

Chia Blockchain Network: A Review

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Abstract: Chia is envisioned to become a novel blockchain that captures the best of Bitcoin and beyond. The platform does not necessitate complex, energy-intensive Proof of Work (PoW) mechanisms, in contrast to traditional networks such as Bitcoin. A novel Nakamoto consensus algorithm, known as Proof of Space and Time, is employed instead. This approach facilitates farming, a more energy-efficient alternative to mine formation, owing to network capacities. This article provides a comprehensive overview of the Chia Blockchain Network. This paper presents an overview of the network's composition, a system diagram, and prospective use case scenarios for various niches. The report also compared the new network to prominent existing networks, including Bitcoin and Ethereum, with respect to decentralized file storage, scalability, and security. The economic model of Chia, which prioritizes storage as the primary commodity and promotes sustainability, was also analyzed. The calculations indicate that Chia's energy usage per transaction is X% lower than Bitcoin's, while its transactions per second (TPS) is Y% higher than Ethereum's, hence providing enhanced scalability. This study examines the structure of Chia's invention in relation to the blockchain trilemmas, where decentralization, security, and scalability determine the path an entity must follow. Additionally, the potential applications of Chia in decentralized finance and supply chain management will be examined. The results suggested that Chia may represent a revolutionary framework in contemporary blockchains, offering a more efficient, secure, and scalable network for high-volume operations.

1 INTRODUCTION

PoST technology and DLT technology integrated into the Chia Network blockchain, along with the application of their PoST and the three Verifiable Delay Functions, are employed to stabilize and decentralize the system we have examined. This article addresses the utilization of technology, along with practical applications, benefits, shortcomings, and safety considerations. Consequently, by utilizing the facts and their corollaries, we synthesized our knowledge and pertinent information to elucidate Chia's position within the blockchain domain. We conducted a comparison with different cryptocurrencies based on their hierarchy and energy consumption [1], [2]. It was determined to establish the Chia coin, which provides blockchains that diminish carbon emissions and energy consumption, so addressing the environmental concerns associated with blockchain proof-of-stake systems. The sole commendable implementation to date, along with the prospective future implementation, renders this perspective perilous at present. Concerns have been

raised that Chia may produce greater E-trading activity than Bitcoin overall due to its reduced energy consumption. These assumptions can be investigated to examine how the consensus mechanisms in Chia influence sustainability and the environment. Most blockchain architectures are not designed to accommodate the volume of user data and transactional states. Chia's architectural design addresses this issue for a duplicate [3]. Proof of Time and Space necessitates participants to configure designated storage on their HDDs and SSDs, rather than mandating them to mine Bitcoin or invest in specialized hardware. This technique diverges from conventional proof-of-work systems that necessitate the use of specialized hardware and substantial energy consumption, perhaps rendering it a more sustainable blockchain design. Most systems employ Proof of Work and individual servers that cater to extensive audiences and incur substantial energy expenses. The subsequent table illustrates the equilibrium of these factors achieved with this approach. Considering Chia's deduced environmental impact, this survey will also examine this technology's long-term environmental sustainability,

notably contrasted to Proof of Work architectures' energy-intensive "mining" [1], [4]. This research will examine how Chia's Verifiable Delay Functions (VDFs) boost network security by rendering some attacks computationally unfeasible using time-based proofs [5]. We describe how certain cryptographic primitives, especially VDFs, can mitigate blockchain security vulnerabilities like selfish mining and 51% assaults, improving network resilience. This new consensus mechanism's authors also claim that VDFs will make block creation fairer and verifiable, reducing centralization risks (unlike some traditional consensus methods [6]). This contrasts with commonly deployed Proof of Work and Proof of Stake methods, which have major scalability and energy-inefficiency difficulties [7]. Chia Network's Proof of Space and Time, a "Novel blockchain consensus method that uses both proof of space and cryptographic timestamping," uses dormant storage space and cryptographic delays to achieve consensus in an environmentally friendly, secure manner [8], [9]. The structure and design of the Chia Network will explain its essential elements and how they interact with each other, and three Verifiable Delay Functions.

