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APPLYING BLOCKCHAIN TO ENHANCE IN-GAME ECONOMIES IN MULTIPLAYER FPS GAMES

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ABSTRACT

The contribution of blockchain technology, in particular the Ethereum platform, for enhancing the security, transparency, and efficiency of the transactions happening in multiplayer FPS games, has been examined. In this paper, a blockchain-driven real-time transaction recording system is proposed and implemented based on the Ethereum PoS consensus algorithm to minimize fraudulent activities and data tampering. Extensive testing demonstrated that the integration of blockchain significantly strengthened security measures and transaction accuracy, while maintaining high game performance and seamless player experience. By addressing two of the most common issues found in online gaming-cheating and vulnerability to centralized data-this study shows how blockchain can truly change the face of game economies. The results highlight the feasibility of integrating blockchain technology to provide a decentralized and secure transaction framework, which will further help in creating fairer and more transparent gaming contexts. Further studies should address the scalability of blockchain marketplaces and its impact on player engagement and satisfaction, adding to the growing debate on the importance of blockchain in game development.

Keywords: *Blockchain, Game, First Person Shooter, Ethereum, Game Development,*

1. INTRODUCTION

The integration of blockchain technology into the gaming industry has revolutionized the way digital assets are created, owned, and traded. Initially, blockchain's success in enabling secure, decentralized financial transactions through Bitcoin paved the way for new applications beyond cryptocurrencies [1]. One of the most notable innovations was Ethereum, which brought decentralized apps (DApps) and Smart Contracts, enabling blockchain technology to go beyond financial transactions and into more intricate fields like gaming [2]. With the intention of developing decentralized software, Vitalik Buterin originally presented Ethereum at the end of 2013 [3]. Early in 2014, the Ethereum software project formally started development through a Swiss corporation. The development of decentralized ecosystems where players may interact with in-game assets that have real-world value was made possible by these advancements.

The development of decentralized ecosystems where players may interact with in-game assets that have real-world value was made possible by these advancements [4]. These systems enable true ownership and verifiable uniqueness of in-game assets through the use of non-fungible tokens (NFTs), which serve as a cornerstone for creating value in gaming. Other digital assets can also be stored in smart contracts. On the Ethereum blockchain, businesses have created contracts that enable the availability and trading of stocks, real estate, gold, US dollars, and other assets [5].

One of the earliest examples of blockchain integration into gaming was CryptoKitties, a game that allowed players to buy, breed, and trade unique digital cats on the Ethereum blockchain. Each CryptoKitty was represented as a non-fungible token (NFT), giving it uniqueness and value within the game [4]. CryptoKitties demonstrated the potential for blockchain to bring real-world economic value into gaming, and it marked a significant shift in how game assets could be owned, transferred, and valued. This breakthrough opened the door for other blockchain-based games and inspired further exploration into how decentralized technologies could impact game design and player experiences.

As blockchain-based games evolved, the distinction between gaming and financial

investments began to blur. Games built on Ethereum and other blockchain platforms began to offer players true ownership of in-game assets, allowing them to trade these assets on cryptocurrency markets and convert them into real-world money. This convergence of gaming and finance, often referred to as GameFi, introduced new dynamics that enhanced player engagement by adding financial incentives to gameplay [6]. However, this shift also raised concerns about the implications of treating in-game assets as speculative investments, posing questions about fairness, accessibility, and the long-term sustainability of such models.

In the context of multiplayer first-person shooter (FPS) games, blockchain integration holds particular promise for redefining player interactions and game economies. FPS games often rely heavily on player progression through the acquisition of weapons, skins, and other in-game items. Integrating blockchain technology into these games could allow players to truly own their in-game assets, trading them securely on decentralized marketplaces without the need for intermediaries [7]. This level of transparency and control over in-game items could lead to deeper player engagement, as they become more invested in the economic aspects of the game. Moreover, blockchain could enable secure and transparent transactions, addressing longstanding issues of fraud and item duplication in online gaming. And SmartContracts can also be used to store other digital assets. Companies have built contracts that make stocks, real estate, gold, US dollars, and various other assets available and tradable on the Ethereum blockchain [5]. The use of smart contracts, which not only store exclusive in-game assets but also make programmable features possible, such automatic tournament prize distribution or royalties for item makers, represents yet another significant possibility.

