guidelines for developing DAOs, recommendations for policy responses and assessments of social impact use cases.

1. The landscape

The first functional DAO, known as "The DAO", was created in 2016. In a matter of weeks, it raised $150 million in ether to create an organization for collective investment in blockchain projects.[2] When a bug in The DAO's code was exploited to siphon off a considerable amount of the committed assets, innovators doubled down on developing improved DAO tooling and supporting infrastructure. Today, DAOs benefiting from a range of tools are

being deployed for functions as various as grant-making, social networking and driving social impact. Generally, the DAO landscape can be segmented according to objective and means; namely, the primary objective of the DAO and the means a DAO uses to achieve that objective. While some DAOs aim to power a network or application, others pursue a specific communal objective. Likewise, while some DAOs manage activities, others deploy capital to achieve their goal. This report offers a novel taxonomy, breaking down the DAO ecosystem into nine categories.

2. Strengths and weaknesses

Although DAOs are nascent, key strengths and weaknesses are already emerging. Relative to traditional organizational forms such as corporations, DAOs may offer a way to achieve greater transparency, trust, adaptability and speed. They also make possible rapid experimentation and the potential to direct activity towards a multiplicity of goals. Conversely, DAOs have many potential weaknesses. DAOs today confront issues of governance, voter engagement, power concentration, cybersecurity and more. Perhaps most crucially, DAOs face regulatory fragmentation and uncertainty.

3. Key risks

Several practical, legal and regulatory risks affect DAOs. Like the blockchains they run on, many DAOs face limitations and security challenges. Likewise, due to their pseudonymous nature, DAOs can create information asymmetries between creators and contributors. DAOs also continue to confront a host of governance-related risks, such as a lack of voter engagement and voter fatigue. Moreover, power concentration in DAOs presents a challenge to the vision of decentralization espoused by DAO practitioners. Crucially, DAOs also face legal and regulatory risks concerning legal status, applicable laws and regulations, and jurisdictional uncertainty.

Critically, the aim of this report is not to provide a comprehensive analysis of the DAO ecosystem but to identify the key emerging benefits and risks of DAOs. DAOs are nascent; their operations, utility and functions are still being defined. As DAOs continue to develop, our hope is that this report will help decision-makers develop informed analyses and actionable strategies.

Introduction

Decentralized autonomous organizations (DAOs) are entities that leverage blockchains, digital assets and related technologies to deploy resources, coordinate activities and make decisions. DAOs attempt to decentralize the operation of firms and other collective entities by making functional and financial information transparent and empowering token-holding members to propose, vote on and enact changes.[3]

DAOs have recently experienced explosive growth. According to the analytics service DeepDAO, the total combined value of DAO treasuries increased roughly fortyfold (from $380 million to $16 billion) from January to September 2021.[4] DAOs are being created to achieve purposes as diverse as investing, community networking, governing decentralized applications and driving social impact.[5] Nonetheless, DAOs are still early in their development.

The aim of this report is to demystify DAOs for a wide range of audiences, including policy-makers, regulators and business leaders. It describes the fundamental elements of DAOs, the DAO ecosystem and key ongoing developments. In addition, it offers case studies that exemplify critical emerging strengths and weaknesses of DAOs and a breakdown of potential risks. Forthcoming publications in this collaboration between the World Economic Forum and the Wharton School of the University of Pennsylvania will offer guidance for developing DAOs, frameworks for evaluating them and assessments of social impact use cases.[6]

DAO is a general term covering a range of organizational structures and applications. We identify nine categories of DAOs based on their primary objective (generative, associative or ad hoc) and primary means of achieving that objective (activity, value transfer and social).[7] While traditional corporate governance relies on management and formal legal structures, DAOs attempt to operate in a decentralized fashion, typically running on public, permissionless blockchains with rules encoded in open-source software protocols and enforced by smart contracts.[8]

Like decentralized web3 technologies more generally, DAOs have been promoted for their potential to realize greater efficiency, transparency and shared ownership. However, they have also been criticized for their risks and unknowns. There have already been several attacks, governance problems and other challenges in the DAO ecosystem. Thus, it is essential for the private and public sectors alike to develop a nuanced understanding of the opportunities, risks and challenges presented by DAOs.

The Wharton Blockchain and Digital Asset Project (BDAP) is a research initiative at the Wharton School of the University of Pennsylvania focused on the evolving blockchain phenomenon. Drawing on the world-class Wharton/Penn faculty, alumni and students, as well as relationships with officials and industry experts from around the world, BDAP seeks to enhance understanding and bridge gaps among stakeholder communities.

The Crypto Impact and Sustainability Accelerator is a project of the World Economic Forum that seeks to catalyse progress on environmental, social and governance (ESG) targets for the crypto ecosystem. Building upon the work of the Forum's Blockchain and Digital Assets Platform and a global network of contributors, the initiative explores emerging topics, such as DAOs, to bridge gaps in understanding between the public and private sectors, drive efforts across the space and shape a cohesive narrative that highlights how crypto can lead in contributions to ESG in web3 and beyond.

1 What is a DAO?

A "decentralized autonomous organization" (DAO) is a general term for a group that uses blockchains and related technologies to coordinate its activities.

1.1 | The emergence of DAOs

Traditionally, hierarchical management has offered a means of directing human activity.[9] Entities as diverse as governments, religious institutions and corporations use centralized methods to govern resources, territories and communities. Utilizing innovations such as joint-stock companies, centralized organizations have become some of the most powerful and economically valuable enterprises ever created.