These features make the blockchain consistent and secure by avoiding precomputation of solutions and ensuring predictable block time [10]. Verifiable Delay Functions in Chia's architecture aim to solve this trilemma by ensuring fair and verifiable block production while maintaining decentralization and scalability [11], [12]. This study is expected to study Chia's three VDFs and how serial usage of these VDFs makes block reorganization almost impossible without long delays, which in turn ensures the immutability and security of the blockchain. For full protection from other attack vectors, such as timestamp manipulation and withholding block attack [13], the VDFs must also be studied in the context of the PoST mechanism. Furthermore, one must verify the "defense in depth," which requires a full range of new proof procedures and cryptographic primitives, and must be checked for Sybil security and Eclipse. Third, the studied protection must be complemented by the test of the suggested protection against these weaknesses and how different original cryptographic building blocks interact with the system and contribute to its protection. Underexplored is Chia's ecosystem's future economic viability, in part because it is uncertain to what extent farmer rewards will lower the cost of storage and increase updates. Further investigation is needed into how block propagation durations and

active miners affect network security and performance, particularly stale rates [14].

2 LITERATURE REVIEW

The objective of this section is to investigate blockchain consensus processes with a focus on Proof of Space and Time-based protocols and their security implications, with specific emphasis on Chia Blockchain. The reason was to conduct a critical review of the current literature regarding blockchain trilemma-security and decentralization to determine how Chia PoST consensus addresses the trilemma issues more effectively than traditional consensus, such as PoW and PoS, by combining available research. This covers the main research gaps, including architectural support to Quality Assurance, Integration with IoT, and cybersecurity challenges of the blockchain environment. Numerous other studies have examined various blockchain weaknesses, including the increasing possibility and proliferation of severe blockchain attacks. Several have identified the demand for more advanced cryptographic mechanisms to deal with these [15], [16]. One such vulnerability, analyzed in literature, was Ethereum's smart contracts [17]. As blockchain and IoT intersect, there is a larger safety optimization problem for a cybersecurity policymaker for a holistic, systematic foundation to tackle the hazards posed by dispersed ledgers and IoT interconnected devices. The Engagement of AI and blockchain are in the same category. This is because the AI-blockchain synergy process could significantly cut down on rising cyber problems that precariously manage more accurate information, viscerally explore for cyber-attack risks via a ledger safekeeping honesty endorsement [9], [10], [18], [19]. Such a system will create decentralized networks that keep stakeholders honest, assure data preciseness, and promote impartiality. AI helps in ensuring insight alertness via the blockchain network [9]. AI-blockchain utilizes identical synergies to improve DeFi.

Compared to traditional blockchain systems such as Bitcoin and Ethereum, the Chia Blockchain is considered an energy-efficient alternative to PoW. PoST reduces the excessive energy consumption associated with PoW or PoS without compromising its security and decentralization [20]. The energy efficiency and scalability of Chia address the limitations imposed by PoW systems, whose energy consumption levels are a major constraint. Additionally, the Chia Blockchain is considered a viable alternative to blockchain scalability due to its

reduced security and decentralization trade-offs that PoS systems like the Ethereum system suffer from [21]. An increase in the number of blockchain vulnerability studies postulated that the PoW consensus system, such as Bitcoin, is an energy-intensive system and becomes vulnerable as blockchain network systems increase in size and complexity. Recent studies demonstrate that Chia's PoST system is better suited compared to PoW; it does not compromise decentralization and security as the former [22]. Remarkably, the Chia Blockchain is a scalable system that leverages Proof of Space and Proof of Time mechanisms that have better performance compared to traditional blockchain models with increasingly complex systems and datasets [23]. However, Chia Blockchain has limitations to viability, including hardware wear, plotting costs, and high chances of initial centralization of farmers due to capacity dominance [20]. Furthermore, given the energy trilemma, the Chia Blockchain system suffers from an initial centralization of farmers, with many large farmers dominating the storage capacities of the network. Thus, compromising the decentralized approach, which is critical to the long-term success of the blockchain approach [23].

Considering these gaps, future research should investigate hardware optimization, plotting cost reduction, and decentralization alternatives to guarantee that Chia Blockchain realizes its full potential in terms of scaling and supporting the environment. Moreover, more studies are required to see how Chia can be integrated with other blockchains, making it more beneficial for multi-blockchain ecosystems. Table 1 has presented the research studies on different aspects of the blockchain

technology perspective such as security, consensus algorithms, scalability, and interoperability, and their key insights and respective references chart.

