

# A Decentralized Publication System for Open Science using Blockchain and IPFS

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**Abstract.** Science publication and peer review raises concerns about fairness, quality, performance, cost or accuracy. The Open Access movements has been unable to fulfill all its promises, and middlemen publishers can still impose policies and concentrate profits. This paper, using emerging distributed technologies such as Blockchain and IPFS, proposes a decentralized publication system for open science. It provides transparent governance, a distributed reviewer reputation system, and open access by-design. The paper concludes reviewing the open challenges of such approach.

**Keywords:** blockchain, decentralized systems, distributed systems, open access, open science, peer review, P2P, publications, reputation

## 1 Introduction

Science publication and peer review are based in a paper-based paradigm, with few changes in the last centuries [1]. Critics to current science publication and peer review systems include concerns about its fairness [2], quality [3], performance [4], cost [5], and accuracy of its evaluation processes [6], among others.

The development of the Internet enabled the proposal of alternatives for science dissemination [7] and evaluation [8]. The reduction of distribution costs enabled wider access to scientific knowledge, and questioned the role of traditional publishers [9]. It is acknowledged that the Open Access and Open Science movements have successfully reduced the economic cost of readers to access knowledge [10]. However it has not successfully challenged traditional publishers business models [11] that are now combining charging readers and charging authors [12].

Peer review has suffered multiple criticism, and yet only marginal alternatives have gathered success [13]. The literature provides multiple proposals around open peer review [14], and proposals of reputation networks for reviewers [15]. In fact, a start-up, Publons<sup>4</sup>, provides a platform to acknowledge reviews and open them up.

Decentralized alternatives, despite their promises [16], are still in their infancy. A few proposals, none of them functional to date, have appeared recently: a peer review proposal using cryptocurrencies [17], a blockchain-enabled app with voting and storage of publications, again using cryptocurrencies [18], or a peer review quality control through blockchain-based cohort trainings [19]. Additionally, Ledger<sup>5</sup> journal records the publication timestamps in the Bitcoin blockchain.

This paper proposes the development of a decentralized publication system for open science. It aims to challenge the technical infrastructure that supports the middlemen role of traditional publishers. Due to the successes of the Open Access movement, some of the scientific knowledge is today freely provided by the publishers. However, the content is still mostly served from their infrastructure (i.e. servers, web platforms). This ownership of the infrastructure gives them a power position over the scientific community which produces the contents [20]. Such central and oligopolistic position in science dissemination allows them to impose policies (e.g. copyright ownership, Open Access prices) and concentrate profits.

The proposed system aims to move the infrastructure control from the publishers to the scientific community. It entails the decentralization of three essential functions of science dissemination: 1)

<sup>4</sup> <https://publons.com/>

<sup>5</sup> <https://ledgerjournal.org>

the peer review process, 2) the selection and recognition of peer reviewers, and 3) the distribution of scientific knowledge. The following section provides an overview of the system features, while the final section discusses its challenges.

## 2 Decentralized publication system for open science

The proposed system relies upon two emerging distributed technologies. On the one hand, the Blockchain [21] provides a public decentralized ledger to record the system’s interactions. On the other hand, IPFS [22] is a distributed file system to store all the papers and reviews sent to the platform. This ensures that all the information is persistent, free and accessible, and does not rely on a centralized server.

The proposed system provides a distributed platform for open science, from submission to publication, including the peer review process communications.

The system rests in three main pillars: a transparent governance, a distributed reviewer reputation system, and open access by design. These are outlined in the following subsections.

### 2.1 Transparent Governance

Peer review process communication nowadays is digitally supported, and yet some argue that its system remains feudal [9]. There are multiple proposals to improve peer review [8], however its communication and processes remain closed and in control of journals and publishers, and their infrastructure [23].

