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Research Article

Blockchain based Resilient Architecture for Handling Manuscript Authenticity

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ABSTRACT

This paper introduces a Blockchain based Resilient Architecture for Handling Manuscript Authenticity, aiming to address the shortcomings present in current scholarly communication and scientific publication processes. These deficiencies include challenges in finding suitable reviewers, biased reviews, lack of transparency, slow processes, high costs, and absence of agreements among stakeholders. BRAHMA establishes clear roles for all stakeholders, ensures agreement through smart contracts, mitigates reviewer bias, promotes transparency, and prevents backdated publication occurrences. Developed on the Polygon blockchain, the system enhances manuscript security and traceability. Additionally, the proposed framework is compared with other similar frameworks to highlight its advantages.

Keywords: *Blockchain, Smart Contracts, Scholarly Communication, Scientific Publication.*

1. INTRODUCTION

Scholarly communication encompasses a systematic process involving the creation, evaluation, distribution, and preservation of academic and scholarly literature. This process involves publishing scholarly articles, books, and conference papers that have undergone thorough peer review by subject matter experts.

The concept of "scientific publication" refers to the organized distribution of research findings to a broader academic and professional community. The sharing of research results, methodologies, and concepts within a specific academic field is crucial for advancing knowledge and promoting collaboration among scholars. Scientific publications encompass various formats, including research papers, articles, conference papers, books, and other media, tailored to the specific attributes of the study and the target audience.

1.1.1 Traditional Peer Review System

Peer review is an essential evaluation process in which a manuscript, research study, or conceptual work undergoes rigorous examination before being published in a journal, conference proceedings, or book. The peer review process includes various approaches, such as single blind, double blind, triple blind, and post-publication methods.

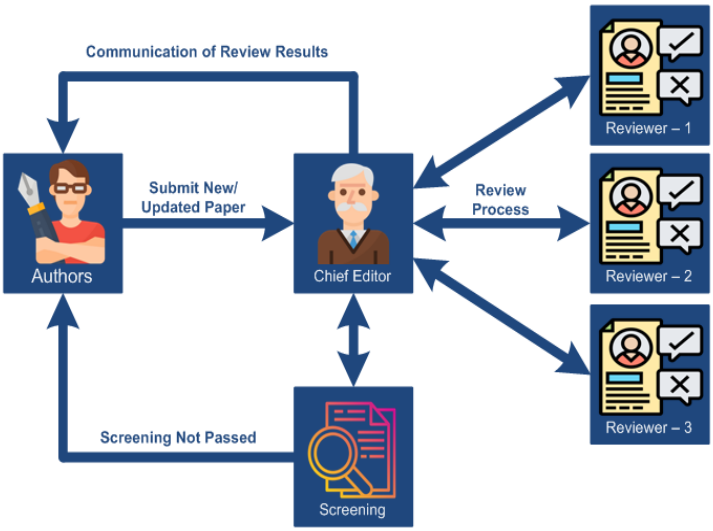

Figure 1: Conventional Peer Review System [1]

In the traditional peer review system, authors submit their manuscripts for review. At times, authors may engage in unethical behavior by simultaneously submitting their articles to multiple publications. However, there is no contractual agreement between the author and the journal to enforce restrictions against this practice.

The chief editor thoroughly examines the work at their own pace before sending it to reviewers. Generally, senior academics take on the role of chief editor as a service. Due to the busy schedules of individuals involved, the paper screening process often spans several months. Occasionally, manuscripts are rejected within three to four months, citing that they do not align with the journal's scope. As a result, authors may lose motivation and opt for a quicker route by submitting their work to predatory publications lacking a peer review system or rigorous screening protocols.

After the initial screening phase, where the article is sent to the reviewer, reviewers proceed at their own pace, causing delays in the communication process. The lack of a contractual agreement among editors, reviewers, and publishers makes it challenging to ensure the timely completion of the review process. In fields like computer science and electronics, where research progresses quickly, there are frequent advancements and subsequent technological obsolescence. In such cases, many scholars prefer alternative review methods. As a result, researchers often present their findings at conference venues to disseminate their research.

The current peer review system suffers from various shortcomings, including difficulties in finding suitable reviewers, potential reviewer biases, susceptibility to manipulation, lack of transparency, expensive, sluggish review processes, and absence of agreements between authors and journals, as well as between editors/reviewers and the journal.

