Journal DAO: User-Incentivized Autonomous Decentralized Scientific Publishing in Web3

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***Abstract*—The academic publishing industry is currently undergoing significant growth but also faces several challenges, mainly including the lack of transparency in the peer review process and the limited rights of authors. The rise of Web3, emphasizing decentralization, openness, and user control over data, opens up new perspectives for academic publishing. This article introduces an innovative academic publishing model, named Journal DAO, leveraging emerging Web3 technologies such as blockchain and decentralized autonomous organization (DAO). First, by recording articles on the blockchain rather than a centralized database, Journal DAO can ensure data security and traceability of the articles. Second, through the governance framework of DAO, tokens are distributed among all the participants of Journal DAO based on the their contributions, safeguarding the rights of each role in the publishing process. Third, effective incentive mechanisms are proposed to reward all participants, ensuring the sustainability of the framework and its autonomous functionality. This work proposes a prospective academic publishing model that aims to reshape the industry through the application of blockchain and DAO in Web3, making a significant contribution to future academic publishing.**

***Index Terms*—Decentralized autonomous organizations, blockchain, Web3.0, decentralized funding, decentralized science**

I. Introduction

THE academic publishing industry is currently facing several pressing challenges. First, the traditional system, often conducted anonymously, fails to ensure fairness and impartiality, leading to a compromised review process that undermines both credibility and integrity. This lack of transparency can undermine the credibility and integrity of the review process. Second, the authors often lack control over associated data of their articles, since the ownership often rests with publishers or electronic databases [1]. This challenges authors in retaining rights, deciding on data use, and hampers their ability to fully leverage research, limiting collaborative opportunities and further advancements in their field. Third, the restrictions on data sharing hinder the free flow of knowledge and inhibit potential collaborations, which limits authors from fully benefiting and making discoveries that could contribute to the scientific community.

The emergence of technologies such as Decentralized Autonomous Organizations (DAOs) [2] and blockchain [3], [4] presents significant opportunities for the advancement of the academic publishing industry. DAOs offer a groundbreaking approach to organizational governance, decision-making, and fund management for academic publishing [5]. Unlike traditional hierarchical structures, DAOs operate without central authorities, relying on transparent and automated processes governed by smart contracts and consensus protocols [6]. This decentralization can provide a transparent and auditable decision-making process, enhance accountability, and facilitate efficient funds distribution for the current academic publishing system. The decentralized and tamper-resistant nature of blockchain can provide a secure and transparent environment for intelligent journals. By integrating blockchain technology into intelligent journals, the data transparency and authenticity can be realized. Through blockchain-based smart contracts, the reliability of data can be steadfastly guaranteed, thereby eliminating the necessity for third-party oversight [7]. This innovative approach not only enhances the credibility of information but also streamlines the process, fostering trust and efficiency within the realm of intelligent journals.

In the literature, the applications of blockchain-based decentralized technologies in academic publishing have received researchers' great attention [8]. Blockchain technology was used to solve the security and efficiency concerns in the distribution and management of open journal systems, ensuring precise distribution, enhancing reputation and trust, and safeguarding paper management against potential hacker threats [9]. Through decentralized InterPlanetary File System (IPFS) and blockchain technologies, the authenticity, trust and reliability of online publications can be ensured, which can effectively address the challenges related to security and privacy in online publications [10]. By leveraging blockchain-based decentralized technologies, a decentralized scientific publishing platform is established, which utilizes Ethereum

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smart contracts to expedite the publication process, reduce biases in peer review, and lower publication costs [11]. The platform can ensure complete traceability throughout the publication processes, and all the participants including the editors, reviewers, and authors will receive system tokens as rewards for their contributions.

However, these existing studies primarily concentrate on specific aspects, such as the use of blockchain to address security and efficiency concerns or enhance transparency in the academic publishing process. They do not comprehensively address the multifaceted challenges prevalent in the current academic publishing landscape. This article proposes an innovative academic publishing model called Journal DAO, which applies emerging Web3 technologies, such as blockchain and DAO, to address these challenges. First, by recording articles on the blockchain, all operations are conducted on the chain rather than belonging to a specific database, ensuring data security and traceability. Second, through the DAO framework, tokens are distributed based on role contributions, protecting the rights of researchers. Third, by designing effective incentive mechanisms, with the consideration of rewarding each participant according to their contributions to the article, a fully autonomous and economically sustainable Journal DAO ecosystem can be realized [12].

The rest of this paper is arranged as follows. Section II introduces the framework of Journal DAO framework. Section III discusses the design and implementation of the incentive mechanism in Journal DAO. Section IV presents experimental results validating the effectiveness of the implemented incentive mechanism. Section V concludes the paper.

II. Framework of Journal DAO

This chapter present the implementation details and methodology of the web3-based Journal DAO system, which combines blockchain technology, smart contracts, and decentralized science(DeSci) practices. The system's design and development are rooted in the utilization of Non-Fungible Tokens (NFTs) to establish a robust incentive framework that benefits all participants. This chapter delves into the technical aspects of the system, outlining the steps taken to create a self-governing and autonomous journal ecosystem. Additionally, the methodology employed for the integration of blockchain, smart contracts, and decentralized scientific practices is discussed in detail. Through a comprehensive exploration of the implementation and methodology, this chapter offers insights into the practical application of the proposed Journal DAO system and its potential to transform traditional journal publication models.

A. The Framework

Based on the depicted framework in Figure 1, it is evident that the operational flow of the blockchain and DAO framework, along with the roles of various participants [13], can be succinctly understood.

In the DeSci framework, the core participants closely resemble those in traditional web2.0 journals. These include article authors, categorized as first author, second author, and

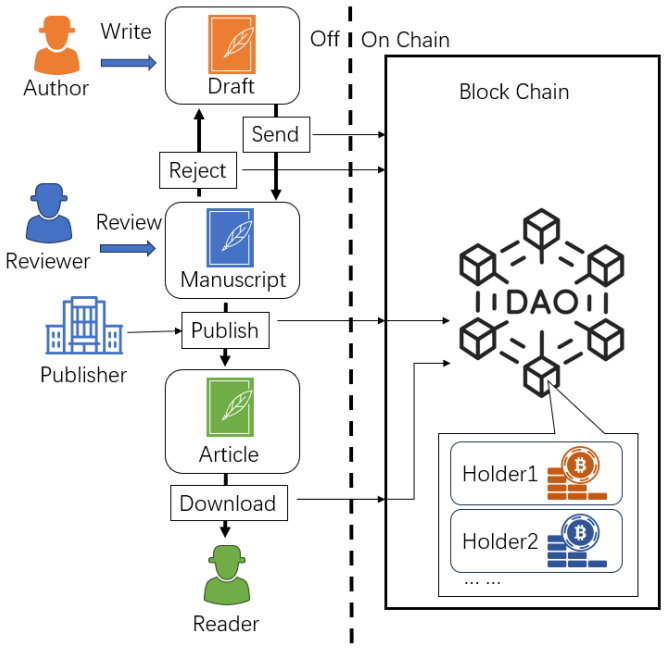

Fig. 1: Framework of Blockchain.

so forth, as well as corresponding authors. The framework also involves peer reviewers, such as Editors in Chief (EIC), Senior Editors (SE), and Associate Editors (AE). Readers form another essential group, who can download articles and even become authors themselves by citing and downloading referenced papers. Additionally, there are publishers representing the journal. The submission process, review assignment, rejection, and final publication in this DeSci framework exhibit minimal differences from traditional journals. Similarly, readers can download articles without significant distinctions from web2.0 journals. However, within this framework, the requirement for cited articles to be downloaded ensures the smooth operation of the DAO Framework, guaranteeing the integrity and functionality of the decentralized ecosystem.

