A Comprehensive Study on Public and Private Blockchain Performance

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ABSTRACT

Blockchain technology has emerged as a transformative innovation, with applications spanning diverse industries. This study provides a comprehensive comparison between public and private blockchains, focusing on six key dimensions: scalability, security, use case distribution, energy efficiency, developer ecosystem, and performance metrics. Data were collected from 30 blockchain systems, representing a wide range of consensus mechanisms and industry applications. The findings reveal significant trade-offs between the two blockchain types. Public blockchains, such as Bitcoin and Ethereum, excel in decentralization and transparency, making them ideal for open and trustless environments like cryptocurrency and decentralized finance (DeFi). However, they face limitations in scalability, high energy consumption, and slower transaction speeds. Conversely, private blockchains, such as Hyperledger Fabric and Corda, demonstrate superior scalability, energy efficiency, and privacy, making them more suitable for controlled environments like healthcare, supply chain management, and enterprise financial services. The study underscores the importance of aligning blockchain technology selection with specific application requirements. Furthermore, it highlights the potential of hybrid blockchain models to integrate the strengths of both public and private systems, addressing existing limitations. These findings provide valuable insights for organizations and developers in leveraging blockchain technologies effectively.

Keywords Blockchain, Public Blockchain, Private Blockchain, Scalability, Energy Efficiency

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Additional Information and Declarations can be found on page 25

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INTRODUCTION

Blockchain technology has become one of the most significant innovations in recent decades, revolutionizing industries such as finance, healthcare, supply chain, and beyond [1]. Initially introduced through Bitcoin as a decentralized ledger for cryptocurrency transactions, blockchain has since evolved to encompass a wide array of applications [2]. This evolution has resulted in the development of two primary blockchain architectures: public and private blockchains [3]. Each type offers unique characteristics, benefits, and limitations, making the choice of blockchain architecture critical for achieving specific operational goals [4].

Public blockchains, such as Bitcoin and Ethereum, are characterized by their open and decentralized nature [5]. These systems rely on consensus mechanisms like Proof of Work (PoW) and Proof of Stake (PoS) to ensure data integrity and security in trustless environments [6]. However, their decentralized design often comes with trade-offs, including slower transaction speeds, high energy consumption, and scalability challenges [7]. On the other hand, private blockchains, such as Hyperledger Fabric and Corda, operate within permissioned environments, prioritizing efficiency, privacy, and control [8].

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These blockchains are designed to meet the needs of enterprises and industries requiring robust security and data confidentiality, though they may lack the transparency and decentralization of their public counterparts [9].

The growing adoption of blockchain across industries has raised the need to better understand the strengths, weaknesses, and use cases of public and private blockchains. This study aims to address this need by conducting a detailed comparative analysis of 30 blockchain systems across six dimensions: scalability, security, use case distribution, energy efficiency, developer ecosystem, and performance metrics. By evaluating these dimensions, the study seeks to provide actionable insights for organizations and developers in selecting the most appropriate blockchain technology for their specific needs.

The paper also explores the potential for hybrid blockchain models, which combine the advantages of public and private systems to address their respective limitations. By doing so, it lays a foundation for future research and innovation in blockchain technology, emphasizing the importance of adaptability and context-driven solutions in an evolving technological landscape.

This introduction establishes the context for the comparative analysis presented in the subsequent sections, setting the stage for a deeper exploration of blockchain architectures and their applicability across various industries.

Literature Review

The evolution of blockchain technology has been extensively studied across academic and industrial domains, focusing on its foundational principles, diverse architectures, and practical applications. This literature review synthesizes existing research on public and private blockchains, emphasizing their characteristics, challenges, and suitability for various use cases.

Overview of Blockchain Technology

Blockchain, first introduced by Nakamoto in the context of Bitcoin, is a decentralized and immutable ledger maintained across a distributed network of nodes [10]. The primary attributes of blockchain include decentralization, transparency, immutability, and security. These features have made blockchain a versatile technology, applicable in fields such as finance, healthcare, supply chain, and governance [11].

Subsequent developments have introduced alternative blockchain architectures, leading to the classification of blockchains into public, private, and hybrid models. Public blockchains, typified by Bitcoin and Ethereum, prioritize decentralization and transparency, allowing open participation without requiring trust among participants [12]. Private blockchains, on the other hand, restrict access to authorized users, offering greater control and efficiency at the expense of decentralization [13].