1.1.2 Traditional Manuscript Publication System

In the traditional procedure of manuscript publication, the task of author acceptance is often assigned to either the chief editor or managing editor. Subsequently, authors are required to submit the final and edited version of their work, often known as the camera-ready copy. Afterwards, the financial section of the publishing company performs the billing method, which involves generating an invoice and sending it to the authors to initiate the payment process. Either the author or the institution associated with them is responsible for covering the expenses of the article processing charges (APC). Once the APC have been received and verified, the publisher begins the procedure to make the work available for online publication. Although many magazines may provide quick accessibility, writers typically have a lengthy waiting time of several months before their piece is made accessible online, even after the payment process has been completed.

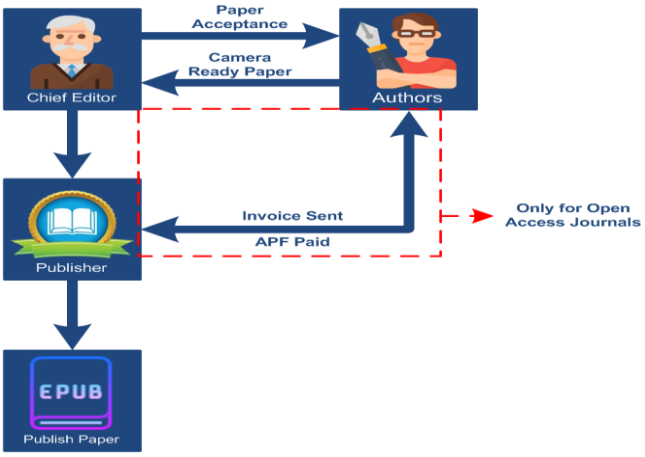

Figure 2: Traditional Publication Process [1]

It is noteworthy to emphasize that some authors make the decision to abstain from fulfilling the obligatory article processing charge or open access cost, and instead choose to withdraw their manuscript. This phenomenon often arises due to the practice of authors concurrently submitting their manuscripts to various publishing venues, leading to a considerable expenditure of important time for both reviewers and editors. Publishing journal papers of exceptional quality is getting ever more difficult owing to numerous factors, including: Hijacked Journals, Cloned Journals, Predatory Journals, Authorship sale, Back-dated Publication and Citation Hacking. Conventional scholarly communication and scientific publication rely on a centralized database.

2. LITERATURE REVIEW

In their study, J. Wang et. al. [2] focused on investigating the scientific and practical consequences of using the blockchain technology in the domain of intellectual property. They meticulously examine the academic studies and practical applications in this particular field and strive to provide a suitable strategy for the next stage of blockchain research and development. Vijay Mohan [3] highlights the importance of developing technologies and current advancements in Open Science in addressing misbehavior when evaluating the ever-changing nature of academic publication. The authors of the study, E. Stojmenova Duh et al., have created a blockchain architecture to enable decentralized collaboration within the academic community. The technology executes a configurable research paper inside a blockchain smart contract. Bela Gipp et. al., [5] devised a method that guarantees the secure verification of the presence of research plans, papers, or preliminary findings prior to submitting the manuscript for review. The proposed approach entails generating a hash, which acts as a digital fingerprint, for the document and its associated consequences, if applicable. Jonathan P. Tennant et. al., [6] analyze the essential elements of a hybrid paradigm that combines peer review and publication, and investigate the possibility of integrating them. The primary advantage highlighted in this research is that the evaluation process becomes intrinsically social and communal, independent of any journal-oriented framework. In their study, Michał R. Hoffman et. al. [7] shown the significant compatibility between blockchains and scientific publishing, using the inherent properties of blockchains. Tim K. Mackey et al. [8] developed a framework with the goal of transforming scientific publishing by using blockchain technology. Each of these strategies, including our own, pose obstacles in terms of acceptance and implementation, necessitating further examination, evaluation, and cooperation with the scientific community. Eashwar Sivakumar et al. [9] addresses problems with scholarly publishing, such as inadequate peer review and the widespread occurrence of fraudulent articles, by suggesting the use of blockchain technology and smart contracts as possible solutions. This paper introduces a novel approach to scholarly communication by utilizing Ethereum and Solidity to implement role-based smart contracts. The innovative framework aims to enhance trust and reputation within the academic community by ensuring academic integrity and timely processing.

3. BLOCKCHAIN BASED RESILIENT ARCHITECTURE FOR HANDLING MANUSCRIPT AUTHENTICITY (BRAHMA)

The proposed system Blockchain based Resilient Architecture for Handling Manuscript Authenticity (BRAHMA) is shown in figure 3. The details of the various steps involved are given below:

1. Author submits paper.

2. Publisher invokes smart contract.

3. Author signs the smart contracts

4. Handling editor screens the paper.

5. If screening is passed, the system broadcasts the availability of paper to review to all the reviewers in the consortium, else if the screening is not passed the paper is rejected and sent back to the author.