In the DAO framework [14], token allocation follows a process where all participants, including authors, reviewers, readers, and publishers, are assigned contributions represented by tokens. This allocation is carried out based on the established procedures within the framework. Within this context, Non-Fungible Tokens (NFTs) can be utilized as a means to determine the distribution proportions of tokens. NFTs are unique tokens that represent specific assets or contributions [15]. By employing NFTs, the token allocation process becomes more granular, allowing for a more precise distribution based on the individual contributions of each participant. When finance is generated within the framework, it is distributed among all token holders according to the predetermined token allocation mechanism. The allocation is determined by the proportion of tokens held by each participant, reflecting their respective contributions and responsibilities within the framework. By implementing token allocation based on NFTs and distributing finance according to the token distribution mechanism, all stakeholders in the DAO framework receive their fair shares in proportion to their token holdings. This incentivizes active

participation and ensures that contributors are rewarded appropriately for their contributions within the framework.

B. The Operation Process

In the operation of the web3.0 journal system, from the user's perspective, there are minimal differences compared to traditional Web2.0 journal systems. Only specific confirmation nodes require the use of blockchain wallet tools such as MetaMask to complete transactions, while the rest remains unchanged. However, from the backend data perspective, all information is no longer stored in the publisher's server database as in Web2.0 journal systems. Instead, data is recorded on the blockchain through smart contracts [16], and the displayed data is merely a mapping of the on-chain data. This approach ensures the authenticity and immutability of the data. All aspects of the article's lifecycle, from peer review to revisions and publication, are recorded on the blockchain, guaranteeing their veracity and effectiveness. Notably, the process of downloading, which holds potential value, is meticulously recorded, ensuring fairness and transparency. By leveraging blockchain technology, the web3.0 journal system establishes a decentralized and tamper-proof environment. The utilization of smart contracts ensures the integrity and reliability of the data, while maintaining transparency and accountability throughout the publication process. This paradigm shift in data storage and record-keeping ensures the highest level of trust and fairness in the journal ecosystem [17] [18] [19].

In the practical implementation of the Journal DAO, this paper leveraged the Aragon framework to establish a decentralized and transparent infrastructure for academic publishing. The execution of the DAO involved several key steps to ensure a seamless and fair distribution of tokens among participants [20]. In a DAO, the concept of incentive mechanisms plays a crucial role in driving active participation and contributions. These mechanisms are designed to provide incentives and rewards to individuals or entities involved in the DAO's activities. By offering tangible benefits such as token rewards, governance rights, or recognition, participants are motivated to actively engage and contribute to the DAO's growth and development. Effective incentive mechanisms foster collaboration, maintain long-term motivation, and encourage innovation within the DAO community. The incentive design of journal dao promotes collaboration, maintains long-term incentives, and promotes innovation within the DAO community in the following aspects.

1) Author motivations:
   Authors, as the initial owners of the articles, receive a significant number of tokens at the beginning. Furthermore, they continue to earn tokens through article downloads and citations. The quantity of downloads and citations serves as an objective measure of the article's quality, showcasing its excellence. With more tokens, authors gain access to increased financial resources, which serves as motivation for them to produce better articles.
2) Reviewer Incentives:
   Reviewers are rewarded with tokens based on their contributions and responsibilities during the peer review process. Each time an article generates financial resources, reviewers receive their share based on their token holdings. This incentivizes more individuals to actively participate in the review process.
3) Publisher rewards:
   Publishers, being the providers of the entire journal system, initially receive the highest number of tokens, reflecting their responsibility for article publication. However, as articles are downloaded and cited multiple times, they will be surpassed by the author of the articles.
4) Reader Bonuses:
   Readers, when downloading and citing articles, also earn tokens. Although individual readers receive a smaller number of tokens, this opportunity allows them to generate income. This incentivizes readers to download and cite articles, and if the downloaded and cited article exhibit high quality, attracting more readers to engage with them, they can earn a substantial amount of financial resources.

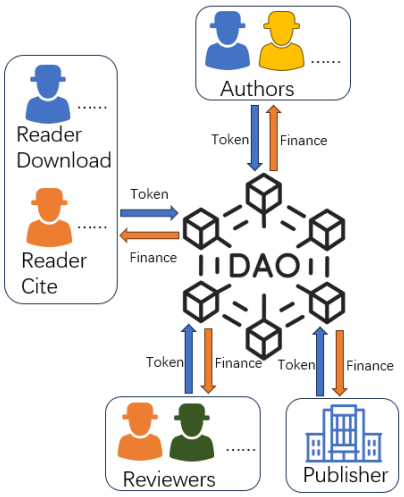

Fig. 2: All holders in DAO

The workflow of the DAO, as shown in Figure 2 depicted. As the DAO initiates the token minting process, specific rules guide the allocation of tokens. Authors are categorized into corresponding roles such as corresponding author, first author, second author, and third author, and so on, each receiving a different token allocation based on their contributions and responsibilities within the manuscript. Similarly, reviewers play a crucial role in the token allocation process. Their allocation is determined by their role in the review process and the ratings they provide for the submitted manuscripts. The publisher, as the platform responsible for facilitating manuscript publication, also receives a certain allocation of tokens due to their administrative role in managing the manuscripts.

This meticulous token allocation mechanism ensures that each contributor, be it an author or a reviewer, receives fair rewards based on their specific contributions and responsibilities [21]. By implementing such a structured system, the DAO

creates a transparent and equitable environment, aligning the incentives for authors and reviewers. This not only cultivates a sense of fairness within the system but also encourages active and meaningful participation from all parties. Guided by DAO principles, the workflow fosters seamless integration of all stakeholders, ensuring a well-functioning and self-sustaining ecosystem.

Every participant in the system has a specific number of tokens by contribution, then finance distributed according to the number of tokens. In this system, authors, reviewers, publisher, readers(who download the papers or references) all possess a specific quantity of tokens. These tokens are considered as NFTs due to their unique nature. Once finance is generated, such as when a user pays to download a paper, the system allocates this finance based on the number of tokens held by the respective parties.This design ensures objectivity, fairness, and transparency within the system. Each participant's contribution is reflected in a specific number of tokens, and the allocation mechanism operates according to the quantity of these tokens. Such a design not only enhances the fairness of the incentive mechanism but also makes the entire system more transparent, allowing participants to clearly understand the relationship between their contributions and rewards.This NFT-based token system provides tangible and verifiable returns for contributors while establishing an effective and operable incentive mechanism for the entire ecosystem [22]. This fair and transparent allocation method is expected to drive collaboration and development in the academic community, creating a mutually beneficial environment for all stakeholders.

C. The Advantages

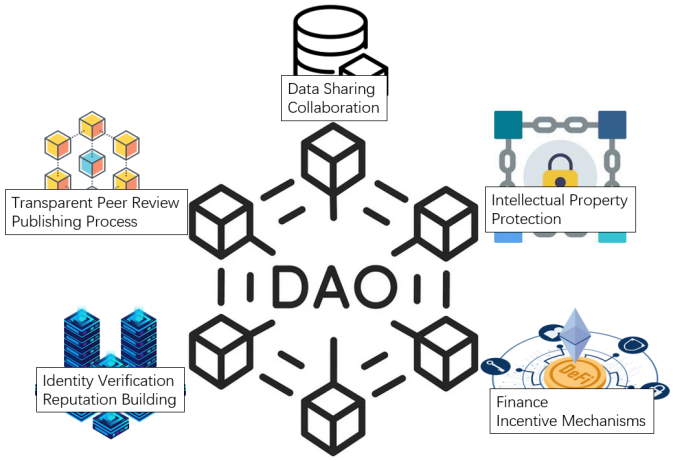

Fig. 3: Application of DAO in Article and Journal

According to the development of district DAO, related blockchain technology, the following DAO to Decentralized Science (DeSci) framework can be summarized as shown in the figure 3.It aims to establish a decentralized scientific publishing platform using blockchain and smart contract technology, enabling fair, transparent, and efficient scientific research dissemination.

