Building motivation above trust: A blockchain-based NFT GameFi model for construction workload assessment

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Abstract. In the VUCA (Volatile, Uncertain, Complex, Ambiguous) era, construction management faces unique challenges, particularly in the realm of workload assessment. This paper proposes an innovative solution to address these challenges: a blockchain-based GameFi model for construction workload assessment. This model leverages blockchain Non-Fungible Token (NFT) technology to issue various badges, reliably representing employees' workload. The technology ensures the authenticity and tamper-proof nature of the badges, thereby fostering employee motivation through a distributed trust system. This study provides fresh insights into the construction industry's digital transformation and is anticipated to lay the groundwork for similar applications in other sectors.

Keywords: Blockchain, construction industry, NFT, GameFi.

1. Introduction

The construction industry plays a crucial role in the global economy, creating infrastructures that drive economic growth and improve living standards. The industry has recently embraced digital transformation to enhance efficiency and productivity [1]. However, the construction sector faces a significant challenge of inefficient project management, which often stems from improper assessment and allocation of employee workload. Accurate and transparent workload assessment ensures employees distribute tasks evenly, preventing resource overload or underutilization [2].

To address the workload assessment problem, we propose an innovative blockchain-based GameFi model that leverages Non-Fungible Token (NFT) technology to record and represent employee workload transparently and securely [3]. Blockchain, a decentralized and distributed ledger system, allows for secure and transparent transactions without a central authority [4]. NFTs, a unique digital asset built on blockchain networks, have gained prominence in recent years due to their ability to authenticate and represent ownership of digital and physical assets. By combining blockchain and NFT technologies, our proposed model aims to create a secure, transparent, and motivating environment for employees in the construction industry, ultimately enhancing project management efficiency [5].

This study first provides an overview of blockchain and NFT technologies and their applications. Next, we describe the design and implementation of our proposed GameFi model, which encompasses badge creation, issuance, verification, authentication, and competitive and collaborative dynamics

among employees. Finally, we discuss the implications of our findings and the potential for further applications of our proposed approach in other industries.

2. Related works

2.1. Construction workload assessment

Traditional construction workload assessment largely depends on various methodologies such as manual observation, interviews, and surveys [6]. These strategies assess the volume and complexity of tasks that workers undertake within a specific time frame. Manual observation, for instance, involves supervisors or project managers watching employees as they carry out their duties, documenting the tasks performed, the conditions under which they are conducted, and the time taken for completion [7].

In the realm of interviews and surveys, these techniques offer a platform for employees to self-report their tasks, the time dedicated to each, and their perceptions of their workload. The subjective data gathered from these methods provide valuable insight into the construction industry's day-to-day operations and help estimate future workloads [8].

Time and motion studies represent a more systematic approach. These studies detail each task, measuring the time required to complete it under various conditions. This data is then employed to predict future workloads for similar tasks. However, despite their proven efficacy, these traditional methods also have their limitations [9]. They can be time-consuming, subjective, and may not accurately reflect the workload in dynamic environments like construction sites. These limitations have sparked the exploration of innovative technologies and models, such as the blockchain-based GameFi model proposed in this study, to enhance the accuracy and reliability of construction workload assessment.

2.2. Blockchain technology

Blockchain technology is a decentralized, distributed ledger system that enables secure and transparent transactions without a central authority. In a blockchain network, transactions are recorded as blocks linked chronologically, forming a chain [10]. Each block contains a unique code called a cryptographic hash, generated based on the information stored in the block and the previous block's hash. This design ensures that the data stored on the blockchain is tamper-proof, as altering the information in any block would require changing the hashes of all subsequent blocks, a computationally infeasible task [11].

Some key advantages of blockchain technology include decentralization, which means that data is stored across a network of computers, eliminating the need for a central authority and reducing the risk of a single point of failure [12]. The technology also offers security, as the cryptographic nature of the blockchain makes it highly resistant to hacking and data tampering. Additionally, blockchain technology provides transparency since all participants in the network can view and verify the transactions, promoting trust and accountability [13]. Lastly, the immutability of blockchain technology ensures that once a transaction is recorded, it cannot be altered or deleted, maintaining data integrity.

