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Exploring the decentralized science ecosystem: insights on organizational structures, technologies, and funding

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Introduction: The scientific community is increasingly interested in leveraging decentralized technologies to address systemic challenges such as the reputation economy, the monopolization of academic publishing, and the replication crisis. This study presents an analysis of the Decentralized Science (DeSci) landscape in 2023, focusing on organizational structures, technological foundations, and funding mechanisms of DeSci organizations.

Methods: A 16-question survey was distributed to DeSci organizations between December 2023 and April 2024, and responses from 49 projects were analyzed using quantitative and qualitative methods.

Results: Results highlight the prominent role of Ethereum as the dominant blockchain platform in DeSci, the varied applications of blockchain in scientific processes, and a significant emphasis on community building and infrastructure development. Funding sources within the ecosystem are moving towards partnerships with more traditional organizations, including academia. However, most projects lack DAO features for governance. It remains uncertain whether they will adopt more DAO-like structures in the future or deploy a different organizational model.

Discussion: Our findings offer a comprehensive overview of the progress and challenges facing the DeSci ecosystem, including slow project progression due to leadership issues and limited funding for most DeSci projects. By identifying key patterns and areas for improvement, this study contributes to a deeper understanding of the factors driving success and sustainability in DeSci.

KEYWORDS
decentralized science, organizational structures, DAO, blockchain technology, ecosystem

1 Introduction

Since the launch of the Bitcoin whitepaper in 2008 and the network in 2009, distributed ledger technology (DLT), particularly blockchain technology, has transformed various sectors by introducing decentralized and secure transaction recording methods (Nakamoto, 2008). The decentralized nature of blockchain and cryptographic security have revolutionized not only financial systems but also various other fields, including supply chain management, voting systems, and data storage (Pilkington, 2015).

Science is another field in which decentralized technologies, such as blockchain, could see a big potential for improving the conditions in which research is conducted. This is because science, in general, faces a series of challenges that make it difficult to create an open, fair, and trustworthy environment to collaborate and seek truth (Song et al., 2022). Among these challenges, we can mention the "reputation economy," where researchers linked to academia have incentives not aligned with producing good-quality scientific work. Reliance on quantitative metrics, such as publication count and citation indices (e.g., the H-index), to evaluate research impact can lead to unintended consequences, such as prioritizing quantity over quality or publishing in less rigorous venues to inflate metrics (Moher et al., 2018; Hicks et al., 2015). However, it is important to recognize that scientific reputation is not determined solely by these quantitative indicators; instead, it is influenced by a more nuanced combination of factors, including the quality of journals, the role of the researcher in authorship (e.g., lead or corresponding author), and the significance of research within its field (Hicks et al., 2015).

There are also problems in the scientific publishing market, mostly related to how the research is published and distributed. It is estimated that a small group of companies concentrates on the majority of published academic material, along with very high fees for publishing academic research (Cudennec et al., 2022). In addition, some publishing journals benefit from a "triple payment" system, where research is funded by public entities, which then deliver the research product for free and pay a fee to publish with that journal. Finally, the journal charges an access or subscription fee to these publications. While there is compensation for journal editors, the peer review process is typically unpaid for volunteer researchers. However, some journals provide small incentives such as "fee discounts" or "vouchers" for future submissions, and in rare cases, peer reviewers are directly compensated (e.g., Journal of Cosmology and Astroparticle Physics, JCAP) (Martin, 2018). Moreover, not all journals have imposed uniform publication fees. A prevalent model involves charging significant fees for open-access publishing while providing an alternative for authors to publish without charge, although such articles are typically placed behind a paywall (Momeni et al., 2021).

Another problem that has been widely discussed for several decades is the replication crisis, where it is estimated that many of the experiments conducted in studies are difficult or impossible for other researchers to replicate, which diminishes the reliability of the results. This problem has multiple causes, but we can highlight that researchers are incentivized to publish new studies rather than verify experiments performed by others, as well as the time required to verify all procedures. This has economic effects since billions of dollars are allocated to research that ends up being irreproducible and thus unverifiable (Mirowski, 2018).

The scientific community cannot afford the luxury of misallocating resources or squandering funds, given the well-known global scarcity of research funding (Mega, 2019; Tollefson, 2023). The current centralized funding model, with its lengthy and tedious grant processes, continues to divert valuable time from researchers and impedes the collaborative spirit necessary to tackle complex scientific challenges. Without sufficient and well-directed funding, many research projects, especially those led by young scientists, may fail to reach their full potential or may never be carried out. Furthermore, recent studies have highlighted that a phenomenon that cuts across all scientific disciplines is that the impact of new research has diminished. In other words, they become less disruptive over time, which could be associated partly with researchers privileging individual careers instead of developing a particular discipline, along with an increasing reliance on a narrower set of existing knowledge (Park et al., 2023).

A previous effort to solve some of these challenges came in the 2000s with the Open Science movement, which is a way to practice science that allows others to collaborate and contribute (Mirowski, 2018). Research data, lab memos, and other research processes are at free disposition under terms that allow the reuse, redistribution, and reproduction of studies, along with their corresponding methodologies and data (Leible et al., 2019). Open science is a wide field of practices that include open access, open data, reproducible research, open science evaluation, new policies, open tools, new metrics, and impact (Banks et al., 2019; Fecher and Friesike, 2014; Vicente-Saez and Martinez-Fuentes, 2018).

In recent years, amid the ever-changing blockchain technology landscape, early approaches using blockchain technology for implementing open science principles and advocating for transparency, collaboration, and accessibility in scientific research have emerged (Hamburg, 2021; Leible et al., 2019). These initiatives have employed blockchain technology to address some of the challenges of the current scientific system, including issues in biomedical research and the pharmaceutical industry and the lengthy time required for scientific advancements to impact everyday life. These early efforts to apply blockchain technology in scientific research have laid the groundwork for a broader and more ambitious movement, Decentralized Science (DeSci). Building on the principles of open science, DeSci seeks to further revolutionize the scientific ecosystem and can be defined as follows:

> *"Decentralized Science (DeSci) represents a collaborative and decentralized approach to science, leveraging technological and infrastructural advancements such as Distributed Ledger Technology (DLT), Web3, cryptocurrencies, and Decentralized Autonomous Organizations (DAO) to enable permissionless, open, and inclusive participation, facilitating collective governance, equitable incentivization, unrestricted access, shared ownership, and transparent funding of the scientific process"* (Weidener and Spreckelsen, 2024).

This definition highlights core concepts and key technological elements based on distributed ledger technology to facilitate improvements in the scientific field. Blockchain and decentralized technologies have facilitated the emergence of novel organizational models within the DeSci ecosystem. DAO have been proposed as frameworks to enhance governance, transparency, and collaboration in science (Introna, 2016; Sicard, 2022). Despite their potential, the adoption of fully decentralized features remains inconsistent across projects, with many blending traditional and decentralized elements to meet operational demands (Weidener et al., 2024). For example, some projects use multi-signature wallets for treasury management, whereas others implement on-chain voting mechanisms or issue governance tokens to facilitate participatory decision-making (Ding et al., 2023a). However, the level of decentralization varies significantly, with only a subset of organizations adopting advanced DAO-specific features such as token-weighted voting or automated smart contract governance (Weidener and Spreckelsen, 2024).