- **Transparent Peer Review and Publishing Process:** Blockchain can be used to create a transparent academic publishing platform, ensuring transparency throughout the peer-review and publishing processes. [23] Smart contracts can manage review, publication, and payment procedures, ensuring traceability and fairness.
- **Protection of Intellectual Property:** Blockchain and smart contracts can safeguard authors' intellectual property, ensuring their works are not copied or distributed without permission [24].
- **Identity Verification and Reputation Building:** Blockchain can be employed to establish scholars' identities and reputations [25]. Smart contracts can automate the validation of scholars' achievements, storing them on the blockchain.
- **Data Sharing and Collaboration:** Blockchain and smart contracts can facilitate data sharing and collaboration among scholars, ensuring data integrity and traceability [26].
- **Finance and Incentive Mechanisms:** DAO and cryptocurrencies can be used to support research finance and incentive mechanisms.Funds can be allocated according to token weights [27].

These application examples highlight the potential value of blockchain, smart contracts, and DAO technology in academic publishing and journal management. They enhance transparency, protect intellectual property, verify identity, automate processes, and encourage collaboration. As these technologies continue to evolve, they hold promise for further innovation and efficiency in academia [28].

In the current web2.0 landscape, both literature storage and payment systems are typically centralized, controlled by a single entity or organization. However, in the decentralized web3.0 network, article data resides directly on the blockchain [29], with websites serving as interfaces to access this data [30] [31] [32]. In this new framework, payments for article downloads are automated and executed through smart contracts within the DAO framework [33]. This ensures complete transparency and traceability, as the fund distribution process follows predefined rules without centralized supervision [34].

In the Web 3.0 paradigm, this novel model signifies a departure from reliance on traditional intermediaries. Instead, it empowers users with the direct participation in DAO frameworks, utilizing smart contracts for automated and secure fund distribution [35]. This shift not only achieves decentralization in the transaction process but also enhances the efficiency of academic article transactions. In the Web 3.0 environment, articles are directly uploaded to the blockchain. All operations, including payment processing and fund distribution, are seamlessly executed through smart contracts. This innovative framework ensures complete transparency and traceability throughout the entire process. When users pay to download articles, the funds are automatically allocated according to the rules established within the DAO framework, eliminating the need for any centralized oversight.

III. Mechanism Design of Journal DAO

This paper introduces a DAO framework tailored for academic journals, incorporating fundamental concepts of DAO

to achieve perfect autonomy within the organization. By implementing effective incentive mechanisms, the framework enables fair and autonomous governance. The framework initiates the minting process, wherein tokens are allocated to all participants involved in the scholarly publication process, including reviewers, authors, and readers, based on predefined mechanisms. These tokens hold the power to influence proposal weighting, and the framework allocates financial resources according to token distribution. The application of blockchain technology ensures equitable and transparent resource allocation within the scholarly journal ecosystem. Participants holding tokens actively engage in the article publication process, such as submitting articles, reviewing papers, and downloading research outputs, thereby influencing the distribution of financial resources based on their token holdings. Through this framework, academic journals operated by DAOs can foster an inclusive and democratic environment, prioritizing the interests of all stakeholders involved. By combining the principles of DAO with academic journal operations, this framework paves the way for a decentralized and community-driven approach to scholarly publishing [36]. It empowers participants, promotes collaboration, and ensures the fair distribution of resources, ultimately leading to a more inclusive and sustainable academic publishing ecosystem.

In this DAO framework, token distribution is determined by a formula that takes into account the token holdings of different participants. As Equation 1 denote the token holdings of authors, reviewers, publishers, and readers as A, E, P, and R, respectively. The allocation mechanism, represented by the variable ω, calculates the total token holdings after each event, denoted as the sum of token changes over a given period (t).

$$\begin{bmatrix} A_t \\ E_t \\ P_t \\ R_t \end{bmatrix} = \omega_{t-1} \begin{bmatrix} A_{t-1} \\ E_{t-1} \\ P_{t-1} \\ R_{t-1} \end{bmatrix} + \omega_{t-2} \begin{bmatrix} A_{t-2} \\ E_{t-2} \\ p_{t-2} \\ R_{t-2} \end{bmatrix} + \cdot + \omega_n \begin{bmatrix} A_n \\ E_n \\ P_n \\ R_n \end{bmatrix} \quad (1)$$

The variable ω represents the weight assigned to each event, indicating the impact of that event on token changes. This weight can be adjusted based on specific criteria, such as the quality of the article, the level of contribution by reviewers, or the number of downloads and citations by readers. By incorporating this formula into the DAO framework, token distribution becomes a dynamic process that reflects the contributions and activities of all participants.

A. Decentralized Governance

DAO, adopting a decentralized governance model, allows token holders to participate in the decision-making process. This ensures community involvement in platform development, creating a democratic and inclusive environment. With robust incentives in place, token holders have made outstanding contributions while also receiving greater rewards. This positive feedback loop forms a self-sustaining ecosystem of active governance [37]. DAOs leverage blockchain technology to provide transparency and trust, recording all proposals, votes, and transactions on the blockchain for public verification. Incentives motivate token holders to actively engage in the governance process, while DAOs offer a meritocratic approach that values expertise. The flexibility and adaptability of DAOs allow them to evolve and respond to the needs of the community. However, challenges such as active participation, governance gridlocks, and power concentration need to be addressed through clear rules and mechanisms. Overall, DAOs empower token holders, foster community involvement, and create a democratic and inclusive environment [38].

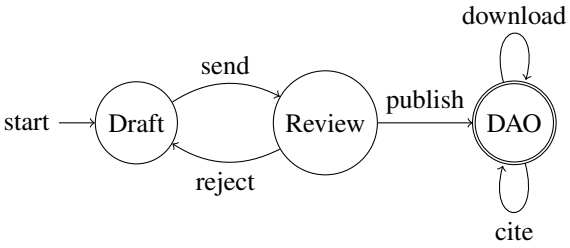

Fig. 4: Automata Machine of the Framework

As illustrated in the state transition diagram depicted in Automaton of Figure 4, the process of article publication within the DAO framework involves several stages. When an author submits an article, it undergoes a review process. If the article is rejected, the author is required to resubmit it, initiating a continuous cycle until it passes the review. Once the article successfully passes the review, it enters the DAO and is officially published. At this stage, the article becomes accessible for unlimited downloads and citations. The decentralized nature of the framework ensures that the article is available to a wide range of readers and can be referenced by other researchers, contributing to the dissemination of knowledge and scientific progress.

