

A Distributed Ledger Approach for Privacy Preservation in Event Ticketing

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Abstract. Traditional ticketing systems are at risk of fraud, counterfeiting, and issues concerning scalability. In this research, we investigate the application of blockchain technology towards the revolutionary concept of event tickets. We analyze how fundamental attributes of blockchain technology, such as immutability, transparency, and decentralization, can be integrated in innovation to provide a secure, efficient, and reliable ecosystem. This research will examine smart contracts, self-executing scripts on the blockchain, as a viable solution for the creation, ownership, and transferability of tickets. A case study approach focusing on existing blockchain ticketing solutions will be used to identify and evaluate best practices through effective systems. This research seeks to demonstrate the disruptive capabilities of blockchain technology in the ticketing sector. From strategically incorporating blockchain technology, we seek to improve security, drastically lower fraudulent activities, and establish trust between ticket buyers and event organizers for a streamlined and optimally secure ticketing process.

Keywords: Blockchain, Ticketing System, Security, Smart Contracts, Decentralization, Transparency.

1 Introduction

The growth of counterfeit tickets, which are often replicas of the original, continue to leave a void in event organizer revenues while also harming users who, in good faith, buy useless forgeries. Blockchain, on the other hand, promises to solve these issues. It provides distributed ledger technology which is a secure database of records shared among multiple computers, places. This decentralized ledger is permanent meaning that transactions captured suffer no editing, deletion, or any sort of modification thereby creating a transparent and verifiable record of tickets issued and transferred. Moreover, fraud and forgery in ticketing will become extremely difficult since transactions are encrypted and secured with impenetrable algorithms. The overriding characteristics of a blockchain system fits perfectly to a dependable and secure ticketing system. This research study aims to assess how blockchain technology can be used to radically change the ticketing sector. We seek to understand how the fundamental attributes of blockchain can be utilized to design an event ticketing solution that is safe, efficient, and dependable. To prepare ourselves for using blockchain in ticketing, we conduct a thorough literature review of existing academic and industry publications. We will also conduct a complete case study analysis of established blockchain-based ticketing systems to find best practices and determine their success in resolving traditional ticketing challenges.

2 Literature Survey

Blockchain technology comes with a plethora of advantages unlike the conventional systems of ticketing. This technology solves the most complex issues in ticketing systems. It solves the issue of security as well as dependability. People thought, and still wonder on how blockchain can transform the system of ticketing. With the integration of smart contracts, security, user experience and event ticketing, researchers are currently looking into the effects on user data.

As is the case with every system that is conventional, ticketing has its short comings. It lacks security, transparency, copability, and trustworthiness among others. Looking at Duale et al. [1], fraud is one of the greatest problems in dealing with decentralized systems. They mostly target duplication and sculping of tickets. Major damage is often sustained by the organizers. Problematic issues arise in high demand events, when centralized servers come into use. There is also a lack of infrastructure that is more secure, which servers rely on when overloaded. Guiding us to conclude Hu et al. [2], we realize that centralised control prevents transparency and verification.

The nuances of blockchain's distributed ledger technology present us with a one-of-a-kind solution to these issues. Blockchain supports traceability and verifiability of the ticketing process by ensuring immutability and public accessibility of every ticket transaction in an open format. One of Tschorsch and Scheuermann's [3] main advancements are that blockchain eliminates intermediaries and enables an open system in which every ticket transaction is publicly transactionable and auditable. Shen and Pena-Mora [4] emphasized that increased transparency would create trust from stakeholders (e.g., organizers and end-users), and minimize the likelihood of conflicts or dishonesty.

This is one of the sectors where it can make the most impact, in part due to the potential for smart contracts. Smart contracts are traders and they work by automating the processing of predefined actions such as ticket issuing, ticket checking, or ticket offer based on specific criteria. In their review, Six et al. [5] discuss how smart contracts can increase efficiency, reduce administrative costs, and prevent errors. In addition, Belchior et al. [6] showed that smart contracts may provide mechanisms to enforce dynamic pricing policies, or establish some sort of user authentication for resale control which can therefore prevent secondary market ticket sale more efficiently.

