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Blockchain-based token system for incentivizing peer review: A design science approach

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ABSTRACT

Peer review is an essential component of the evaluation and dissemination of new scientific knowledge. The peer review process can be viewed as a decision support framework relying on scholarly review systems, where decision-makers (editors) solicit input from experts (reviewers) to make editorial decisions on submitted manuscripts. Unfortunately, the challenges editors face in securing sufficient reviewers are well-documented, leading to prolonged review times and potentially diminished review quality. We explore and validate this trend through a literature review and interviews with scholars. We then employ a design science research methodology to design, develop, and evaluate potential incentive mechanisms to reverse that trend. In addition to proposing formal design principles that such mechanisms should follow, we suggest a concrete blockchain-based token system that enables editors to offer review incentives while enabling reviewers to flexibly utilize these incentives to meet their needs. We also explain how different types of tokens can be connected to practical submission and reward policies that journals may adopt. Our cost analysis, along with a survey-based field study and qualitative interviews with academics, highlight the effectiveness of our solution. Finally, we propose a formal design theory framework that designers of peer review systems can follow to create meaningful incentives to attract reviewers.

1. Introduction

"*The search for reviewers who are willing and able to evaluate scholarly manuscripts is turning into a challenge of significant proportions. This difficulty arises not simply because the peer review process is time-consuming but because it often goes unrewarded and unrecognized despite the critical deadlines that reviewers are expected to meet*" [1].

Peer review is considered by most scholars to be essential to the evaluation and publication of new scientific knowledge [2,3]. Academic journals and conferences, as outlets for the dissemination of knowledge, seek out experts to assess submitted manuscripts for their relevance, methodological rigor, findings significance, writing clarity, and adherence to ethical standards. The peer review process then naturally depends on having expert reviewers willing to review submissions. Unfortunately, editors are finding it increasingly difficult to secure enough reviewers for the submissions they are managing and guiding through the publication process [4]. A case in point, in 2023, editors at the Cyberpsychology journal needed to contact an average of 26.3 experts to obtain two reviews per article, more than double the number required in 2021 [5].

The challenge is linked to opportunity costs (i.e., weighing the time required to complete a review against other commitments and assessing potential gains and losses) [6]. By one estimate, the monetary value of the time reviewers worldwide spend on reviews each year exceeds 2 billion USD [7]. The calculus of those opportunity costs is also changing, due in part to the publish-or-perish culture in academia, where the standards for research productivity continue to increase, forcing scholars to spend greater portions of their time conducting and submitting their research for publication [8]. The result is both more manuscripts that require reviewing and less bandwidth for academics to contribute their time as reviewers. Our goal in this research was to gain a deeper understanding of these issues in order to design a formal decision support system and develop a concrete artifact to address the specific need for more effective reviewer incentives [9]. The research question guiding our efforts is: *How can peer review systems be effectively designed to better incentivize reviewers?*

Although many studies have documented the growing difficulty in

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securing timely, high-quality peer reviews, few have proposed proactive, system-level solutions to address this challenge. For instance, Peterson et al. [10] and Fox [11] provide descriptive analyses of reviewer participation, exposing recruitment failures and their impact on review quality, but stop short of proposing concrete, scalable solutions. Others, including Aczel et al. [7] and Spector [12], suggest conceptual fixes like greater transparency or increased desk rejections, but lack empirical support or implementation frameworks. Incentive-based approaches—such as recognition and monetary compensation—have been explored, but results have varied with some studies reporting positive effects (e.g., Warne [13]; Chetty et al. [14]), while others found limited or even negative impacts (e.g., Zaharie & Seeber [15]; Yu et al. [16]). These limitations of prior research highlight the need for more effective, system-based, and proactive solutions to address persistent challenges in the peer review process.

Following a design science research methodology, we performed exploratory interviews with editors and reviewers and assessed the literature to better understand the ongoing issues with incentivizing reviewers. These efforts led us to formulate a set of *design principles* that prospective solutions should satisfy: *incentives*, *flexibility*, and *trust*. We instantiate a concrete solution (artifact) from our design principles through three *design features*: *tokenization*, *immutability*, and *decentralized storage*. We explain how blockchain technology enables and implements all the design features, directly fulfilling the design principles. Finally, we conducted both quantitative and qualitative validation of the proposed system, confirming its effectiveness and economic feasibility. Thus, our contributions are twofold. First, we propose an empirically and theoretically grounded set of design principles as well as a formal design theory for incentivizing expert reviewers. Second, we develop a concrete prototype that demonstrates the feasibility of our design. Through the systematic development of linked design principles and features, we demonstrate how blockchain technology can complement and enhance existing peer review systems to enable a broad range of reviewer incentives.

2. Research background

2.1. Academic peer review

Peer review, the standard for determining what research is published in academic journals and conference proceedings, developed out of the increasing specialization of scientific work and growing competition for space in academic outlets [17]. The goal of peer review is to reduce the likelihood of Type 1 and Type 2 publishing errors, where Type 1 errors are the acceptance of papers that are not valued by the academic community, and Type 2 errors are the rejection of papers that the academic community would have valued [18]. In pursuit of this goal, for each submitted paper, editors typically recruit at least two reviewers with expert knowledge in the paper's subject areas, and these reviewers must commit to participating in multiple rounds of review over several months or even years, while consistently providing high-quality review reports.

Peer review is typically voluntary, with scholars giving their time to review the work of others. Studies have evidenced various reasons why individuals participate in the peer review process. Tite and Schroter [4] found that a majority of reviews are undertaken to learn something new or because the topic was relevant to the reviewer's own research. Others have noted that scholars choose to review based on feelings of reciprocity (i.e., because others have given their time to evaluate a scholar's work, that scholar feels compelled to give their time to review the work of others) or because they see reviewing as an important service to the profession [19]. Journals and conferences have largely relied on these motivations to secure needed peer reviews, but increasingly, editors are finding it difficult to recruit reviewers and ensure they submit quality reports on time [10,20,21]. Scholars have argued that this is due in part to universities raising the bar for faculty research productivity, which impacts reviewer recruitment through the devaluation of reviewing activities relative to publications in promotion decisions and annual evaluations [20,22]. Whatever the reason for the paucity of quality peer reviewers, there is a growing recognition that something must be done to address the issue [7,23].

Peterson et al. [10] suggest that raising awareness of reviewer shortages may be sufficient to encourage more people to participate as reviewers, while Aczel et al. [7] propose crowdsourcing reviewers as an alternative to traditional direct recruitment. El-Guebaly et al. [24] recommend reviewer recognition and training to increase participation and quality. However, some studies have evidenced potential limitations of recognition. For example, Zaharie and Seeber [15] found that recognition decreased invitation acceptance rates when only the best reviewers were recognized, and Yu et al. [16] found that reviewers receiving accolade awards tended to reduce their reviewing afterwards, which the researchers attributed to the recipients realizing they were reviewing more than average. This suggests that recognition may work best as an incentive when it acknowledges individual reviewer efforts without making comparisons to other reviewers.

In addition to recognition, some journals have implemented other types of incentives. For example, publishers MDPI and PeerJ give reviewers vouchers and tokens, respectively, which can be used to reduce the article process charge of a future submission [25,26], while Elsevier gives reviewers one month of access to Scopus, ScienceDirect, and Reaxys [27]. Monetary compensation has also been suggested as a reviewing incentive [23], and some journals have tried direct payments to reviewers. For example, the Journal of Public Economics experimented with a $100 cash incentive to reduce review turnaround time and found it was effective without negatively impacting the quality of the reviews [14]. More recently, the Critical Care Medicine journal conducted an experiment incentivizing a portion of their reviewers with $250 for a completed review, finding that it significantly increased the number of invited reviewers who completed a review without affecting review quality [28]. Scholars have also proposed market systems and gift systems to incentivize reviewers [29], and others have suggested the addition of reciprocal rules for reviewing to modify reviewer incentives and the application of mathematical methods to more objectively assess review quality [3]. While studies have proposed incentive-based solutions to the problem of too few reviewers, and journals have experimented with some solutions, the paucity of reviewers remains a challenge, suggesting that further research is needed to design more effective incentive systems. We contribute to these efforts by developing a theory-driven solution using blockchain tokens.