Yet centralization is not without its costs. With a small minority in charge, centralized entities tend to make decisions opaquely and consolidate power at the top. The overheads of centralized management can be considerable. Moreover, centralized organizations may overemphasize narrow goals, like maximizing shareholder profits, at the expense of broader considerations such as contributing to efforts to address the climate crisis.[10]

Recognizing the limitations of centralized governance, internet pioneers use open protocols and standards to empower participants around the world to collaborate on ambitious projects. Techniques of social production, utilizing open-source software, online collaboration tools and open interfaces played a key role in the development of the internet.[11] Over time, however, power has become consolidated in a handful of large corporations occupying strategic intermediation points in the digital world.[12]

Today, entrepreneurs are using web3 technologies, including blockchain, digital assets and DAOs, to create new mechanisms of decentralized governance and coordination. By empowering token-holding members to propose, vote on and enact changes to an entity, DAOs enable communities to work collaboratively towards achieving shared goals. DAOs aspire to operate without conventional centralized intermediaries or institutional structures for functions such as the allocation of tasks and deployment of resources.[13] Their open, composable structure makes them simple to launch and customize with incentive structures. By locking agreements into automatically executing computer code, DAOs can foster rapid and transparent decision-making.

These features have made the DAO landscape fertile ground for innovation. In recent years, DAOs have mushroomed across sectors, serving a wide variety of functions. DAOs are being leveraged to make investments, network around common interests and even advance the ESG agenda. Nonetheless, DAOs are nascent; their operations, utility and functions are still being defined.

In practice, DAOs are as numerous and diverse as the communities that build them. The analytics firm DeepDAO estimated as of early 2022 that there were 4,228 DAOs in operation, ranging from large communities with multiple aims[14] to applications that are nothing more than "group chat[s] with a shared bank account".[15] By leveraging social media and viral marketing, DAOs have demonstrated their ability to quickly develop and rapidly deploy funding to launch projects.[16]

❝ By empowering token-holding members to propose, vote on and enact changes to an entity, DAOs enable communities to work collaboratively towards achieving shared goals.

The history of DAOs

> **The DAO ecosystem accelerated in 2020 as decentralized finance (DeFi) platforms took off and incorporated DAOs, awarding early participants with governance tokens.**

Coined in the 1990s by the German computer scientist Werner Dilger, the term "DAO" was taken up two decades later by blockchain enthusiasts and developers, most notably Ethereum's Vitalik Buterin, who began theorizing in 2014 about DAOs as entities featuring "automation at the centre, humans at the edges".[17] Blockchain-based DAOs take advantage of smart contracts, which can immutably execute software code on a blockchain network.

The first functional entity denominated as a DAO, The DAO, was created in 2016. The DAO raised roughly $150 million in ether in a matter of weeks to create a platform for collective investment in blockchain-based projects.[18] Shortly afterwards, a bug in The DAO's smart contract code was exploited to siphon off a considerable amount of the committed digital assets.[19] Given the immutable nature of Ethereum smart contracts, no one had the power to return the funds. The end result was a contentious and disruptive hard fork, or radical change, of the entire Ethereum blockchain.[20]

Seeking to avoid a repeat of this fiasco, innovators developed improved DAO tooling and supporting infrastructure. Platforms for creating DAOs, solutions for facilitating voting and security protocols for auditing code were established, and these innovations were iterated upon.[21] Experimental use cases such as collective grants for Ethereum developers provided real-world experience with DAO governance.[22] The DAO ecosystem accelerated in 2020 as decentralized finance (DeFi) platforms took off and incorporated DAOs, awarding early

participants with governance tokens. The growth of non-fungible tokens (NFTs) further expanded the DAO landscape as groups built NFT collections. Most recently, DAOs for rapid single-purpose capital allocation have attracted significant interest. ConstitutionDAO was able to raise approximately $47 million over a few days to bid on a copy of the US Constitution, and AssangeDAO amassed more than $50 million in a matter of weeks.[23]

Today, DAOs leverage a wide variety of voting methods and experiment with different forms of representation. Some DAOs operate on a "one token, one vote" basis, whereby some if not all collective decisions are made through a direct participatory system. Some DAOs support the delegation of voting or proposal power to other individuals through a representative system. Many DAOs increasingly provide greater voting power to individuals who "lock up" or stake their tokens in an escrow smart contract for a fixed amount of time. Others use weighted voting to provide greater power to individuals with greater investment. While some of these governance models result in broad representation through collective decision-making, others risk recreating quasi-oligarchic dynamics by concentrating governance tokens in the hands of a small number of powerful players like venture capitalists and early insiders. Although some DAOs are attempting to mitigate the risk of co-optation through delegation efforts, the challenges of power concentration remain.[24] Many DAOs adopt a goal of "progressive decentralization",[25] building out structures for participation and moving greater control to token holders over time.[26]


CASE STUDY 1 | **ConstitutionDAO**

ConstitutionDAO was formed in November 2021 to acquire one of the 13 remaining original printed copies of the US Constitution at a Sotheby's auction. It raised $47 million worth of ether from 17,437 contributors in under a week. In return for providing ether, contributors to the DAO received the $PEOPLE token, representing a share of the ConstitutionDAO. $PEOPLE token holders would be given the right to vote on what to do with the copy of the Constitution and what the organization should do in the future.