2.3. NFT technology and GameFi

Non-Fungible Tokens (NFTs) have come into the spotlight as unique digital assets underpinned by blockchain networks like Ethereum. Uniquely distinct from fungible cryptocurrencies like Bitcoin or Ether, NFTs cannot be replaced like-for-like [14]. NFTs' value lies in their ability to authenticate and denote ownership of a wide array of digital and physical assets - from artwork and collectibles to virtual games and real estate [15]. NFTs' blockchain infrastructure ensures a clear and verifiable trail of ownership and provenance, providing a secure, transparent authentication method.

NFT technology's benefits are manifold. Each NFT is unique and irreplaceable, ensuring the authenticity of its digital assets. Additionally, the comprehensive history of the NFT, from its creation to its transactions, is chronologically recorded on the blockchain. This record facilitates

straightforward verification of the asset's provenance [16]. Moreover, NFTs offer interoperability, allowing for seamless integration with various digital ecosystems across different platforms and applications [17].

Emerging from the confluence of gaming and finance is GameFi, a concept integrating blockchain technology, cryptocurrencies, and decentralized finance (DeFi) principles into gaming and interactive platforms [18]. GameFi platforms often use NFTs to represent in-game assets, achievements, and rewards. This creates a play-to-earn model where users can generate income through their in-game activities and accomplishments. Additional DeFi features like decentralized exchanges, staking, and lending enable further monetization of digital assets and broader participation in the digital economy. In summary, integrating NFTs and GameFi principles heralds a transformative shift toward value creation and distribution in the digital ecosystem. This convergence paves the way for economic empowerment in the virtual world and lays the foundation for linking the real and virtual worlds from an economic perspective.

3. The proposed GameFi model

The proposed GameFi model requires three steps: creating and issuing badges as NFT, the verification and authentication of these badges via the blockchain, and utilizing these tokens based on each employee's performance. Compared with the traditional separated assessment and incentive methods, such as performance evaluations and monetary bonuses, the proposed GameFi integrates these elements, promoting a resilient, adaptable solution that can navigate rapid changes and uncertainties, enhancing management and productivity.

3.1. Badge creation and issuance

The first step in our proposed GameFi model involves creating and issuing digital badges based on employee workload. These badges represent various workload levels, skill sets, and achievements and are designed as NFTs to ensure their uniqueness and authenticity.

To create badges, we establish criteria and performance metrics for each type of badge, corresponding to specific tasks, skill levels, and milestones within the construction industry. Examples of badges might include "Safety Expert," "Project Manager," and "Deadline Champion," among others, as shown in Figure 1. These badges represent an employee's skills and accomplishments, contributing to a sense of pride and ownership.
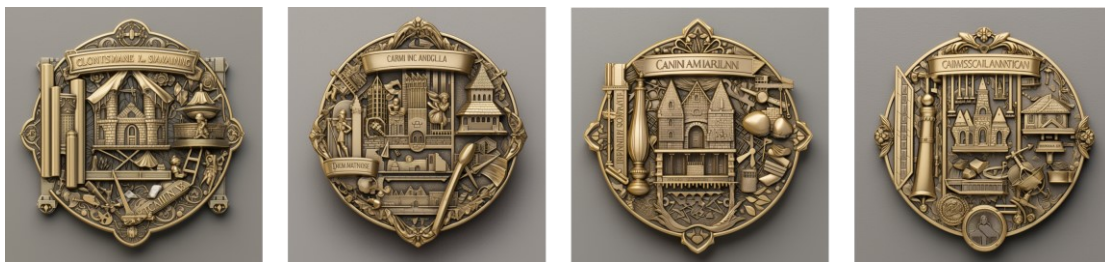

Figure 1. Badges design for NFT.

Employees receive badges upon completing tasks, reaching milestones, or demonstrating particular skills or expertise. The issuance of badges is automated and transparent, with the system utilizing smart contracts to assign badges based on predefined criteria and performance metrics. This eliminates the potential for bias or favoritism, ensuring that badges are earned fairly and objectively.