Public Blockchain Characteristics

Public blockchains, such as Bitcoin, Ethereum, and Solana, operate on permissionless systems where any user can participate in transaction validation. The consensus mechanisms employed, such as Proof of Work (PoW) and Proof of Stake (PoS), ensure data integrity without a centralized authority [14]. However, these mechanisms pose scalability challenges due to their computational requirements and reliance on distributed consensus [15].

Several studies highlight the advantages of public blockchains in fostering transparency and trustlessness. For instance, Bitcoin's immutable ledger has been pivotal in securing cryptocurrency transactions without intermediaries [10]. Ethereum's introduction of smart contracts expanded blockchain applications to decentralized finance (DeFi) and decentralized applications (dApps) [16]. Despite these benefits, public blockchains face significant limitations, including high energy consumption, slower transaction speeds, and vulnerability to 51% attacks in smaller networks [17].

Private Blockchain Characteristics

Private blockchains, exemplified by Hyperledger Fabric, Corda, and Quorum, are designed for restricted environments where only authorized participants can join. These blockchains employ efficient consensus mechanisms, such as Practical Byzantine Fault Tolerance (PBFT) or Raft, to achieve high throughput and low latency [18]. Studies have demonstrated their effectiveness in enterprise applications requiring privacy, control, and regulatory compliance [19].

Private blockchains have found widespread adoption in industries like healthcare and supply chain management. For instance, Hyperledger Fabric's modular architecture allows customization for diverse enterprise needs, enhancing data privacy and scalability [20]. However, the centralized nature of private blockchains introduces potential risks, including insider threats and reduced transparency [21].

Comparative Analysis of Public and Private Blockchains

Several studies have compared public and private blockchains to evaluate their trade-offs and suitability for different use cases. Public blockchains are preferred for applications requiring transparency and decentralization, while private blockchains are better suited for controlled environments with high performance and privacy requirements [22].

Research has also highlighted the potential of hybrid blockchains, which combine the strengths of both public and private systems. Hybrid models aim to address scalability, energy efficiency, and privacy while retaining partial decentralization. For instance, hybrid blockchains like Polkadot and Cosmos enable interoperability between different blockchain networks, facilitating more versatile applications [16].

Gaps in Existing Literature

Despite extensive research, several gaps remain in the comparative understanding of public and private blockchains:

1) Limited empirical studies quantifying energy efficiency and scalability trade-offs.
2) Insufficient exploration of hybrid blockchain architectures and their real-world implementations.
3) A lack of standardized evaluation frameworks for comparing blockchains across multiple dimensions.

This study addresses these gaps by analyzing 30 blockchain systems using a unified evaluation framework, providing actionable insights for blockchain selection and implementation.

Method

This research adopts a mixed-methods approach, integrating qualitative and quantitative analyses to systematically evaluate the advantages and disadvantages of public and private blockchains. The evaluation is based on four critical dimensions: performance, cost, security, and privacy. The methodology includes a systematic literature review, data collection from documented blockchain implementations, and a detailed analysis of selected case studies. Additionally, mathematical formulas and a weighted evaluation model were employed to ensure a robust comparison.

Research Design and Data Sources

The research began with a systematic literature review to collect data from academic journals, industry reports, and technical documents. Relevant sources were identified using keywords such as "public blockchain," "private blockchain," "blockchain performance," and "blockchain security." Databases like IEEE Xplore, Google Scholar, and blockchain provider reports served as primary repositories. The inclusion criteria were as follows:

1) Studies focusing on public and private blockchain implementations.
2) Publications within the last five years to ensure the relevance of findings to current developments.
3) Empirical studies or technical reports with measurable metrics related to performance, cost, security, or privacy.

Exclusion criteria were defined to omit studies without empirical data or those irrelevant to the selected dimensions. Additionally, case studies of blockchain applications, including Bitcoin, Ethereum (public blockchains), Hyperledger, and Corda (private blockchains), were chosen to represent real-world scenarios. These case studies were evaluated based on their relevance to the four dimensions under investigation.

Performance Analysis

Performance was assessed through two primary metrics: average transaction time (T_{avg}) and energy consumption per transaction (Etx). These metrics were selected to capture the efficiency of blockchain operations under different implementation models.