ConstitutionDAO did not have a long-term roadmap. Individuals who contributed financially were so aligned with the purpose, and motivated by the community, that they simply wanted to contribute and spread the word. At the time, Sotheby's did not allow DAOs to bid directly, nor did the auction house accept anything other than government-issued currencies. ConstitutionDAO teamed up with a crypto exchange to convert its ether to dollars, as well as with Endaoment, a non-profit, to make bids on the DAO's behalf. The group also formed a corporation to help facilitate the transfer.

In the end, the DAO failed in its bid. The artefact was sold for $43.2 million, and ContitutionDAO was ultimately limited by Sotheby's to $43 million to factor in taxes and the costs required to protect, insure and move the Constitution. There was a period of uncertainty afterwards, but the DAO ultimately offered full refunds to its community minus transaction fees. Although some argued the funds collected should be applied to other objectives, the project was eventually closed by the founding team. Several other community-based DAOs have sprung up claiming to use the $PEOPLE token as their project's native token.

As this case study illustrates, DAOs can enable communities to quickly mobilize to achieve a specific aim. While ConstitutionDAO was focused on purchasing an artefact, future ad hoc DAOs could coordinate to pursue a wide variety of aims, including supporting a political campaign or purchasing a stake in another entity in order to determine its strategy.
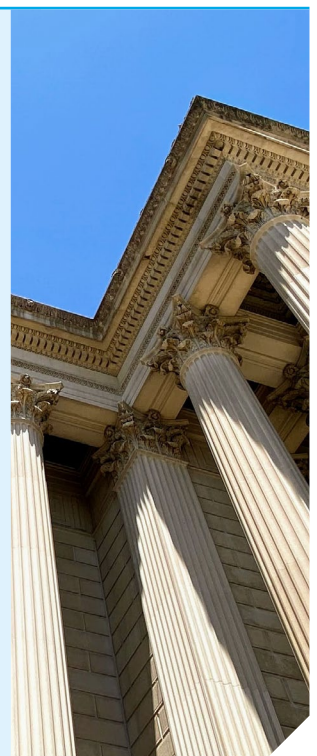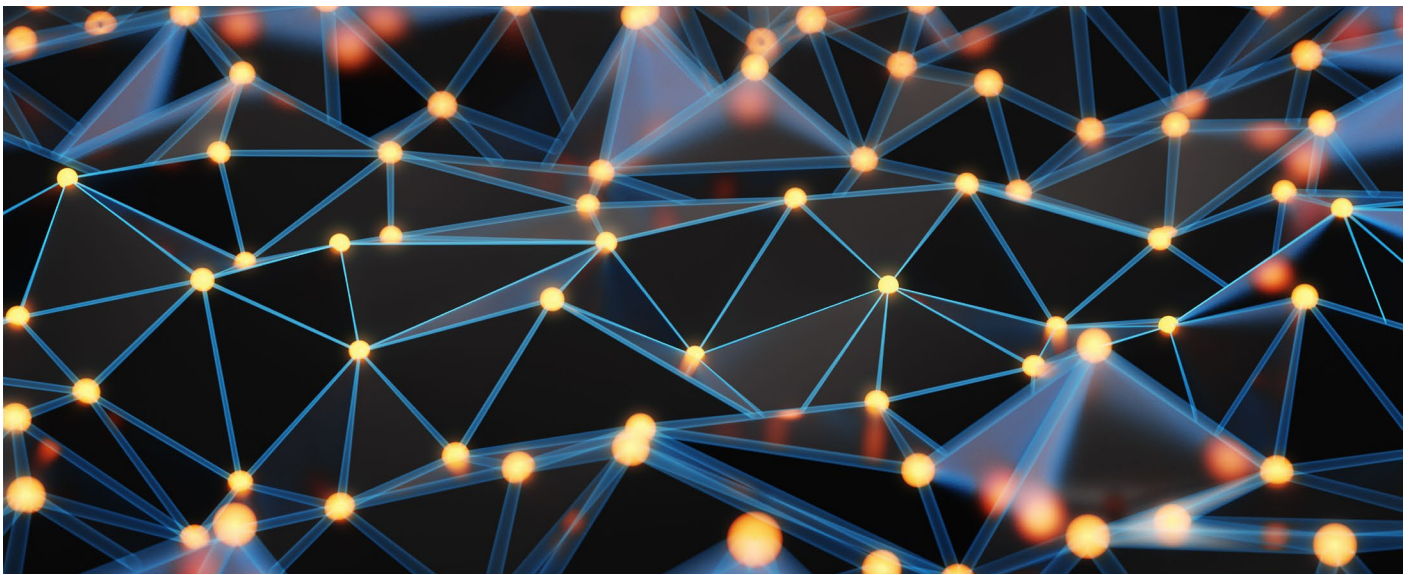
1.3 | DAO strengths and weaknesses

Although it is still early in their development, some key strengths and weaknesses of DAOs are already becoming evident. Relative to corporations and other traditional organizational forms, DAOs may achieve greater transparency, trust, adaptability and speed. All token holders in a DAO, not just executives, can have a role in the decision-making. All DAO participants can view financial and operational information stored on public permissionless blockchains in real time,[27] and anyone with sufficient expertise can check its smart contract code. The open, composable structure of DAOs makes it possible for communities to establish organizational structures quickly, with customized incentive structures directed at a wide array of goals.[28] Using token-based governance, DAOs can consider and implement changes at any time, according to a community vote.[29] DAOs facilitate experimentation with innovations such as treasury management, quadratic voting, subsidies for public goods provision, streaming payment of salaries and multifaceted reward structures for contributors.