Blockchain is a game changer in the critical sector of security. Unlike centralized alternatives, hacking is eliminated and the data remains tamper-proof. Thus, it is also not possible to forge the ticket and make an illicit copy as we often meet in traditional ticketing models as demonstrated in [Moustafa et al. [7]. Chen et al. [3] further explain how blockchain can prevent ticket tampering with decentralized identity systems and cryptographic verification, which protects every transaction and identity of users without the necessity of a central database. The secondary market has long been a hotbed of unconscionable fees, price gouging and scams perpetrated by unregulated middlemen. Blockchain eliminates these third-party intermediaries through decentralising peer-to-peer exchange. Smart contracts can ensure smooth, secure, and automatic resale, with change in ownership occurring in off-chain.

User experience is another area, in which blockchain makes far-reaching inroads. Zhang et al. [12] highlight that through blockchain the customers possess full ownership and control, as they can store their tickets in secure digital wallets. This reduces the risk of tickets being lost or

stolen and eliminates the need to wait for in person delivery or pick up. Furthermore, Lin et al. [13] discuss how ticketing systems can combine with decentralized identity (DID) systems to allow for privacy preserving identity verification. This way, user privacy is protected and personalized ticketing experiences are provided.

All in all, the research firmly suggests that blockchain is a promising solution to the problems of traditional ticketing. The Blockchain is the most revolutionary new technology that provides greater security, automation, and consumer power and market clarity.

Numerous studies focused on the application of Blockchain to induce transparency and apply smart contracts for automation. For instance, Alharby and Moorsel surveyed various blockchain smart contracts and emphasized their trustworthiness and capability for automatic execution in decentralized architectures [11]. Casino et al. presented a comprehensive survey on the usage of blockchain and identified some of its major challenges such as scalability and privacy issues [12]. In the field of event ticketing, Tikhomirov and scholars have proposed the Blockchain-based “Smart Ticket” system for secure and verifiable ticket transactions [13]. Similarly, Bertolotti and Bitetto investigated real-world applications of blockchain for event ticketing and highlighted the promises and technological hurdles, particularly in terms of usability and integration [14]. In order to help distinguish between different types of blockchains for varied applications Tasca and Tessone introduced a classification scheme that ranks blockchains according to the purposes for which they can be used [15]. In combination, they illustrate the need for a privacy preserving, blockchain enabled ticketing solution that is secure, easy to use, achieving tamper resistance.

3 Proposed System

Creating a blockchain-powered ticketing platform is the name of the game for the proposed system, one that aims to prioritize privacy, security, and efficiency above all else. Leveraging the inherent strengths of blockchain technology immutability, decentralization, transparency it promises to solve problems caused by tradition

3.1 System Architecture

- The architecture is made up of several key components:
- Blockchain Network: This serves as the unchangeable ledger for all ticket transactions.
- Smart Contracts: These automate the processes involved in generating, validating, and reselling tickets.
- Event Organizer Portal: A web interface designed for creating events and issuing tickets.
- User Wallets: Secure digital wallets that help users store and manage their tickets.
- Decentralized Identity (DID): This feature allows users to verify their identity without having to share personal information.

3.2 Working Model

- Event producers are deploying smart contracts to govern the creation, pricing and resale of tickets.
- All tickets are generated as an exclusive non-fungible token (NFT), which lands immediately in the user’s wallet.

- As for ticket purchasing, both the cryptocurrency and all integrated payment methods are available for payment.
- When ownership is transferred, the whole swapping process is automated through smart contracts, and everything is visible.
- Plus, the smart contract imposes roadblocks to resale that can make it trippy for scalping and fraud.

3.3 Security and Privacy Features

- **Cryptographic Security:** Transactions are protected through public-key encryption.
- **Anonymity:** Users can engage with the system without revealing any sensitive personal details.
- **Fraud Prevention:** Each ticket is uniquely linked to a transaction hash, making it nearly impossible to forge.

It reduces the potential for duplicate and fraudulent ticketing, while giving control of all transactions to the user. It creates a decentralized and fair ecosystem for event ticketing at all ticketing systems. Fig. 1 illustrates the flow diagram of ticketing system.