3.2. Badge verification and authentication

Once a badge is issued, it is recorded on the blockchain, ensuring a tamper-proof record of the employee's workload and accomplishments. Blockchain technology guarantees the authenticity and security of the badges, as the data stored on the blockchain is immutable and transparent. As shown in Figure 2, after uploading the badge NFT to the IPFS distributed network, the exclusive CIDs (Content

Identifiers) will arrive. This CID is the hash value of the image, and the verification of the hash value can ensure that the NFT will not be easily tampered with.

Employees can verify and authenticate their badges by checking the transaction history and ownership records stored on the blockchain. This feature promotes trust and accountability among employees and employers, as the badges serve as a reliable and verifiable record of each employee's workload and performance. Additionally, the secure nature of blockchain technology prevents fraudulent badge claims or unauthorized badge transfers, further increasing the value and credibility of the badges.

NFT   CID information

Figure 2. NFT saved into a distributed network.

3.3. Employee incentives and token utilization

3.3.1. Incentives for employees. To motivate employees and encourage active participation in the GameFi model, we incorporate a range of incentives that align with the objectives and values of the construction industry. These incentives include skill development, task completion, peer recognition, collaboration, and safety and sustainability.

Employees can earn badges and tokens by acquiring new skills or enhancing existing ones, which can benefit their professional growth and career progression. Furthermore, employees who complete tasks on time and meet predefined quality standards are rewarded with badges and tokens, incentivizing them to perform their duties efficiently and effectively. The public display of badges and achievements on leaderboards or social platforms encourages employees to strive for recognition among their peers, fostering a healthy competitive spirit. Teams that successfully collaborate on complex tasks or projects can earn special badges and tokens, promoting employee teamwork and synergies. Lastly, employees who adhere to safety protocols and contribute to sustainable construction practices can earn badges and tokens, emphasizing the importance of responsible workplace behavior.

3.3.2. Token utilization. The tokens earned by employees within the GameFi model can be used in various ways, offering tangible benefits and value to the participants. Some possible uses for the tokens include reward redemption, skill enhancement, internal marketplace, staking and lending, and voting and governance.

Employees can use their earned tokens to redeem rewards, such as gift cards, vouchers, or other tangible items, providing a direct financial incentive for their efforts. Tokens can also be used to access training courses, workshops, or seminars, allowing employees to develop their skills further and advance their careers. In addition, employees can trade or sell their tokens in an internal marketplace, allowing them to monetize their achievements and invest in other employees' badges or tokens. Integrating DeFi features in the GameFi model enables employees to stake or lend their tokens, earning passive income through interest or dividends. Finally, tokens can be used to participate in company-wide decision-making processes or governance mechanisms, empowering employees with a sense of ownership and influence within the organization.

4. A mock focused workshop

Figure 3 shows two concentrated workflows based on prior research, each addressing distinctive yet complementary aspects of quality assessment and efficiency measurement. The first workflow delves into traditional methodologies involving manual testing and paper records, focusing on assessing work counts and time delays. This traditional process offers an insightful exploration into the established norms of quality control, efficiency tracking, and the potential for refinement. Meanwhile, the second workflow encapsulates more modern digital innovations, specifically examining the application of NFTs in GameFi models and their implementation within mobile applications. This contemporary approach reflects the disruptive potential of technology in revolutionizing operational processes.
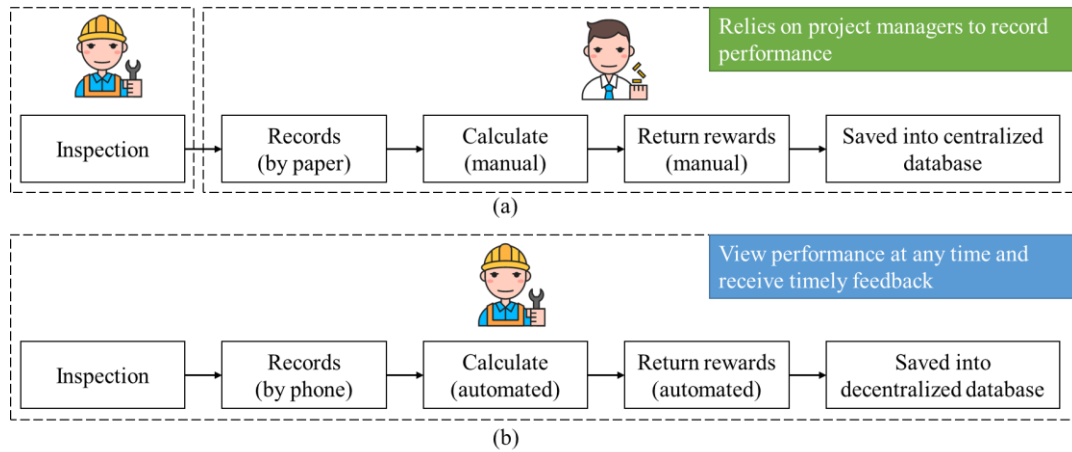