Distributing and opening peer review communication infrastructure, the proposed system aims to improve its transparency, empower the scientific community, and foster innovation. The system will support the peer review interactions in an open and decentralized network. Each interaction, from first submission to the final acceptance is registered in a public decentralized ledger. Thus, processes like the selection of reviewers, or the contents of the reviews, are open to the public eye. Thus, with interactions being time-stamped and tamper-proof, they can be monitored, audited, and held accountable. More complex iterations of the system can consider blind reviews, as discussed in section 3.

Opening the peer review process communications to the public could even change the acceptance dynamics of the system. Currently, high rejection ratios are encouraged because the risk of rejecting a relevant paper are negligible, while the acceptance of not so relevant content is penalized [9; 24]. However, within a more transparent system, the first may be penalized also.

This transparency, combined with a distributed infrastructure for peer review, facilitates the exploration of new workflows [23]. The following subsection explores one of these possibilities.

### 2.2 A distributed reviewer reputation system

The information concerning each reviewers quality and reliability is usually held private by publishers and journals (and even editors). There is no easy way to predict reviewer quality from reviewers training and experience factors [25]. This information is valuable, and yet it is kept private, reinforcing the publishers and journals influential positions.

This proposal extends traditional peer review communication workflow with the possibility of rating peer reviews, building a reputation system for reviewers [26]. Reviewers get rewarded for worthy, fair, and timely reviews, or penalized otherwise.

This open reputation network of reviewers would increase the visibility and recognition of the reviewing work [27]. In fact, they could be easily rewarded since third parties like founders could offer paid reviews to highly reputed reviewers. Moreover, creating a public reviewers reputation network reduces, or at least exposes, unfair and biased reviews [2; 23].

### 2.3 Open access by design

Open Access focuses in the free access to scientific knowledge. While publishers provide free of charge their Open Access content, their control of the science dissemination infrastructure allows them to impose certain rules, such as charging authors unreasonable fees to offer their work as Open

Access (Gold Open Access) [28] or the temporal embargo and restrictions on the dissemination of the final version (Green Open access) [29], among others.

The system proposes a decentralized infrastructure for science publication. Academic documents - from first drafts to final versions, including peer reviews- are shared in an open P2P network [22]. Thus, the system inherently grants Open Access by the design of its distributed infrastructure and circumvents the publishers dominant role.

### 3 Discussion and Conclusion

This paper proposes the opening and decentralization of three of the peer review and publication functions: 1) the peer review process communication, 2) the reputation of reviewers, and 3) the distribution of papers and peer reviews. Arguably, this decentralization of the infrastructure could help to challenge the central role of middlemen such as traditional publishers.

Distributed technologies such as Blockchain and IPFS may finally realize the promise of Open Access, while enabling new not-for-profit models of science dissemination. Opening and decentralizing the infrastructure enhances the transparency and accountability of the system, and fosters innovation.

Note the proposed system does not rely on the use of cryptocurrencies, since it is focused on a not-for-profit approach, far from the startup-driven commercial approaches common in the blockchain space.

This challenging proposal raises multiple issues. The opening of the peer review process may reduce the privacy of current closed system. Blind review relies in such privacy, and a lack of this protection can cause a great rejection by the community. Recent technical cryptographic innovations may be used to circumvent this issue [30] and allow transparency while still allowing double blind reviews.

The introduction of a new public metric (reviewers' reputation) may also affect researcher careers, adding pressure to the already straining processes for academic survival [31].

Additionally, the proposed system's infrastructure relies in new technologies with their own challenges. Blockchain technologies face scalability, transaction costs, inclusiveness and usability problems that remain open and under discussion. On the other hand, distributed file systems such as IPFS may be more resilient, but they still need somebody in charge of preserving and providing the data, since without that responsible actor, it may result in unpredictable loss of content.

Other open issues that may be explored in future work are the exploration of different copyright regimes, the challenging of traditional journal-centered metrics to rate publication quality, different reputation algorithms, different levels of openness, and the exploration of decentralized autonomous journals.

Despite the existing challenges, we are confident that decentralizing the processes that Science relies on, would open up a whole new playing field, with implications we cannot possibly foresee now. Will its benefits outweigh its risks? We believe it is a conversation worth having.

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