In addition, the development of specialized technical infrastructure, such as blockchain platforms and tokenized ecosystems, has enabled DeSci initiatives to pursue unique goals, including data ownership, monetization, and open access. Funding mechanisms also reflect hybridity, spanning traditional grants, institutional partnerships, token launches, and crowdfunding platforms. These organizational structures and infrastructure address the key needs of open science, including collaborative environments, censorship resistance, and identity and reputation management (Leible et al., 2019), while also improving working conditions for researchers (Introna, 2016; Sicard, 2022). Understanding how these components coalesce to drive DeSci projects is critical for evaluating an ecosystem's capacity to address systemic challenges in science and achieve sustainable growth.

The use of blockchain technology at the team operation level has been proposed as a means to enhance transparency and accessibility (Ding et al., 2023b; Tenorio-Fornés et al., 2021; Gazis et al., 2022; Miao et al., 2023), which are core principles of open science practices. By recording research activities and data on an immutable ledger, teams can potentially provide proof of their adherence to these principles. However, it is important to acknowledge that blockchain tools are not necessary for adopting open science practices. Existing frameworks and tools, such as publicly accessible repositories and preprint servers, enable teams to align with open science principles without the use of blockchain. For example, platforms such as arXiv and Zenodo already provide open access to preprints and data, thereby fulfilling many open science goals without the added complexity of blockchain integration. Furthermore, blockchain-based solutions alone do not inherently prevent misuse or centralized control. Blockchain technology cannot verify the authenticity of the provided data itself, as the system only ensures the immutability and traceability of the recorded information, but does not assess its validity or accuracy. This limitation underscores the need for complementary verification tools such as oracles or decentralized identity solutions to validate data authenticity. We have seen some early proposals to improve the publication system of academic writing and the peer-review process (Coelho and Brandão, 2019; Gazis et al., 2022; Tenorio-Fornés et al., 2021), and also the use of tokens (Lee et al., 2023) to monitor and track working conditions and create new reputation systems, similar to open science "badges" to certificate the conditions in which the research was done (Zong et al., 2023).

Early approaches to leverage DAO to enhance innovation and discovery have been found in academic literature, arguing that smaller teams perform better in scientific discovery and disruption (Wu et al., 2019; Xu et al., 2022). DAO can be used to govern data markets (Ding et al., 2023a) and enhance discoveries in different scientific fields, such as longevity, reproductive health, and machine learning (Fantaccini et al., 2024). The DAO structure can also help tackle the "open washing" problem where science teams cannot prove that they're aligning with open science practices, but the use of blockchain technology at the level of team operations can solve this issue, making data accessible and transparent (Miao et al., 2023).

For example, VitaDAO has successfully demonstrated how DAOs can accelerate longevity research by pooling resources from a global community of contributors and allocating funding in a decentralized and transparent manner (Fantaccini et al., 2024). Since its launch in 2021, VitaDAO has deployed over $4.2 million to fund over 20 research projects, including a noteworthy $285,000 investment in Newcastle University's Korolchuk Lab to identify novel autophagy activators that could play a critical role in treating age-related diseases. This model not only democratizes access to funding, but also fosters collaboration between researchers, investors, and community members, creating a more inclusive and efficient approach to advancing science (Fantaccini et al., 2024). VitaDAO's success exemplifies the potential of DAO frameworks to disrupt traditional research funding and enable impactful scientific innovation in a decentralized ecosystem.

Given the novelty of DeSci and its broader blockchain-related movements, limited information is available on the ecosystem and its associated projects. A previous study explored the impact of funding received during the Gitcoin Round 15, a public goods funding round, on participating DeSci teams, focusing on their achievements and financial needs (Magennis et al., 2023). However, this research was limited by its focus on teams that applied for Gitcoin Grants, thereby excluding other key stakeholders in the DeSci ecosystem. Building on these earlier findings, this study aims to provide a more comprehensive understanding of the current DeSci landscape and identify the critical factors influencing the success and sustainability of its initiatives.

2 Objectives

The objective of this study was to comprehensively evaluate the state of projects within the DeSci landscape in 2023, focusing on their organizational structures, technological foundations, and funding mechanisms.

This research is particularly motivated by critical gaps in the understanding of the operational dynamics of DeSci projects. Despite the increasing interest in leveraging blockchain and Web3 technologies in scientific research, there is a limited understanding of how these technologies are operationalized in practice, particularly in the early stages (Weidener and Spreckelsen, 2024; Ding et al., 2023b). Questions such as which blockchain platforms and tools dominate, how DeSci teams balance decentralization with operational constraints, and whether funding sources align with long-term sustainability, remain largely unexplored. Additionally, there is a lack of clarity on how DeSci initiatives integrate the traditional scientific infrastructure and partnerships while innovating with decentralized frameworks.

Specifically, this research aimed to:

1. Identify the associations, focus areas, objectives, and achievements of DeSci organizations in 2023.
2. Examine the technologies employed, including blockchains and engagement platforms of DeSci organizations.
3. Explore the various sources of funding that support these organizations.

By addressing these objectives, this study aimed to fill important knowledge gaps regarding the operational and strategic models of DeSci organizations, offering insights for their development and contributing to the advancement of the broader DeSci ecosystem. The resulting findings and insights are intended not only to inform researchers and support continued research, but also to help non-participants better understand the ecosystem, potentially enabling increased participation, greater representation of additional disciplines, and enhanced interdisciplinary collaboration.

3 Methodology

This study employs a dual methodological approach, combining qualitative and quantitative data analysis, to provide a comprehensive understanding of the DeSci ecosystem. The methodological framework is further guided by the expertise of the authors, who are actively involved in various DeSci organizations, offering practical insights and contextual relevance to the study.

In this study, organizational structures were defined as the frameworks and models adopted by DeSci projects to coordinate activities, allocate resources, and make decisions. This encompasses a range of organizational forms, including DAO, hybrid models that integrate elements of decentralization with traditional structures, and partnerships with academic institutions or non-governmental organizations (NGO). The analysis focuses on the presence and effectiveness of formal governance mechanisms, collaborative frameworks, and technical infrastructure supporting the scientific process.

This study also incorporates an evaluation of the technological foundations underpinning DeSci projects, with a focus on blockchain platforms, tokenized ecosystems, and the role of multichain approaches. These elements were assessed to understand their contribution to governance, resource allocation, and operational efficiency. Funding mechanisms were analyzed to capture the hybrid nature of resource acquisition within DeSci. These include decentralized models, such as token sales and crowdfunding, as well as traditional sources, such as grants, venture capital, and institutional partnerships. By examining the intersection of funding and operational models, this study provides insights into the sustainability and scalability of DeSci organizations.

3.1 Selection process

To identify relevant DeSci organizations and projects for this study, a structured selection process was implemented. The process involved the use of three primary sources that document and map DeSci initiatives:

- The DeSci Wiki: An extensive, community-maintained document providing insights into various DeSci organizations and projects. (Accessed at: https://docs.google.com/document/d/1aQC6zn-eXflSmpts0XGE7CawbUEHwnL6o-OFXO52PTc/edit#heading=h.arcrgw3lu7wt).
- The Messari Ecosystem Map: A visual representation of DeSci projects and their ecosystem connections, curated by Messari Crypto. (Accessed at: https://x.com/MessariCrypto/status/1633127885539274752/photo/1).
- The DeSciWorld Dashboard: A comprehensive dashboard providing data on DeSci projects and their activities. (Accessed at: https://desci.world/dashboard).