2.2. Blockchain technology

Blockchain is a decentralized, distributed ledger technology that securely records transactions across a network. Blockchain technology was initially the basis for Bitcoin and continues to provide the underlying infrastructure for many digital assets. An increasing range of blockchain use cases is supported through programs called *smart contracts*, which are algorithms automatically executed by the nodes within a blockchain network when a condition specified in the code is met [30]. Smart contracts extend blockchain beyond its roots as a distributed database system to become a consensus mechanism for the execution of algorithms, thus enabling application developers to create self-executing, transparent code useful in many domains [30].

Approaches and designs have been proposed to leverage blockchain technology to improve different aspects of the scientific publishing process. For example, blockchain immutability could protect authors from dishonest reviewers and data leaks by enabling a tamper-proof record of timestamped manuscript submissions [31]. To address paywall issues that limit the accessibility of published research, Wang et al. [32] designed a decentralized publication platform as an alternative to existing publication venues. Leveraging blockchain's ability to support both anonymity and transparency, Zhou et al. [33] proposed a privacy-preserving publication scheme that would enable a double-blind review process while still providing transparency. Also focusing on transparency, Tenorio-Fornes et al. [34] designed a decentralized publication system with transparent governance processes. However, previous studies have not fully explored the role that blockchain tokens could play in the peer review process to incentivize reviewers. Our work adds to the blockchain literature by examining the applicability of different types of tokens on the design of incentives to attract peer reviewers.

One notable initiative from industry is ResearchCoin, a blockchain-based system that rewards researchers with tokens for various academic contributions, including sharing, curating, and peer reviewing academic work within the ResearchHub platform [35]. While our work shares a similar goal of using blockchain to incentivize peer review, it differs in an important way. In particular, our proposed artifact emphasizes compatibility with existing journal workflows, supporting both fungible and non-fungible tokens with journal-specific policies. In contrast, ResearchCoin functions more as a generalized platform without a built-in peer review interface or the ability to tailor token logic to individual journal policies. By embedding our system within existing editorial processes and enabling journals to define incentive structures that align with their operational needs, our approach offers a more flexible and practically deployable solution for enhancing reviewer engagement.

3. Research methodology

We employed a design science research methodology in our work because of its suitability when: 1) the primary objective is to develop and evaluate artifacts that address real-world problems or enhance existing processes, and 2) the research aims to generate both practical, actionable contributions and theoretical insights [36]. Within that methodology, we applied the framework by Peffers et al. [37], which involves six phases: *problem identification*, *defining solution objectives*, *artifact design and development*, *artifact demonstration*, *evaluation*, and *communication*. The framework was chosen based on its proven effectiveness for creating innovative artifacts to solve complex problems [38–40]. Fig. 1 summarizes the framework within the context of our research.

During the first phase, we sought to better understand the current state of the peer review process and identify major problems with it. To do so, we studied the literature and conducted semi-structured interviews with ten members of the academic community who had experience as editors or reviewers for academic outlets in various disciplines. Our main goal was to determine the scope of issues for academic community members regarding participation in the peer review process. Table 1 shows relevant characteristics of our study participants.

The interviews primarily focused on asking participants what motivates them to contribute their time as reviewers or editors. We found that responses fit into one of five categories: *learning*, *service to the community*, quid pro quo, *promotion requirement*, and *monetary rewards*. For some, the opportunity to see the latest research topics and methods and discover new ideas for their own research was a strong motivator. This aligns with other studies that found relevance to a reviewer's own work and the opportunity to learn something new were motivating factors for accepting a review request [4]. Feeling that participation in the peer review process was an important and necessary service to the academic community also motivated many of our participants. This also aligns with previous studies that found scholars were motivated to contribute time to peer review to benefit their academic community [2]. A related perspective was that of quid pro quo, where participants acknowledged contributing their time to review the work of others because others had contributed time to review their work [3]. Some saw their participation in the peer review process as an obligation for promotion and tenure, while others felt they should be compensated for reviewing. A selection of quotes related to each category is provided in Table 2.

Table 1
Summary of study participant characteristics.

Participant	Reviewing Role	Discipline	Academic Position	Gender
P1	Reviewer	Computer Science	Assistant Professor	Male
P2	Reviewer	Computer Science	Assistant Professor	Male
P3	Editor-in-Chief	Information Systems	Professor	Male
P4	Editor-in-Chief	Information Systems	Professor	Male
P5	Reviewer	Computer Science	Assistant Professor	Female
P6	Associate Editor	Computer Science	Associate Professor	Male
P7	Reviewer	Computer Science	Assistant Teaching Professor	Male
P8	Associate Editor	Gerontology	Assistant Professor	Female
P9	Associate Editor	Computer Science	Associate Professor	Male
P10	Editor-in-Chief	Statistics	Professor	Female

We also asked the participants who were editors about their challenges with the review process. One noted challenge was the increasing number of submissions they must handle. P8 explained that in her editorial role, the journal "*sends me emails almost every single day,*" and P9 said he receives three editorial requests per day from just one journal. P10 said she handles an average of 170 papers per year, but the most extreme case was P4, who, as an editor-in-chief, said, "*In a year, I tend to handle between 900 and 1,000 manuscripts*." The editors also noted an increasing difficulty in finding enough qualified reviewers to perform the necessary reviews. One aspect that made it more difficult was the growing problem of free riders. P9 stated, "*What I have found is that we get a lot of submissions from some people who will never review for us.*" The result is that inviting and managing reviewers is becoming a more significant and challenging component of an editor's role. P4 explained

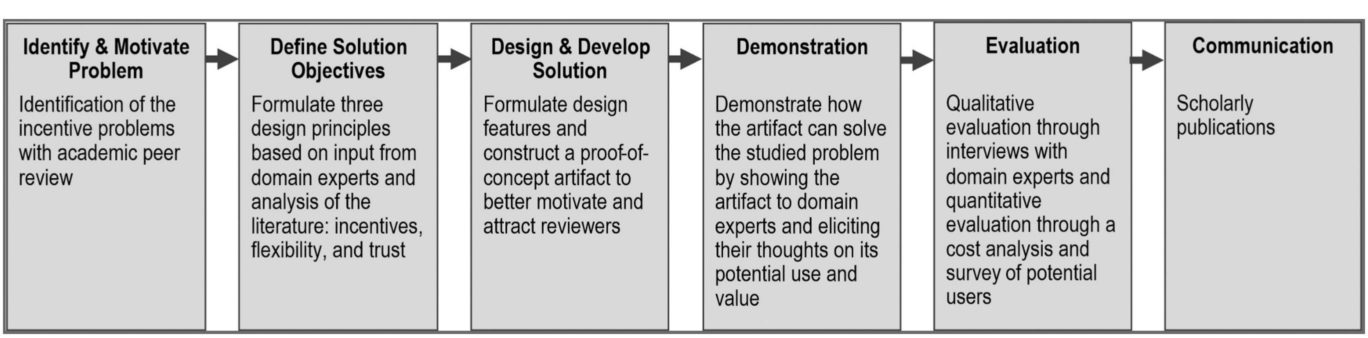

Fig. 1. Design science research framework applied to this research [37].

Table 2
Motivations to engage in peer review as reviewers/editors.