DAOs also have many limitations and potential disadvantages. Defining responsibilities and compensation structures for contributors, matching them with community needs and coordinating activity through messaging systems such as Discord is not always a smooth process. Some DAOs give central management power to a small number of individuals for pragmatic reasons or because they established the DAO. Even when engaging in decentralized governance, DAOs have experienced plutocracy, vote buying, manipulation and co-optation, as well as issues of low voter turnout and voter fatigue.[30] When governance votes do pass off-chain, it can often take weeks or months of coordination to push a proposal through.

Further, the lack of DAO contributor information or reputable on-chain credentialling can create issues of accountability. Information asymmetries between creators and contributors can open the door to fraud and manipulation and make legal recourse challenging.[31] DAOs are also subject to the security challenges that face all smart contract-based solutions today.[32] Hacks and exploits directed at DAOs have resulted in the loss of hundreds of millions of dollars in assets.[33] DAOs may also violate members' privacy or agency through the transparent recording of member actions and reputation in blockchain systems.[34] DAOs can also be limited by their foundational infrastructure. The scalability challenges common to blockchain platforms such as Ethereum could diminish the functionality of large-scale DAOs,[35] namely, the extent of the decentralization of many DAOs.

Perhaps the greatest threat to DAOs today is uncertainty. Without clear legal status, DAOs cannot take advantage of the same protections as corporations, such as legal personhood, limited liability and simplified tax arrangements.[36] Initiatives such as Colorado's Uniforma Limited Cooperative Association Act and Wyoming's DAO legislation provide pathways for DAOs to attain legal recognition.[37] Privately crafted approaches within existing law, such as the unincorporated non-profit association structure,[38] decentralized autonomous associations under Swiss law and the dYdX framework for non-US trusts, are also emerging.[39] Fitting global DAOs into varying national legal structures will be an important challenge.

In considering the strengths and weaknesses of DAOs, it is useful to compare them with traditional business associations such as corporations, partnerships, foundations and limited liability companies (LLCs), as well as with communities that organize without formal legal protections.

❝ Perhaps the greatest threat to DAOs today is uncertainty. Without clear legal status, DAOs cannot take advantage of the same protections as corporations, such as legal personhood, limited liability and simplified tax arrangements.

TABLE 1 | **Strengths and weaknesses of DAOs compared to alternatives**

	Strengths	Weaknesses
Community	No barriers to entry/exit Adaptability Stakeholder alignment Global access Inclusive participation	Lack of legal protections Member liability Absence of tax planning Slower decision-making Difficult to scale Opaque, informal rules Lack of capital access Free riding Collective action challenges
Business association	Clear legal status/protections Well-established legal precedents Tax planning opportunities Scalability Access to traditional sources of capital Clear management powers	High barriers to entry/exit Opacity Inflexibility Limited participant in governance Management dominance Separation of ownership/control
DAO	Low barriers to entry/exit Speed Adaptability Transparency Composability Decentralized governance Token-based incentives Opportunity to experiment Smart contract automation	Legal uncertainty Lack of clearly defined roles Difficult informal coordination Limited tooling Governance challenges Security vulnerabilities Surveillance potential Tax uncertainty Free riding

DAOs are still early in their development, and their full potential is not yet known. A forthcoming report will offer further insight into the advantages and disadvantages of DAOs relative to other organizational forms.

Practical elements

(2)

In recent years, entrepreneurs have developed a suite of tools to streamline the processes of joining, creating and governing DAOs.

2.1 | Launching DAOs

Membership in a DAO is generally represented by a digital asset. These "governance tokens" enable holders to propose and vote on changes to the protocol. Proposals can range from cybersecurity upgrades to overhauls of the organization's purpose.

While some DAOs are private, most are based on freely-tradable digital assets, enabling any user to obtain governance tokens and become part of the DAO. DAOs may also grant initial allocations, including through airdrops – in which tokens are provided for free for past usage or in exchange for a service – to founders and other stakeholders who have demonstrated engagement with a relevant platform.

As with any organization, the critical first step in establishing a DAO is galvanizing a community united by a common purpose.[40] Often, DAOs are launched by peers coordinating on communications platforms such as Discord, Telegram and Twitter. Founders work together to determine the DAO's purpose, agree on parameters for governance and develop a rollout plan. DAO communities often leverage iconography, memes, acronyms and other references to organize themselves.[41] A DAO might also be built around an existing community or blockchain-based application.

Once the group has attained agreement, the community can then encode their mandate and rules into smart contracts, which will ultimately bind the group to its decisions. While some DAOs opt to code their own rules, DAO creation platforms such as Gnosis, Moloch, Aragon, Colony and DAOStack provide off-the-shelf tools for developing smart contract code. Users of DAO creation services can set parameters such as the primary token, proposal velocity, voting period, voting mechanisms and proposal mechanisms.

MolochDAO v1, launched by Ameen Soleimani in February 2019, is a DAO on the Ethereum blockchain. It was created to provide the Ethereum ecosystem and its core developers with a sustainable, distributed source of capital to fund open source development. The DAO was seeded through a donation of 1,000 ether each from ConsenSys founder Joseph Lubin and Ethereum co-founder Vitalik Buterin, plus 2,000 ether more from individuals at ConsenSys and the Ethereum Foundation. Since 2019, MolochDAO has distributed approximately $1.4 million in grants to 67 recipients,[42] including projects like DApp Node, Ethereum Cat Herders, Tornado Cash, Lodestar, Lighthouse, clr.fund, Flashbots and multiple reports – State of Eth2.0 (2019), State of the Mixers (2019), State of Optimistic Rollup (February 2020) and Eth2.0 Economic Review (July 2020).