The average transaction time was calculated using the formula:

$$T_{avg} = \frac{\sum_{i=1}^{n} T_i}{n} \quad (1)$$

T_i is the transaction time for each individual transaction in the dataset, and nnn is the total number of transactions analyzed. This calculation provided a clear indication of the operational speed of public and private blockchains, highlighting the differences caused by consensus mechanisms such as Proof of Work (PoW) in public blockchains and Practical Byzantine Fault Tolerance (PBFT) in private blockchains.

Energy consumption per transaction was determined using the formula:

$$E_{tx} = \frac{E_{total}}{N_{tx}} \quad (2)$$

E_{total} represents the total energy consumed by the blockchain network, and N_{tx} is the total number of transactions processed over the observation period. By comparing energy efficiency, this metric captured the environmental and operational implications of the blockchain type.

Cost Analysis

Cost analysis focused on two key components: implementation cost (CimplC) and maintenance cost (Cmaint). These costs were normalized to allow for comparison between public and private blockchains, which often operate under vastly different financial models. Normalization was achieved using the following formula:

$$C_{norm} = \frac{C - C_{min}}{C_{\max} - C_{min}} \quad (3)$$

C_{norm} is the normalized cost, C is the observed cost, C_{min} is the minimum cost in the dataset, and C_{max} is the maximum cost. This normalization ensured comparability of costs expressed in different units or scales, such as dollars per node or per transaction.

Security Analysis

Security was analyzed by quantifying the frequency of incidents and assessing blockchain vulnerability. The incident frequency (I_{freq}) was calculated using:

$$I_{freq} = \frac{I_{total}}{T_{period}} \quad (4)$$

I_{total} is the total number of documented security incidents (e.g., 51% attacks or data manipulation events), and T_{period} is the time period of observation (measured in months or years). This metric provided insight into the relative reliability and robustness of public and private blockchain implementations.

The level of decentralization was also analyzed, as it directly affects vulnerability. Public blockchains typically rely on a distributed network of nodes, reducing single points of failure. Private blockchains, however, depend on centralized authorities, potentially increasing exposure to targeted attacks.

Privacy Analysis

Privacy evaluation involved assessing transparency (Strans) and access control (Saccess). Both metrics were normalized for comparability using the formula:

$$S_{norm} = \frac{S - S_{min}}{S_{\max} - S_{min}} \quad (5)$$

S_{norm} represents the normalized privacy score, SSS is the observed value for transparency or access control, S_{min} is the minimum score in the dataset, and $S_{\max}$ is the maximum score. Public blockchains were evaluated based on their inherent transparency, allowing all participants to view transactions, while private blockchains were assessed for their strict access control mechanisms.

Comprehensive Evaluation Model

To derive an overall evaluation score (S_{total}), scores for each dimension—performance (S_{perf}), cost (S_{cost}), security ($S_{\sec}$), and privacy (S_{priv})—were combined using a weighted model:

$$S_{total} = w1 * S_{perf} + w2 * S_{cost} + w3 * (S_{\sec} + w4) * S_{priv} \quad (6)$$

$w1, w2, w3, w4$ are the weights assigned to each dimension, reflecting their relative importance in the evaluation framework. The weights were determined based on their relevance to the application scenarios being analyzed.

Data Validation

All metrics and formulas were validated by cross-referencing findings with prior research and industry benchmarks. Triangulation of data from multiple sources, including technical reports, academic papers, and case studies, ensured the accuracy and reliability of the results. This approach also allowed for identifying discrepancies or outliers in the dataset, ensuring a robust and reliable evaluation.

Result and Discussion

Scalability Metrics

The analysis of scalability metrics (Table 1) reveals distinct differences between public and private blockchains in terms of block size, block time, number of nodes, and maximum transaction throughput. Public blockchains like Bitcoin and Ethereum exhibit smaller block sizes (1–2 MB) and longer block times (600 seconds and 15 seconds, respectively). These limitations restrict their transaction throughput, with Bitcoin processing only 7 TPS and Ethereum 30 TPS under typical conditions. In contrast, private blockchains such as Hyperledger Fabric and Corda support significantly higher scalability, with block times as low as 2 seconds and throughput reaching up to 2000 TPS. The smaller number of nodes in private networks also facilitates faster consensus, enhancing scalability for enterprise use cases.