Following data collection from these sources, duplicates and non-organizational entities were systematically removed. For example, community-driven initiatives, such as Telegram groups (e.g., DeSci Japan), were excluded, as they did not meet the organizational criteria (as defined in Section 3: Methodology). Additional inclusion criteria specified the use of DLT or demonstrated aspiration for adoption in the future. This aspiration was indicated by the use of blockchain technology, the presence of a token, or plans to become a DAO (e.g., as specified in a project roadmap). Furthermore, evidence of activity in 2023 was required, demonstrated by at least one post on communication channels such as Telegram, X (formerly Twitter), or Discord. A total of 133 organizations were identified for the recruitment process.

3.2 Data collection process

To maximize participation and achieve comprehensive coverage of the DeSci ecosystem, the developed survey was distributed using multiple outreach methods. Primary communication was conducted via email, targeting identified DeSci organizations and projects. To supplement this, alternative communication channels were employed where appropriate, ensuring broader accessibility and engagement. These included:

- Direct Messaging: Platforms such as X (formerly Twitter), Telegram, Discord, and LinkedIn were utilized to directly reach project representatives, recognizing the DeSci community's strong presence on these social platforms.
- Conference Networking: DeSci-related conferences provided an additional avenue for recruitment, including notable events such as DeSci London, DeSci Summit, and SciOS side events at ETHDenver.

This multi-channel approach was designed to ensure the inclusion of a diverse range of projects and organizations, particularly acknowledging that DeSci initiatives often rely on informal social channels, such as Telegram and X, for communication and coordination. Data was collected using an online survey provider (Qualtrics) between December 2023 and April 2024.

No formal ethical approval was sought for this study, as the data were collected in an anonymized manner and did not involve sensitive personal information. Qualtrics was utilized as the data collection platform to ensure the security and privacy of the collected data, offering enhanced privacy controls and secure data storage. All participants representing the identified DeSci organizations provided informed consent for the use and analysis of their responses. This approach adhered to standard ethical guidelines for research involving anonymization and voluntary participation.

3.3 Survey development

The 16-question survey used in this study (see Supplementary Material) was designed with reference to a previous analysis of crowdfunding's effects on project development (Magennis et al., 2023). In the absence of established survey instruments for DeSci, questions were developed based on the collective expertise of the authors and consultation with the lead author of the prior analysis. Following the initial formation of the questions, the authors engaged in an iterative review process to refine the survey instrument. This process involved several cycles of evaluation to ensure clarity, relevance, and alignment with the study objectives.

Although no control questions or formal pre-test was conducted, the survey was reviewed by the authors and lead author of the prior analysis to ensure clarity, relevance, and alignment with the study objectives. Additionally, measures were taken to enhance data integrity during the data-cleaning phase, such as systematically removing responses identified as non-serious or duplicate. These steps were aimed at mitigating potential biases and improving the reliability of the dataset.

3.4 Data analysis

The collected data were analyzed using a combination of quantitative and qualitative methods. Microsoft Excel served as the primary tool for organizing and processing the data, and statistical tests were performed to ensure rigor and precision of the analysis. Quantitative data were categorized and the proportion of responses was calculated as a percentage of the total valid responses. To maintain the integrity of the analysis and avoid introducing bias due to incomplete data, only responses from projects that provided answers to a given question were included in the analysis. This approach ensured that the findings for each question were based on a complete dataset, thus enhancing the reliability of the derived insights. While this decision may limit the sample size for certain questions, it was considered necessary to avoid misinterpretation or skewing of the results due to partial or ambiguous responses. In addition to the descriptive statistics, inferential statistical methods were used to deepen the analysis. Chi-square tests for goodness of fit were used to evaluate whether observed distributions, such as project goals or blockchain utilization, deviated significantly from the expected distributions. Z-tests for proportions were applied to compare key categories, such as structured organizations and those with DAO-specific features, to assess significant differences in representation. These statistical methods allowed the study to move beyond descriptive insights and to provide a more robust interpretation of the data.

Qualitative data were analyzed using inductive content analysis, an exploratory methodology that allows categories and themes to emerge from the data to simplify the exploration of meaning in the texts (Bengtsson, 2016). The process followed four stages: decontextualization, recontextualization, categorization, and compilation. During decontextualization, the data were broken into meaning units, the smallest segments capturing relevant information, and codes were assigned to facilitate organization. Recontextualization involved revisiting the original texts to ensure that all relevant data were included and extraneous information was excluded. In the categorization phase, codes were grouped into categories, which were then refined into overarching themes to ensure internal homogeneity and external heterogeneity (Bengtsson, 2016). Finally, the compilation stage involved synthesizing the themes into coherent findings that addressed the study objectives. A separate coding process was conducted for each qualitative question (Q4, Q8, and Q9), with themes developed to reflect the significance and prevalence of the responses. To validate the coding process and minimize potential bias, the results were crosschecked within the research team to ensure consistency and enable a consensus-based approach to theme development.

4 Results

This section summarizes the key survey findings on the operational status, organizational affiliations, focus areas, goals, achievements, and other critical aspects of projects within the DeSci ecosystem supported by the corresponding figures. Responses were collected from 55 of the 133 identified and contacted organizations, representing 41.35% of the total outreach. To ensure the integrity of the analysis, only responses from projects that provided answers to specific questions were included in each corresponding dataset. Consequently, the sample size varied across questions with the number of responses specified for each analysis. This approach allowed for robust insights derived from complete datasets, while acknowledging variations in response rates.

4.1 Operational status of projects

Of the fifty-five projects that responded to the question, “Is your project still operational?,” 96% (n = 50) reported that they were currently operational. However, four projects indicated slower progress due to barriers, such as lack of funding (cited by all four) and leadership challenges (cited by two), including unclear objectives, undefined projects, and ineffective leadership structures. Only one project was reported to be non-operational.

To examine whether the distribution of projects across operational statuses deviated from an equal distribution, a chi-squared test for goodness-of-fit was performed. The null hypothesis stated that the projects were equally distributed across the three categories (“operational,” “operational but slower,” and “not operational”). The alternative hypothesis states that the distributions are not equal. The results of the chi-square test revealed a significant deviation from equal distribution ($\chi^2 = 82.29$, $p < 0.001$), indicating that the majority of projects remained operational, while only a small fraction faced slower progress or ceased operations. A visual overview of the operational status is shown as Figure 1.

4.2 Organizational affiliations

Twenty-one projects responded to the question regarding their organizational affiliations, with 62% indicating that their projects are associated with other organizations. The analysis identified five key categories of affiliations:

1. Partnerships (15 projects, 71%): These projects formed partnerships with health federations, NGO, funding

FIGURE 1
Operational Status of DeSci Organizations: Distribution of Responses to the Survey Question "Is your project still operational?" (N = 55).