6. Publisher invokes smart contract.

7. The reviewer signs the smart contract.

8. Volunteers from the consortium of reviewers agree to review. We use first come first serve algorithm to determine the reviewers.

9. If the ORCID of the reviewers is matched with the ORCID of authors, the reviewer will not be considered for review. If there is no match, the counter is triggered. When count is equal to 5 the system broadcasts that no action is required by the remaining reviewers in the consortium.

10. Once the reviewer submits the decision it is stored in the server.

11. After receiving all the reviewer's decision, based on the review comments review decision is made.

12. If the decision is accepted, it is shared with the publisher and if the decision is reject/revise, the decision and review comments are shared with the authors.

13. Once the publisher receives the acceptance information, they invoke smart contract to be signed by the author.

14. The author signs the smart contract and transfer's copyright.

15. Publisher generates e-invoice for the author to pay article processing fee/open access fee.

16. Author pays and updates the paper in the system.

17. Manuscript is published and made available online.

18. A new block is generated.

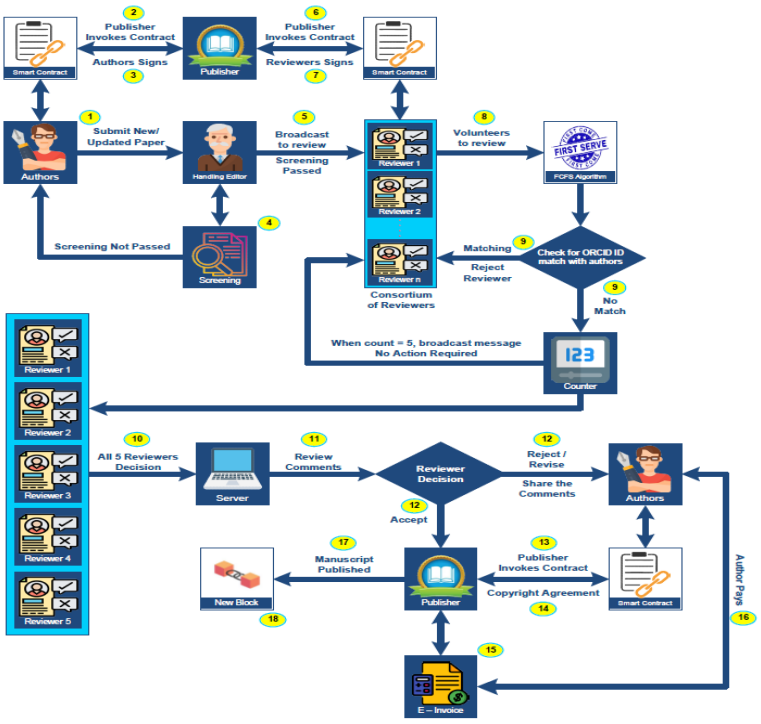

Figure 3: Architecture of BRAHMA

2.1. Roles of Authors

Authors regularly create and submit their research papers, which undergo evaluation by reviewers before being published. Upon receiving feedback from reviewers, authors integrate their suggestions and revise their papers accordingly. In our platform, authors release their papers after undergoing decentralized review. Additionally, authors execute two smart contracts, RBSC1 for manuscript submission and RBSC3 for copyright transfer.

2.2. Roles of Reviewers

Reviewers on this platform have the capability to perform the following functions.

- Reviewers have the ability to access the papers that have been accepted for review.
- Reject, approve or provide recommendations for modification.
- Reviewers can add comments to all the papers which are yet to be published.
- The consortium of reviewers would provide final approval, which would occur through a decentralized voting structure.
- By signing smart contracts, reviewers acknowledge and consent to all the regulations outlined in RBSC2.

2.3. Role of Managing Editor

- Managing editor is responsible for managing the entire system (Administrator).
- Administer all reviewers and store reviewer's information.
- They are able to conduct paper screening and plagiarism checks.

2.4. Role of Publisher

- Publishers can access reviewed/screened papers.
- Publishers can publish reviewed papers.
- If reviewing or screening is done by reviewers, and publication is done, the author signs the smart contract and transfer's copyright to the publisher. Publishers can access Submitted / Reviewed / Screened Papers.
- Publisher generates e-invoice for the author to pay article processing fee/open access fee.
- Manuscript is published and made available online. This means all the data would reside on the blockchain

Our paper publishing platform is designed to simplify the complex process of paper submission, review, and publication for academic authors and publishers. This comprehensive system streamlines the entire workflow, ensuring efficiency, security, and transparency at every stage. Here's an overview of the key features and functionalities:

Author Registration and Submission

- Authors can easily register on the platform.
- Upon registration, authors utilize Metamask for secure authorization.
- Authors can submit their manuscripts, providing essential details and uploading their work.