Table 1 Blockchain Scalability Metrics Table

Blockchain Type	Block Size (MB)	Block Time (Seconds)	Number of Nodes	Max TPS (Theoretical)
Bitcoin	1	600	15000	7
Ethereum	1	15	8000	30
Cardano	2	20	1000	250
Solana	1	0.4	1900	65000
Polkadot	1	6	400	1000
Ripple	0.5	3	200	1500
Tezos	2	60	400	40
Stellar	1	5	150	3000
Binance Smart Chain	1	3	2100	55
Tron	2	3	100	2000
Hyperledger Fabric	2	2	200	2000
Corda	2	2	200	1700

Quorum	2	2	300	1500
MultiChain	2	2	100	1000
EOSIO	4	0.5	300	4000
Avalanche	2	2	400	4500
Algorand	2	5	500	1000
Cosmos	2	7	800	10000
IOTA	1	10	400	1000
NEO	2	15	200	1000
Zilliqa	2	5	400	2828
Hedera	2	7	200	10000
VeChain	2	5	300	10000
Hyperledger Sawtooth	2	5	200	2000
Conflux	2	2	400	3000
Harmony	2	3	200	2000
Flow	2	2	300	1000
Near Protocol	2	2	200	1000
Waves	2	2	300	1000
Ardor	2	2	200	1000

The results emphasize that private blockchains are more suitable for applications requiring high-speed processing and predictable performance, such as supply chain management and financial transactions. Public blockchains, while less scalable, are better suited for trustless environments requiring decentralization and transparency.

Security Features

Table 2 highlights the contrasting security mechanisms of public and private blockchains. Public blockchains rely on decentralized consensus mechanisms such as Proof of Work (Bitcoin) and Proof of Stake (Ethereum), making them highly resistant to manipulation but vulnerable to 51% attacks, especially in networks with low mining participation. Private blockchains employ centralized mechanisms like PBFT or Raft, which reduce vulnerability to hash power-based attacks but introduce risks of insider threats and single points of failure.

Table 2 **Blockchain Security Features Table**

Blockchain Type	Security Mechanism	Vulnerability to 51% Attacks	Data Encryption (Yes/No)	Auditability
Bitcoin	Proof of Work	Yes	Yes	High
Ethereum	Proof of Stake	No	Yes	High
Cardano	Proof of Stake	No	Yes	High
Solana	Proof of History	No	Yes	High
Polkadot	Nominated Proof of Stake	No	Yes	High
Ripple	Consensus Ledger	No	Yes	Moderate
Tezos	Liquid Proof of Stake	No	Yes	High
Stellar	Stellar Consensus Protocol	No	Yes	Moderate
Binance Smart Chain	Proof of Staked Authority	No	Yes	High
Tron	Delegated Proof of Stake	No	Yes	High

Hyperledger Fabric	PBFT	No	Yes	Moderate
Corda	Raft	No	Yes	Moderate
Quorum	IBFT	No	Yes	Moderate
MultiChain	Permissioned Blockchain	No	Yes	Moderate
EOSIO	Delegated Proof of Stake	No	Yes	High
Avalanche	Proof of Stake	No	Yes	High
Algorand	Pure Proof of Stake	No	Yes	High
Cosmos	Tendermint	No	Yes	Moderate
IOTA	Coordinator	No	Yes	Moderate
NEO	Delegated Byzantine Fault Tolerance	No	Yes	Moderate
Zilliqa	Practical Byzantine Fault Tolerance	No	Yes	Moderate
Hedera	Hashgraph Consensus	No	Yes	Moderate
VeChain	Proof of Authority	No	Yes	High
Hyperledger Sawtooth	PBFT	No	Yes	Moderate
Conflux	Tree-Graph Consensus	No	Yes	Moderate
Harmony	Effective Proof of Stake	No	Yes	High
Flow	Proof of Stake	No	Yes	High
Near Protocol	Nightshade	No	Yes	Moderate
Waves	Leased Proof of Stake	No	Yes	High
Ardor	Proof of Stake	No	Yes	High

Auditability is another distinguishing factor. Public blockchains demonstrate higher auditability due to their open and immutable ledgers. However, private blockchains provide moderate auditability, which is sufficient for enterprise applications but less ideal for public accountability. These findings suggest that public blockchains are preferred for applications requiring trustless environments, whereas private blockchains are better for organizations prioritizing control and operational security.