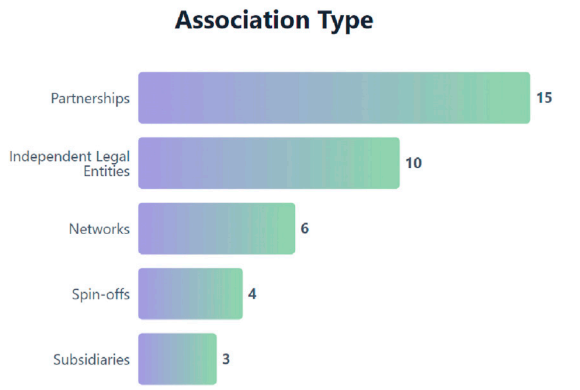

FIGURE 2
Organizational Affiliations of DeSci Organizations: Distribution of Responses to the Survey Question "Is your project associated with any organization?" (N = 21).

partners, clinical research organizations, and businesses. These collaborations have enabled projects to raise funds, access legal representation, share research, build a client base, and co-produce content.

2. Independent Legal Entities (10 projects, 47%): Nearly half of the teams that responded to this question established their own registered organizations to operate independently while complying with legal requirements. Some opted for Limited Liability Companies (LLC) or for-profit C Corps, while others chose special jurisdictions, such as the Marshall Islands. One project formed separate LLC in Europe, North America, and Asia.
3. Networks (six projects, 28%): This category includes teams that collaborate within an ecosystem of similar organizations, such as association members, project incubators, funding communities, and a network of supporters.
4. Spin-offs (four projects, 19%): These projects represent the Web3 arm of traditional organizations or adopt different business models from their original organizations.
5. Subsidiaries (three projects, 14%): Similar to spin-offs, these projects were established to support or complement other organizations or projects by providing incentivization layers or content production.

A chi-squared test for goodness-of-fit was performed to examine whether the observed distribution of projects across these categories deviated from an equal distribution. The null hypothesis assumed an equal distribution among all categories, while the alternative hypothesis posited an unequal distribution. The results showed a statistically significant deviation ($\chi^2 = 12.79$, $p = 0.012$), indicating that certain organizational affiliations, such as partnerships, are significantly more prevalent than others are. The association type of the DeSci organizations is shown as Figure 2.

4.3 Area of focus

Of the forty-nine projects that responded to this question, 67% (n = 33) selected three or more areas of focus. The most common focus areas were Research (69%), Community Building (61%), and Technical Infrastructure (55%).

A chi-squared test for goodness-of-fit was performed to examine whether the observed distribution of the focus areas deviated from an equal distribution. The null hypothesis assumes that the focus areas are equally distributed among the five categories, whereas the alternative hypothesis posits an unequal distribution. The results indicated a statistically significant deviation from equal distribution ($\chi^2 = 28.76$, $p < 0.001$), highlighting that Research, Community Building, and Technical Infrastructure were significantly more represented as focus areas than others.

4.4 Project goals and objectives

Forty-five projects responded to this question, with the DeSci teams focusing on five major areas: building infrastructure, nurturing specific science domains, promoting DeSci, funding projects, and conducting research.

1. Promoting DeSci (36 projects - 80%): The majority of surveyed projects share the goal of promoting DeSci, which involves nurturing communities, educating the public about science, or raising the visibility of specific scientific fields. Of the 36 projects that focus on promotion, 16 achieve this by forming communities, while seven have ongoing educational programs, such as online seminars or in-person events. These projects also aim to recruit more individuals to the DeSci ecosystem and onboard scientists to Web3.
2. Building Technical Infrastructure (16 projects, 35%): These projects are dedicated to developing technical platforms that support research, publication, data transfer, and monetization in various ways. Examples include healthcare platforms, computing marketplaces, layer 2 blockchains (L2s) designed for decentralized computing, intellectual property platforms, and data marketplaces with user ownership features.
3. Nurturing Specific Science Domains (10 projects, 22%): These projects concentrate on specific fields, such as longevity, brain health, reef conservation, cannabis research, and space exploration. They may conduct research, fund projects, or

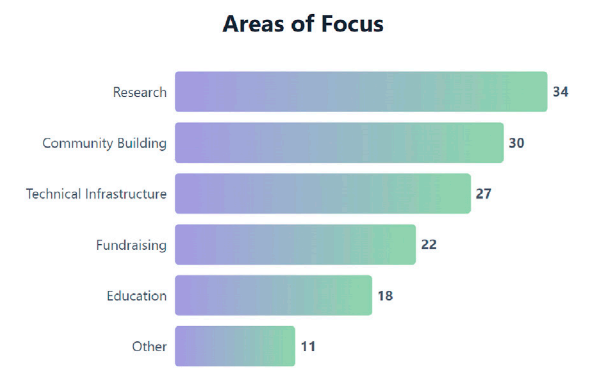

FIGURE 3
Areas of focus among DeSci organizations: Distribution of responses to the survey question on project focus areas (N = 49).

FIGURE 4
Project goals and objectives in the DeSci ecosystem: Distribution of responses to the survey question on primary goals (N = 45).

create communities around their areas of expertise using Web3 tools to advance these domains.

4. Funding (10 projects, 22%): These projects focused on securing funding for research or investing in other DeSci projects. They engage in investment, crowdfunding, or other innovative funding mechanisms, either by incubating DAO/teams or by directly financing research initiatives.
5. Research (seven projects, 15%): A smaller subset of projects explicitly mentioned that their primary goal was to conduct research. These organizations take responsibility for their own research activities, with one project also emphasizing a dual role in research and consultancy, indicating a broader scope of operations.

It is noteworthy that "Research" is identified as a focus area by 67% of the projects in Figure 3, but appears as a primary goal for only 7% of the projects in Figure 4. This discrepancy likely stems from the distinction between research-enabling activities and direct execution of research. Many projects prioritize creating conditions for research, such as developing technical infrastructure, securing funding, or fostering collaborative communities, rather than conducting original research themselves. This distinction underscores the ecosystem's broader role in facilitating scientific advancements, with fewer projects positioning research as their primary operational objective.

A chi-squared test for goodness-of-fit was conducted to evaluate whether the distribution of project goals significantly deviated from an equal distribution across categories. The null hypothesis assumed equal distribution among all categories, while the alternative hypothesis posited unequal distribution. The results revealed a significant deviation ($\chi^2 = 34.99$, $p < 0.001$), indicating that promoting DeSci is disproportionately represented compared with other goals.

4.5 Achievements in 2023

Forty-seven projects responded to this question, and we identified five major categories of achievements for DeSci projects by 2023: general milestones, DeSci promotion, use cases, product launches, and onboarding.

1. General Milestones (47 projects, 100%): All projects reported achieving significant milestones, which generally involved progressing toward the launch of a final product, completing research, or fully establishing their organization. The most common milestones included forming partnerships (15 projects, 32%), organizational development (12 projects, 25%), raising funds (8 projects, 17%), and building new infrastructure (7 projects, 15%).
2. Promoting DeSci (45 projects - 95%): A large number of projects succeeded in promoting DeSci by creating networks of like-minded teams (19 projects - 40%), hosting educational activities (18 projects - 38%), or publishing their work (8 projects - 17%).
3. Product Launch (32 projects, 68%): This category includes projects that successfully launched a usable version of a product or achieved a significant end goal. This relates to the new scientific infrastructure, the launch of a token, or making a pilot version of a product available for public testing (five projects, 10%).
4. Onboarding (18 projects, 38%): We differentiated between community growth and engagement (12 projects, 25%) and onboarding new members (6 projects, 12%). Community growth focuses on increasing public engagement, while onboarding involves recruiting specific talents, such as scientists, engineers, and lawyers, to join teams.
5. Use Cases (8 projects, 17%): These projects reported having practical use cases, meaning they achieved revenue, secured customer deals, or generated demand for their products or services. Specific achievements included consulting services (one project, 2%), conducting medical trials (one project, 2%), generating revenue from platform use (three projects, 6%), and providing other unspecified services (three projects, 6%).