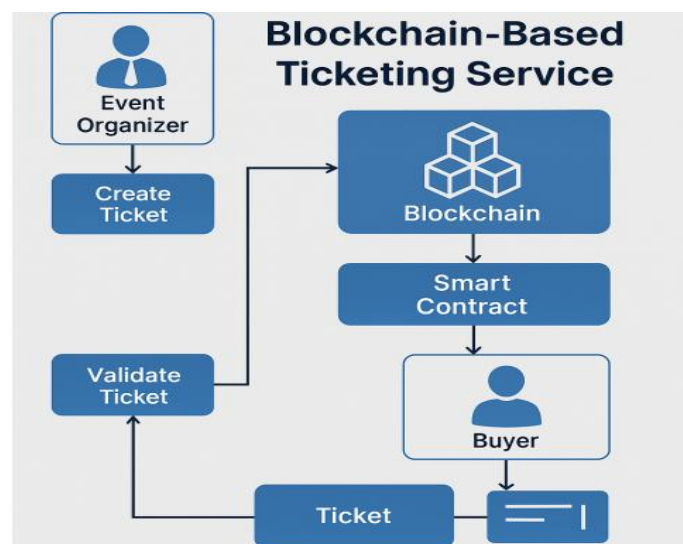


Fig. 1. Flow Diagram of Ticketing System.

3.4 Implementation

The implemented ticketing platform, based on blockchain, was implemented on the Ethereum platform. We've written smart contracts using Solidity to control the entire cycle of a ticket, from its creation and passing, to its verification.

3.5 Smart Contract Development

Smart contracts were coded such that all ticketing procedures would take place autonomously and securely. Each ticket is hashed to a unique, traceable identifier using a hash function.

$$Ti = \text{Hash}(\text{Eid} \parallel \text{Uid} \parallel \text{T S}) \quad (1)$$

Where:

- Ti = Unique ticket token
- Eid = Event ID
- Uid = User ID
- T S = Timestamp

This ensures that each ticket is unique and tamper-proof.

3.6 Blockchain Integration

The system was evaluated utilizing Rinkeby Ethereum test- net. Ganache facilitated local blockchain simulation whereas MetaMask facilitated interaction with deployed smart contracts. Web3. js was used as the bridge between the UI and the blockchain.

3.7 Frontend and Backend

The interface was designed with HTML, CSS, and JavaScript. The backend, written in Node. js which controlled all user data and interaction with decentralized identity modules.

3.8 Ticket Lifecycle

The lifecycle of tickets includes creation, distribution, validation and resale all on-chain. Table 1 tabulates the smart contract function descriptions.

Table 1. Smart Contract Function Descriptions.

Function	Purpose
createTicket	Mint and assign a ticket
transferTicket	Transfer ticket to another user
verifyTicket	Validate a ticket's authenticity
getTicketOwner	Fetch current owner of ticket

3.9 Security Measures

Ownership was verified using blockchain's cryptographical properties. Ticket details were saved in hashed, on-chain format, making them tamperproof and impossible to counterfeit. The smart contract has rules to prevent ticket duplication or transfer to users who are not authorized.

This case study demonstrates that a ticketing system based on decentralization can provide security, efficiency, and transparency, solving several issues common to traditional ticketing systems.

4 Results and Discussion

The blockchain-based ticketing prototype has been successfully deployed and tested in the simulated mode on the Ethereum Rinkeby testnet. The system was fully functional and concluded the ticket deposit, ownership transfer, and resale by means of smart contract.

4.1 Security Improvements: The realization has demonstrated that blockchain-based technologies ensure a high degree of security. Tickets held in the blockchain could not be tampered with or copied. Smart contracts ensured that sales of tickets could not be conducted without authorization, and that a history in transactions of all kinds was in unalterable form. The use of cryptographic encryption with decentralized identity verification made it even more secure.

4.2 Transparency and Trust: Transparency was made possible by the public ledger on the blockchain, where users could authenticate where each ticket came from, instead of having to trust the broker for authenticity. Event producers and buyers could easily track the life cycle of these tickets, minimizing disputes and creating trust.