The implementation of the Journal DAO has yielded positive results in terms of increased engagement, quality submissions, and a more inclusive academic ecosystem. The transparent and automated token distribution mechanisms have effectively addressed issues of ownership and reward distribution, fostering a collaborative and fair scholarly environment. In order to create a strong incentive for active participation, a well-designed incentive mechanism is implemented in the decentralized governance framework. After authors publish their articles, the generated finance from user downloads is distributed not only to the publishers but also to all the authors and reviewers, motivating authors to produce high-quality articles and encouraging more individuals to serve as reviewers. To further enhance participation, readers who download the papers are also allocated a share of the revenue. This encourages more people to download the papers, leading to increased revenue for the DAO. As a result, all participants are incentivized to actively engage in the ecosystem, fostering a thriving and automatic academic community. This incentive mechanism ensures that all contributors, including authors, reviewers, publishers, and readers, are fairly rewarded for their contributions. It creates a positive cycle where authors are motivated to produce quality work, reviewers are incentivized to provide valuable feedback, and readers are incentivized to access and support the academic content. Overall, this system

promotes a healthy and autonomous academic ecosystem within the DAO framework [39].

B. Initial Token Distributions

In the DAO framework, tokens are minted during key events, first of all is article publication, then distributed to participants according to predetermined proportions. All these processes are executed through smart contracts, ensuring transparency and traceability. Having a well-designed token allocation mechanism forms the foundation of the entire framework, enabling a self-sustaining and self-regulating environment.

$$\begin{aligned} D_0 &= \sum_{i=1}^{m} x_i \\ 1 &= \alpha_1 + \alpha_2 + \alpha_3 \\ A_0 &= \alpha_1 D_0 \quad (A = \{a_0, a_1, a_2, a_3, \cdots a_n\}) \\ E_0 &= \alpha_2 D_0 \quad (E = \{e_1, e_2, e_3, \cdots e_m\}) \\ P_0 &= \alpha_3 D_0 \quad (P = \{p\}) \end{aligned} \tag{2}$$

Upon publication of an article, a DAO specific to that particular article is established, and tokens are minted and distributed among the authors(A), reviewers(E), and the publisher(P). The total number of tokens minted after this process, denoted as D_0, is determined based on Equation 2, taking into account the distribution proportions among the three parties: α_1, α_2, and α_3. Consequently, the allocation of tokens is as follows: the authors receive $A_0 = \alpha_1 D_0$, the reviewers receive $E_0 = \alpha_2 D_0$, and the publisher receives $P_0 = \alpha_3 D_0$.

$$\begin{aligned} 1 &= \beta_0 + \beta_1 + \beta_2 + \beta_3 + \cdots + \beta_n \\ &\quad (\beta_1 \geq \beta_2 \geq \beta_3 \cdots \geq \beta_n) \\ a_i &= \beta_i A \quad (a \in A) \\ a_{i0} &= \beta_i A_0 \quad (a_0 \in A_0) \end{aligned} \tag{3}$$

In the case of having a total of n authors, the allocation of tokens for each author is determined by the proportions specified in Equation 3. In this equation, β_0 represents the token allocation for the corresponding author, β_1 represents the token allocation for the first author, β_2 represents the token allocation for the second author, and so on. The total number of tokens allocated to all authors is denoted as A, and each author a_i receives a portion of tokens distributed according to the respective β ratio.When the article is published, tokens are minted and distributed to all authors. The total number of tokens allocated to the authors is denoted as A_0, and each author a_{i0} receives tokens distributed in the same proportions as determined by the β ratios.

$$\begin{aligned} 1 &= \gamma_1 + \gamma_2 + \gamma_3 + \cdots + \gamma_m \\ e_i &= \gamma_i E \quad (e \in E) \\ e_{i0} &= \gamma_i E_0 \quad (e_0 \in E_0) \end{aligned} \tag{4}$$

The number of reviewers is denoted as m, the allocation of tokens for each reviewer follows the proportions specified in Equation 4. In this equation, the token allocation for each reviewer e_i is determined by the respective γ ratio. The proportions for the reviewers may be determined based on other factors, such as the role the reviewers. The total number of tokens allocated to all reviewers is denoted as E.When the article is published, tokens are minted and distributed to all reviewers. The total number of tokens allocated to the reviewers is denoted as E_0, and each reviewer e_{i0} receives tokens distributed in the same proportions as determined by the γ ratios. The distribution mechanism remains consistent with that of the authors.

The publisher is unique so that it will not be subdivided.

C. Token Distributions upon Article Download or Citation

Unlike the singular issuance of tokens associated with article publication, the act of downloading articles by users as readers is a recurring event that perpetually exists within the DAO framework. The act of downloading an article not only represents recognition of the article itself but also serves as recognition of the article's author. Therefore, tokens need to be allocated to the authors, with the primary author and corresponding author, who contribute the most, receiving a larger share. Furthermore, readers who download articles both recognize the value of the article and also receive tokens as a result. This dual recognition mechanism ensures that both authors and readers are rewarded within the DAO framework. By allocating tokens to authors and readers, the system fosters a sense of acknowledgment and incentivizes active participation from all stakeholders involved in the publication and consumption of articles.

$$\begin{aligned} D_1 &= D_{1a} + D_{1r} \\ A_1 &= D_{1a} \\ \Sigma_1^A &= A_0 + A_1 \\ E_1 &= 0 \\ P_1 &= 0 \\ R_1 &= D_{1r} \end{aligned} \tag{5}$$

After the publication of the article, when users read and download the article, additional token minting occurs according to the formula specified in Equation 5. The purpose of this additional token minting is to incentivize authors and provide benefits to readers. In this process, new tokens are allocated to both authors and readers, while the token allocations for reviewers and the publisher remain unchanged.

$$\begin{aligned} 1 &= \beta_{1,0} + \beta_{1,1} + \beta_{1,2} \\ a_{1,0} &= A_1 \beta_{1,0} \\ a_{1,1} &= A_1 \beta_{1,1} \\ a_{1,2} &= A_1 \beta_{1,2} \end{aligned} \tag{6}$$

According to Equation 6, the tokens generated through the user's download behavior will be allocated to the corresponding author, first author, and second author in certain proportions. However, the token allocations for other authors remain unchanged.

$$
\begin{aligned}
D_2 &= D_{2a} + D_{2r} \\
A_2 &= D_{2a} \\
\Sigma_2^A &= A_0 + A_1 + A_2 \\
E_2 &= 0 \\
P_2 &= 0 \\
R_2 &= D_{2r} \\
\Sigma_{r1} &= R_1 + R_2 \quad if \quad R_1 = R_2 \quad (r_1 \in R)
\end{aligned} \tag{7}
$$

According to Equation 7, if a user cites a previously downloaded article in their own article, it triggers token minting. The tokens generated in this case are allocated to both the authors of the cited article and the user who made the citation.

D. Finance Distributions by Token

By employing token allocation based on NFT principles, the framework ensures a fair distribution of rewards among token holders. Through transparent smart contracts, the DAO framework establishes a self-regulating environment that incentivizes active participation and contribution. The implementation of this token-based distribution mechanism requires tracking token ownership and automated distribution of finance.

$$
\begin{aligned}
1 &= \frac{A}{D} + \frac{E}{D} + \frac{P}{D} + \frac{R}{D} = \alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 \\
F &\in \{ETH, Bitcoin, \cdots\} \\
F_A &= \alpha_1 F \quad (A = \{a_0, a_1, a_2, a_3, \cdots a_n\}) \\
F_E &= \alpha_2 F \quad (E = \{e_1, e_2, e_3, \cdots e_m\}) \\
F_P &= \alpha_3 F \quad (P = \{p\}) \\
F_R &= \alpha_4 F \quad (R = \{r_1, r_2, r_3, \cdots r_i\})
\end{aligned} \tag{8}
$$