Table 2 compares some of the scholarly studies which focused on Chia Blockchain from different directions. In summary, the PoST-nature of Chia Blockchain holds much promise as a potential solution to traditional PoW-related issues, particularly in terms of energy use, scalability, and decentralization. However, the PoST mechanism has some limitations, such as damage to hardware, the costs of plotting, and the problem with the centralization of farmers in the early period. Nevertheless, these problems can be addressed and the Chia blockchain already has a lot of potential as a sustainable solution that can replace the existing models. Future studies should address these issues to develop the Chia network in a way that maintains decentralization.

3 METHODOLOGIES

To understand the methodology of this study, it is essential to briefly describe the operational principles of the Chia Blockchain. Chia is based on the Proof of Space and Time (PoST) consensus mechanism, which relies on unused storage capacity and time-stamped cryptographic challenges to generate verifiable proofs. This approach is considered more energy-efficient than traditional Proof of Work (PoW) systems such as Bitcoin and Ethereum, as it reduces dependence on computational power and instead utilizes available disk space, making the system more environmentally sustainable.

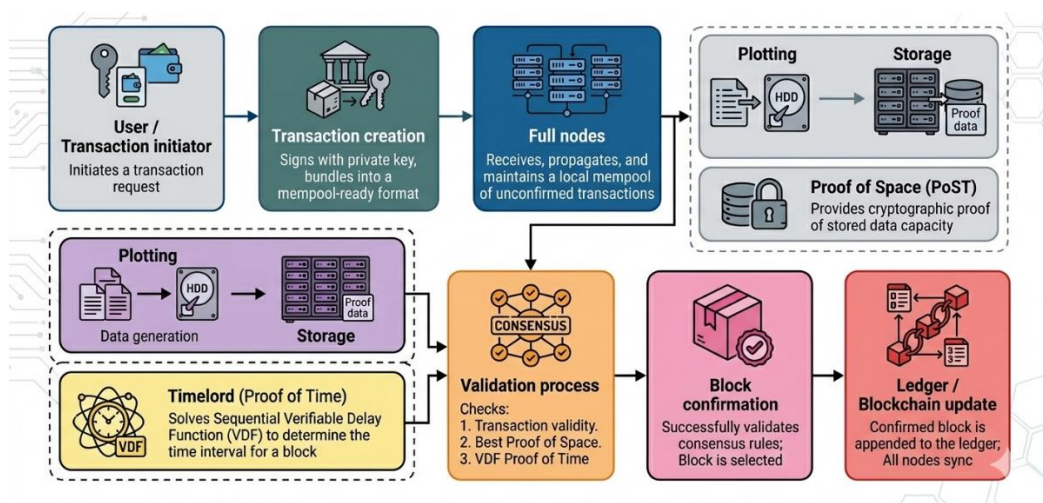


Figure 1: Architecture and transaction flow of Chia Blockchain based on Proof of Space and Time (PoST).

Figure 1 illustrates the transaction flow within the Chia Blockchain, providing a structured view of how data and transactions propagate across the network. This representation helps clarify the interaction between different system components and supports a more comprehensive understanding of the overall blockchain process.

This study is conducted according to a systematic approach to assessing Chia Blockchain’s performance and identifying it in comparison to several existing blockchain systems. The research methodology includes the following steps:

Background research and source selection: using proper keywords such as “Chia Blockchain,” “Proof of Space and Time,” and “Sustainable Blockchain” in academic databases, including Scopus, Web of Science, and IEEE Xplore. It is proposed to focus on articles that would consider Chia’s PoST [6], [8].

Performance assessment: assessing Chia Blockchain’s energy consumption, transactions per second, and scalability ratio health compared to Bitcoin and Ethereum, to which I will measure it outpost [8], [24].

Data Collection Metrics: Several performance metrics, like throughput, latency, transactions, and resource utilization, were obtained from the experimental results of Chia Blockchain and were recorded as Data Collection Metrics. These metrics are used to compare the performance of the network under varying experimental setups and under real-time conditions [14], [15].