4.3 Efficiency and Automation: Smart contracts took care of a lot of things like issuing tickets or verifying them. It helped to minimize human intervention and was a step in "improving the capability of executing satellites with the right trajectory". Ticket resale was made quicker and safer than the older systems.

4.4 User Experience: The UI supported the management of tickets in digital wallet of customers. That got rid of the issues of lost physical tickets and diminished delays in ticket delivery. It also enabled decentralized identity (DID) verification that simplified the entry, and to protect users' identity, it worked well.

4.5 Limitations: Despite these promising outcomes, there were some restrictions. Public blockchains may have high transaction fees (gas fees) during busy times of the network. And the success of blockchain ticketing isn't just up to the end-user knowledge but also infrastructure.

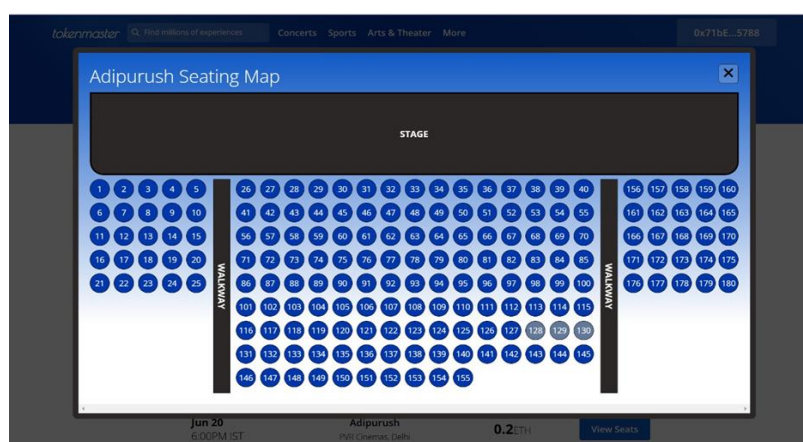


Fig. 2. Output 1.

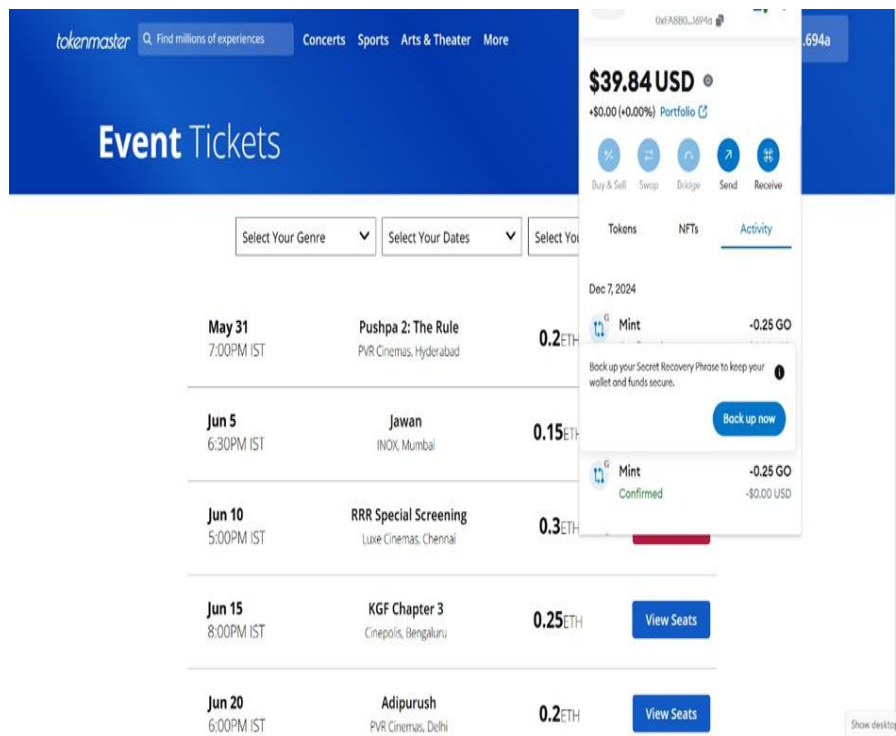


Fig. 3. Output 2.