The DAO prides itself on its speed and efficiency in funding public goods, with funds being distributed more rapidly due to the management of the DAO. At the core of MolochDAO is a smart contract, allowing contributors to deposit ether and receive proportional voting power to vote on grant funding. If contributors disagree with how grants are distributed, they can "ragequit", exiting the DAO by exchanging their tokens for a pro-rata claim on the treasury's assets. This widely-adopted mechanism provides confidence that a crisis such as the one that destroyed the DAO will not immobilize participants' funds.[43]

Membership in MolochDAO is an on-chain process where candidates must first be endorsed by existing members of the DAO and undergo an internal member-driven evaluation. To become a member of MolochDAO, an applicant must have the consent of the economic majority of MolochDAO members.

Since MolochDAO v1, several hundred other DAOs, including MetaCartel, Raid Guild and Meta Gamma Delta, have used the MolochDAO framework or extended its code. With the release of Moloch v2, MolochDAO now invests in a variety of assets in addition to making grants.

The current MolochDAO v2 contract standard was designed through a collaborative effort between MetaCartel, ConsenSys's The LAO and Moloch. In order to limit legal liability on members of a for-profit deployment of Moloch v2, the members may opt to form an LAO. LAOs are DAOs wrapped in a legally compliant entity, such as an LLC or C corporation (C-Corp). The LAO can enter legal contracts, custody off-chain assets (e.g. simple agreements for future tokens or "SAFTs"), and distribute dividends. Investors in an LAO must be accredited, but service providers compensated in LAO shares can earn their shares of the LAO portfolio.[44]

2.2 | Managing DAOs

Beyond tools for launching DAOs, a host of providers have emerged to offer token services, voting management, treasury oversight, risk management, growth products, community platforms, basic operational tools and legal services. There are also a number of analytics services being developed to provide insights into the emerging DAO ecosystem. Products also exist with the aim of making DAOs more efficient without compromising on their decentralized structure. Multi-signature or "multisig" wallets are digital technologies that make it possible for multiple users to sign a document as a group.[45]

Tools also exist for creating legal infrastructure for DAOs. Organizations offer DAOs legal wrappers to cover their liability and apply old partnership models such as cooperatives[46] and investment clubs[47] to offer DAOs legal standing. The existence of these tools notwithstanding, the question of the legal status of DAOs remains largely unresolved.

In sum, a wide variety of tools have been created to ease the process of joining, launching and managing a DAO. Indeed, in recent years this ecosystem of DAO infrastructure has become a productive ground for innovation in decentralized governance in its own right.

Categories of DAOs

A taxonomy of different types of DAOs, categorized by means and objective.

3.1 | Means and objectives

A DAO may begin with one goal, such as collective investment in NFTs, and then morph into a community, a grants organization, a sponsor of creative work, an incubator of entrepreneurial ventures, a trading platform, or anything else.

A corporation might be a multinational manufacturing firm with tens of thousands of employees, a small charitable organization with no employees, an educational institution, a sports team, an investment vehicle and everything in-between. The potential applications of DAOs are at least as broad. Distinguishing DAO categories is important for evaluating DAOs accurately.

However, categorizing DAOs is challenging. All DAOs operate based around digital assets, which may be desirable for their financial value, but not all DAOs are themselves oriented towards making money; some are even designed to give it away.[48] A DAO may begin with one goal, such as collective investment in NFTs, and then morph into a community, a grants organization, a sponsor of creative work, an incubator of entrepreneurial ventures, a trading platform, or anything else. Some DAOs begin with a well-defined objective, while others are more diffuse from the start.

Nonetheless, at any moment in time, a DAO will generally have a predominant goal. This may be established in founding documents, such as an explicit "constitution", or it may be articulated more informally. DAOs associated with operational protocols, such as DeFi DAOs (e.g. Synthetix, Yearn Finance, dYdX), are connected in some way with the objectives of that protocol. While some DAOs are more focused than others, this is also true of corporations. Some conglomerates span many industries and startups that pivot through multiple business models.

We divide DAOs along two axes. First, **what is their primary objective**? Do they seek to create something new (including wealth), enhance the functioning of a community or society, or achieve a specific goal and then disband? Second, **what are the means they use to achieve that objective**? Do they seek to manage some activity, deploy capital, or organize people? This produces a three-by-three matrix of major DAO types (Table 2).

TABLE 2 | **DAO taxonomy**

Objective Means	Generative	Associative	Ad hoc
Activity	**Functional** Power a network or application *Bitcoin, Ethereum, Tezos, Avalanche*	**Governance** On-chain management of a community *Uniswap, Yearn, ENS, SteemDAO, Illuvium, Sandbox*	**Task** Pursue a specific communal objective *UkraineDAO*
Value transfer	**Investment** Facilitate participant investment activity *Metacartel, Olympus Pro, Pleasr, Flamingo, Whale, CityDAO*	**Philanthropic** Fund public goods *GitcoinDAO, MolochDAO, EduDAO, KlimaDAO, LexPunk*	**Special purpose acquisition DAO (SPAD)** Buy a unique item or other companies/DAOs *ConstitutionDAO, SpiceDAO*
Social	**Production** Compensate people for work they do *dOrg, HumanDAO, Yield Guild Games, Mirror, MODA, Audius, Nouns, Squiggle*	**Community** Networking and coordination *Friends With Benefits, Bored Ape Yacht Club, LexDAO, Bankless*	**Flashmob** People come together at a place and/or time

DAOs continuously evolve. MolochDAO and other DAOs for deploying grants developed mechanisms for effective coordination that addressed The DAO's limitations. DeFi DAOs associated with the 2020 "DeFi Summer" explosion of value locked in the DeFi protocol showed that DAOs could successfully control millions or even billions of dollars in their treasuries. And in 2021, DAOs associated with NFTs, whether for collective investment, creator outreach, or social experiences gated by tokens, rode the NFT boom. However, as Table 2 illustrates, there is much more happening. Throughout this report, there are brief case studies of DAOs that illustrate many of the categories in the typology.