According to Equation 8, the token allocation ratios for authors, reviewers, publisher, and readers are denoted as α_1, α_2, α_3, and α_4, respectively. Once finance is generated, it is distributed to all token holders based on these ratios. To respect intellectual property rights, many publishers require users to pay for downloading articles. In such cases, finance enters the DAO and is distributed to all authors, reviewers, publisher, and readers according to their token ratios. Articles typically attract a significant number of downloads, with exceptional ones garnering even more. Importantly, this distribution mechanism enables sustained earnings, thereby incentivizing authors to produce higher quality articles. While users initially act as consumers when downloading articles, they also become partial owners of the downloaded articles. As a result, they are eligible to receive a portion of the generated finance based on their token ratios. Motivating readers is crucial as it encourages them to willingly pay for article downloads, ultimately creating more finance and fostering a real automated organization. By implementing this approach, all participants receive fair allocations for their contributions. The autonomous nature of the framework drives authors to produce outstanding articles and incentivizes readers to pay for downloads, thereby generating more finance and establishing a virtuous cycle within the system.

$$
\begin{aligned}
F_r^* &= \sum_{i=0}^{n} F_{ei} \frac{T_r}{\sum_{j=0}^{i} T_j} \\
\omega_r &= \frac{F_r^*}{F_e} = \sum_{i=0}^{n} \frac{T_r}{T_0 + iT_1} \\
\omega_r &= \sum_{i=1}^{n} \frac{1}{W_0 + iW_1}
\end{aligned} \tag{9}
$$

According to Equation 9, the total income for readers who download articles within the DAO framework is denoted as F_r^*. Each download generates a financial gain, F_e, which is distributed among all token holders based on their respective token proportions. The reader's income from a specific download is represented as $F_{en}\frac{T_r}{\sum_{i=0}^{n} T_i}$. As other readers download articles more frequently, the total token holdings within the system gradually increase. Thus, while the reader's income may increase over time, the income from each individual download decreases. The finance received from each download event is fixed. By comparing the reader's total income with their expenses, which is equivalent to the finance per download event, a ratio called ω_r is obtained. When this ratio equals 1, the reader's income matches their expenses, and any subsequent income becomes additional. T_r represents the number of tokens held by the reader and remains constant. To simplify the equation, T_0 and T_1 are expressed as ratios to T_r, denoted as W_0 and W_1, respectively. Ultimately, the balance between income and expenses is determined by W_0, and W_1,.

$$
\begin{aligned}
\omega_r^1 &= \sum_{i=2}^{n} \frac{1}{W_0 + iW_1} \\
\omega_r^t &= \sum_{i=t+1}^{n} \frac{1}{W_0 + iW_1}
\end{aligned} \tag{10}
$$

In the context of Equation 10, the allocation of financial gain within the DAO framework is elucidated. The first reader who downloads the article obtains the entirety of the financial gain from all subsequent events. However, subsequent readers can only receive their share of the financial gain starting from the next download event. For instance, the second reader can obtain finance only from the second download event onwards, and the t-th reader can receive finance from the $t+1$-th download event. This allocation mechanism is influenced by the continuous increase in the total quantity of tokens within the DAO system. Consequently, earlier events hold a higher proportion of the financial gain, while later events receive a smaller portion. As each download event yields a gradually diminishing income, waiting for a high download count before downloading the article may result in an inability to reach a break-even point, where income matches expenses.

IV. A Case Study

In this section, we present experimental results by adjusting several parameters to reasonable values and conducting experiments to observe the distribution of the results. These experiments aim to provide insights into the outcomes under different parameter settings and offer a better understanding of

the system dynamics. By analyzing the experimental results, we can evaluate the impact of parameter adjustments on the observed distributions, enabling us to make informed decisions and recommendations for optimizing the system performance.

A. Parameters Adjust and Simulation

According to Equation 9, the factors influencing the balance between income and expenses are represented by W_0 and W_1. To visualize these factors, we will now construct a heatmap. The value of W_0 is expected to be relatively large as it encompasses the major contributors within the current DAO, such as authors, reviewers, and publishers. On the other hand, the value of W_1 is expected to be relatively small and involves only authors and readers, but it continues to cycle and trigger recurrently.

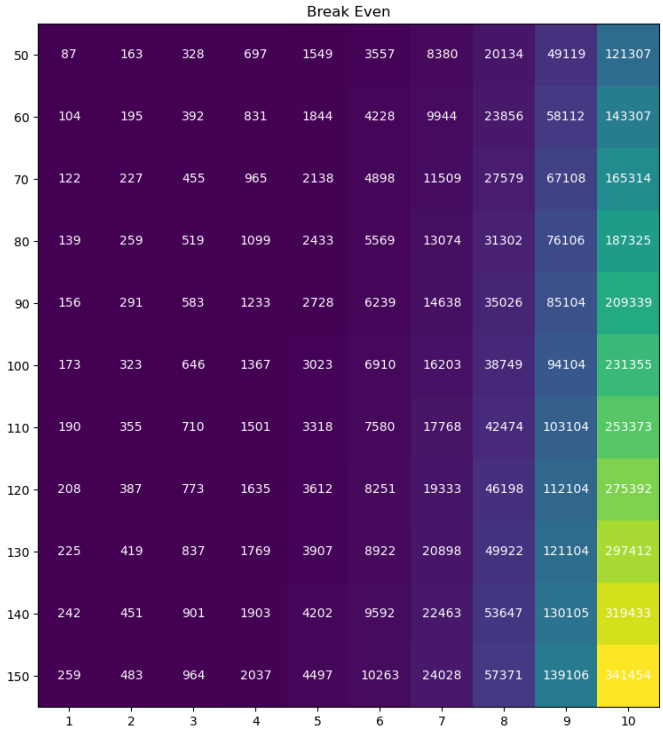

Fig. 5: Heatmap of Break Even.

In order to depict the relationship between different values of W_0 and W_1, a heatmap Figure 5 is constructed. As W_0 and W_1 increase, the number of required event triggers for break even tends to increase. It is suggested to define the values of W_0 and W_1 based on the download count of an outstanding article. By using this approach, the break even point can be optimized, ensuring a sufficient number of event triggers to achieve equilibrium.

In addition to the theoretical framework, there need conducted simulations to evaluate the effectiveness of the proposed DAO system [40]. Table I presents results from 20 simulated downloads, illustrating the distribution of finance among holders. This simulation provides a comprehensive overview of how finance is allocated to holders based on their token holdings [41]. And did data visualization processing [42]. Within the DAO framework, authors, as the owners of the articles, experience an increase in their tokens and ownership ratio when their articles are downloaded or cited, leading to higher profits. Reviewers, as participants in the article review process, initially receive tokens that do not increase over time. Although their ownership ratio gradually decreases, their profits continue to increase. The accuracy of their ratings directly benefits themselves. Readers, during the process of downloading and citing, also receive tokens, albeit in smaller quantities and with lower ownership ratios. However, as the articles are downloaded or cited, their overall profits increase. Additionally, the profit margin gradually decreases, meaning that readers who download and cite the articles in the early stages will benefit from higher profits, thus incentivizing the early identification of outstanding articles.

B. Proportion of Trend

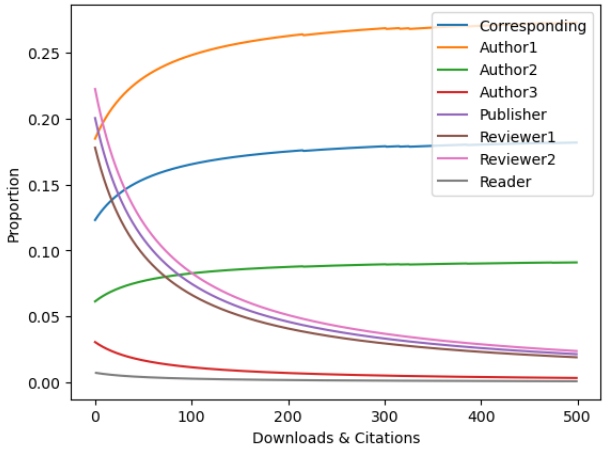

Fig. 6: Proportion of All.