Participant	Category	Quote
P1	Learning	"*To see what other researchers are doing. I see reviewing as a platform that I can continue my research.*"
P5	Learning	"*I can understand the development of the current research area or my related research area, and sometimes I can get new ideas.*"
P4	Learning	"*I can keep up with all those new concepts, research methods and the ideas and the topics. I think that really benefits me, allows me to stay up to date about the current research.*"
P5	Service to the Community	"*I think serving as a reviewer is a contribution to this community.*"
P6	Service to the Community	"*Nurturing the next generation of researchers to see their work published.*"
P10	Service to the Community	"*You have to contribute to your discipline in increasing levels of authority where you can use your experience, so it's just a natural progression.*"
P4	Service to the Community	"*I feel like it is a contribution to the field. I can help the authors go through the review process and publish their good research.*"
P1	Quid Pro Quo	"*It feels bad when you spend so much time for your research, you submit your paper, and there is no reviewer accepting to do the review for your work. So, I try to help in that capacity to participate in this process.*"
P3	Quid Pro Quo	"*You do reviews as a service, and in return, someone reviews your work as a service. So, it's really a social capital issue. You make contributions to the pool of intellectual assets that will be reviewing work, and you'll receive reviews.*"
P2	Promotion Requirement	"*Something that I can put on the annual review, on the tenure review.*"
P7	Promotion Requirement	"*Reviewing papers is a service, and service is counted toward tenure and promotion.*"
P8	Promotion Requirement	"*Going through the P&T requirements, I kept on hearing from people, 'You have to step up and become an editor for some journals.'*"
P1	Monetary Rewards	"*I think reviewers should be compensated.*"
P2	Monetary Rewards	"*I think if I was compensated, I would put a lot more effort into the reviewing process.*"

that "*finding the appropriate reviewers, that's kind of difficult to start with. Then, keeping track of the reviewers and making sure they produce a timely and constructive review, that's also a challenge.*" P9 noted that "*I usually have to invite about 30 people in order to get three who accept*" and "*the three who accept may not deliver … they just drop dead, no response, nothing, full-on ignore after they've accepted.*"

When asked how reviewers might be incentivized to perform more and better-quality reviews, there was a range of responses. P5 noted the recognition she received for reviewing, saying, *"All my review works will be recognized to the Web of Science and my ORCID system…I think it's valuable."* P4 also talked about reviewer recognition at his journal, saying, *"one mechanism we're thinking about or actually would do it for [journal], which was not done before, is provide reviewer of the year recognitions."* This aligns with the findings of other studies that acknowledgments of review work by institutions and journals can incentivize reviewers [4]. Monetary compensation was also mentioned as an incentive. P1 noted that MDPI has a monetary incentive system for reviewers where the *"incentive is in the form of credit that a reviewer can use if they want to submit their paper …* [so if you] *review ten papers where you get the incentives, then you can make the publishing fee basically free."* P1 liked this incentive and felt it motivated him to review for MDPI.

4. Defining solution objectives

In the second phase of our methodology, we leverage what we learned from the academic peer review literature and our interviews to "*infer the objectives of a solution from the problem definition and knowledge of what is possible and feasible*" [41]. We state objectives in terms of *design principles* that any solution must satisfy, where design principles are "*prescriptive statements that indicate how to do something to achieve a goal*" [41]. For the problem of incentivizing reviewers, this led to three design principles: *incentives*, *flexibility*, and *trust*.

4.1. Incentives

Peer review is traditionally structured so that potential reviewers can accept or decline requests to participate in the process. Therefore, designing a system to support and enhance peer review requires an understanding of the *incentives* that lead reviewers to contribute their time. Incentives are factors that influence motivation by driving individuals to engage in activities, thus shaping behavior and goal-directed actions. Organismic Integration Theory (OIT) is a widely recognized psychological framework that explores how intrinsic and extrinsic motivation drives human behavior. OIT posits that individuals internalize extrinsic motivation to varying extents, leading to distinct forms of behavioral regulation that, in turn, affect both actions and well-being [42]. OIT proposes four types of extrinsic motivations — *identified*, *integrated*, *introjected*, and *external*. Identified regulation and integrated regulation have an internal locus of causality, while introjected regulation and external regulation have an external locus of causality [42]. In other words, motivations exist on a continuum (i.e., intrinsic–identified–integrated–introjected–external). In the case of peer review, choosing to review because it is considered a part of what defines an academic scholar would be an identified regulation, while choosing to review because there are rewards for doing so would be an external regulation [42–44].

In studying incentives, Rusin and Szandala [45] found that peer recognition positively influences employee engagement and motivation within organizations. Similarly, Manzoor et al. [46] reported that incentives, such as recognition for achievements and expressions of appreciation, significantly enhance employees' motivation to perform their work effectively. Previous studies have also identified a synergistic effect when incentives align with an individual's values, autonomy, and competence. For example, Fischer et al. [47] empirically showed that different types of incentives complement each other in fostering creativity and innovation among knowledge workers. Likewise, Cerasoli et al. [48] conducted a meta-analysis that identified a complementary relationship between various types of motivations. These studies suggest that extrinsic incentives can complement intrinsic motivation when the incentives are structured to support autonomy (e.g., allowing individuals to choose how they achieve performance targets). In the context of peer review, reviewer autonomy to accept or decline invitations and to select journals offering incentives that align with their preferences should facilitate complementary interactions between intrinsic and extrinsic incentives. Consequently, an effective system to support peer review must be capable of incentivizing reviewers through the continuum of motivation types. We formalize this in our first design principle in Table 3.

Table 3
The *incentives* design principle following the scheme by Gregor et al. [41].

Aim, implementer, and user	For designers of peer review systems (implementers) to create a system (aim) that effectively incentivizes potential reviewers (users) to contribute to the peer review process for manuscripts submitted to academic outlets.
Context	Academic peer review process.
Mechanism	Provide incentives to reviewers that appeal to their specific motivations.
Rationale	Understanding and leveraging different types of motivations ensures that the peer review system effectively encourages participation, sustaining the quality and reliability of the peer review process.

4.2. Flexibility

Through our interviews, we identified multiple ways in which academics are being incentivized to participate in the peer review process. These include learning (identified regulation), service to the community (integrated regulation), quid pro quo (introjected regulation), and promotion requirements (external regulation). Interviewees also noted the potential value of other extrinsic motivations like public recognition (introjected regulation) and monetary rewards (external regulation). The variety of incentives that motivate reviewers to participate in the peer review process leads to our next design principle, which is *flexibility*. Vroom's expectancy theory, a theory of motivation, postulates that individuals are differently motivated to perform work depending on the type of reward they expect to receive for that work [49]. According to the theory, the fact that reviewers vary in their motivations to participate in the peer review process indicates that for a system to enable editors to incentivize enough reviewers, that system must be flexible. Here, flexibility as a design principle focuses on the capabilities of a system to support functionality that is customizable based on the needs of the system's stakeholders [50]. For example, while some journals may prefer to motivate reviewers with recognition for their service, others may find it desirable to offer a monetary reward as an incentive. Table 4 formalizes the above discussion in our second design principle.

4.3. Trust

The critical role of trust in motivating individuals to participate more actively in certain behaviors has been widely studied, particularly in the context of information systems usage [51,52]. In the context of the academic peer review process, trust refers to the confidence that scholars have in the integrity, security, fairness, and impartiality of the review system, including the expectation of appropriate recognition or compensation for their efforts. It encompasses the belief that reviewers will provide objective, constructive, and confidential evaluations without the threat of their identities being exposed to the authors while trusting that their contributions are valued through formal rewards such as acknowledgment, professional recognition, or other compensatory incentives. Authors similarly trust that their work will be judged on its scholarly merit, free from bias or conflicts of interest. This mutual trust is essential for maintaining the credibility and sustainability of the peer review process.

Most academic outlets use blind review systems, including single-blind (i.e., the reviewers know the identity of the authors) and double-blind (i.e., both reviewers and authors are unknown to each other). Blind review systems hide the identity of reviewers from the authors to encourage reviewers to be honest in their assessment of the manuscripts they are tasked with evaluating and to protect them from potential retaliation by the authors. Consequently, reviewers must trust the review systems along with the editors who manage those systems to not expose their identities to the authors. In support of trust, the system must behave as expected when providing incentives by ensuring that the process is fair and transparent. If reviewers perceive that the system is biased or inconsistent in how it allocates credit, recognition, or other incentives, their willingness to participate in the peer review process could be undermined. This leads us to our last design principle formalized in Table 5.

Table 4
The *flexibility* design principle following the scheme by Gregor et al. [41].

Aim, implementer, and user	For designers of peer review systems (implementers) to create a flexible system (aim) that allows editors to customize incentives based on the diverse motivations of potential reviewers (users).
Context	Academic peer review process.
Mechanism	Customizable functionalities can accommodate varying incentive schemes depending on the specific needs and preferences of each journal.
Rationale	Flexibility in the system ensures that different journals can tailor their approach to incentivizing reviewers, thereby increasing the likelihood of securing enough willing reviewers while respecting the diversity in reviewer motivations.