However, the integration of blockchain into FPS games also presents significant challenges. The high transaction fees and scalability issues faced by early blockchain games, such as CryptoKitties, serve as a cautionary tale for developers [7]. Ethereum 2.0, users start the transaction process by deciding how much ether they want to send and the recipient's address in their wallets. Following creation, the transaction is routed to the mempool, where unverified transactions await validation by validators depending on several criteria, including gas pricing [8]. Potential solutions for addressing these scaling problems in gaming applications include Ethereum 2.0. Ethereum's network congestion during CryptoKitties' peak popularity led to slow transaction times and exorbitant fees, which ultimately drove players away. For blockchain to be successfully implemented in fast-paced multiplayer games like FPS, where transactions need to occur rapidly and efficiently, solutions to these scalability and latency issues must be found. Recent advancements, such as Layer 2 solutions, such as Polygon or Optimism, further enhance scalability by handling transactions off-chain before bundling them onto the Ethereum mainnet, making them particularly suitable for high-speed gaming applications. Layer 2 solutions and other blockchain protocols, offer potential remedies, but their effectiveness in the gaming context remains to be fully explored.

In addition to addressing scalability, blockchain integration in FPS games could revolutionize how players perceive ownership and reputation within the game. By enabling decentralized ownership of unique in-game assets, blockchain allows for items with verifiable histories and reputations. For example, a weapon used in a famous tournament or by a well-known player could hold additional value due to its provenance, adding depth to the game's lore and player interactions. This would create new opportunities for in-game storytelling and social dynamics, as players could trade not only for functional advantages but also for status and prestige [6].

Furthermore, blockchain technology has the potential to foster greater transparency and trust between players. In multiplayer FPS games, where team dynamics and cooperation are essential, the ability to ensure fair and transparent transactions is crucial for maintaining a positive gaming environment. Blockchain’s immutable ledger can provide a reliable record of in-game transactions, reducing the risk of fraud and promoting trust among players. This level of accountability is especially important in competitive gaming, where disputes over asset ownership or unfair trades can harm the gaming experience [9].

The user experience is another important consideration. Blockchain integration needs to be easy to use and accessible if gaming is to adopt it more widely. To take use of blockchain's advantages, players shouldn't have to be familiar with its complexities. The user experience could be enhanced by wallet integrations, streamlined user interfaces, and off-chain transaction methods, guaranteeing that blockchain technologies promote gameplay rather than interfere with it.

In conclusion, the intersection of blockchain technology and multiplayer FPS games offers promising opportunities to redefine player engagement, asset ownership, and game economies. By leveraging the security, transparency, and decentralization that blockchain provides, developers can create more immersive and financially rewarding experiences for players. However, the challenges of scalability, transaction costs, and user experience must be addressed to fully realize the potential of blockchain in gaming [7]. This paper aims to analyze the effectiveness of blockchain technology in enhancing transaction speed, transparency, and trust in multiplayer FPS games, while exploring the implications of integrating decentralized economies into the gaming industry.

2. RELATED WORKS

Blockchain technology has been applied in various gaming contexts, providing different benefits and challenges depending on its use. One of the early studies by Lee Examined the role of blockchain in Cryptokitties, a game where players collect and trade virtual cats [10]. Lee found that while blockchain could enhance the enjoyment of playing the game, this effect was not universal. Factors such as players' goals—whether for fun or speculation—played a significant role in how they experienced the game, suggesting a complex interplay between technology and player motivation.

Building on the idea of enhancing player engagement through blockchain, explored the integration of digital assets into video games, with a focus on how blockchain could authenticate and manage these assets. Based on the patent from NIKE, Inc. (US11308184B2), the study demonstrated how blockchain could provide secure and transparent ownership of digital goods, offering a new level of player immersion. However, the study also pointed out technical challenges such as managing metadata, an issue that could limit the practical application of blockchain in gaming [11].

Further expanding on the potential of blockchain to motivate players, introduced a Proof-of-Achievement algorithm, where players are rewarded with cryptocurrency for completing in-game objectives. This approach directly linked gameplay achievements with real-world rewards, motivating players to continue playing. Unlike previous studies, this research emphasized how blockchain could be used to maintain player interest by offering financial incentives, which could be exchanged for Ethereum, adding a tangible economic layer to gaming [12].