Integrating DAO technology into the realm of academic journals holds immense potential for benefiting authors, reviewers, and readers alike. Look at Figure 6. Authors, being the rightful owners of their published works, would reap the most substantial rewards from such a system. By leveraging the decentralized nature of DAOs, authors can secure a greater share of the financial gains associated with their articles. As time progresses, their earnings could potentially increase, providing a long-term incentive for continued contributions. Reviewers, as the gatekeepers and custodians of scholarly integrity, would also stand to gain from the implementation of DAOs in journals. Initially, they would hold a higher proportion of benefits, reflecting their crucial role in the early stages of article evaluation. However, as time progresses and articles are published, their share of benefits may gradually diminish, ensuring a fair distribution of rewards among all stakeholders. Readers, as active participants in the scholarly discourse, would also have the opportunity to benefit from DAO-operated journals. While their gains may be comparatively lower than authors and reviewers, early engagement with the DAO ecosystem could yield higher returns. By accessing articles and participating in the DAO's governance processes, readers can contribute to the growth and success of the journal,

TABLE I: Finance for DAO.

	Authors				Publisher	Reviewers		Readers	
index	Corresponding	Author1	Author2	Author3	Publisher	Reviewer1	Reviewer2	Download	Cite
0	0.122997	0.184696	0.061298	0.030449	0.200321	0.177885	0.222356	0	0
1	0.124113	0.186367	0.061860	0.029945	0.197006	0.174941	0.218676	0.007092	0
2	0.125194	0.187984	0.062403	0.029457	0.193798	0.172093	0.215116	0.006977	0
3	0.125000	0.187688	0.062312	0.028529	0.187688	0.166667	0.208333	0.006757	0.013514
4	0.126016	0.189209	0.062823	0.028086	0.184775	0.164080	0.205100	0.006652	0.013304
5	0.127001	0.190684	0.063319	0.027656	0.181951	0.161572	0.201965	0.006550	0.013100
6	0.127957	0.192115	0.063799	0.027240	0.179211	0.159140	0.198925	0.006452	0.012903
7	0.128884	0.193503	0.064266	0.026836	0.176554	0.156780	0.195975	0.006356	0.012712
8	0.129784	0.194850	0.064718	0.026444	0.173974	0.154489	0.193111	0.006263	0.012526
9	0.130658	0.196159	0.065158	0.026063	0.171468	0.152263	0.190329	0.006173	0.012346
10	0.131508	0.197431	0.065585	0.025693	0.169033	0.150101	0.187627	0.006085	0.012170
11	0.132333	0.198667	0.066000	0.025333	0.166667	0.148000	0.185000	0.006000	0.012000
12	0.133136	0.199869	0.066404	0.024984	0.164366	0.145957	0.182446	0.005917	0.011834
13	0.133917	0.201038	0.066796	0.024643	0.162127	0.143969	0.179961	0.005837	0.011673
14	0.134677	0.202175	0.067179	0.024312	0.159949	0.142035	0.177543	0.005758	0.011516
15	0.134268	0.201558	0.066978	0.023676	0.155763	0.138318	0.172897	0.005607	0.011215
16	0.134994	0.202645	0.067343	0.023370	0.153752	0.136531	0.170664	0.005535	0.011070
17	0.135701	0.203704	0.067699	0.023072	0.151791	0.134791	0.168488	0.005464	0.010929
18	0.136391	0.204736	0.068046	0.022782	0.149880	0.133094	0.166367	0.005396	0.010791
19	0.137063	0.205743	0.068384	0.022499	0.148017	0.131439	0.164298	0.005329	0.010657
20	0.137719	0.206725	0.068713	0.022222	0.146199	0.129825	0.162281	0.005263	0.010526
Total	2.749313	4.127544	1.371082	0.543292	3.574286	3.173966	3.967458	0.121463	0.214788

potentially increasing their benefits over time. The implementation of DAO mechanisms, such as token-based incentives, transparent governance structures, and decentralized decision-making processes, would enable a fair and equitable model for academic journals. This model fosters a sense of ownership, rewards active participation, and ensures the sustainability and long-term viability of the journal ecosystem.

C. Break Even of User Download

Indeed, allowing users to offset their expenses or even earn profits through downloading articles can effectively stimulate user participation. While individual reader earnings may be modest, readers constitute the largest group within the DAO framework, making them a critical factor for the system's autonomy. By providing readers with the opportunity to offset their expenses or earn profits, the DAO framework can incentivize their active engagement. Despite individual earnings being relatively small, the cumulative impact of a large number of readers participating in the ecosystem contributes significantly to the overall success and sustainability of the DAO [43]. As a result, readers play a crucial role in driving the self-governing nature of the DAO framework.

The total revenue for downloading users is depicted in Figure 7. As readers who own the downloaded articles, their total revenue increases with a growing number of users downloading the articles. However, as more readers download the article and become owners, the individual token proportion naturally decreases as Equation 10. Consequently, the per-download revenue gradually declines. To simulate the distribution ratios following scenario, mainly look at the key break-even points [44]: the first reader who downloads the article breaks even when the article is downloaded 559 times; the tenth reader breaks even when the article reaches 651 downloads; and the one hundredth reader breaks even at a staggering 1579 downloads. This incentive mechanism aims to encourage readers to discover exceptional articles earlier

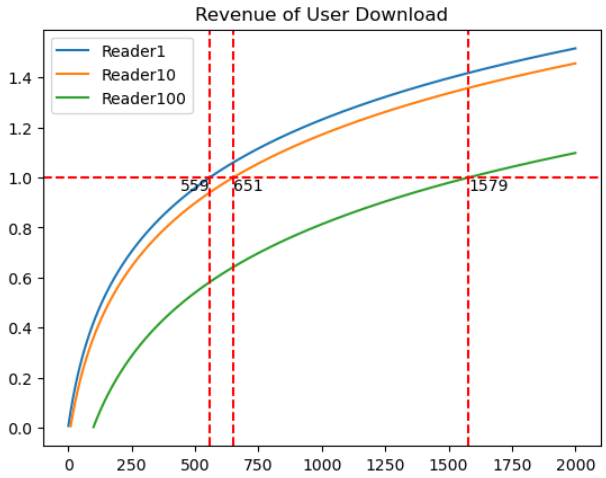

Fig. 7: Revenue of User Download.

rather than following the crowd since owning the article no longer yields significant returns. This approach incentivizes readers to identify outstanding articles sooner, as the potential for substantial earnings diminishes once an article has already demonstrated its quality.

D. Real Article simulation

Furthermore, we applied our DAO framework to a real-world case by analyzing a published paper with 2154 downloads and 42 citations. As shown in Table II. By simulating the income distribution within the current DAO structure [45], we observed that download users not only offset their initial payment but also gained additional earnings. The incentivized system encourages users to respect copyright and, more importantly, has achieved a level of autonomy.The provided tables and case study demonstrate the practical application and positive outcomes of our proposed DAO framework. By

TABLE II: Finance of Real Article for DAO.