A chi-square test for goodness-of-fit was conducted to assess whether the distribution of achievements deviated significantly from an equal distribution across the categories. The null hypothesis assumed an equal distribution, while the alternative hypothesis posited an unequal distribution. The results indicated a significant deviation ($\chi^2 = 38.20$, $p < 0.001$), highlighting that general milestones and promotion of DeSci are

FIGURE 5
Achievements of DeSci projects in 2023: Distribution of responses to the survey question on project achievements (N = 47).

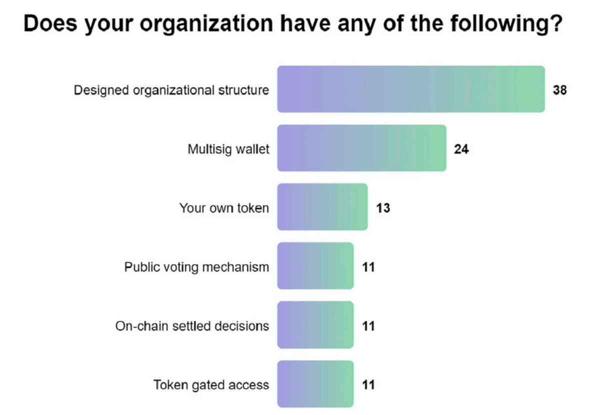

FIGURE 6
Web3 organizational structures in DeSci: Distribution of responses to the survey question on organizational features and DAO-Specific characteristics (N = 49).

disproportionately represented compared to other categories. A visual overview of the 2023 achievements is shown as Figure 5.

4.6 Web3 organizational structures

Forty-nine projects responded to the question regarding their Web3 organizational status. Approximately 78% reported operating within a designed organizational structure. However, the presence of features typically associated withDAO, such as tokenized voting, decentralized governance tools, or autonomous financial mechanisms, was relatively low, with most features present in less than 30% of organizations.

A z-test for proportions was conducted to compare the proportion of structured organizations (78%) with that of organizations implementing DAO-specific features (30%). The results showed a highly significant difference ($z = 5.58$, $p < 0.001$), confirming that while structured organizations are common in the DeSci ecosystem, only a small subset incorporate sufficient DAO-specific features to qualify as "true" DAO.

These findings suggest a predominance of hybrid organizational models that integrate decentralized principles to varying extents but often stop short of full DAO implementation. This could reflect the challenges in adopting decentralized governance or a preference for models that balance traditional and decentralized approaches. An overview of Web3 organizational structures is shown as Figure 6.

4.7 Blockchain utilization

Forty-two projects responded to this question by providing insights into the distribution of blockchain usage. The majority of projects (55%, n = 23) were based on a single chain, with Ethereum being the most frequently used platform (48% of single-chain projects), followed by Polygon (22%). Among the multichain projects, 31% (n = 13) utilized three or more chains, whereas 14% (n = 6) operated on two chains. Notably, seven projects (17%) reported that they did not use blockchain technology.

A chi-squared test for goodness-of-fit was conducted to evaluate whether the distribution of projects across the four categories (single chain, three or more chains, two chains, and no blockchain) deviated significantly from an equal distribution. The null hypothesis assumed equal distribution, while the alternative hypothesis posited unequal distribution. The results revealed a statistically significant deviation ($\chi^2 = 14.92$, $p < 0.01$), indicating that single-chain projects are disproportionately represented compared with other categories. Blockchain protocols of the surveyed projects is shown as Figure 7, with the multichain utilization shown as Figure 8.

4.8 Engagement platforms

Forty-eight teams responded to this question, aiming to identify how people discover and participate in projects and the primary platform for key conversations and decisions. Among the respondents, the Discord platform was the most commonly used, with 40% (n = 19) of the projects relying on it for engagement. Websites were the second most popular platform, accounting for 23% (n = 11) of the projects, while the remaining teams used other platforms, such as Telegram or social media channels (37%, n = 18).

A chi-square test for goodness-of-fit was conducted to evaluate whether the distribution of engagement platforms deviated significantly from an equal distribution across the categories. The null hypothesis assumed an equal distribution among the three categories (Discord, Websites, and Other Platforms), while the alternative hypothesis posited an unequal distribution. The results ($\chi^2 = 2.38$, $p = 0.305$) showed no statistically significant deviation, suggesting that the predominance of Discord was not disproportionate relative to other platforms in the dataset. An overview of the engagement platforms used is shown as Figure 9.

4.9 Funding sources

Among the forty-nine projects that responded, there was a balanced distribution of funding sources, including grants, token sales, and venture capital investments. Projects could select more than one

Chain	# of mentions	% of projects
Ethereum	28	57%
Optimism	14	29%
Polygon	12	24%
Other	11	22%
Arbitrum	9	18%
Cosmos	3	6%
Base	2	4%
Avalanche	1	2%
BsC	1	2%
Cardano	1	2%
Ceramic	1	2%
Etica	1	2%
Filecoin	1	2%
GOSH	1	2%
Gridcoin	1	2%
Internet Computer Protocol	1	2%
Near Protocol	1	2%
PGN	1	2%
Solana	1	2%

FIGURE 7
Blockchain platforms used by DeSci projects: Distribution of responses to the survey question on blockchain usage and specific chain selection (N = 42).

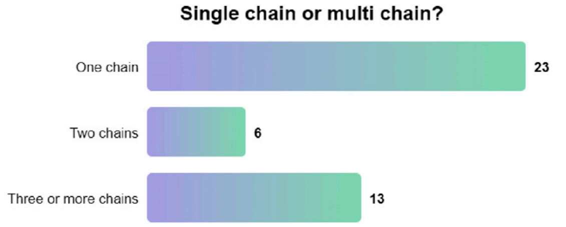

FIGURE 8
Multichain utilization among DeSci projects: Distribution of projects by number of blockchain platforms used (N = 42).

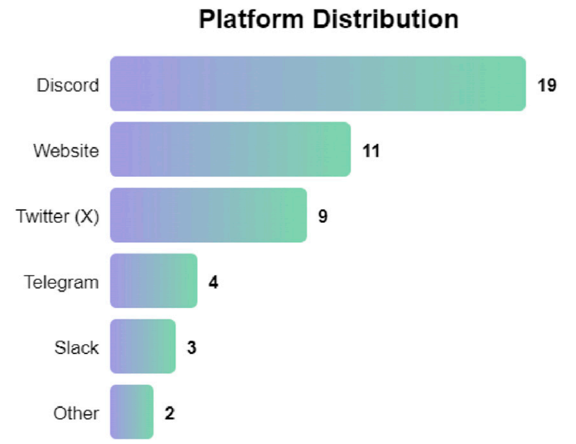

FIGURE 9
Engagement platforms used by DeSci projects: Distribution of responses to the survey question on platforms for discovery, participation, and decision-making (N = 48).