5. Artifact design, development, and demonstration

In our methodology's third and fourth phases, we design, develop, and demonstrate a concrete artifact guided by our design principles. We do so by first, specifying *design features* that delineate the technical aspects of a solution and second, create a tangible artifact from the abstract design. Fig. 2 shows how the proposed design features are linked to the design principles.

Our first design feature is *tokenization*, which is "*the process of creating a unique digital representation of* [valuable] *assets in the form of a token*" [53]. For our purposes, tokens enable multiple types of extrinsic incentives. For example, certificates declaring that individuals reviewed for a specific outlet (introjected regulation) can be enabled through *non-fungible tokens* (NFTs), while financial compensation (external regulation) can be enabled through *fungible tokens*. In other words, tokenization tackles not only the incentives aspect of our design principles but also supports flexibility in creating different types of incentives. We elaborate on how to create meaningful value based on different tokens in Section 7.

Recently, blockchain has become one of the most appealing technologies for tokenization for two primary reasons. First, blockchain storage is *immutable*, a property that represents our second design feature. Specifically, once data is recorded on a blockchain, it cannot be altered or deleted, ensuring the integrity and authenticity of the tokenized assets. Immutability provides a high level of security, as any attempt to tamper with the data would be evident and rejected by the network, protecting the value and ownership of the tokens. The second reason, and our third design feature, is *decentralization*. Unlike traditional centralized systems, where a single entity controls the data, blockchain operates on a distributed network of nodes. This decentralization eliminates the need for central authorities, potentially reducing costs and increasing the transparency of transactions. It also enhances the resilience of the system, as there is no single point of failure, making it difficult for any one entity to manipulate or compromise the tokenization process or create vendor lock-in issues, as seen in centralized platforms like Publons, a platform that aggregates peer review data in partnership with select publishers under the control of a single corporate entity. The lock-in risk is reflected in the Terms of Use for Publons, which allow the parent company to terminate access to the platform and its data at any time without notice [54].

We argue that the features of immutability and decentralization address the trust design principle. Specifically, reviewers are assured that their rewards will not be easily compromised due to, for example, data manipulation or a technology provider no longer being interested in offering a product. That is, using blockchain technology guarantees

Table 5
The *trust* design principle following the scheme by Gregor et al. [41].

Aim, implementer, and user	For designers of peer review systems (implementers) to build systems that enhance trust (aim) among reviewers (users) in the peer review process.
Context	Academic peer review process.
Mechanism	Ensuring that reviewers' identities are protected in blind review processes and that incentives are allocated properly.
Rationale	Trust in the peer review process is critical for maintaining the credibility of published research. A system that is transparent, fair, and protective of reviewers' anonymity in blind reviews and allocates credit, recognition, and other incentives in a consistent manner can help sustain reviewers' participation.

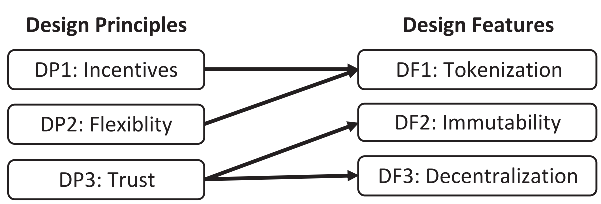

Fig. 2. Relationships between design principles and features.

that rewards in the peer review process are free of vendor lock-ins while preserving data in perpetuity. At the same time, we propose that blockchain technology should be used only as a log system to store reward data, which is how many successful blockchain implementations are currently deployed [55]. In other words, we suggest disassociating aspects of the review process, such as paper submissions and review invitations, from the blockchain to avoid unwanted disclosure of reviewer assignments and identities. In what follows, we elaborate on some of the above points while introducing and demonstrating our concrete artifact.

Table 6
Blockchain decision model questions and answers.

Question	Answer	Rationale in the Context of Academic Peer Review
Do you need to store data?	Yes	Data storage is essential in peer review processes, such as tracking review allocation (i.e., who reviewed which paper)
Are there multiple writers?	Yes	Multiple journals can issue tokens and write data to a storage technology, justifying the need for a decentralized solution
Can you rely on a third party?	No	Scholars have proposed peer review systems relying on trusted third parties. For example, Chua [29] proposed a review bank with proprietary technology to create and distribute tokens. However, concentrating power in a centralized system creates potential for misuse and corruption. Such a bank would have the power to reverse transactions and even permanently ban reviewers and authors, effectively controlling access to the academic publishing process.
Are all writers known?	No	Given the number of academic journals and reviewers, not all data writers may be known to each other.

5.1. Blockchain network

Our artifact relies on blockchain technology to allocate and transfer incentive tokens. A common question that arises is why blockchain should be the core technology of a particular solution. Over the years, several decision models for blockchain adoption have been proposed, including the model in Fig. 3 [56], which we apply to our solution in Table 6.

Based on the answers to the decision path model, a public blockchain, which allows anyone to validate and store transactions and/or read blockchain data and create transactions, is the optimal solution. In addition to the transparency benefits already mentioned, the open nature of public blockchains eliminates vendor lock-in and single points of failure, while mitigating counterparty risks prevalent in centralized solutions.

We selected the Polygon network as the public blockchain underlying our artifact. Polygon is one of the most prominent blockchains with a very active and strong ecosystem, a large developer community, and extensive documentation, while allowing for smart contracts, a crucial feature when minting and allocating incentive tokens. More specifically, different types of tokens are programmatically defined as smart contracts on Polygon. In addition, we have also developed smart contracts that 1) incorporate administrative capabilities, allowing for the addition or removal of system administrators, and 2) facilitate token issuance, enabling both single and multiple token minting, token transfers, and balance inquiries. System administrators, such as journal representatives, can manually or automatically invoke these functions to efficiently manage token creation and distribution to reviewers. All smart contracts were written using Solidity, an object-oriented programming language. To enhance the security of our smart contracts and mitigate potential vulnerabilities, we applied Mythril [57] — a symbolic execution-based security analyzer — and Slither [58] — an open-source static analysis framework — to identify known issues in Solidity-based smart contracts, including reentrancy vulnerabilities, boolean equality errors, unused return values, and integer overflows. Beyond security, ensuring system reliability in a blockchain environment requires addressing potential network congestion, failures, and operational challenges. Our selection of Polygon mitigates transaction bottlenecks as it is a high-throughput Layer 2 scaling solution for the Ethereum network. Polygon supports a theoretical maximum of 65,000 transactions per second, far higher than the 15–30 value on Ethereum's base layer at the time of writing. By utilizing Polygon's infrastructure, we improve scalability while reducing transaction fees, a point we return to in the following section.

Unlike more traditional information systems, where users authenticate using usernames and passwords, blockchain technology relies on cryptographic keys for authentication. In particular, users access and transfer their digital assets through blockchain *wallets* managing private keys. Consequently, reviewers must have access to their blockchain wallets in order to receive tokens and create transactions. We envision that the associated public keys and the blockchain addresses derived from them will serve as the reviewers' unique identifiers, similar to how the Open Researcher and Contributor ID (ORCID) currently works. We expect that many reviewers will not already have a blockchain wallet and will therefore need to set up a wallet in order to receive and use tokens. Similarly to how journals provide technical support for their current submission systems, that support could easily be extended to include help with setting up a blockchain wallet. Establishing a wallet would be a one-time activity, and connecting that wallet to token-enabled reviewing systems would only have to happen once for each journal. Managing tokens would be an ongoing activity, but both

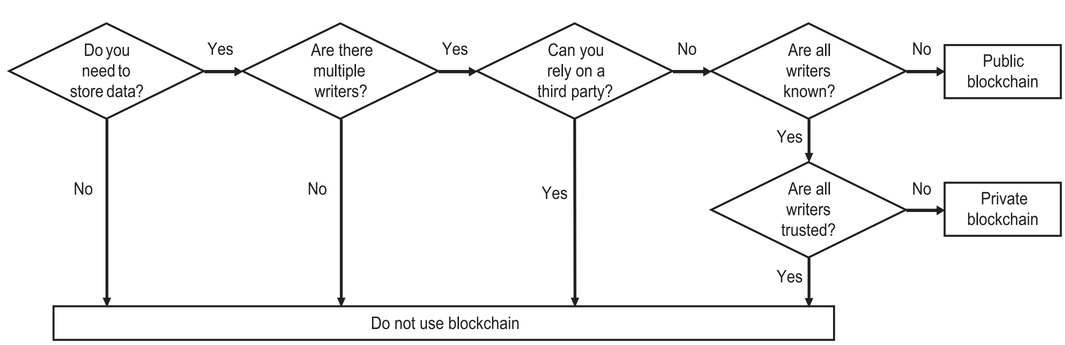

Fig. 3. Decision model for blockchain adoption [56].

journals and academic associations (e.g., the Association for Information Systems) could provide reviewers with support services to help them manage their tokens.