	Authors				Publisher	Reviewers		Readers	
index	**Corresponding**	**Author1**	**Author2**	**Author3**	**Publisher**	**Reviewer1**	**Reviewer2**	**Download**	**Cite**
0	0.122997	0.184696	0.061298	0.030449	0.200321	0.177885	0.222356	0	0
1	0.124113	0.186367	0.061860	0.029945	0.197006	0.174941	0.218676	0.007092	0
2	0.125194	0.187984	0.062403	0.029457	0.193798	0.172093	0.215116	0.006977	0
3	0.126240	0.189550	0.062929	0.028986	0.190694	0.169336	0.211670	0.006865	0
4	0.127252	0.191066	0.063438	0.028529	0.187688	0.166667	0.208333	0.006757	0
...	...	...	...	...	...	...	...	...	...
998	0.184995	0.277503	0.092486	0.001690	0.011121	0.009876	0.012345	0.000400	0.000801
999	0.185000	0.277511	0.092489	0.001689	0.011111	0.009867	0.012333	0.000400	0.000800
1000	0.185005	0.277519	0.092491	0.001687	0.011101	0.009857	0.012322	0.000400	0.000799
1001	0.185010	0.277526	0.092494	0.001686	0.011090	0.009848	0.012310	0.000399	0.000799
1002	0.185015	0.277534	0.092497	0.001684	0.011080	0.009839	0.012299	0.000399	0.000798
...	...	...	...	...	...	...	...	...	...
2151	0.186032	0.279053	0.093011	0.000803	0.005285	0.004693	0.005867	0.000190	0.000381
2152	0.186034	0.279056	0.093012	0.000803	0.005283	0.004691	0.005864	0.000190	0.000380
2153	0.186036	0.279059	0.093013	0.000803	0.005281	0.004689	0.005861	0.000190	0.000380
2154	0.186038	0.279062	0.093014	0.000802	0.005278	0.004687	0.005859	0.000190	0.000380
Total	392.406327	588.652390	196.160264	6.520750	42.899672	38.094909	47.618636	1.537177	1.768627

aligning incentives with user behaviors, the system not only offsets costs for downloaders but also significantly incentivizes engagement. This not only respects copyright but also establishes a self-sustainable and autonomous ecosystem, providing valuable insights for the future development of decentralized academic publishing.

After voluntarily making a payment, users' ability to participate contributes to a robust incentive mechanism, fostering a sense of autonomy within the entire framework. Through this design, users become direct contributors to financial activities, injecting new value into the framework and creating potential opportunities for self-reward. This decentralized autonomous model empowers users to engage directly in decision-making and contributions, shaping a more open, fair, and virtuous ecosystem. Overall, this autonomous framework cultivates a more positive and sustainable participation experience for users and the entire community. Through the detailed simulations and analyses, the incentive mechanisms within the DAO framework emerge as crucial drivers in shaping the dynamics of authorship and user participation. As downloads and citations increase, the token-driven rewards become a powerful motivator for authors, leading to an accumulation of influence and financial gains. This incentive structure not only acknowledges and rewards the contributions of authors but also establishes a direct correlation between their efforts and the benefits they accrue. Furthermore, users who engage with the system by downloading papers witness a direct impact on their influence and, subsequently, on their earnings. This creates a dual incentive structure, where authors and users are mutually motivated to contribute to and participate in the DAO environment. The concept of decentralized autonomy becomes evident as the system operates independently, fostering a self-sustaining loop of contributions, rewards, and governance. In this context, the DAO framework provides a powerful tool for aligning interests and promoting a fair distribution of rewards based on tangible contributions. The transparency and automation inherent in DAO contribute to a governance model that minimizes external intervention, allowing the ecosystem to evolve organically through the collective actions of its participants. This synergy of incentives and autonomy within DAO not only enhances the overall efficiency of the academic publishing model but also creates a robust and self-regulating environment for authors and users alike [46].

V. Conclusion

This paper extensively explores the framework of DAO and provides a thorough analysis of its potential applications in the academic publishing domain. By placing papers on the blockchain, we have achieved transparency in ownership, allowing authors to have complete control over their works while also creating diverse financial opportunities. The autonomous nature of DAO enables users to directly participate in decision-making and contributions, constructing an ecosystem that is open, fair, and characterized by positive feedback loops. Under this framework, users can not only pay for paper downloads but also receive rewards through participation in financial activities. This novel academic publishing model grants authors greater creative freedom while motivating users to actively engage, contribute, and share knowledge. The decentralized autonomous design brings a more open and fair publishing mechanism to academia, breaking away from the limitations of traditional academic publishing.

Once an article is recorded on the blockchain, it opens up endless possibilities for the future, and the application of DAOs is expected to become increasingly widespread. Starting with the initial use of tokens to govern proposals, the introduction of NFTs, and now the emergence of recursive inscriptions, we are witnessing the continuous development of new applications within the DAO ecosystem. These advancements indicate that the realm of DeSci can also benefit from these innovative applications. The integration of blockchain technology, NFTs, recursive inscriptions, and other emerging technologies within DeSci can revolutionize the way scientific research is conducted, incentivize collaboration, facilitate knowledge sharing, and enhance the overall efficiency and transparency of the scientific process. As the technological landscape continues to evolve, we can expect to see even more novel applications that will further enhance the capabilities and impact of DeSci.

REFERENCES

[1] F. W. Lancaster, "The evolution of electronic publishing," 1995.

[2] V. Buterin *et al.*, "A next-generation smart contract and decentralized application platform," *white paper*, vol. 3, no. 37, pp. 2–1, 2014.

[3] M. Swan, *Blockchain: Blueprint for a new economy*. " O'Reilly Media, Inc.", 2015.

[4] R. Qin, Y. Yuan, and F.-Y. Wang, "Optimal block withholding strategies for blockchain mining pools," *IEEE Transactions on Computational Social Systems*, vol. 7, no. 3, pp. 709–717, 2020.

[5] S. Wang, W. Ding, J. Li, Y. Yuan, L. Ouyang, and F.-Y. Wang, "Decentralized autonomous organizations: Concept, model, and applications," *IEEE Transactions on Computational Social Systems*, vol. 6, no. 5, pp. 870–878, 2019.

[6] W. A. Kaal, "A decentralized autonomous organization (dao) of daos," *Available at SSRN 3799320*, 2021.

[7] W. Mougayar, *The business blockchain: promise, practice, and application of the next Internet technology*. John Wiley & Sons, 2016.

[8] M. Alharby, A. Aldweesh, and A. v. Moorsel, "Blockchain-based smart contracts: A systematic mapping study of academic research (2018)," in *2018 International Conference on Cloud Computing, Big Data and Blockchain (ICCBB)*, 2018, pp. 1–6.

[9] F. Agustin, S. Syafnidawati, N. P. L. Santoso, and O. G. Amrikhasanah, "Blockchain-based decentralized distribution management in e-journals," *Aptisi Transactions on Management (ATM)*, vol. 4, no. 2, pp. 107–113, 2020.

[10] N. Nizamuddin, H. R. Hasan, and K. Salah, "Ipfs-blockchain-based authenticity of online publications," in *Blockchain–ICBC 2018: First International Conference, Held as Part of the Services Conference Federation, SCF 2018, Seattle, WA, USA, June 25-30, 2018, Proceedings 1*. Springer, 2018, pp. 199–212.

[11] M. Beştaş, R. Taş, E. Akin, M. Ozkan-Okay, Ö. Aslan, and S. S. Aktug, "A novel blockchain-based scientific publishing system," *Sustainability*, vol. 15, no. 4, p. 3354, 2023.

[12] W. Ding, J. Hou, J. Li, C. Guo, J. Qin, R. Kozma, and F.-Y. Wang, "Desci based on web3 and dao: A comprehensive overview and reference model," *IEEE Transactions on Computational Social Systems*, vol. 9, no. 5, pp. 1563–1573, 2022.