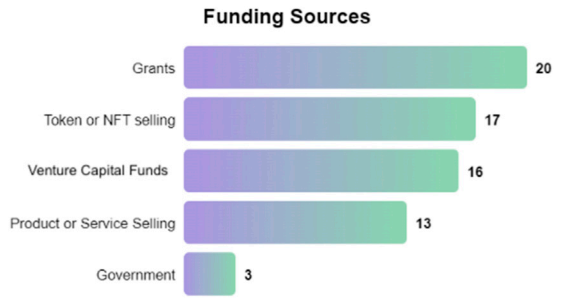

FIGURE 10
Funding sources for DeSci projects: Distribution of responses to the survey question on funding mechanisms, including grants, token sales, venture capital, and revenue generation (N = 49).

funding source, and it is noteworthy that 13 projects (27%) mentioned generating revenue by offering a product or service, indicating that some teams had already developed solutions ready for market testing. Government funding was mentioned in three of the 49 projects (6%).

A chi-squared test for goodness-of-fit was conducted to evaluate whether the distribution of funding sources deviated significantly from an equal distribution across the six categories. The null hypothesis assumes an equal distribution among funding categories, while the alternative hypothesis posits an unequal distribution. The results ($\chi^2 = 10.63$, $p = 0.059$) were not statistically significant at the 5% level, suggesting that the observed funding sources were relatively balanced with some minor variations. Notably, projects generating revenue (27%) were slightly more represented than were government-funded projects (6%). An overview of the funding sources for the surveyed DeSci projects is shown as Figure 10.

5 Discussion

The reported operational status of the projects may not fully reflect the actual level of activity within the DeSci space. While the majority of the responding projects were still operational, inactive projects may have been less likely to participate in the survey, potentially leading to selection bias. Responses were collected from 55 of the 133 identified and contacted organizations, representing 41.35% of the total outreach. While this response rate demonstrates a significant level of engagement among active DeSci organizations, it also underscores the potential for non-response bias. In particular, organizations facing operational challenges or those that are less integrated into visible ecosystems may be underrepresented. Future research should aim to implement strategies to improve participation rates, such as leveraging broader outreach channels or incentivizing survey completion to ensure a more representative sample of the diverse DeSci landscape. Understanding the reasons behind project inactivity is crucial, as it could offer valuable insights into the challenges facing DeSci initiatives and help identify areas where additional support or resources are needed. It is important to encourage inactive projects to share their experiences to strengthen the overall ecosystem. This bias may also partially explain the underrepresentation of projects operating outside the primary focus areas of this study, such as those not engaging with blockchain technologies or Web3 ecosystems. Future efforts should aim to obtain a more representative sample to deepen our understanding of the ecosystem.

We remark this because we see that the current DeSci landscape is not very diverse in terms of research area. Based on the three primary sources mentioned in Section 3.1 and the responses we got from our survey, we estimate that at least half of DeSci teams focus on drug discovery or biological sciences, whereas social sciences or engineering areas are hardly present here. Therefore, being able to contact more projects would hopefully allow us to cover other scientific fields. The current focus of DeSci on biotech and longevity projects underscores this point, reflecting its concentration in fields with clearer funding opportunities and established blockchain applications. However, it is yet to be determined whether securing funding through on-chain mechanisms is easier than through traditional means. This ambiguity highlights the need for further exploration of how decentralized funding models can better support basic science and underrepresented fields, particularly those lacking immediate business models. Expanding into less representative disciplines, such as engineering or social sciences, may also require targeted initiatives and infrastructure development.

Additionally, we encountered instances in which some projects we attempted to contact were no longer reachable, with inactive accounts, and no apparent means of communication. This lack of transparency can hinder trust and raise concerns within the community. To maintain the reputation and credibility of the DeSci ecosystem, transparency and openness are essential, especially for securing future funding and ensuring the long-term sustainability of space. Engagement platforms, such as Discord and websites, which are heavily used within the ecosystem, must be optimized to facilitate ongoing communication and prevent projects from falling into obscurity.

The finding that over half of the respondents indicated that their projects were associated with other organizations underscores the critical importance of cross-collaboration within the DeSci ecosystem and with non-Web3 institutions. This trend differentiates DeSci projects from other Web3 initiatives that often operate independently. Given that much of the world's scientific research is conducted within traditional institutions such as universities, private research institutes, and NGOs, it is imperative for DeSci projects to establish and maintain these partnerships to leverage existing infrastructure and expertise. These findings suggest that partnerships may provide a strategic advantage in accessing resources and networks, explaining their predominance in decentralized science ecosystems. However, the long-term success of these collaborations depends on balancing decentralization with the constraints of traditional organizational models. Alternatively, the overrepresentation of partnerships could signal reliance on external structures for legitimacy and stability in a nascent field, highlighting the challenges of scaling purely decentralized approaches. This suggests that for many DeSci projects, traditional partnerships remain a necessary transitional strategy rather than a long-term operational model.

We also see these associations as a way for DeSci to transition from a niche innovation into an established component of a scientific regime. Disruptive innovations in DeSci require time to diffuse and stabilize within the general scientific system. This is why partnering with organizations, such as universities or private research institutes, could enhance trust and facilitate the integration of DeSci within the sociotechnical system of science (Geels, 2019). Collaborations with traditional scientific institutions could also be beneficial in overcoming the negative perceptions surrounding the cryptospace. Such partnerships may enhance credibility, demonstrate the practical benefits of decentralized technologies, and foster trust within the broader scientific community and general public. We see these associations as a positive strategy for "anchoring" with the general scientific system. They also present an opportunity to bring legitimacy to the general cryptocurrency-related space (Lehner et al., 2017). However, the lack of focus on expanding into underrepresented regions or disciplines, such as the social sciences and engineering, may restrict the breadth of this integration. Expanding these partnerships to include diverse fields and geographies could enhance the ability of DeSci to address global scientific challenges more equitably.

Regarding the areas of focus, the preference for a generalist approach, with most projects concentrating on three or more areas, reflects the strategic adaptation within the new scientific research paradigm that DeSci stands for. The emphasis on community building, even among tech- and research-focused projects, highlights the shift towards user-centered models where engagement and participation are paramount. This finding underscores the ecosystem's emphasis on foundational work, such as organizational development and community engagement, which are likely prerequisites for achieving more advanced goals, such as product launches or generating use cases (Friedman et al., 2022). Additionally, the focus on user-centered approaches aligns with the Web3 principle of decentralization, suggesting that DeSci projects intentionally position themselves as accessible and participatory platforms for diverse stakeholders, including scientists and non crypto natives. However, the strategic focus on multiple areas could also dilute resources, potentially leading to slower progress in critical areas such as technical infrastructure or funding mechanisms. Projects with narrower focus areas may see faster progress in achieving tangible outcomes, thus providing an alternative operational model for others in the ecosystem. The absence of a clear attempt to maintain and grow a community could, however, also lead to a higher risk of failure of the project and, therefore, needs to be balanced critically.