Figure 3. Two types of performance records workflows. (a) Paper-based; (b) NFT and GameFi model-based.

For this study, we asked people from a number of different disciplinary backgrounds to participate in laboratory simulations, including building management, BIM designer, architectural design, and computer science. By accurately documenting the time costs involved in the simulation process and receiving timely feedback from the different work streams, we were able to explore and understand the impact of the different work streams on the quality inspection process as a whole and collect a wide range of data for comprehensive and detailed analysis.

In order to quantitatively assess the proposed GameFi model, four principal metrics will be utilized: Accuracy, Efficiency, Security, and Impact on Performance, as shown in Table 1. Each metric will be evaluated on a scale of one to five, with five being the highest achievable score. Accuracy will measure whether the actual workload of the employee is consistent with the workload being recorded. Efficiency will examine the model's comparative advantage in terms of time and resource utilization over traditional assessment methods. Security, a critical feature given the reliance on blockchain technology, will evaluate the system's robustness and the reliable maintenance of badge authenticity. Lastly, Impact on Performance will consider whether implementing the GameFi model contributes to a noticeable improvement in employee performance and other relevant metrics in the construction industry. The aggregate of these scores will offer a comprehensive assessment of the GameFi model's effectiveness and potential for implementation.

Table 1. Users' rating for their experience.

Workflow types	Accuracy	Efficiency	Security	Impact on Performance
Paper-based	3.5	4.5	3	3.5
NFT and GameFi model-based	4.5	4	5	4.5

A scholarly comparison delineates discernible differences between the traditional paper-based workflow and the innovative NFT and GameFi model-based workflow. The conventional paper-based

approach registers moderate scores in various domains, with an accuracy rating of 3.5, efficiency at 4.5, security marked at 3, and a performance impact measurement of 3.5. In contrast, the NFT and GameFi model demonstrates superior outcomes. The proposed model garners an exceptional accuracy score of 4.5, indicative of its precision in workload evaluation. While its efficiency rating of 4 is slightly diminished compared to the paper-based method, presumably due to challenges associated with adopting new technology, it compensates with an impeccable security score of 5, largely attributable to the robustness of blockchain technology. Furthermore, the GameFi model substantially augments performance, securing a rating of 4.5 regarding its impact on performance. This score suggests significant advancements in relevant industry metrics.

5. Conclusion

In this study, we proposed an innovative blockchain-based GameFi model for assessing employee workload in the construction industry. By leveraging the unique features of blockchain and NFT technologies, our model creates a secure, transparent, and engaging environment for employees, promoting competition, collaboration, and tangible rewards. We explored the main components of the model, the incentives provided, and the potential uses of tokens earned within the system.

However, it is important to note that the current tests and evaluations of the proposed NFT and GameFi model are primarily conducted within controlled laboratory environments. While these initial tests provide valuable insights, further validation is necessary by applying the model in practical, real-world scenarios. Testing the model in diverse and practical cases can more accurately assess its effectiveness and viability. This iterative validation process will enable the development of products and solutions that can be implemented on a larger scale, ensuring their practicality and suitability for real-world applications.