5.2. Tokenization

Tokenization enables the creation of different types of incentives. Our developed artifact supports two incentive models: non-transferable certificates of recognition built using *soulbound tokens* and *fungible tokens*. Any academic outlet using our artifact can choose the most appropriate incentive model based on its policies.

Soulbound tokens (SBTs) are an extension of the ERC-721 standard for non-fungible tokens (NFTs) designed to serve as a digital certification or badge [59]. By following such standards, our smart contract implements battle-tested functions such as balanceOf and Transfer that can be called upon by journals to determine how many tokens a reviewer has received or to transfer a token to a given reviewer once a review task is complete. SBTs are unique NFTs as they are non-transferable. Upon minting, SBTs are assigned to a blockchain address that permanently ties the token to that particular "soul," serving as an immutable record of one's experiences, skills, memberships, and achievements within the digital ecosystem [60]. In our artifact, these SBTs serve as immutable and public certificates of recognition for reviewers' contributions, from single reviews to review awards. SBT metadata stores the token name, description, type of contribution, journal name, and reviewer's blockchain address, all of which allow the user holding the token to have verifiable proof/acknowledgment of their contribution.

Meanwhile, *fungible tokens* (FTs) can be used to remunerate reviewers. FTs are built using the ERC-20 token standard and can be transferred and redeemed for various benefits within the system [59]. As such, similar to SBTs, we implement pre-defined functions such as balanceOf, Transfer, and totalSupply that are part of the ERC-20 standard. Fungible tokens enable creative incentive policies to enhance the peer review process. For example, to encourage timely review report submission, editors can adjust the token distribution to reward reviewers more generously for completing their assignments within the provided deadlines. Section 7 elaborates on the potential uses of FTs within peer review.

5.3. Off-chain storage operations

Public blockchain transactions are inherently open and transparent, making it challenging to preserve the anonymity of users and potentially unsafe to record confidential information. Using a public blockchain for the overall review process risks reviewers being traced back to the reviews they submitted through blockchain transaction details and incentive token generation timestamps. Therefore, we propose a hybrid approach using blockchain in tandem with an off-chain storage service. Transactions related to reviewer incentives (e.g., token minting and transfer) are performed on the blockchain, while confidential information related to the review process (e.g., submissions and reviewer assignments) is securely managed through an off-chain storage service. A scheduled job check would be performed periodically (e.g., monthly or quarterly) to detect any new review activity on the off-chain storage service. A blockchain transaction to mint and assign tokens would be automatically initiated if any new submission pending reward allocation is found. Such a batch processing of rewards helps break the link between the time when reviews are performed (private information) and when rewards are received (public information), thus appropriately fulfilling the trust design principle.

5.4. User Interface

To demonstrate the feasibility of our token-based incentive system, we built a full-fledged web system that supports the entire peer review process, including submission handling, reviewer assignments, editorial decision making, and incentivization. The user interface was built using the React.js library, which provides reusable component-based architecture for development and efficient rendering, and the Web3.js library, which supports interactions with Polygon nodes and smart contracts. We used MetaMask as the blockchain wallet. After successfully authenticating their MetaMask account, users are redirected to their respective dashboard based on their user role. We store the mapping of roles off-chain. Fig. 4 illustrates how an editor can define the type of rewards reviewers will receive as well as some allocation policies.

Authors can submit manuscripts to participating journals from their dashboards, after which editors can view the submitted manuscripts to either make a decision about the manuscript (e.g., desk reject) or invite reviewers. In the invitation letter, reviewers would see the outlet's reward policy, including the tokens offered for reviewing the submission. Reviewers would need to register with the platform before accessing the submission, which would include connecting their blockchain address. After reviewers upload their reviews, the editor can make a decision, and subsequently, the authors can view the decision status along with any reviews or notes.

All the information about the review process is stored off-chain using traditional relational databases. Periodically, a script checks which reviewers have performed a review but have not been rewarded yet. When that happens, those reviewers receive their rewards, be they SBTs and/or FTs, and the resulting ownership data is stored on the blockchain. Fig. 5 shows how those tokens would be organized and presented to the reviewer on their reputation page. That page retrieves data from the blockchain using a reviewer's blockchain address.

We would like to emphasize that the components of our prototype supporting submission handling, review management, and editor decision making are only included to showcase how our token-based incentive system could be operationalized within a peer review system. Journals may not want to replace or heavily modify their existing review infrastructure, and therefore, we designed our token system to require limited changes to existing review structures and processes. Tokens would have to be configured to align with the journals' business processes, but the tokens are designed to be flexible enough to accommodate a range of configurations. Most journal systems are already configured to support standards like ORCID, and our token system could be implemented through similar data format standards, where a blockchain address would replace a researcher's ORCID. Adopting a parallel conversion approach would also help mitigate the disruptive effects of the integration process. A parallel approach would allow for implementation and testing of the token system with a subset of the journal's manuscripts while allowing the rest of the journal's operations to run as is until the quality and functionality of the integration can be confirmed.

6. Artifact evaluation

In the fifth phase of our methodology, we evaluate our design and artifact through analytical (quantitative) and descriptive (qualitative) evaluations, according to the definitions by Hevner et al. [36]. For the analytical evaluation, we examined the costs associated with running our proposed artifact, and we surveyed potential system users. For the descriptive evaluation, we asked the previously interviewed scholars to evaluate the effectiveness of the proposed design and artifact.

6.1. Cost analysis

Our proposed approach uses Polygon, a public blockchain network. An important characteristic of public blockchains is the need for users to pay transaction fees when submitting data or executing computations. These fees can fluctuate significantly based on factors such as network congestion and the consensus mechanism in use. Hence, we conducted a cost analysis to evaluate the financial implications of deploying our proposed system on Polygon. Before presenting the results of that analysis, it is essential to explain the concept of gas, a unit used to

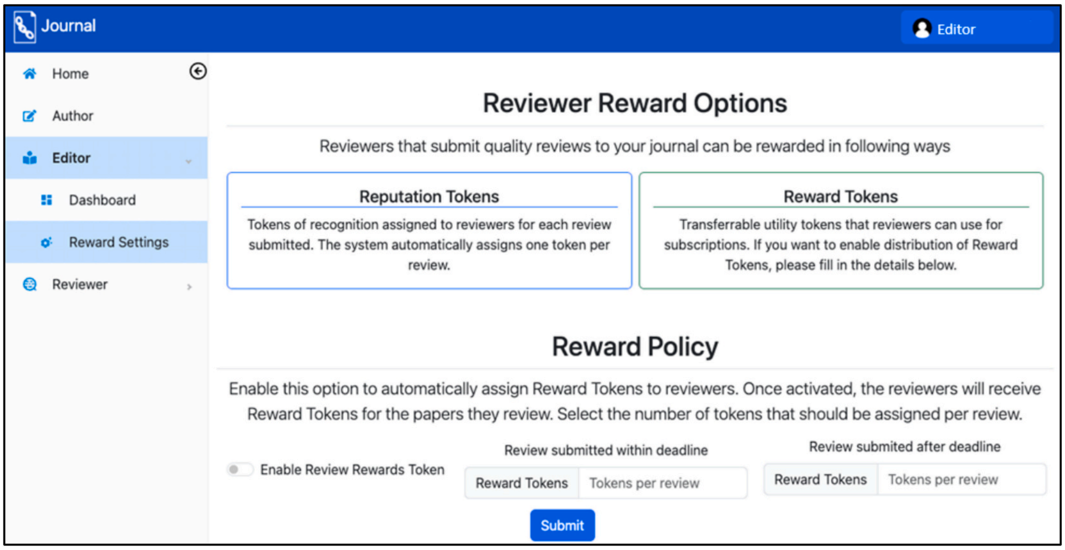

Fig. 4. Reward settings for the editor role.