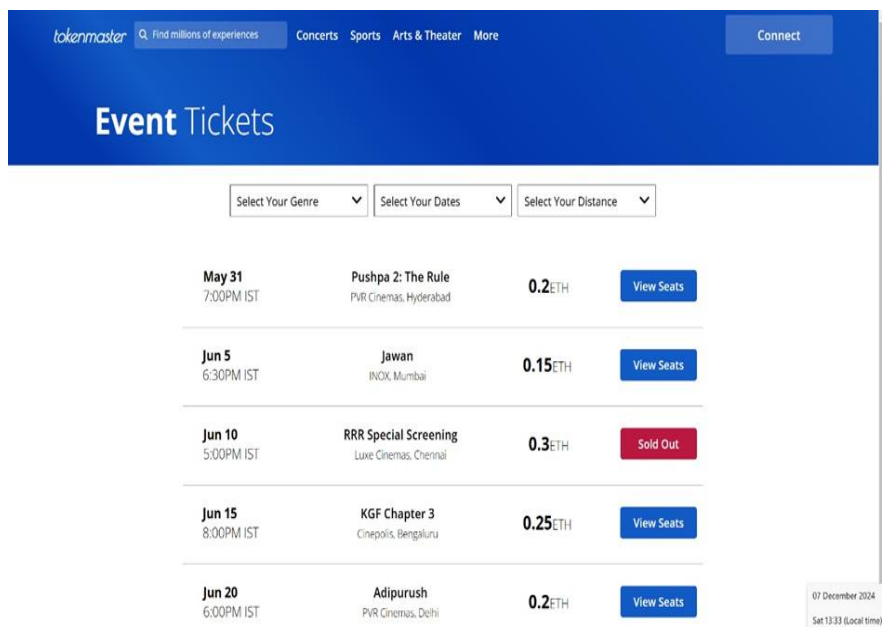


Fig. 4. Output 3.

Fig. 2-4 summarize key functionalities and outputs of the blockchain ticketing system we have developed. Fig. 2 provides an overview of the ticketing platform user-interface, which present users can see, clear and juncture their tickets. Fig. 3: The system with the MetaMask Chrome extension Fig. 4 shows when the user accesses the MetaMask Chrome extension (how the system interacts with the MetaMask Chrome extension) in the steps of booking a ticket with Ethereum (ETH). Meanwhile, from Fig. 4, it can be concluded that more than one tickets were successfully booked post transactions conducted through the MetaMask payment gateway. In conclusion, we showed that a blockchain distributed approach can address limitations for traditional ticketing systems and increase security, transparency, and control by users.

5 Conclusion

In this article, we dove deep and did a comprehensive study on how blockchain technology can revolutionize ticketing system by making it more secure, transparent and more efficient. Standard ticketing systems face problems of fraud, scalping, and a lack of transparency, not to mention the vulnerabilities of a centralized system. But blockchain has its caveats decentralization, immutability, and smart contract execution and provides a worthy alternative. Through a literature review and an implementation-oriented case study, we demonstrated how a smart contract can alleviate the congestion in both ticket issuing, transferring, and validating. The decentralized nature of this system increases the ability for users to control the process and also reduces the need for relying on third party platforms. According to our research results, we believe that the blockchain technology can greatly improve the reliability and convenience in event management and can be used by organizers and event participants (attendees). As a future line of research, performance optimization, development of dynamic pricing with AI and further application and experiment on a larger scale using the same system in the actual real time would be explored.

6 Future Work

The current version of the blockchain ticketing system shows a lot of promise, but there's still room to make it even better. One exciting idea for the future is using something called Non-Interactive Zero-Knowledge (NIZK) proofs. Simply put, NIZK lets someone prove that something is true without giving away any extra details—and without needing back-and-forth communication.

In ticketing, this means a user could prove they have a valid ticket without actually showing the ticket or sharing any personal information. This adds a strong layer of privacy and helps protect users from being tracked or having their data misused.

Future systems might use advanced versions of NIZK, like zk-SNARKs or zk-STARKs, to make the ticketing process even more secure and private.

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