On the other hand, the use of blockchain in gaming has also raised concerns about its similarities to gambling [6]. Examined Ethereum-based games and highlighted the use of smart contracts to facilitate in-game transactions and the creation of game-specific currencies. The study found that these games often resembled gambling platforms, with players trading in-game assets for Ethereum in a manner that mirrored betting mechanics. This raised questions about the ethical implications of blockchain games and their potential risks for players.

Lastly, explored the use of Non-Fungible Tokens (NFTs) in the game NFTSmith, focusing on how NFTs could secure in-game transactions and ensure player ownership of digital assets. Their research demonstrated that blockchain-based economies in games, particularly through the use of NFTs, could provide players with full control over their assets [13]. However, they also encountered challenges related to the technical limitations of metadata storage, which is an ongoing issue in the development of blockchain-based gaming ecosystems.

By using blockchain in the context of multiplayer first-person shooter games—a very competitive and dynamic gaming genre—our study builds on earlier findings. This study investigates how in-game currency, achievement awards, and player development might be improved by utilizing blockchain to reinforce the in-game economy, in contrast to earlier studies that concentrated more on collectible games or NFTs. Our study goes deeper into tackling the issues of real-time transaction security in multiplayer first-person shooter games, where numerous players engage at once, even if earlier research has demonstrated the advantages of blockchain in granting ownership and transparency of digital assets.

The problems addressed in earlier research are likewise identified and addressed in our study, especially those pertaining to data storage. We offer design techniques that take ethics and possible gambling dangers into account, along with solutions for effectively preserving metadata in real-time online gaming settings. Our study presents fair and transparent reward mechanisms that lessen the possibility that games may become gambling or speculative platforms, in contrast to earlier research that found ethical problems with betting processes in blockchain-based games.

3. RESEARCH AND METHOD

This research adopts a Research and Development (R&D) approach to integrate

Ethereum blockchain technology into multiplayer FPS games. The methodology aims to address challenges in centralized control, lack of transparency, and security vulnerabilities in in-game transactions. It combines technical testing and player surveys to provide a comprehensive evaluation of blockchain's impact on game performance and user experience.

3.1 GAME DEVELOPMENT PROCESS

The game development process followed an iterative R&D approach, comprising three main stages: Requirement Analysis, System Design, and Implementation.

3.1.1 Requirement Analysis

The goal of the requirement analysis phase is to pinpoint and specify the essential requirements needed to create a multiplayer First Person Shooter (FPS) game on the blockchain. This analysis concentrates on the components required to incorporate blockchain technology into the game and guarantee safe, open, and effective in-game transactions. The following are the needs that this study identified,

3.1.1.1 *Blockchain Platform*

Ethereum is the selected blockchain technology since it offers a reliable infrastructure and a Proof of Stake (PoS) consensus process, which is more effective and energy-efficient than Proof of Work. (PoW).

3.1.1.2 *Game Engine*.

Creating an interactive game environment, making it easier to create 3D visuals, and supporting connection with blockchain systems are all made possible by using Unity 3D as a game engine.

3.1.1.3 *Secure Transactions*.

All player transactions, including the buying and selling of goods, have to be documented on the blockchain and kept unaltered. This covers handling transactions safely with Metamask as a wallet.

3.1.1.4 *Transparency*.

Every player on the blockchain has access to their transaction history using a blockchain explorer, which offers information on transaction hashes, gas costs, and timestamps.

3.1.1.5 *Key components*

The store for purchasing and selling goods, a wallet for managing digital assets, and a multiplayer system that enables real-time player interaction are essential components for any multiplayer first-person shooter game.

Game Engine	Unity Engine 2022.3.17f1
Sistem Operasi	Windows 11
3D Design	Blender 4.2
Script Editor	Visual Studio 2019
Ethereum Gateway	Meta Mask

Tabel 1. Software Used

3.1.2 System Design

System design is done at this stage to make sure the game can work in accordance with the requirements found in the previous step. Diagrams that aid in the visualization of player interactions with the system and the flow of transactions carried out within the game are created during this design step.

3.1.2.1 Use *Case graphic*

This graphic shows how players interact with the game in many ways, including when they launch it, adjust settings, use the armory, and shop. All of the key elements and features that will be included in the game are identified with the aid of this diagram.