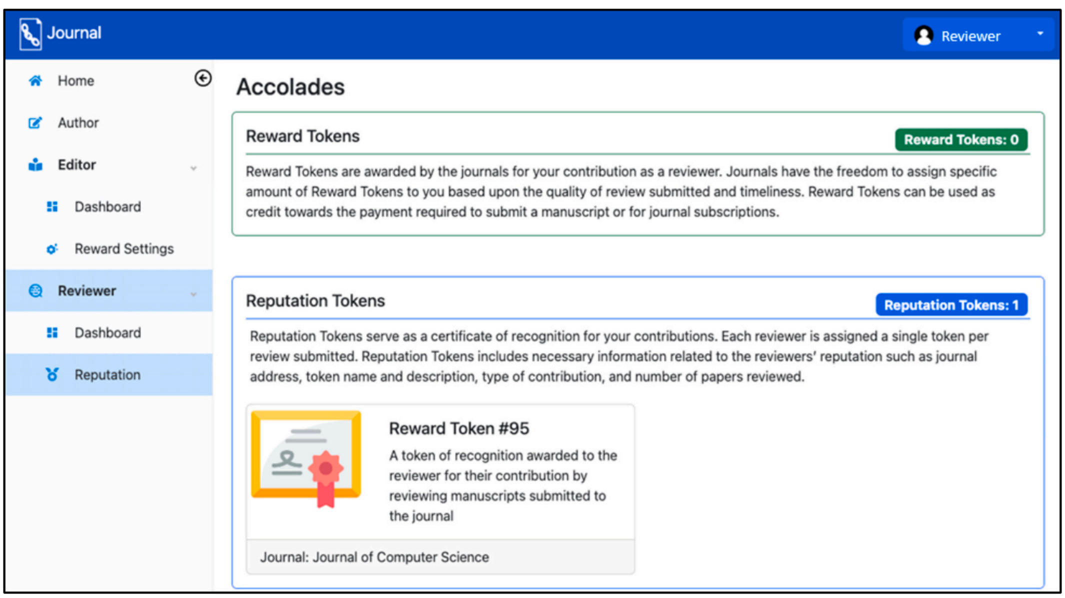

Fig. 5. Reviewer's reputation page.

measure the computational cost of executing transactions. Simple function calls consume less gas, while more complex operations, such as smart contract deployment, require significantly more. Users must pay for the gas consumed by the called operations using the MATIC cryptocurrency. Table 7 presents the smart contract functions required for our system, their consumed gas, corresponding cryptocurrency prices, and prices in USD. Overall, the values suggest that our system is cost-effective. The most expensive operation (*bulkMintSBT*) concerns minting multiple soulbound tokens simultaneously, whose USD cost is approximately $0.05. One critical operation in our system is the transfer function (*transfer*), which sends a minted token to a reviewer. Since this function will be used frequently, it must remain low-cost, as journals issuing the tokens will bear the expense. At the time of writing, the average cost of transferring tokens is considerably less than one cent.

Table 7
The average price in USD of different function calls. The MATIC price was approximately $0.6166 at the time of writing.

Function	Consumed Gas	Price (MATIC)	Price (USD)
addAdmin	36,199	0.00167	0.00103
revokeAdmin	24,272	0.00112	0.00069
bulkMintFT	49,791	0.00229	0.00141
singleMintFT	36,680	0.00169	0.00104
balanceOf	0	0.00000	0.00000
transfer	34,468	0.00159	0.00098
bulkMintSBT	1,801,248	0.08286	0.05109
singleMintSBT	626,946	0.02884	0.01778
getTokensOwned	0	0.00000	0.00000

The previous discussion considers only technology costs, excluding the cost of compensating reviewers with tokens. Soulbound tokens, functioning similarly to badges, have no monetary value, whereas fungible tokens do. To realistically estimate the annual cost of implementing our proposed solution with FT tokens, we use data from the Decision Support Systems (DSS) journal. In 2023, DSS received 1915 submissions, desk-rejecting 81 % (1551) and sending 19 % (364) for review. Reviewer compensation would likely vary from journal to journal, but for this cost estimate, we assume a payment of $200 per review regardless of the number of revisions, which is within the range of rates ($100–$250) offered by journals that have experimented with direct cash payments [14,28,29]. In 2023, DSS used an average of 2.5 reviewers per submission. Under a cost-maximizing scenario where all reviewers complete their reviews on time, the total annual cost would be $\$200 \times 2.5 \times 364 = \$182{,}000$. Given this, the cost of minting and transferring tokens (less than one cent) is negligible compared to human costs. We explore potential subsidies for reviewer compensation in Section 7, but note that, all else being equal, a $100 submission fee per article would more than cover DSS's annual review costs.

6.2. Quantitative evaluation: the system users

To assess the potential influence of our incentive systems on reviewer motivations, we conducted a field survey targeting academicians in the United States. An invitation letter was distributed to 79 academicians, providing 1) a brief description of the research objective, 2) a video demonstration highlighting key features of our system, and 3) a survey link. A total of 49 usable responses were collected and included in the data analysis.

Our sample included professors ($n = 6$), associate professors ($n = 19$), assistant professors ($n = 18$), and lecturers (n = 6). Participants reported performing an average of 3.55 peer reviews per year and having a moderate level of blockchain knowledge (mean = 2.06 on a 3-point scale, where 3 represents "expert knowledge"). Only 12 % of respondents reported ever receiving monetary compensation for reviewing, while 43 % had paid for review services. Respondents expressed strong interest in both NFTs (mean = 2.61/3, where 3 = "very interested") and FTs (mean = 2.84/3) as potential forms of compensation. In examining respondents' incentive preferences, we identified a significant positive correlation between service to the academic community and interest in token-based incentives (Pearson's $r = 0.338$, $p < 0.05$). This finding supports the complementary relationship between different types of incentives, consistent with prior research (e.g., [47,48]).

To evaluate the determinants of system adoption and use intention, we employed the IS Success Model [61] as a theoretical framework. We developed a measurement instrument to assess the relationships between three quality dimensions—system quality, information quality, and service quality—and use intention. The instrument items were identified through an extensive literature review (e.g. [62]) and further refined by four domain experts with expertise in blockchain, peer review, and instrument development to ensure its relevance to our system adoption context, resulting in four items for system quality (e.g., "I find the system easy to use"), three for information quality (e.g., "The information generated by the system is useful for peer review"), three for service quality (e.g., "Adequate technical support is anticipated from the system's provider"), and four for use intention (e.g., "I expect to use the system"). To validate the measurement properties, we conducted an exploratory factor analysis with varimax rotation. The results confirmed convergent validity, as all factor loadings exceeded 0.65, and discriminant validity, as the square root of the average variance extracted for each construct (minimum 0.746) was greater than its highest correlation with any other construct (maximum 0.605). Additionally, Cronbach's alpha exceeded 0.85 across all constructs, indicating high reliability. Next, we performed a regression analysis to assess the impact of system quality, information quality, and service quality on use intention. The findings indicated that all three quality factors significantly influenced use intention ($R^2 = 0.477$), with system quality ($M = 4.29$, $\beta = 0.293$, $p < 0.05$), information quality ($M = 4.12$, $\beta = 0.246$, $p < 0.05$), and service quality ($M = 3.95$, $\beta = 0.360$, $p < 0.01$) exhibiting significant effects. Notably, service quality had the strongest impact, underscoring the importance of providing adequate system support to enhance user adoption. This finding aligns with qualitative feedback from editors and reviewers, which is discussed in the next subsection.

6.3. Qualitative evaluation: editorial board members

As further validation of our solution, we conducted follow-up interviews with each of the editors and reviewers we had initially engaged with (see Table 1). The interviews began with a video demonstration of the finished prototype, followed by questions about the prototype designed to solicit feedback on what they saw and how the prototype fit their expectations.