PleasrDAO is a collective of artists, DeFi leaders, NFT collectors and crypto influencers that collect culturally significant NFTs with a charitable twist.
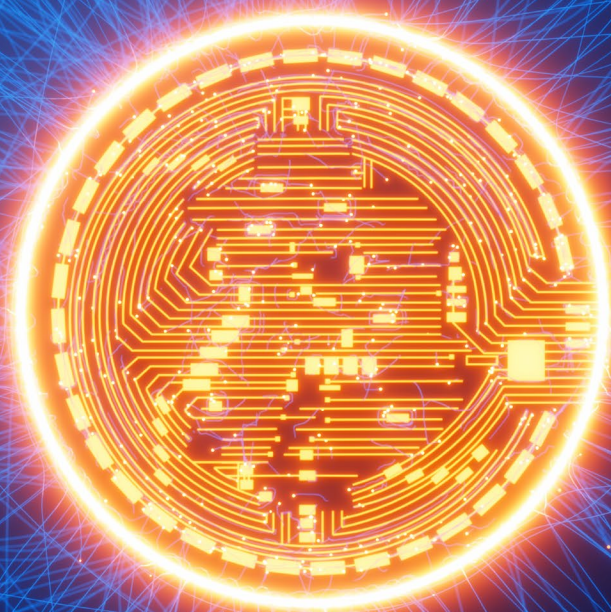
PleasrDAO was created by Leighton Cusack, the co-founder of PoolTogether. Its members paid $525,000 towards purchasing its genesis piece, pplpleasr's Uniswap V3 NFT, an animated Uniswap ad created by artist pplpleasr depicting a pink unicorn making its way towards an Ethereum logo-cradling oasis. Proceeds of the sale were given to charity. Cusack told the news site Decrypt he started the DAO because he could not afford the piece himself but wanted to buy "this piece of history".[49]

The DAO is composed of 74 members who collectively own the NFTs. PleasrDAO has since spent $4 million on an NFT of the image that inspired Dogecoin, $5.5 million on Edward Snowden's Stay Free NFT and $4 million on an unreleased Wu-Tang Clan album.
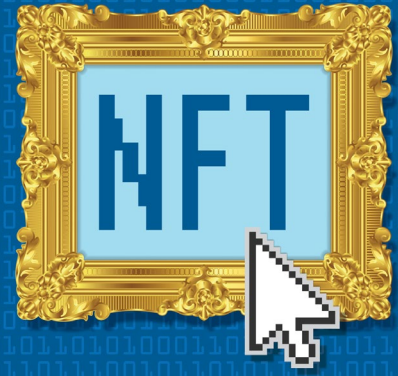
Each category can be further subdivided. For example, DeFi governance DAOs such as Uniswap and Yearn coordinate activity around financial transaction protocols, while Illuvium and Sandbox, in the same box, do so for games, and ENS does so for censorship-resistant domain names. While DAO activity is more concentrated today in some areas, the distribution is likely to change as market conditions shift and DAO structures mature. The "ad hoc" column has the fewest examples today. However, the story of ConstitutionDAO illustrates the power of this model. Given the potential efficiency of automated DAO mechanisms for quickly developing and winding down organizations, new kinds of ad hoc DAOs are likely to develop.

This is not the only way DAOs might be categorized. There are many other metrics that could be used, such as size, which might be measured based on community membership, the number of token holders, treasury size, total value of locked digital assets, or token market capitalization. Another dimension is whether the DAO supports on-chain voting that directly alters the smart contracts or whether some participants have the power to control funds and actions of the DAO directly. DAOs with native tokens might also be distinguished from those that use established cryptocurrencies.

3.2 | Defining terms

DAOs also differ in terms of how decentralized and autonomous they are. Indeed, many DAOs leverage a mix of centralized and decentralized governance. Further, decentralization has technical, geographic, political, economic and legal dimensions. How technically decentralized a DAO is depends on several factors, such as the kind of blockchain it is deployed on and how many nodes are operating on the network to validate transactions. Geographic decentralization can be understood as the degree to which DAO contributors operate in different jurisdictions. Political decentralization is dependent on how diffuse power is in the organization. For example, is the DAO effectively governed by its original developers? Who holds the DAO's administrator keys? Who is in charge of implementing changes? How effective are the governance mechanisms? Economic decentralization refers to the distribution of resources across the community. Does a small group control the majority of tokens or other resources? Each of these dimensions has implications for how the DAO could be legally categorized. Moreover, these dimensions are rarely static. DAOs may become more centralized or decentralized over time as the community and resources evolve.

Likewise, DAOs differ in terms of how autonomous they are. Some DAOs leverage smart contracts to enact changes directly, according to governance votes. Others rely on individuals or groups of individuals to implement changes. Algorithmic DAOs, which defer entirely to software, can be differentiated from participatory DAOs that use voting mechanisms to upgrade smart contracts. A forthcoming report will offer frameworks for evaluating how decentralized and autonomous a DAO is.