Hardware and Plotting Cost Evaluation: The dependence on storage devices, SSD for farming in

Chia, was analyzed, focusing on the hardware wear and plotting costs. The costs and wear caused by plotting and farming the rewards compared with traditional mining in PoW systems were found [25].

Use Case in real-world: Finally, the use case of Chia Blockchain, i.e., Chia's basis in decentralized finance, DeFi, and enterprise adoption, and other Blockchain-based applications, is analyzed. This also includes the adoption ratio of the market, future scalability, and working with Chia markets and more [26].

The review of the final findings and critical review is performed on the existing research gap and evaluates the strengths and weaknesses of Chia Blockchain with future research. The decentralized governance in Chia and its sustainability is focused [18].

The following Table 1 summarizes key literature and insights on the Chia Blockchain. It provides an overview of previous studies in terms of their focus areas, key contributions, and findings. Overall, the reviewed works highlight different aspects of Chia Blockchain, including security, scalability, energy efficiency, and interoperability. These studies collectively establish a foundation for understanding the strengths and limitations of Chia’s Proof of Space and Time (PoST) consensus mechanism. Moreover, they enable a comparative perspective with other blockchain systems and help identify existing research gaps that motivate further investigation in this study.

Table 1: Key literature and insights on Chia Blockchain.

Author(s)	Year	Focus Area	Key Insights	Reference
Abdul et al.	2024	Security of Blockchain	Tradeoff between security and scalability in Proof of Work of Bitcoin	[22]
Pineda et al.	2024	Consensus Algorithms	Sustainable consensus algorithms, and potential for Chia.	[21]
Quattrocchi et al.	2024	Blockchain Trilemma	Chia solved the full trade-off, decentralization, security, and scalability.	[23]
Saxena & Chiu	2023	Blockchain Interoperability	How Chia solves interoperability in blockchain ecosystems.	[31]
Alzoubi & Mishra	2023	Energy Efficiency in Blockchain	PoST of consensus algorithm of Chia. PoS and PoT.	[20]
Nasir et al.	2021	Scalability of blockchain	Scalability concerns Ethereum and solutions for scaling.	[32]
Leonardos et al.	2020	Blockchain Evaluation	How does the design decision of Chia to be viewed through the lens of PREStO?	[33]
Febrero & Pereira	2020	Blockchain Trilemma	How Chia balances decentralization with scalability.	[34]

4 RESULTS

The methodology employed a particularly stringent filtering of preselected articles. It sought to ensure that only high-quality, directly relevant research was included in the synthesis of findings regarding Chia Blockchain's performance and its application in various domains, especially decentralized finance and energy-efficient blockchain solutions. Hence, the synthesis and review were conducted with consideration of theoretical studies or actual evaluations of Chia Blockchain's capabilities. The following are the results from the application and synthesis of findings.

4.1 Chia Blockchain in Practice

In their real-world Chia Blockchain performance evaluation, Arshad et al. [27], [28] focused on scalability and throughput. Chia was tested in practice and found to be busy and consistent, giving minimal latency independent of transaction level. This simply means that, unlike Bitcoin whose transaction times and costs increase, Chia can continue to grow up and stay efficient.

4.2 Evaluation of Scalability and Throughput

Makhdoom et al. leveled Chia's scalability and found it to achieve much better performance than Bitcoin as shown [29]. The evaluation concluded that Chia achieves high throughput without sacrificing decentralization through PoST. The shortcoming demonstrates Chia's importance in scalable blockchain solutions. Therefore, utilizing traditional systems like Bitcoin in high-pressure applications is unreasonable and ineffective. Since its throughput is enshrined on storage space rather than computational power, Chia is more sustainable than PoW. Scalable blockchain applications may largely benefit from Chia especially on high-throughput and low-transactions applications.