The predominance of Ethereum as the primary blockchain for DeSci projects despite its higher transaction fees can be attributed to the robust and trusted Ethereum community. The platform's established infrastructure and the support it receives from influential figures such as Vitalik Buterin, who has been a vocal advocate of DeSci, likely contributed to this trend. This choice underscores the importance of trust and community in the decision-making processes of DeSci projects, suggesting that, even in a decentralized ecosystem, the reputation and stability of the underlying technology play a significant role. The limited adoption of multichain approaches and the presence of projects that do not utilize blockchain technology reflect both technological constraints and resource limitations, as well as a divergence from core decentralization principles in some initiatives. Broadening the use of blockchain platforms and exploring multichain interoperability could help projects mitigate the risks associated with over-reliance on a single ecosystem, as well as compensate for the higher costs associated with fees. Alternatively, some DeSci founding teams may selectively use blockchain technology for specific tasks, such as publishing or managing lab infrastructure, while retaining traditional organizational structures. This approach allows projects to leverage the benefits of blockchain technology without fully transitioning to a decentralized model such as a DAO, thereby balancing innovation with operational efficiency. The reliance on Ethereum and limited multichain use may also reflect a cautious approach in an uncertain regulatory environment. Projects could prioritize single-chain solutions to ensure stability before exploring more complex multi-chain strategies, which might become necessary for scalability and broader adoption in the future. The focus on a single blockchain and related ecosystem could also remove some of the complexities that may be helpful in onboarding non-cryptocurrency native individuals.

Although only a small percentage of projects sought government funding, the fact that some DeSci initiatives are exploring this avenue is noteworthy. This dual approach of seeking both decentralized funding sources and traditional government grants reflects the hybrid nature of DeSci, which operates at the intersection of traditional and decentralized scientific models (Sicard, 2022). This highlights the potential for DeSci projects to integrate within the existing scientific funding landscape, while also pushing the boundaries of how science can be funded and conducted. However, limited engagement with government funding may also suggest barriers related to regulatory uncertainty or misalignments with the priorities of traditional funding agencies. Exploring these barriers could provide valuable insights into scaling DeSci projects and securing more diverse funding sources. Furthermore, government funding may provide a stabilizing effect on early-stage projects or basic science research projects offering reliable support that complements the flexibility of decentralized funding mechanisms. It may also increase the level of trust from the general public, especially in countries where cryptocurrency adoption is still resisted or questioned. However, heavy reliance on government funding could potentially constrain innovation if projects must align with strict funding mandates or bureaucratic requirements.

Regarding the use of DAO as an organizational model to improve science governance, we found that even though DeSci teams had a designed organizational structure, these organizations do not resemble a DAO at its full length (Sharma et al., 2024). The most common feature was the use of multi-signature wallets, but other features, such as on-chain voting or having their own token for governance, were present in nearly one out of every four projects surveyed. However, this could be expected from these early stage organizations, as they cannot afford to completely decentralize and operate on-chain while they are still figuring out how to build new infrastructure and services for scientific research. These findings highlight that, while structured organizations are common in the DeSci ecosystem, the integration of DAO-specific features remains limited. This could reflect barriers, such as the complexity of implementing decentralized governance systems or a preference for hybrid approaches that balance traditional and decentralized elements (Goldberg and Schär, 2023). We could expect that DeSci teams would adopt a progressive decentralization approach, as other DAO have done or deviated from the DAO model, and adopt new frameworks for decentralized organizations (Qin et al., 2023). This staged adoption of decentralization suggests that hybrid models may provide a practical alternative, enabling projects to address immediate operational needs while gradually transitioning to full decentralization. Such models could serve as templates for scalability and sustainability within the DeSci ecosystem.

Recent studies highlight that open standards and blockchain-based governance are necessary, but not sufficient, conditions for a decentralized and neutral platform. DAO-like governance frameworks bring their own set of challenges for voting (Goldber and Schär, 2023), long-term viability of the organization based on the incentives it provides (Rikken et al., 2019), and coordination of internal and external operations (Sharma, T. et al., 2024). This could make an argument for DeSci organizations to think about hybrid models or adapt decentralized features in a way that fits their own necessities, instead of adopting the entire DAO stack just for the need to fit inside the DAO model.

The observed trends in the limited adoption of DAO-specific features, reliance on Ethereum, and constrained funding mechanisms highlight challenges that extend beyond individual project choices. Scalability remains a significant concern for DeSci organizations, particularly because many teams struggle to balance decentralization with the practical demands of governance, resource allocation, and technological constraints (Mohammed Abdul, 2024). For example, fully decentralized decision making can introduce inefficiencies that hinder rapid development, leading projects to adopt hybrid governance models (Rikken et al., 2019). Additionally, the global disparity in crypto adoption, shaped by factors such as regulatory environments, cultural acceptance, and economic infrastructure, may create uneven opportunities for DeSci projects to expand beyond early adopters. Regulatory hurdles further complicate cross-collaboration with traditional institutions, as compliance requirements often conflict with decentralized principles. Addressing these barriers will require exploring governance models that prioritize adaptability and efficiency while maintaining the core values of transparency and inclusivity (Atici, 2022). Future research should critically examine how these trade-offs influence the success of DeSci initiatives, and identify the best practices for integrating decentralized frameworks into diverse regulatory and cultural contexts.

Recent literature highlights both the promise and complexity of decentralization in science, emphasizing that decentralization can democratize access to scientific knowledge and resources, but often faces resistance from traditional systems entrenched in hierarchical governance and centralized funding (Wang et al., 2019). The limited adoption of DAO-specific features observed in this study echoes findings arguing that early stage projects often lack the resources to fully embrace decentralization, while navigating compliance and infrastructure limitations (Axelsen et al., 2022). Furthermore, reliance on Ethereum aligns with broader trends, showing that blockchain ecosystems often coalesce around trusted platforms despite trade-offs in cost and scalability (Faqir-Rhazoui et al., 2021). These connections to existing literature suggest that DeSci is in a formative stage, where projects blend decentralization with practical adaptations to meet current operational demands, setting the stage for incremental, rather than revolutionary, decentralization.

The future of science may see coexistence and collaboration between traditional (TradSci) and decentralized (DeSci) models (Friedman et al., 2022). As DeSci projects continue to mature, they increasingly require specialized members to manage the growing complexity within their organizations. This maturation process is reflected in the diverse organizational structures and partnerships that DeSci projects are forming, which are essential for navigating the legal, economic, and social systems that science interacts with. DeSci must collaborate with these systems not only to advance its goals but also to ensure that its innovations can function effectively within the broader societal context. The coexistence of the TradSci and DeSci models offers the potential to blend the strengths of each system, enabling a more adaptive and inclusive approach to scientific discovery. However, achieving this balance requires intentional strategies for governance, funding, and engagement, which account for the unique challenges of decentralization. The degree of interaction between decentralized and traditional scientific models is highly context-dependent and is influenced by the broader economic, regulatory, and institutional environment in which scientific activities occur. Factors such as a country's economic stability, trust in financial institutions, and adoption of cryptocurrencies can play a pivotal role in shaping the likelihood of migration toward decentralized approaches (Saiedi et al., 2021). In contexts where trust in traditional financial systems is low or economic instability prevails, cryptocurrency adoption may be more appealing, facilitating the use of decentralized funding mechanisms. Conversely, significant challenges may arise in environments that are either highly or excessively unregulated. For example, the utility of crypto-based funding may be diminished if cryptocurrencies cannot be used to procure essential research equipment, conversion of digital assets into fiat currency is prohibitively complex, or the absence of clear regulatory frameworks exposes researchers to legal or reputational risks, such as accusations of illicit financial activities.