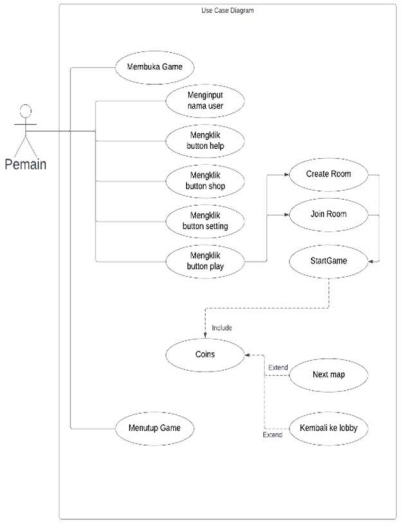

Figure 1. Use Case Diagram

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3.1.2.2 Activity diagram

An illustrates the game's progression for players. Among the tasks that players must do are selecting the start button, settings, shop, armory, and purchased stuff. This graphic illustrates the player's many options and how each action results in a distinct game state. It facilitates comprehension of the player's path and the order in which the game's interactions take place. By outlining every possibility, developers may guarantee a seamless and captivating experience, directing players to important game features and functionalities.

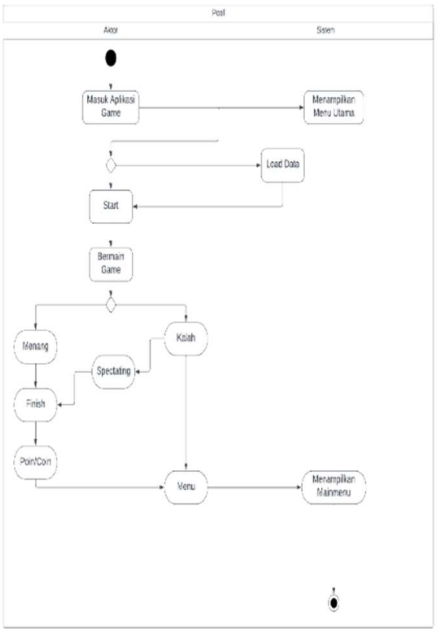

Figure 2. Activity Diagram

3.1.2.3 *Class Diagram*

This diagram illustrates the connections between the player, wallet, and transaction, among other significant elements in the game. The transaction object, which communicates with the blockchain system directly, keeps track of and oversees each transaction the player makes.

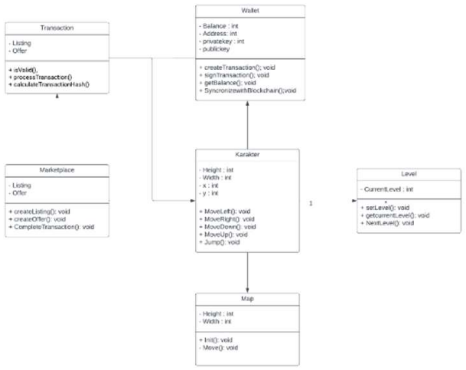

Figure 3. Class Diagram

3.1.3 Implementation

Using Ethereum as the transaction platform, blockchain technology is implemented into the game during the implementation stage. At this point, all player transactions—including the buying, selling, and trading of goods—are tracked by smart contracts. The goal of this solution is to guarantee that every transaction may be carried out safely and instantly recorded on the blockchain. The following are included in the implementation process,

3.1.3.1 *Integration of Blockchain with Unity*

In-game transactions can be directly linked to Ethereum through the use of Thirdweb, which serves as a bridge between blockchain and Unity. Thirdweb adds an extra degree of protection to each player's transaction by enabling all transactions to be made using wallets such as Metamask.

3.1.3.2 *Smart Contracts*

in the game transaction procedures are controlled by smart contracts. Every transaction, including the buying and selling of items by players, is recorded by this contract into the blockchain. The Proof of Stake (PoS) mechanism is used by the blockchain system to validate every transaction. The number of tokens that validators stake in the network determines their selection as validators.

3.1.3.3 *Penetration testing*

used in security testing to make sure there are no security flaws or data leaks that might be used to manipulate transactions. During transactions, data traffic is examined using fiddler.

3.1.3.4 *Testing Transaction Speed*

Transaction speed is measured by timing how long it takes to finish a transaction depending on the choice of gas price. Compared to the PoW process, Ethereum's PoS mechanism enables transactions to be executed more quickly and with less gas expense.