Admin Management

- Admins have access to the system to oversee the entire process.
- They can manage reviewers by adding their email addresses.
- An automated email is sent to reviewers, inviting them to register on the platform.

Paper Screening

- Admin/Managing editor screens the papers submitted by authors to ensure compliance with guidelines.
- The criteria include conducting a Plagiarism Check with a requirement of less than 10 percent similarity, ensuring that the manuscript falls within the scope of the journal, and maintaining high-quality standards for the paper etc.

Reviewer Workflow

- Reviewers receive email notifications when papers in their research area are available for review.
- Reviewers can add papers to their review list, with a maximum limit of five papers.
- They can review papers and provide feedback, including the options to accept, reject, or request improvements.
- Reviewers must sign a transaction on Metamask to confirm their decisions.

Publication Process

- Once a paper passes the review process, the author is notified via email.
- Authors can make the necessary payments for publishing their papers.
- Payment verification is performed, and authors are required to sign a copyright transfer agreement.
- DOI Assignment: Admins add Digital Object Identifiers (DOIs) to the papers, ensuring proper identification and citation.

Blockchain Publication

- Publishers, with proper access, can publish papers on the Polygon blockchain, enhancing the security and traceability of published content.
- This platform offers a seamless, end-to-end solution for authors, administrators, reviewers, and publishers, creating a secure and efficient environment for paper submission and publication in the academic world. It leverages blockchain technology and email notifications to ensure transparency and communication throughout the process.

The utilization of blockchain timestamping processes in this system can eradicate the occurrence of backdated publications.

4. COMPARISON OF BLOCKCHAIN BASED FRAMEWORKS

Scientific publishing companies are currently investigating the integration of blockchain technology into their operations to improve the dissemination of research. Several initiatives, including Artifacts, Manubot, Orvium, Pluto, Sciencematters Eureka, Scienceroot, Shared Governance Framework and Aletheia have been outlined in whitepapers and research papers. A comparative analysis of these frameworks, detailed in Table 1, evaluates various criteria such as consensus mechanisms, utilization of Business Process Management (BPM) and Lean Six Sigma (LSS) principles, token utilization, transparency and efficiency, management of intellectual property, establishment of researcher identity, transparency of data sources, peer review processes, operation of proprietary publishing platforms, creation of decentralized journals, implementation of role-based smart contracts, collaboration with traditional publishers, publication verification, and methods for selecting reviewers.

Table 1: Comparison between blockchain based scientific publishing frameworks

Frameworks	Artifacts	Manubot	Orvium	Pluto	Sciencematters EUREKA	Scienceroot	Shared Governmance Framework	Aletheia	BRAHMA
Consensus	Proof of Existence	Open Time Stamps	Proof of Existence	Proof of Stake	Proof of Stake	Proof of Stake	Proof of Authority	Proof of Authority	Proof of Stake
Usage of BPM Principles	NO	NO	NO	NO	NO	NO	NO	NO	YES
Usage of LSS Principles	NO	NO	NO	NO	NO	NO	NO	NO	YES
Token Use	NO	NO	YES	YES	YES	YES	YES	YES	YES
Transparency & Efficient Use	YES	YES	YES	YES	YES	NO	YES	YES	YES
Intellectual Property Management	YES	NO	YES	YES	NO	YES	YES	NO	YES
Establishing Researcher Identity	YES	NO	YES	YES	YES	YES	YES	YES	YES
Peer Review	NO	NO	YES	YES	YES	YES	YES	YES	YES
Transparency to Data Sources	YES	NO	YES	YES	YES	YES	YES	YES	YES
Operates its own publishing platform	NO	NO	NO	YES	YES	NO	NO	NO	YES
Creation of Distributed Journals	NO	NO	YES	NO	NO	YES	NO	YES	YES
Works with Traditional Publishers	YES	NO	NO	NO	YES	NO	YES	YES	YES
Role Based Smart Contract	NO	NO	NO	NO	NO	NO	NO	NO	YES
Attestation of Publication	NO	NO	NO	NO	NO	NO	NO	NO	YES
Reviewer Selection	NA	NA	Authors invite reviewers	Public Open Peer Review	Manual Selection of Reviewers	NA	Manual Selection of Reviewers	Authors select reviewers & review method	Automated

Artifacts

Artifacts [10] use the Proof of Existence consensus method to effectively serve as a public notary service on the Bitcoin ecosystem. This method enables users to verify the presence of a document at a specific time without disclosing the file or its information. The method functions with transparency and efficiency, making it especially helpful for activities such as managing information and intellectual property. Furthermore, Proof of Existence effortlessly incorporates itself into conventional publishing companies, ensuring compatibility and adaptability. It is transparent, efficient, establishes researcher identity and offers intellectual property management, further it also works with traditional publishers.