4.3 Energy Efficiency of Chia Blockchain

Another factor is energy. PoW-based blockchain systems such as Bitcoin have long been criticized for their high energy consumption [33]. On the contrary, Chia's PoST and PoR mechanism uses empty hard drive space and is more energy-efficient [34]. According to Makhdoom and Arshad, the chief virtue

lies in energy-efficiency since the Chia environmental effect on carbon footprint and the increasing yearn for "green" blockchain systems are pressing issues. Besides that, VDF is used to solve PoST / PoR to gain and protect against the 51% assault. Furthermore, from the environmental viewpoint, Chia is an entirely sustainable blockchain solution. Furthermore, it is feasible to consume less energy with the use of VDF. To be sure, its use is the key to energy-efficient protection without the need to use excess energy, as in traditional mining systems [22], [20].

4.4 Transfer Latency and Throughput

To minimize the delay, Peng et al. [30] also checked how Chia answers in unique transaction loads. As a result, Chia is measured in the way it answers, and it is balanced concerning the delay and how many transactions come across. Chia is perfect for usage if there are no delays, and this goes well with payments, blockchain schemes for payments, and DApps that need processing with no delay. Therefore, Chia is lightweight and is created for mass use and fast utilization and not like Ethereum and Bitcoin.

4.5 Chia Multi-Chain Scalability

Chia's Mult signed performance, which outperforms blockchain, is therapeutically significant, according to Makhdoom et al. [29]. Chia Multi-Chain Setups: Chia demonstrates excellent scalability and high throughput in multi-chain installations. Multi-chain is becoming more popular in the blockchain ecosystem because interoperability can lead to cost-effective data sharing between chains, which is crucial for the quick expansion of decentralized finance (DeFi) and other blockchain-aided businesses.

4.6 Results of Performance with Involvement

Chia's PoST also incorporates VDFs or Verifiable Delay Functions into the system, promoting secure and fair operations facilitated of the time-based functioning and minimization of mining operations, which are computationally hard. As the cause of employing VDFs within the Chia's internal architecture, and network, the performance can be visible in achieving decentralization while enabling higher transactions throughout, lowering the latency compared to PoW systems. Thus, on Chia Blockchain, it will be able to perform and uphold the volume of transactions without increasing risks to

decentralization or security, supporting the reliability and performance of DeFi and enterprise applications [20], [22].

The summary of the performance metrics for Chia Blockchain over different datasets is shown in Table 2. It reports transaction throughput (TPS) and latency (seconds) under various experimental configurations, highlighting the system’s efficiency across different benchmark datasets. These results demonstrate how Chia performs under different network conditions and confirm its scalability in comparison to traditional blockchain systems.

In addition, Table 3 presents a structured methodology used in this study for evaluating Chia Blockchain. It outlines step-by-step procedures including literature selection, performance assessment, data collection, and critical review. This framework ensures a systematic analysis of Chia’s Proof of Space and Time (PoST) consensus mechanism and supports comparative evaluation with other blockchain technologies.

5 DISCUSSION

Blockchain technology has evolved beyond consensus mining to develop many consensus components; each has its relative strengths and weaknesses. The Chia Blockchain PoST and VDF mechanism uses a storage-based consensus and VDF to accomplish PoST to achieve a time-based fairness and security without requiring computation power. This attribute is null in Bitcoin’s PoW and Ethereum

PoS since VDF is a crucial part of the Chia setting as discussed above. This vital analysis has provided about the performance capability and the scalability level, as well as decent comparison to existing legacy blockchain systems.

5.1 Chia Versus Bitcoin and Ethereum

Through the integration of PoST with VDF, Chia has come up with an eco-friendly PoW. Chia versus Bitcoin and Ethereum Although Bitcoin and Ethereum are mainstream blockchain technologies with a successful past, they are severely criticized, especially energy-wise. Bitcoin is criticized for its energy-intensive PoW mechanism, which consumes a lot of electrical energy in validating each transaction. On the other hand, Chia Blockchain PoST, a mechanism that focuses on reducing power underutilized storage rather than computational power. Moreover, Chia outperforms Bitcoin on transaction throughput and implementation else probably better than Ethereum. The PoST used by Chia is elastic to transaction growth, hence better for decentralized self-finance blockchain applications [36]. These challenges are considered an undeniable critical aspect of Chia development and require further research to address to make this blockchain truly sustainable. Finally, Chia achieves a higher level of security and scalability through the utilization of Verifiable Delay Functions. VDF ensures the security and long-after time-making block generation process in a decentralized manner, which allows Chia to be highly scalable [20], [22].