CASE STUDY 4 | **MakerDAO**

An Ethereum-based lending platform, the Maker protocol, is an open-source project that enables users to access loans collateralized by cryptocurrency.[50] With a roughly $2 billion market cap, Maker is one of the most established platforms in the DeFi space.[51] To oversee the protocol's early development, the Maker Ecosystem Growth Foundation was launched in 2018 with the aim of gradually ceding full control to a DAO.[52]

As the case of Maker protocol illustrates, hybrid centralized-decentralized approaches to governance can have operational and legal benefits. Although the move to centralize oversight of Maker initially drew sharp criticism from community member, the Maker Foundation Chief Executive Officer Rune Christensen argued that the foundation ultimately benefited the protocol by enabling a small group of highly-skilled participants to collaboratively effect needed developments.[53] The Maker Foundation also offered legal benefits to the nascent protocol.

Without formal legal structures, DAOs may subject their members to liability risk. But the existence of the foundation effectively shielded community members from litigation when, in April 2020, it became the subject of a class-action lawsuit following one of the worst price slumps in crypto history.[54] After high losses during a period of volatility, dubbed "Black Thursday", users launched a class-action lawsuit directed at the foundation. The lawsuit alleged that the terms of service had deliberately misrepresented the structure of the protocol to downplay risks associated with its use, seeking $30 million in damages.[55] At the request of the Maker Foundation, the case ultimately entered arbitration proceedings.[56]

In July 2021, the Maker Foundation's Chief announced that it would cede full control to a DAO.[57] Christensen credits the foundation with having played an important, though temporary, role in the protocol's development.[58] Today, MakerDAO is composed of individuals around the world that own the governance token MKR, which enables holders to vote on changes to the protocol.[59] The centralized-decentralized approach to governance pioneered by the Maker Foundation may herald more hybrid governance strategies to come.[60]

Distinguishing between different types of DAOs is useful, not only for those seeking to understand the space but also for regulators.[61] DAOs that are vehicles for investment raise different public policy and legal questions than those seeking to facilitate freelance work by software developers or produce creative work. In some cases, DAOs are similar to traditional corporations seeking the same objectives; in others, DAOs perform functions that have no parallel in centralized organizations.

4 Key issues for the future of DAOs

Despite improvements in recent years, DAOs still face a number of challenges.

4.1 Practical challenges

The state of smart contract security and mechanisms for responding to attacks have come a long way since the hack of The DAO in 2016. However, there is still a long way to go. Because DAOs directly control assets, vulnerabilities will always run the risk of causing catastrophic losses. Moreover, due to their foundational infrastructure, DAOs are subject to many of the same limitations and security challenges as the blockchains that they run on.[62]

CASE STUDY 5 | **BadgerDAO**

Focused on bringing bitcoin into the DeFi ecosystem, BadgerDAO provides products and infrastructure to support the use of bitcoin across blockchains.[63] In 2020, the DAO distributed Badger tokens to enable its community members to propose, vote on and enact new product ideas. Ahead of launching the governance tokens, the founding team commissioned a third-party audit of all contracts to verify the security of the protocol.[64] Despite this early focus on cybersecurity, in December 2021, BadgerDAO suffered a hack that resulted in the loss of roughly $130 million in funds.[65] According to Rekt News, the theft was then the fourth largest DeFi hack of all time.[66]

DAOs face several potential technical risks, including smart contract failures and programming errors. According to BadgerDAO, the hack was the result of a phishing incident made possible by the injection of malicious code from Cloudflare, a platform running on Badger's network. Leveraging a compromised application programming interface key, the hacker began injecting code in November 2021.[67] In December 2021, the hacker used their access to drain funds from the wallets of dozens of users of the BadgerDAO yield vault.[68] Blockchain data and security analytics company Peckshield concluded that the total losses amounted to about 2,100 bitcoin and 151 ether, nearly 10% of the total value locked at the time of the hack.[69]

The BadgerDAO hack not only exemplifies the technical risks DAOs confront but also the complexity of community-led restitution efforts. In response to the attack, many of BadgerDAO's 32,000 users and 25 core contributors developed an ambitious plan to restore user assets. Making use of blog posts and forums, members of the BadgerDAO community created several Badger Improvement Proposals (BIPs) aimed at indemnification. BIP-79 proposed distributing new governance tokens to users that lost theirs in the hack. BIP-33 suggested introducing an emergency function that could allow some wallets to pause smart contracts, mitigating the potential for further damage. Community members also floated several proposals (BIP 76, 77 and 78) that would result in a one-time function contract upgrade to take a portion of the funds back from the hacker's address. It is worth noting that passing any of these proposals required the affirmative vote of BadgerDAO users, the vast majority of whom did not have funds drained in the attack. In this way, the restitution effort serves as an example of the complexity of DAO restitution efforts.[70]

Many DAOs operate pseudonymously; users are able to develop trust within communities and exercise their token-based voting rights without revealing their real identities. The widespread use of pseudonymous identity in DAO communities, however, may create information asymmetries that can disadvantage participants in these ecosystems. Much like shell companies used to shield identities, pseudonymity can enable individuals with bad reputations to disguise their identities and continue participating in business transactions. Pseudonymity can also contribute to a lack of accountability and hinder efforts to police financial crime.