Manubot

Manubot [11] employs Open Time Stamps to add timestamps to HTML and PDF outputs, offering a means to verify the authenticity of a specific version of an article prior to its official publication date. This approach utilizes blockchain technology to authenticate the presence of the item at a certain moment in time. Timestamps are included as a safeguard against altering text history, guaranteeing validity, and perhaps settling disputes over authorship or precedence. It is transparent and efficient.

Orvium

While Orvium [12] shares similarities with Artifacts, it sets itself apart by incorporating a peer review system that not only provides public acknowledgment but also offers economic incentives in the form of ORV tokens. Authors have the ability to invite reviewers directly within the Orvium Platform. Orvium introduces several innovations, such as swift publishing, support for manuscript versioning, and the flexibility to tailor copyright and user licenses. Moreover, it enables the establishment of community-driven decentralized publications.

Pluto

Pluto [13] utilizes blockchain technology to provide a transparent system for documenting the distribution of research. The method guarantees the safeguarding private information and the preservation of intellectual property rights, all while fostering transparency and impartiality. Tokens function as a means of remuneration for stakeholders. Significantly, the system functions without a centralized mechanism or authority for governance. It utilizes Proof of Stake consensus algorithm.

Sciencematters Eureka

Sciencematters [14] is a platform in the context of open-access publication that is specifically designed for research focused on individual discoveries. In addition to its two freely accessible publications, the platform utilizes Ethereum to power its tokenized academic evaluation and review mechanism called Eureka. Sciencematters utilizes a unique approach to the review process by using a blinded blockchain peer-review mechanism. According to this approach, researchers provide an initial contribution to cover the costs of reviewers, who are then subsequently compensated with Eureka tokens. The platform leverages cryptographic tokens to enhance simultaneously its functionality and privacy.

Scienceroot

Scienceroot [15] is a centralized network designed to streamline access to funding, career opportunities, and scientific publishing. It employs a centralized review process and utilizes a token system to incentivize and compensate participants. Notably, it archives adverse outcomes alongside successful publications. Recently, Scienceroot has undergone a transformation into a traceable blockchain system. This transition aims to enhance security and transparency in transactions, particularly safeguarding publishers' exclusive information. Smart contracts play a pivotal role in simplifying online transactions and mitigating risks associated with unauthorized file replication and redistribution.

Shared Governance Framework

Implementing a shared governance framework [16] enhances researchers' comprehension of the management of their papers prior to publication in a journal or by a publisher. Employing smart contracts and token payments facilitates the visualization of the publication process. Peer reviewers are chosen from a pool of community experts

who participate in the shared governance model. Additionally, establishing a Democratic Autonomous Organization (DAO) is noteworthy as it allows for decentralized and user-driven governance.

Aletheia

Aletheia [17] utilizes Ethereum blockchain technology to create a decentralized journal governed by a community of experts. The platform introduces a novel reputation system. Users can easily engage with the Aletheia client and take part in various community tasks, such as peer reviewing, document examination, metadata evaluation, voting, auditing, and contributing to the source code. Authors can opt for either a targeted peer review involving a select group of individuals or a comprehensive peer review involving the entire reviewer pool when soliciting feedback on their work.

BRAHMA

BRAHMA incorporates proof of stake consensus, Business Process Management (BPM) principles, Lean Six Sigma (LSS) principles, tokenization, transparency, intellectual property management, researcher identity establishment, peer review, data source transparency, proprietary publishing platform operation, decentralized journal creation, collaboration with traditional publishers, role-based smart contracts, publication attestation, and reviewer selection.

5. CONCLUSION

The architecture of BRAHMA is presented, elucidating the responsibilities of authors, reviewers, managing editors, and publishers in the process of article submission and publishing. The solution utilizes smart contracts, decentralized review, and blockchain technology in order to optimize the publishing process, guarantee authenticity, and bolster security. Ultimately, this analysis presents a comparison between BRAHMA and other frameworks that are based on blockchain technology. The focus is on highlighting their distinct characteristics, consensus methods, and contributions to the field of scientific publication. BRAHMA distinguishes itself with its all-encompassing strategy, which encompasses proof of stake consensus, BPM and LSS principles, tokenization, transparency, and engagement with conventional publishers, among other notable attributes.

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