We start by noting that most of the participants saw potential value in the system in terms of motivating reviewers. For example, P4 noted that *"if too many journal articles* [are] *being submitted, too much labor-intensive volunteer work, it might come in handy to … have an incentive system that they* [reviewers] *might be attracted to."* P10 saw value for users at different career stages, noting, *"I believe that early career academics want things like best reviewer awards and things like that. And I think to the extent that those tokens can be used to provide points for objectively choosing the best reviewer, it would be a good thing."* Faster review times were a benefit noted by P6, who said, *"If the reviewers are rewarded, then they will be more interested to do the reviews and that way reviewers…will participate and that will make the reviewing time faster, backlog slower, and overall trust improvement will be there. So overall, the reviewing process and the quality of the peer-reviewed publications will also improve."* Similarly, P4 noted, *"I think you might get people responding to review deadlines if they're getting tokens for it. I don't see any negatives there."* However, a few participants saw potential negative effects of incentivizing faster reviews, with P7 noting, *"I worry about human incentive for greed and gamifying rewards effectively. If I review more papers, I get more tokens, and then my review quality will go down because I'm speeding up review processes for the sake of getting more tokens. That's what worries me."* P8 offered a similar comment, saying, *"If we start incentivizing, a lot of us might just start reviewing things to collect those tokens and accumulate over time, and I don't know if the overall quality of the peer review might go down."* Such concerns certainly need to be taken into consideration when implementing new types of incentives. We return to this point in Section 7, where we discuss how different practices and policies can mitigate such concerns.

In addition to the questions on incentives and customization, we also asked our participants about transparency, trustworthiness, and the general usability of our artifact and design. Some participants raised potential adoption issues with a blockchain-based system. For example, P8 noted that *"You have to understand that as an editor and reviewer, a lot of us do not have a computer science background to understand a lot of those things."* Similarly, P2 said, *"I don't see people from technology or STEM-related backgrounds having any trouble using the system. However, I can see users who are not used to cryptocurrency or decentralized blockchain might struggle to understand what happens. So, there might be a steeper learning curve."* While designing optimal user interfaces is outside the scope of our work, we argue that it is technically feasible to design well-crafted interfaces that abstract away the complexity of using blockchain-based applications.

Overall, the general consensus of the participants was that the token system could help improve peer review as long as it did not undermine current processes that were working and was sufficiently easy to use that it would not add a significant burden on users.

7. Discussion

7.1. Contribution to peer review practice

The results of our interviews with editors and reviewers confirm extant literature that the lack of qualified reviewers is seriously affecting the scientific peer review process [20,23]. As such, novel solutions are needed to create incentives that will attract and retain reviewers. A major contribution of our work is highlighting how tokenization can be the basis for a range of incentives. We next explore the different types of incentives our solution enables and explain how academic outlets can effectively assign meaningful value to tokens, enabling reviewers to use them in ways that best meet their needs.

First, reviewers can receive unique, non-tradable, non-fungible tokens called soulbound tokens as recognition for their review work. These tokens can serve as irrefutable proof that a scholar has reviewed papers for a specific outlet. This is important data for scholars because it is often included in both annual evaluations and tenure and promotion processes. Journals can further increase the utility of these tokens by implementing internal policies that leverage them. For example, journals could introduce rules requiring authors to earn 'credit' through activities like peer reviewing before they can submit a manuscript [3]. Such a credit system could be based on soulbound tokens. For instance, if each submission requires three reviewers, a paper's authors would need to collectively acquire three new soulbound tokens before being allowed to submit their paper. Such a reciprocal review system aligns with the concept of *contributory justice*, a fairness principle where individuals are required to contribute in proportion to the benefits they seek [63]. Similar fairness policies can also be applied when selecting editorial board members. That is, rather than relying on recommendations, a fairer process to select editors might be based on review contributions (e.g., the number of soulbound tokens one has earned through work with the journal). To the best of our knowledge, similar practices are not pervasive today. One exception is the APA Decision Journal, whose invitation email sent to reviewers in 2023 stated, "*The editor's policy is to invite a reviewer to become a member of the editorial board after he or she completes at least 12 reviews within a three-year window. (This invitation is intended to be an incentive to do reviews.)*

In addition to soulbound tokens, reviewers can also be awarded fungible tokens, which could hold monetary value and serve as the foundation for a market-driven peer review system [64]. In such a system, fungible review tokens could be traded, bought, or sold. Token owners could 1) exchange them for fiat currency, effectively receiving monetary rewards for their efforts; 2) pay submission fee charges; or 3) pay to access previously published articles. The idea of providing financial compensation to reviewers has garnered growing interest [3], with promising outcomes in pilot programs. For example, Else [65] highlights experiments conducted by the journals Critical Care Medicine and Biology Open, which found that paying for reviews led to moderate improvements in both the acceptance rate of review invitations and the speed at which reviews were completed.

7.2. Theoretical contributions

A design theory is a "*set of postulates or a framework that provides a systematic and organized approach to the practice of design*" [66]. Our theoretical contribution lies in a new theory for the design of peer review processes that offers explicit incentives for reviewers. In developing the theory summarized in Table 8, we adhere to the guidelines set forth by Jones and Gregor [67], who provide a clear pathway for researchers to develop artifacts that contribute both practically and theoretically.

The first component, *purpose and scope*, determines what the system is for. As such, the purpose and scope of a design theory is intrinsically related to the investigated problems, as they apply to an entire class of artifacts rather than a single instance. Accordingly, the purpose and scope of our design theory is to develop peer review processes that explicitly incentivize reviewers.

The second component, *constructs*, refers to "*representations of the entities of interest in the theory. These entities could be physical phenomena or abstract theoretical terms*" [67]. That is, constructs represent the fundamental units of a design theory. Our solution to incentivize reviewers relies on tokenization. Therefore, "tokens" become the key construct in our design theory.

The third component, *principle of form and function*, defines an abstract blueprint of the proposed artifact. This includes both the general shape and function of the artifact. After defining the blueprint of our design through design principles, we developed a concrete solution that fulfills the principles through design features. Together, the design principles and features provide actionable guidelines delineating the artifact's form and function.

The fourth component, *artifact mutability*, acknowledges the mutable nature of information systems artifacts by specifying potential changes that affect an artifact's form and functionality. As noted previously, our design accommodates both fungible and non-fungible tokens, which motivate reviewers in distinct ways. Additionally, policymakers, such as editors, can further assign value to different tokens, thereby stimulating demand and enhancing the provided incentives. Importantly, the artifact is designed to evolve with long-term shifts in reviewer behavior and academic publishing norms. For example, if the demographics of reviewers change (e.g., more early-career researchers), token types can be adjusted (e.g., more monetary tokens to meet the financial incentive preferences of younger reviewers). More broadly, a journal can future-proof itself regarding changes in preferences over incentive types by offering both fungible and non-fungible tokens (e.g., younger researchers may also prefer greater autonomy in selecting incentive types [68]). The incentive mechanisms themselves can also be adapted. In particular, journals might adjust token amounts or tie them to inflationary expectations, disciplinary norms, or journal-specific review policies. These potential mutations make the system inherently future-oriented, allowing it to flexibly accommodate changes while preserving the desired functionality.

The fifth component refers to truth statements written as *testable propositions* of the general form: "*If a system or method that follows certain principles is instantiated, then it will work, or it will be better in some way than other systems or methods*" [67]. In line with this definition, two key testable propositions involving our constructs emerge as part of our design theory. First, we confirmed with key stakeholders that a token-based peer review process has the potential to attract more peer reviewers. Second, through interviews and cost analysis, we demonstrated that the proposed system is affordable and feasible.

The sixth component, *justificatory knowledge*, regards the use of a kernel theory that "*gives a basis and explanation for the design*" [67]. In our context, we justify our design primarily by drawing from the literature on motivation, such as organismic integration theory. This body of knowledge provided a firm foundation for articulating our central idea of creating different types of incentives using various token types.