5.1 Limitations

This study has several limitations that may affect the validity, reliability, and generalizability of the findings. One prominent limitation stems from the involvement of researchers who are actively working in DeSci. Their perspectives and interpretations may be influenced by their own experiences and expectations, potentially skewing their analysis and conclusions. While providing valuable insight, this insider perspective may inadvertently introduce subjectivity. To mitigate this, quantitative analyses, including statistical tests, such as chi-square tests and z-tests for proportions, were performed collaboratively and cross-checked within the research team. However, the absence of formal intercoder reliability assessments leaves room for further improvements to ensure objectivity. Another limitation arises from the reliance on survey responses, which may not fully represent the perspectives of the entire organization. It is unclear whether there was an internal consensus within these organizations regarding the submitted responses. Individual respondents, particularly those in leadership or public-facing roles, may have overemphasized positive outcomes while underreporting challenges or failures, leading to potential bias in the representation of project achievements. The absence of control questions in the survey design is another limitation. Control questions could have helped verify the attentiveness and consistency of respondents. While this gap was partially addressed through rigorous data cleaning (e.g., removing non-serious or duplicate responses and excluding incomplete surveys), the lack of direct verification measures leaves room for undetected response biases. This absence may have impacted findings such as organizational affiliations or project goals, where survey interpretation plays a key role. Future studies should incorporate validation mechanisms, including control questions or redundant items, to ensure consistency in the responses.

The sampling process in this study presents another challenge. Responses were collected from 55 of the 133 identified and contacted organizations, representing a 41.35% response rate. This moderate response rate introduces potential nonresponse bias, as the perspectives of organizations that did not participate may differ from those that did. This limitation may affect the generalizability of the findings, particularly given the potential for underrepresentation of organizations with differing operational models, focus areas, or geographical contexts. Although outreach efforts targeted multiple platforms (e.g., Telegram, Discord, X, LinkedIn) and conferences (e.g., DeSci London, DeSci Summit, and SciOS side events at ETHDenver), the sample remains skewed toward projects with a strong presence in "Western-centric" networks. The underrepresentation of projects from non-Western regions, including Asia, the Middle East, and Africa, limits the diversity of the perspectives captured in this study. This lack of geographical representation restricts the generalizability of the findings, and reinforces the need for future research to engage with underrepresented communities. The study also relied on self-reported data, which inherently carries the risk of social desirability bias. Respondents may have overstated their successes or minimized their challenges to align with their perceived expectations or present their projects in a favorable light. This limitation is particularly relevant to findings related to project achievements, operational status, and engagement platforms. The absence of external validation mechanisms to cross-check self-reported data against independent metrics (e.g., public blockchain data and financial disclosures) limits the ability of the study to fully verify these claims.

The methodological framework of this study was constrained by several factors that affected the depth and reliability of the findings. Reliance on survey responses without triangulation with independent metrics such as public blockchain data, financial disclosures, or public activity logs limits the ability to fully validate self-reported data. For example, respondents may have overstated achievements such as partnerships, funding success, or operational milestones, and without external verification, these claims remain unverifiable. The sampling strategy, while comprehensive in targeting multiple platforms and conferences, inherently favored projects with a strong digital or Western-centric presence. This likely excluded initiatives with minimal online visibility or those operating in underrepresented regions such as Asia or Africa, potentially biasing findings such as blockchain platform usage, funding mechanisms, or organizational structures. The survey design, constrained to a concise 16-question format, ensured accessibility, but limited the exploration of complex phenomena. For instance, questions on organizational affiliations or the integration of DAO-specific features may have been interpreted inconsistently because of the absence of pretesting or control questions. The lack of systematic validation increases the risk of response bias or misinterpretation. Similarly, small sample sizes in specific categories, such as multichain projects or those achieving practical use, limited the statistical power of the findings. The reliance on inferential statistical methods, such as the chi-square and z-tests, further constrained the analysis. Although useful for descriptive insights, these methods lack the granularity to uncover causal relationships or complex interdependencies, particularly for findings on governance structures or funding models. Finally, qualitative coding lacks formal validation measures, such as intercoder reliability assessments, potentially introducing subtle biases during thematic development and interpretation. Future research should address these gaps through external data validation, mixed-method approaches, and rigorous pre-testing to enhance the robustness of the findings.

Further research should address these limitations by incorporating mixed-method approaches, including longitudinal studies, control questions, external data triangulation, and targeted sampling, to improve the diversity and robustness of the findings. Expanding the scope to include case studies and deeper qualitative one on one interviews would also allow for a more nuanced exploration of the complexities within the DeSci ecosystem.

6 Conclusion

This study provides an understanding of the state of the DeSci ecosystem in 2023 by examining its organizational structures, funding models, technological foundations, and operational challenges. While some findings, such as the dominance of Ethereum confirm existing knowledge, this research offers new insights into the limited integration of DAO-specific features, persistent reliance on centralized elements, and barriers posed by funding shortages and leadership issues. These findings underscore the need for DeSci projects to balance decentralization with operational effectiveness and address scalability through strategies such as multichain adoption and collaborative governance models.

In practice, these findings highlight actionable strategies based on the collected data. The analysis of DeSci's organizational structures reveals the critical role of partnerships between decentralized projects and traditional organizations. Such collaborations can facilitate access to existing infrastructure and resources, thereby addressing one of the primary barriers faced by smaller or early stage projects. Similarly, insights into funding mechanisms suggest that DeSci initiatives should diversify their strategies beyond tokenization models by incorporating traditional grant and crowdfunding approaches to ensure financial sustainability, particularly for basic science projects without clear commercial applications. The study also underscores the limited adoption of DAO-specific features across the ecosystem, suggesting that most projects are still in a transitional phase toward full decentralization. Teams can leverage progressive decentralization, starting with foundational tools such as multi-signature wallets for treasury management and gradually integrating advanced governance models such as on-chain voting or token-based decision-making. Additionally, the findings showed a concentration of DeSci activity in fields such as biotechnology and longevity. Projects in underrepresented disciplines, such as social sciences or engineering, could use these findings to identify strategies for aligning their operational models and funding approaches with the broader ecosystem. These insights also provide a benchmark for assessing organizational priorities and positioning within the DeSci landscape.

Despite its contributions, this study highlights the need for further research to address gaps in representation, such as the underrepresentation of non-Western projects and a lack of demographic diversity within DeSci organizations. Expanding future studies to include longitudinal research and qualitative approaches could provide a deeper understanding of how progressive decentralization impacts ecosystem sustainability and scalability. While challenges remain, this study showcases the potential of DeSci to transform the scientific landscape by addressing key systemic issues and advancing equitable, transparent, and collaborative scientific practices.

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.

Ethics statement

Ethical approval was not required for the studies involving humans because only project specific information was collected (personal information was anonymized). All participants agreed to the collection, analysis, and publication of the data. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

FD: Conceptualization, Data curation, Formal Analysis, Methodology, Software, Validation, Writing–original draft, Writing–review and editing. CM: Conceptualization, Formal Analysis, Funding acquisition, Methodology, Project administration, Writing–original draft, Writing–review and editing. LW: Conceptualization, Investigation, Methodology, Supervision, Validation, Writing–original draft, Writing–review and editing.

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Conflict of interest

Author CM was employed by DeSciWorld. Author LW was employed by Molecule.

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

Generative AI statement

The author(s) declare that no Generative AI was used in the creation of this manuscript.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fbloc.2025.1524222/full#supplementary-material

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