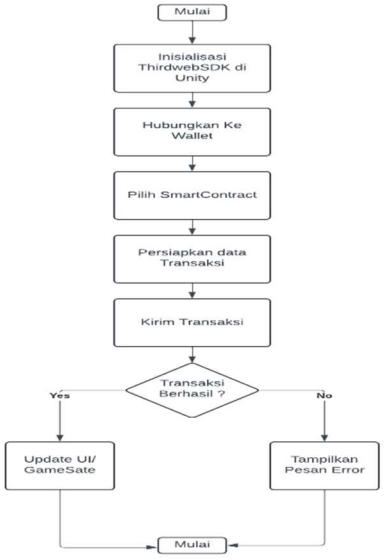

Figure 4. Flowchart Process Transaction Ethereum

3.2 DATA COLLECTION

Following the completion of game development and the incorporation of blockchain technology, data collecting is conducted to assess system performance and gauge user impressions of the security, speed, and transparency of transactions based on blockchain in the game. Technical testing and player surveys are the two primary methods used in the data collection procedure.

3.2.1 Technical Testing

Technical testing is conducted to evaluate the performance of the game system, particularly regarding security, transaction speed, and the transparency of transactions conducted by players. Some types of testing carried out are as follows:

Penetration Testing, this test aims to detect potential security vulnerabilities in the system that can be exploited by third parties to attack or manipulate transactions. Tools like Fiddler are used to monitor network traffic during transactions, checking whether any sensitive data is exposed or not well protected. The test results show that all transactions are protected by encryption and there are no data leaks that can be exploited.

Transaction Speed Testing, speed tests are conducted to measure the time required to complete transactions in the game using Ethereum. Each transaction is recorded based on the selected gas fees option, such as slow, market, and fast. The speed of the transaction is influenced by the amount of gas fees paid, with higher fees allowing for faster transaction completion.

Audit Trail Testing, transparency testing is conducted to ensure that every transaction in the game can be tracked by players using a blockchain explorer. This testing records the transaction hash, timestamp, and gas fees used to ensure that transactions can be viewed in real-time and are immutable. Players are also given the opportunity to view and verify their transactions through this tool, which contributes to an increased sense of trust in the gaming system.

3.2.2 Player Surveys

To complement the technical testing, data was also collected through player surveys. This survey aims to evaluate players' experiences in using blockchain-based games, focusing on aspects of security, transparency, and trust.

The survey contains questions asking players to assess how safe they feel when making transactions in the game, whether they can clearly see the transaction history, and to what extent blockchain technology increases their trust in the game system. The 1-5 Likert scale is used to measure players' perceptions.

The survey was conducted with a sample of 30 players who actively play online games, including first-person shooter (FPS) games. Eight Question, all pertaining to the Feature Transaction, Security and transparency, and Understanding the Concept of Blockchain

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Transactions. These are the inquiries from the initial survey: Q0) How easy is it for you to access your transaction history in the game?; Q1) Do you feel more comfortable transacting in the game compared to before?; Q2) Do you find it difficult to access transaction records on the blockchain? Q3) Do you feel safer and more transparent when conducting transactions after the implementation of blockchain technology?; Q4) Do you feel that the recorded transaction cannot be changed?; Q5) How much do you believe that blockchain technology can reduce cheating in games?; Q6) Do you feel that the current system provides clear information about each transaction?; Q7) How easy is it for you to understand how this blockchain system works in the game?.

4. RESULT

4.1 Security Testing

Penetration testing findings demonstrate that the game's blockchain architecture effectively shields transaction data from alteration or unwanted access. During testing, no leaks of sensitive data were found, and MetaMask is used for data encryption in all transactions. This ensures that players' personal and transactional information remains secure throughout their gaming experience. Additionally, the system's ability to prevent unauthorized access guarantees the integrity and privacy of sensitive player information.