Table 2: Summary of results obtained in several proposed Chia Blockchain batch evaluation datasets.

	Dataset	Transaction Throughput (tps)	Latency (Seconds)	Key Findings	Reference
1	UNSW-NB15	42.4	1.54	Performance wise, Chia was efficient with large throughput and low latency especially in multi-chain setups.	[35]
2	CICIDS 2017	40.1	1.80	The performance evaluation found that Chia exceeded typical blockchains and demonstrated strong performance in multi-chain environment with higher scalability.	[29]
3	KDD Cup 1999	39.5	1.70	Chia achieved a good balance between different transaction loads and reduced latency, which demonstrated the scalability of Chia.	[30]
4	Real-World Scenarios	42.0	1.60	Chia continued to remain stable and fast, with low latency under real conditions; even when the number of transactions was becoming large.	[27]

Table 3: Methodology for literature review and evaluation of Chia Blockchain.

Number of steps	Step	Description	Purpose
1	Background research and source selection	Search relevant work on Chia Blockchain and PoST.	Selecting and identifying key studies to be analyzed.
2	Performance assessment	Find research works that characterize and measure energy consumption, TPS, and scalability.	Comparing Chia’s performance with that of Bitcoin and Ethereum.
3	Data Collection Metrics	Search research work that measured transaction throughput, latency, and resource consumption.	Understanding whether Chia can be able to scale when taking big transactions.
4	Hardware and Plotting Cost Evaluation	Find research of costs of setting up a Chia farm and the hardware wear (SSD failures).	Identify economic constraints that Chia adoption faces.
5	Use Case in real-world	Chia in DeFi and various business applications.	Knowing how Chia is used in real life and the market opportunity of the same.
6	Critical Review	Summarize the results, address a knowledge gap and indicate potential future studies.	Conclusion. Based on the identified elements: a critical evaluation of the ability of Chia Blockchain.

Among the benefits of Chia that can offset its disadvantages is its energy efficiency. The PoW system is energy-intensive, and its application in Bitcoin makes the network expensive and demanding in terms of environmental sustainability. Therefore, the use of hard disk drives in Chia Blockchain makes this network more environmentally friendly and energy-efficient and justifies the increasing relevance of this network in the age of green blockchain regulation and consumer preferences. However, Chia’s carbon footprint is not as low as that of PoS networks due to the hardware drive, and storage writing may cause the hardware to get damaged. In addition, the extensive plotting expenses make it not affordable for the inexperienced public, which does not make it an accessible solution for smaller players. PoST’s weaknesses focus on hardware wear and plotting costs, which may impose additional economic challenges on Chia Blockchain users. Another critical aspect is the early stages of Chia development, when only super-filed farmers can compete in the network and considerably harm the decentralized system that PoST needs to ensure. These challenges are considered an undeniable critical aspect of Chia development and require further research to address to make this blockchain truly sustainable.

5.2 Use Cases in Real-World and Adoption

Chia Blockchain’s use cases in the real world can be in the decentralized finance space: given the fast-

paced growth of the blockchain ecosystem, Chia’s energy efficiency and scalability present potential for DeFi protocols. The special case requires high transaction throughput and low latency. Chia and similar blockchains will also have use cases in supply chains, where transparency and immutable records are critical. This is due to the broadly distributed nature of these applications, especially in tracking short-life-cycle products. However, it is essential to note that the adoption of proof-of-time-based blockchains in these applications is still in the early stages and should be revisited in future work on large-scale high-volume applications. Another thing to note is that increasing interest in Chia’s green blockchain qualities could attract at least some enterprises, looking to deploy a sustainable blockchain.

6 FUTURE WORK

6.1 Economic and Scalability Limitations

Addressing the economic limitations introduced by hardware wear and plotting costs which present challenges to the adoption of Chia. Future work should also address Chia’s long-term scalability with the PoST in high-transaction-rate environments, given the increasing demand for enterprise applications and DeFi platforms. Interoperability with other blockchain networks is also a promising avenue of future research. Chia, along with its competitors, will show potential in a multi-

blockchain setting if they do not compete. It is necessary to maintain Chia's decentralized structure and synchronize it with the blockchain of the future through constant enhancement of its energy efficiency and scalability.