References

[1]   V. Koscheyev, V. Rapgof, and V. Vinogradova, "Digital transformation of construction organizations," in *IOP Conference Series: Materials Science and Engineering*, 2019, vol. 497, no. 1: IOP Publishing, p. 012010.

[2]   A. O. Olanipekun and M. Sutrisna, "Facilitating digital transformation in construction—a systematic review of the current state of the art," *Frontiers in built Environment,* vol. 7, p. 660758, 2021.

[3]   J. Proelss, S. Sevigny, and D. Schweizer, "GameFi-The Perfect Symbiosis of Blockchain, Tokens, DeFi, and NFTs?," *Tokens, DeFi, and NFTs,* 2023.

[4]   R. Zhao, Z. Chen, and F. Xue, "A blockchain 3.0 paradigm for digital twins in construction project management," *Automation in Construction,* vol. 145, p. 104645, 2023.

[5]   L. V. Kiong, *Web3 Made Easy: A Comprehensive Guide to Web3: Everything you need to know about Web3, Blockchain, DeFi, Metaverse, NFT and GameFi*. Liew Voon Kiong, 2022.

[6]   J. Chen, X. Song, and Z. Lin, "Revealing the "Invisible Gorilla" in construction: Estimating construction safety through mental workload assessment," *Automation in Construction,* vol. 63, pp. 173-183, 2016.

[7]   Y. Yu *et al.*, "Automatic biomechanical workload estimation for construction workers by computer vision and smart insoles," *Journal of Computing in Civil Engineering,* vol. 33, no. 3, p. 04019010, 2019.

[8]   J. Chen, J. E. Taylor, and S. Comu, "Assessing task mental workload in construction projects: A novel electroencephalography approach," *Journal of Construction Engineering and Management,* vol. 143, no. 8, p. 04017053, 2017.

[9]   E. Aktas Potur, Ş. Toptancı, and M. Kabak, "Mental Workload Assessment in Construction Industry with Fuzzy NASA-TLX Method," in *Proceedings of the Sixteenth International Conference on Management Science and Engineering Management–Volume 2*, 2022: Springer, pp. 729-742.

[10] K. Wüst and A. Gervais, "Do you need a blockchain?," in *2018 crypto valley conference on blockchain technology (CVCBT)*, 2018: IEEE, pp. 45-54.

[11] L. Kong *et al.*, "When permissioned blockchain meets IoT oracles: An on-chain quality assurance system for off-shore modular construction manufacture," 2022.

[12] W. Lu, L. Wu, R. Zhao, X. Li, and F. Xue, "Blockchain technology for governmental supervision of construction work: Learning from digital currency electronic payment systems," *Journal of construction engineering and management,* vol. 147, no. 10, p. 04021122, 2021.

[13] R. Zhao, L. Wu, Z. Chen, M. Tang, W. Lu, and F. Xue, "A Study on Protocols of Cross-Chain Data Synchronization for Permission Blockchain for Construction Management," in *Proceedings of the 26th International Symposium on Advancement of Construction Management and Real Estate*, 2022: Springer, pp. 1090-1101.

[14] Q. Wang, R. Li, Q. Wang, and S. Chen, "Non-fungible token (NFT): Overview, evaluation, opportunities and challenges," *arXiv preprint arXiv:2105.07447,* 2021.

[15] K. Vasan, M. Janosov, and A.-L. Barabási, "Quantifying NFT-driven networks in crypto art," *Scientific reports,* vol. 12, no. 1, pp. 1-11, 2022.

[16] D.-R. Kong and T.-C. Lin, "Alternative investments in the Fintech era: The risk and return of Non-Fungible Token (NFT)," *Available at SSRN 3914085,* 2021.

[17] L. Ante, "The non-fungible token (NFT) market and its relationship with Bitcoin and Ethereum," *FinTech,* vol. 1, no. 3, pp. 216-224, 2022.

[18] A. Kirillov, A. Rahman, and A. Aggarwal, "Rental NFT Protocol With Advanced Rewards Splitting," in *2022 IEEE International Conference on Big Data (Big Data)*, 2022: IEEE, pp. 3201-3206.