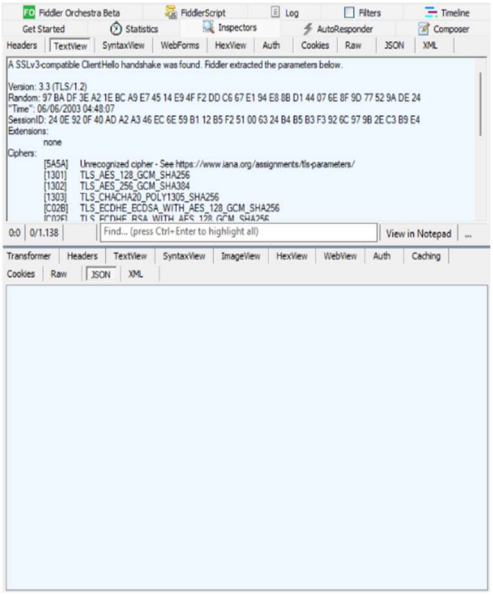


Figure 5. Transaction Manipulation Testing

Test for Transaction Manipulation, a Man-in-the-Middle (MITM) attack was attempted, but it was unsuccessful, proving that the blockchain technology in use is adequately safe from manipulation of transactions.

4.2 Penetration Test

Fiddler was used to access and manipulate sensitive data; the results showed how strong encryption and network security are.

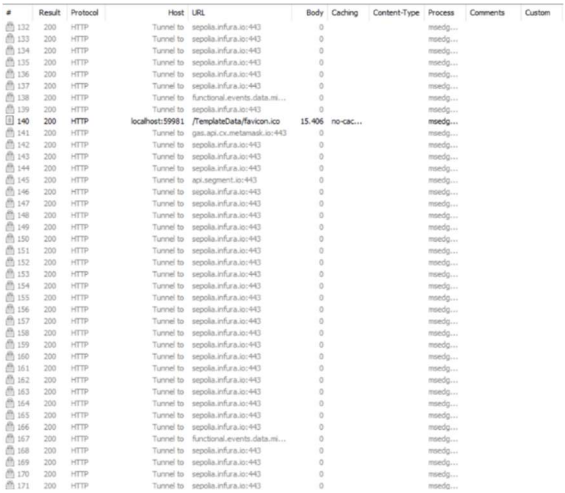
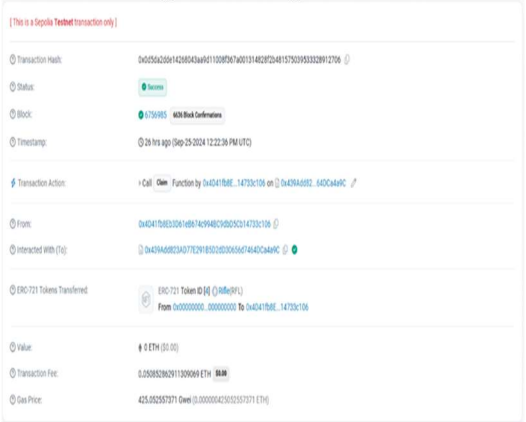


Figure 6. Penetration Testing

4.3 Transaction Speed Testing



Several gas fee variations were tested for transaction speed on the Ethereum network. The test results indicate that the player's choice of a greater gas cost resulted in a faster transaction completion time. Transactions can be finished in an average of 5 seconds with the fastest gas option (fast), and 45 seconds with the slowest gas option (slow).

Testing	Slow	Market	Fast
Testing 1	56 Second	6 Second	14 Second
Testing 2	54 Second	9 Second	4 Second
Testing 3	50 Second	7 Second	6 Second
Testing 4	53 Second	6 Second	2 Second
Testing 5	57 Second	5 Second	5 Second
Testing 6	56 Second	15 Second	8 Second
Testing 7	55 Second	8 Second	3 Second
Testing 8	1 Minute 2 Second	7 Second	4 Second
Testing 9	55 Second	6 Second	5 Second
Testing 10	59 Second	8 Second	3 Second

Tabel 2. Transaction Speed Test

4.4 Tranparancy Testing

Every transaction conducted in the game may be seen by players using a blockchain explorer. Players can instantly check the transaction history because every transaction has a hash, a timestamp, and a gas cost. This helps players have more faith in the gaming system.

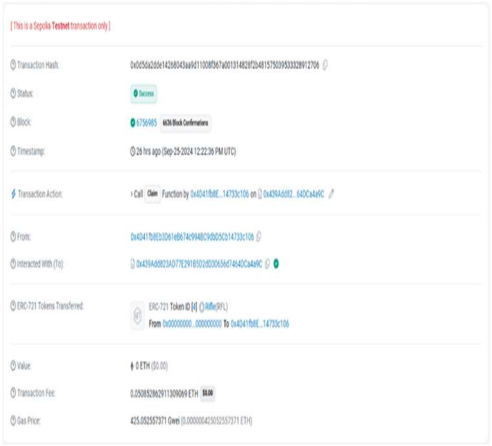


Figure 7. Transparancy Testing

4.5 Player Survei Result

The majority of players believe that the blockchain system improves security and transparency in the game, according to the findings of a player survey that was done following the game testing. Because they can view the transaction history transparently, this study also shows that participants have greater faith in the system's integrity. Players' opinions on three key areas are gauged using a 1–5 Likert scale: security, transparency, and trust.