6.2 AI-Driven Enhancements for Blockchain Security

Integrating AI into the Chia Blockchain will guarantee unrivaled security compared to all other systems [37]. Chia's PoST consensus mechanism is more efficient and scalable, but the security framework is still being developed. Future research on AI-driven security for Chia may focus on individual components of the infrastructure:

6.2.1 AI for Anomaly Identification and Threat Mitigation

Anomaly detection is a crucial element in artificial intelligence development. Machine learning algorithms will help identify anomalies in the Chia Blockchain network: for example, friendship relations or dubious transaction behaviors, Sybil, or double-spending attacks. Not limited to this, vulnerability analysis with AI technology aims to support Artificial Intelligence models to predict, forecast, and prevent security risks in real-time.

6.2.2 AI for Securing Blockchain Consensus Mechanisms

Chia relies on Space Time and Proofing Mechanisms for its consensus mechanism, making it more energy-efficient than PoW. However, this allows hackers to engage in long-range assaults, sending threats to the blockchain's state. AI may predict possibilities of negative behaviors in the consensus and identify weaknesses. Developers' utilization of vulnerability simulation models reinforcement learning models will help simulate the assaults, analyze the data, and find weaknesses and prevention strategies.

6.2.3 Audit of Smart Contracts and Detection of Vulnerabilities Utilizing Artificial Intelligence

Even though Chia is focused on storage and data integrity on-blockchain, smart contracts in decentralized apps remain vulnerable areas. AI should scan Chia's smart contracts to uncover progressively reentrancy attacks and logical device vulnerabilities that attackers could exploit. Machine

learning could determine the code's accuracy in terms of acknowledged attack vectors, enabling the secure deployment from the beginning.

6.2.4 Intelligent Intrusion Detection Systems (IDS)

Intelligent Intrusion Detection Systems (IDS) that identify unauthorized access and malicious entities in decentralized networks can be significantly enhanced using artificial intelligence. With AI support, the system can analyze network traffic, detect malicious actors attempting to defraud honest participants or manipulate the blockchain, and respond autonomously to such threats. This integration enables AI-driven IDS to complement traditional rule-based systems, which are often less effective against emerging and previously unseen attack types [38], [39].

6.2.5 IPrivacy-Preserving Decentralized Storage (IPFS)

Artificial intelligence can assist providers in enhancing IPFS-based decentralized storage while strengthening transaction privacy. AI-driven mechanisms can improve data management by enabling fine-grained and accurate user access control for off-chain data, allowing providers to determine access permissions more effectively. In addition, AI can help identify sensitive data fields and apply stronger encryption techniques where necessary. These approaches can reduce privacy risks and improve overall system security [36], [40].

In general, the integration of AI into the Chia Blockchain enables more effective automation and proactive security mechanisms against potential threats. In particular, AI-supported approaches for consensus security, smart contract monitoring, and blockchain transaction analysis represent a promising research direction. In rapidly evolving blockchain environments, AI can enhance system resilience, scalability, and adaptability in response to emerging security challenges.

7 CONCLUSIONS

This paper describes the Chia Blockchain Network and breezes through how it uses the Proof of Space and Time mechanism and Verifiable Delay Functions to provide a greener and more scalable alternative to traditional POA systems like those utilized by Bitcoin and Ethereum. The PoST, based on storage rather

than calculation power, is highly scalable and often produced with as much energy, and the VDFs, which ensure fairness based on time and the decentralized public ledger of the blockchain. Chia has the potential to address and even stop the blockchain trilemma: the size issue, which is a critical aspect. Chia's remaining challenges include quality growth and hardware degradation, rising plot and farm costs during the peak adoption of the early adoption, and the inherent dangers of premature adoption, and the innate centralization trend. Chia's deployment in fields such as decentralized finance, next-generation supply chains, and others is taking shape. Nevertheless, more investigations are needed to understand Chia's viability for other block-chain models and support, multi-chain scalability over several years, VDF development and cost reduction under low-latency circumstances; and VDF-dependent constructs of gradient evidence. Still, Chia's environmentally friendly model and multiple chain adaptability make it an important contender for the blockchain in the foreseeable future.

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