The last two components are optional, but we include them in our design theory, as "*the credibility of the work is likely to be enhanced … by* [the] *provision of an instantiation as a working example*" [67]. The seventh component, *principles of implementation*, concerns "*the means by which the design is brought into being*" [67]. As we discussed in Section 5, using different tokens supported by blockchain technology can effectively generate meaningful incentives for peer reviewers. The eighth and final theory component is the *expository instantiation* of an artifact. Jones and Gregor [67] state that "*a prototype system can often be used to illustrate*

Table 8
Components of the proposed design theory.

Theory Component	Description
Purpose and Scope	Develop peer review processes that explicitly incentivize reviewers
Constructs	Tokens
Principle of Form and Function	- Design Principles: DP1, DP2, and DP3 - Design Features: DF1, DF2, and DF3
Artifact Mutability	- Different types of tokens - The value attached to tokens
Testable Propositions	- Valuable tokens can attract peer reviewers - Token-based systems are affordable
Justificatory Knowledge	Motivation theories
Principles of Implementation	- Tokens representing valuable digital assets - Blockchain enables tokens and serves as the storage layer
Expository Instantiation	Open-source peer review platform

how a system functions, with better communicative power than a natural language description." This was indeed the case in our work, where the open-source peer review platform we developed served as a representation and exposition of the design theory. In particular, the prototype allowed us to demonstrate how our artifact functions in practice so that it could be evaluated by key stakeholders (see Subsection 6.1).

8. Conclusion, limitations, and future research

In this research, we examined the challenge facing academic peer review of securing enough qualified reviewers. Through a literature review and interviews with scholars, we identified key motivators and barriers to reviewer participation. Guided by theory-driven design principles, we developed a blockchain-based artifact that demonstrates the feasibility of using both fungible and non-fungible tokens to incentivize reviewers. Empirical evaluations, including feedback from scholars and a detailed cost analysis, validated our solution's potential to improve reviewer participation and the overall efficiency of peer review processes. As a theoretical contribution, we proposed a formal design theory for peer review systems, providing the foundation for implementing trustworthy and flexible incentives that can attract and motivate reviewers.

While our study contributes valuable insights for both scholars and practitioners, it is important to acknowledge the presence of limitations and potential areas of concern that warrant deeper exploration in future research. First, although our proposed solution is intended to complement – rather than replace - existing peer review systems, with a particular emphasis on incentivizing reviewers through a blockchain-based token mechanism and thereby minimizing disruptions to the remainder of the review process, resistance from publishers and academic institutions may still arise. Such resistance is likely rooted in expectations of required adjustments to established processes and institutional infrastructures. To address this challenge, it is essential to proactively engage stakeholders by clearly articulating the system's potential benefits in addressing longstanding issues in peer review and by providing comprehensive guidance on how the framework can be integrated into existing workflows allowing journals and conferences to continue using their current reviewer selection and dispute resolution mechanisms without disruption.

Second, the potential reluctance of editors, reviewers and publishers to adopt token-based systems represents an additional limitation of our study. A significant proportion of these stakeholders do not possess technical backgrounds, and relatively few academics are familiar with blockchain wallets and token management, which may hinder adoption. Moreover, concerns about the irreversibility of lost wallet credentials, particularly in contrast to the familiarity of password reset mechanisms, may further discourage potential users. Future research could address these concerns by enhancing the system's design to abstract away complex technical elements, developing comprehensive user manuals and instructional video tutorials tailored to different adoption contexts, and offering technical support to assist with implementation. These efforts may help mitigate stakeholder hesitancy and facilitate broader adoption of the proposed framework.

Third, a further limitation of our study pertains to the uncertain and potentially contentious issue of funding sources for reviewer compensation. While certain journals—such as *The Accounting Review*, *Journal of Finance*, and *Journal of Financial Economics*—already impose article processing charges (APCs) on authors, which could be redirected to support reviewer payments, the broader sustainability of such a model remains unclear. Alternative funding mechanisms may include allocations from membership fees collected by professional associations that sponsor journals (e.g., the Association for Information Systems), revenue generated through subscriptions or individual article sales, premium charges for expedited review services, a share of grant overhead from funding agencies, or rebate programs by publishers to incentivize institutional peer review contributions. Nonetheless, given the diversity in journal funding structures and editorial missions—ranging from community-driven models to more profit-oriented or even exploitative practices [69]—a standardized approach to reviewer compensation may not be feasible. Future research should explore the economic viability and organizational willingness to adopt such funding models across different types of journals. Investigating the practical implementation and stakeholder perceptions of these funding mechanisms would provide valuable insight into the conditions under which token-based reviewer compensation systems could be adopted more broadly.

Fourth, a potential limitation of our study involves the unintended consequences associated with incentivizing peer review through fungible tokens. Specifically, such incentives may encourage reviewers to prioritize the quantity of reviews over their quality, potentially diminishing the rigor and relevance of peer feedback. Although prior research has found that monetary compensation does not inherently compromise review quality [14,28,65], the safeguards embedded in our proposed framework - such as criteria that reward timeliness and quality in addition to completion, and mechanisms to blacklist consistently substandard reviewers - remain untested in practice. A related challenge that may arise is the risk of over-inviting a subset of reviewers, which could lead to financial imbalances and exacerbate inequities in the distribution of reviewing responsibilities. To mitigate this, fairness criteria could be established to guide review allocation and ensure more equitable participation across the reviewer pool. The transparency afforded by blockchain technology could support such fairness measures by offering visibility into individual reviewer contributions over time, thereby fostering accountability and enabling stakeholders to monitor reviewer activity. Future research is needed to empirically assess both the behavioral impacts of token-based incentives and the effectiveness of transparency-driven allocation mechanisms, with the goal of refining reviewer compensation systems that uphold both efficiency and academic integrity.

Fifth, another notable limitation lies in the potential implementation challenges associated with adopting our proposed solution. One such concern involves the volatility of fungible tokens, a characteristic common to many existing cryptocurrencies. This issue, however, can be mitigated through the use of stablecoins such as USDC, EURC, and Tether Gold, which are designed to maintain stable value by being pegged to fiat currencies (e.g., USD, EUR) or tangible assets like gold. Leveraging existing stablecoins also eliminates the need for journals to design and mint proprietary fungible tokens, thereby reducing both technical and operational burdens. A further critical issue pertains to the use of soulbound tokens (SBTs), particularly regarding their implications for reputational integrity and the potential for error. For instance, a journal might mistakenly issue an SBT to an unintended recipient, or a reviewer may later wish to dissociate from a journal due to reputational decline. Although SBTs are inherently non-transferable, emerging standards such as ERC-5484 introduce a framework for revocable SBTs, granting users the ability to resign ownership or allowing issuers to revoke tokens issued erroneously. Our proposed design is deliberately adaptable and can integrate such evolving standards to support secure and flexible token management. Future studies could explore the development of user-friendly implementation protocols, governance models for token revocation, and empirical evaluation of stakeholder responses to these mechanisms to further enhance adoption and trust.

Finally, while our study presents a solid system design and field study results involving potential reviewers, it is limited by the lack of empirical validation through real-world implementation. To further enhance the peer review process, future research can investigate the integration of our system with advanced infrastructural technologies, including reviewer-matching algorithms, dispute resolution mechanisms, and reviewer quality assessment methods. For instance, deploying an in-house generative AI system, trained on historical reviewer data from journals and publishers, could significantly improve the precision and efficiency of reviewer-paper matching. In addition, ongoing developments in AI-based tools for evaluating review quality may offer valuable support for editors in assessing reviewer performance. Another avenue for future work is to expand this study by testing the proposed artifact in a live peer review setting to gather quantitative data on its effectiveness. Additional research is also needed to explore the long-term impact of token-based incentives on review quality and community engagement. Overall, we see our research as a fundamental step in paving the way for a more efficient, effective, transparent, and engaging peer review process.

CRediT authorship contribution statement

Chad Anderson: Writing – review & editing, Writing – original draft, Methodology, Investigation. **Pratiksha Shrestha:** Writing – original draft, Visualization, Software, Formal analysis, Conceptualization. **Suman Bhunia:** Writing – review & editing, Writing – original draft, Software, Investigation, Formal analysis, Conceptualization. **Arthur Carvalho:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Conceptualization. **Younghwa Lee:** Writing – review & editing, Writing – original draft, Investigation.

Declaration of competing interest

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Data availability

Data will be made available on request.

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