Question	Score
How easy is it for you to access your transaction history in the game?	4,03
Do you feel more comfortable transacting in the game compared to before?	3,67
Do you find it difficult to access transaction records on the blockchain?	3,41
Do you feel safer and more transparent when conducting transactions after the implementation of blockchain technology?	3,8
Do you feel that the recorded transaction cannot be changed?	3,74
How much do you believe that blockchain technology can reduce cheating in games?	4
Do you feel that the current system provides clear information about each transaction?	3,77
How easy is it for you to understand how this blockchain system works in the game?	3,1

Tabel 3. Survey Results on Security and Transparency.

Overall, the survey results indicate that players feel more comfortable, safe, and confident in transacting using blockchain technology within the game, although there are still challenges in understanding and accessibility of the blockchain system for some players. Increased education and ease of access could further enhance the player experience in using this blockchain feature.

5. DISCUSSION

5.1 Transaction Security

From the results of these tests, it was concluded that the integration of blockchain technology with the PoS method could increase transaction security in multiplayer FPS games. The test for penetration and the test for manipulating transactions could not find any vulnerabilities. It is expected because previous research found that blockchain

technology has strong security for maintaining the integrity of transaction data.

5.2 Transaction Speed

The gas fee a player chooses affects the speed of the transaction. Transactions including a slow gas fee took an average of 55 seconds to process during performance testing, whereas transactions involving a fast gas fee took less than 5 seconds. Although this is consistent with Ethereum's gas-based prioritizing method, network congestion may cause gameplay disruptions.

5.3 Transparency and Player Trust

Players in the game system are more trusting of the system since blockchain transactions are transparent. Through a specialized transaction history interface, gamers may instantly confirm every in-game transaction because there is an unchangeable audit trail. By guaranteeing transaction integrity and allaying worries about data manipulation, this feature boosts user confidence. These results are consistent with earlier studies showing that open transaction records increase player confidence and reduce perceived risks of fraud or cheating.

5.4 Trade-offs Analysis: Transparency, Speed, and Gas Fees

There is a critical trade-off that exists among transparency, transaction speed, and gas fees. While blockchain's immutable ledger maximizes transparency and security, keeping these features on often includes very high gas fees, unaffordable for players. On the other hand, to reduce gas fees, transactions are slowed down, which might disrupt the gaming experience.

This is where dynamic adjustments of gas fees depending on the urgency of the transaction will solve these trade-offs. Non-critical in-game purchases, say, cosmetic ones, can have low gas fees, while important ones relating to in-game progress are tagged higher in fees. This would further encourage exploring Layer 2 solutions for scale with the help of rollups or sidechains for cost reduction in transactions and thus scalability.

5.5 Limitations and Challenges

While these results show improvement in both security and transparency, the study limits itself to Ethereum-based implementations. This could be extended by looking into other blockchains with lower fees and faster transaction speeds such as Solana, Polygon, or Avalanche. Such platforms may be more efficient while still allowing most of the benefits associated with blockchain technology.

6. CONCLUSION

This study aimed at understanding how the Proof of Stake mechanism of the Ethereum blockchain can address the problems of security and transparency in the online gaming transactions. Based on the findings of this study, it can be stated that blockchain can help enhance the security, transparency and speed of transactions in multiplayer first person shooter games. It is also important to note that blockchain prevents transaction fraud since it is secured by security testing and audit trails where players can verify each transaction in real time thus building trust within the gaming environment.

may However, mean the delayed study gameplay. also Therefore, revealed future a research challenge can in also the explore form into of other transaction blockchains speed with versus low gas fees fees and where slowly fast transaction times including Solana or Binance Smart Chain.

Thus, this work contributes to the understanding of how blockchain may be implemented into multiplayer games to improve the security of the industry. New research should thus focus on implementing various blockchain platforms into the game and integrating features such as blockchain marketplaces to enhance players' engagement.

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