[13] J. Zhu, Y. Yuan, F.-Y. Wang, and G. Wang, "Federated control: A trustable control framework for large-scale cyber-physical systems," *IEEE Transactions on Industrial Informatics*, pp. 1–9, 2024.

[14] Y.-Y. Hsieh, J.-P. Vergne, P. Anderson, K. Lakhani, and M. Reitzig, "Bitcoin and the rise of decentralized autonomous organizations," *Journal of Organization Design*, vol. 7, no. 1, pp. 1–16, 2018.

[15] G. Wang, R. Qin, J. Li, F.-Y. Wang, Y. Gan, and L. Yan, "A novel dao-based parallel enterprise management framework in web3 era," *IEEE Transactions on Computational Social Systems*, vol. 11, no. 1, pp. 839–848, 2024.

[16] N. Szabo, "Smart contracts: building blocks for digital markets," *EXTROPY: The Journal of Transhumanist Thought,(16)*, vol. 18, no. 2, p. 28, 1996.

[17] F.-Y. Wang, W. Ding, X. Wang, J. Garibaldi, S. Teng, R. Imre, and C. Olaverri-Monreal, "The dao to desci: Ai for free, fair, and responsibility sensitive sciences," *IEEE Intelligent Systems*, vol. 37, no. 2, pp. 16–22, 2022.

[18] W. Ding, J. Li, R. Qin, S. Guan, and F.-Y. Wang, "Ai4s based on desci: Reference model and research issues," in *2023 IEEE International Conference on Systems, Man, and Cybernetics (SMC)*, 2023, pp. 4784–4789.

[19] S. Shilina, "Decentralized science (desci): Web3-mediated future of science," *URL: https://medium. com/paradigm-research/decentralized-science-desci-web3-mediated-future-of-science-2547f9a88c40. Accessed*, vol. 12, p. 23, 2023.

[20] Y. El Faqir, J. Arroyo, and S. Hassan, "An overview of decentralized autonomous organizations on the blockchain," in *Proceedings of the 16th international symposium on open collaboration*, 2020, pp. 1–8.

[21] W. Ding, J. Li, R. Qin, R. Kozma, and F.-Y. Wang, "A new architecture and mechanism for decentralized science metamarkets," *IEEE Transactions on Systems, Man, and Cybernetics: Systems*, vol. 53, no. 9, pp. 5321–5330, 2023.

[22] D.-R. Kong and T.-C. Lin, "Alternative investments in the fintech era: The risk and return of non-fungible token (nft)," *Available at SSRN 3914085*, 2021.

[23] S. Nakamoto, "Bitcoin: A peer-to-peer electronic cash system," *Available at SSRN 3440802*, 2008.

[24] G. Gürkaynak, I. Yılmaz, B. Yeşilaltay, and B. Bengi, "Intellectual property law and practice in the blockchain realm," *Computer law & security review*, vol. 34, no. 4, pp. 847–862, 2018.

[25] N. Radziwill, "Blockchain revolution: How the technology behind bitcoin is changing money, business, and the world," *The Quality Management Journal*, vol. 25, no. 1, pp. 64–65, 2018.

[26] P. Praitheeshan, L. Pan, J. Yu, J. Liu, and R. Doss, "Security analysis methods on ethereum smart contract vulnerabilities: a survey," *arXiv preprint arXiv:1908.08605*, 2019.

[27] F. Schär, "Decentralized finance: On blockchain-and smart contract-based financial markets," *FRB of St. Louis Review*, 2021.

[28] A. Vacca, A. Di Sorbo, C. A. Visaggio, and G. Canfora, "A systematic literature review of blockchain and smart contract development: Techniques, tools, and open challenges," *Journal of Systems and Software*, vol. 174, p. 110891, 2021.

[29] F. A. Alabdulwahhab, "Web 3.0: the decentralized web blockchain networks and protocol innovation," in *2018 1st International Conference on Computer Applications & Information Security (ICCAIS)*. IEEE, 2018, pp. 1–4.

[30] J. Li, R. Qin, S. Guan, J. Hou, and F.-Y. Wang, "Blockchain intelligence: Intelligent blockchains for web 3.0 and beyond," *IEEE Transactions on Systems, Man, and Cybernetics: Systems*, pp. 1–10, 2024.

[31] G. Lai, M. Liu, F.-Y. Wang, and D. Zeng, "Web caching: architectures and performance evaluation survey," in *2001 IEEE International Conference on Systems, Man and Cybernetics. e-Systems and e-Man for Cybernetics in Cyberspace (Cat.No.01CH37236)*, vol. 5, 2001, pp. 3039–3044 vol.5.

[32] G. Lai, Q. Zhang, D. Wen, Y. Gao, Z. Feng, G. Ke, and H. Lu, "A prototype of the next-generation journal system for its: Academic social networking and media based on web 3.0," *IEEE Transactions on Intelligent Transportation Systems*, vol. 13, no. 3, pp. 1078–1087, 2012.

[33] L. Cao, "Decentralized ai: Edge intelligence and smart blockchain, metaverse, web3, and desci," *IEEE Intelligent Systems*, vol. 37, no. 3, pp. 6–19, 2022.

[34] J. Li and F.-Y. Wang, "The tao of blockchain intelligence for intelligent web 3.0," *IEEE/CAA Journal of Automatica Sinica*, vol. 10, no. 12, pp. 2183–2186, 2023.

[35] J. Li, J. Li, X. Wang, R. Qin, Y. Yuan, and F.-Y. Wang, "Multi-blockchain based data trading markets with novel pricing mechanisms," *IEEE/CAA Journal of Automatica Sinica*, vol. 10, no. 12, pp. 2222–2232, 2023.

[36] X. Liu, L. Liu, Y. Yuan, Y.-H. Long, S.-X. Li, and F.-Y. Wang, "When blockchain meets auction: A comprehensive survey," *IEEE Transactions on Computational Social Systems*, pp. 1–13, 2024.

[37] R. Beck, C. Müller-Bloch, and J. L. King, "Governance in the blockchain economy: A framework and research agenda," *Journal of the association for information systems*, vol. 19, no. 10, p. 1, 2018.

[38] M. C. Jensen and W. H. Meckling, "Theory of the firm: Managerial behavior, agency costs and ownership structure," in *Corporate governance*. Gower, 2019, pp. 77–132.

[39] P. Bolton and D. S. Scharfstein, "Corporate finance, the theory of the firm, and organizations," *Journal of Economic Perspectives*, vol. 12, no. 4, pp. 95–114, 1998.

[40] C. M. Macal and M. J. North, "Agent-based modeling and simulation," in *Proceedings of the 2009 winter simulation conference (WSC)*. IEEE, 2009, pp. 86–98.

[41] D. Liu, Z. Qin, H. Hua, Y. Ding, and J. Cao, "Incremental incentive mechanism design for diversified consumers in demand response," *Applied Energy*, vol. 329, p. 120240, 2023.

[42] S. Few, "Show me the numbers," *Analytics Pres*, 2004.

[43] J. M. Leimeister, "Collective intelligence," *Business & Information Systems Engineering*, vol. 2, pp. 245–248, 2010.

[44] H. Norreklit, "The balance on the balanced scorecard a critical analysis of some of its assumptions," *Management accounting research*, vol. 11, no. 1, pp. 65–88, 2000.

[45] B. Efron and R. J. Tibshirani, *An introduction to the bootstrap*. Chapman and Hall/CRC, 1994.

[46] E. Ostrom, *Governing the commons: The evolution of institutions for collective action*. Cambridge university press, 1990.

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