Voter engagement is another problem present in many of today's most significant DAOs. Research has shown that most participants in online communities and open source environments are "lurkers", as is prevalent in decentralized communities.[71] Most token holders do not actively participate in governance, either abstaining completely or ceding power to "protocol politicians". Various responses are being trialled, such as optimistic voting, in which proposals are adopted by default unless a quorum of voters objects. Other proposals include delegating votes and weighted voting, where participants are rewarded with greater power for voting.[72] Proportionally weighting votes, however, can re-centralize power in the hands of a few resource-rich participants. A forthcoming publication in this series will examine current and future DAO governance solutions.

CASE STUDY 6 | **Uniswap**

The DeFi protocol Uniswap provides liquidity for the exchange of Ethereum requests for comment-20 tokens on the Ethereum network.[73] In September 2020, Uniswap issued 1 billion Uniswap tokens, a governance token, to empower its community members to alter elements of the protocol. At the time, the move was represented as a boon for community governance.[74] But when low voter turnout stymied an early and overwhelmingly popular proposal, some began to identify a lack of engagement as a problem for DAOs.[75]

Low voter turnout is a common concern across many types of organizations, including DAOs.[76] This is true even of protocols where governance tokens confer broad powers upon holders. Prior to the issuance of UNI, the core development team had sole responsibility for guiding the development of the project. With the launch of UNI tokens, it became possible for community members to help define certain aspects of protocol strategy. Specifically, holders of the governance token can vote on proposals concerning the UNI community treasury, protocol fee switch, Uniswap.eth ENS name, Uniswap Default List and SOCKS liquidity tokens. Furthermore, any UNI holder can submit a proposal to alter or introduce new features for review by the community. If a proposal passes a series of votes and a code audit, it can become eligible for implementation.[77]

The problem of voter engagement is exemplified by the aforementioned early vote on the Uniswap protocol. Despite 98% of votes being cast in favour of a proposed change, the total number required for passage fell short by roughly 400,000. Ironically, the vote had been intended to determine whether or not to lower the vote threshold required to pass proposals on the protocol.[78]

In response to the early trouble with voter engagement in DAOs, mechanisms for streamlining governance processes are being trialled. Lido, an Ethereum-based liquid staking solution, recently proposed creating a fast-track governance process via the introduction of motions that pass automatically unless challenged to reduce voter fatigue.[79] Other proposals include delegating votes and introducing a system of weighted voting, where participants would be rewarded with greater power for voting and, conversely, diminished power for failing to do so.[80] While technology cannot solve the problem of voter turnout, it can help make voting faster and simpler.

Power concentration presents a counterpoint to the narrative of decentralization espoused by DAO practitioners. Especially at the beginning of a project, most power lies with the founders and core contributors. This problem is epitomized by the idea of so-called "Dark DAOs," wherein a cartel of powerful users purchases sufficient votes to influence governance votes or manipulate markets.[81] There are a variety of other issues DAOs presently face, including a high turnover of contributors, a lack of key policies such as codes of conduct and off-boarding procedures, compliant compensation and many more.

4.2 | Legal and regulatory challenges

Key unresolved legal and regulatory questions confronting DAO practitioners concern legal status, applicable laws and jurisdictional uncertainty. Can a DAO fit within legally recognized corporate forms, or do new forms of legal recognition need to be created? Do DAOs need to register and pay taxes? How can they retain, recruit and pay for talent? Do DAO tokens fall under securities regulation, which would create a host of compliance issues?

DAOs do not fit easily into any existing corporate model, raising questions such as whether members who are unaware of their DAO membership due to a gift of assets or airdrop, for example, can still be considered general partners. Some DAOs have attempted to address this problem through a hybrid centralized-decentralized approach, where a traditional legal structure is coupled with a decentralized organization to create some form of legal status. A number of jurisdictions are creating specialized corporate law frameworks for DAOs, but these remain legally untested.[82] However, although new, these approaches do recognize that in many contexts, it may be more suitable to approach DAOs as novel structures rather than shoehorning them into existing regulatory frameworks.

Conclusion

It remains to be seen where DAOs will ultimately have the greatest impact.

DAOs' autonomous code-driven functionality makes them a natural fit for decentralized applications, especially those in DeFi that control and transact digital assets. On the other hand, DAOs for coordinating humans, whether networks of collectors or donors seeking to funnel money to good causes are gaining momentum thanks to their efficiency and flexibility. There is strong interest in using DAOs to address ESG challenges, where collective action problems often loom large. Forthcoming reports will provide frameworks for evaluating DAOs, propose responses to the policy questions they raise and examine the application of DAOs to social impact.

Whether DAOs are ultimately seen as a new corporate form, as specialized implementations of traditional ones, or as challenges to the very notion of a corporation, they are rapidly becoming more than mere hypotheticals. Their long-term importance will depend on how effectively they solve organizational and governance problems. For millennia, any tool that manifestly improved human coordination eventually caught on and produced dramatic economic and social gains. Only time will tell whether DAOs should be added to this list.

Contributors

Lead authors

David Gogel
Head of Growth and Operations, dYdX Foundation, Switzerland

Bianca Kremer
Research Fellow, Blockchain and Digital Asset Project, Wharton School, University of Pennsylvania, USA

Aiden Slavin
Project Lead, Crypto Impact and Sustainability Accelerator, World Economic Forum, USA

Kevin Werbach
Professor of Legal Studies and Business Ethics and Director, Blockchain and Digital Asset Project, Wharton School, University of Pennsylvania, USA

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