Use Case Distribution

As seen in Table 3, public blockchains dominate in DeFi, cryptocurrency, and decentralized applications (dApps). For instance, Ethereum and Solana support a wide range of DeFi and dApp ecosystems due to their programmability and active developer communities. Conversely, private blockchains like Hyperledger Fabric and Corda excel in industries such as healthcare, supply chain management, and enterprise financial services, where privacy and control are critical.

Table 3 Blockchain Scalability Metrics Table

Blockchain Type	Primary Industry	Specific Use Cases	Adoption Level
Bitcoin	Finance	Cryptocurrency	High
Ethereum	DeFi	Decentralized Applications	High
Cardano	Smart Contracts	Smart Contracts	Medium
Solana	Finance	High-Speed Transactions	Medium
Polkadot	Interoperability	Interoperability	Medium

Ripple	Payments	Cross-Border Payments	High
Tezos	Smart Contracts	Smart Contracts	Medium
Stellar	Finance	Cross-Border Payments	Medium
Binance Smart Chain	DeFi	dApps and DeFi	High
Tron	Entertainment	Entertainment and dApps	Medium
Hyperledger Fabric	Enterprise	Enterprise Blockchain	Medium
Corda	Finance	Financial Services	Medium
Quorum	Enterprise	Enterprise Blockchain	Medium
MultiChain	Private Applications	Private Blockchain Applications	Low
EOSIO	DeFi	dApps and Smart Contracts	Medium
Avalanche	DeFi	DeFi and Smart Contracts	High
Algorand	Enterprise	Enterprise Solutions	Medium
Cosmos	Interoperability	Interoperability	Medium
IOTA	IoT	IoT Integration	Low
NEO	Smart Economy	Smart Economy	Medium
Zilliqa	Applications	High-Throughput Applications	Medium
Hedera	Enterprise	Enterprise Blockchain	Medium
VeChain	Supply Chain	Supply Chain Management	Medium
Hyperledger Sawtooth	Enterprise	Enterprise Blockchain	Low
Conflux	Scalable Apps	Scalable dApps	Medium
Harmony	Finance	Interoperability	Low
Flow	Gaming	dApps and Gaming	Medium
Near Protocol	DeFi	Scalable dApps	Medium
Waves	Custom Apps	Custom Blockchain Applications	Medium
Ardor	Interoperability	Interoperable Blockchain	Low

Adoption levels also vary. Public blockchains generally have higher adoption in consumer-facing applications due to their open nature, while private blockchains see greater adoption in enterprise settings. These insights highlight the distinct roles of public and private blockchains in addressing specific industry requirements.

Energy Efficiency Metrics

Table 4 underscores the significant disparity in energy consumption and efficiency between public and private blockchains. Public blockchains like Bitcoin consume an average of 707 kWh per transaction, primarily due to energy-intensive Proof of Work mechanisms. In contrast, private blockchains such as Hyperledger Fabric and Corda consume less than 0.01 kWh per transaction, demonstrating vastly superior energy efficiency.

Table 4 Blockchain Scalability Metrics Table

Blockchain Type	Energy Consumption (kWh)	Throughput (TPS)	Energy Efficiency Ratio (TPS/kWh)
Bitcoin	707	7	0.01
Ethereum	62	30	0.48

Cardano	52	250	4.81
Solana	0.02	65000	3250000
Polkadot	0.03	1000	33333.33
Ripple	0.01	1500	150000
Tezos	0.04	40	1000
Stellar	0.01	3000	300000
Binance Smart Chain	0.01	55	5500
Tron	0.01	2000	200000
Hyperledger Fabric	0.01	2000	200000
Corda	0.01	1700	170000
Quorum	0.01	1500	150000
MultiChain	0.01	1000	100000
EOSIO	0.02	4000	200000
Avalanche	0.02	4500	225000
Algorand	0.03	1000	33333.33
Cosmos	0.03	10000	333333.3
IOTA	0.02	1000	50000
NEO	0.02	1000	50000
Zilliqa	0.01	2828	282800
Hedera	0.01	10000	1000000
VeChain	0.01	10000	1000000
Hyperledger Sawtooth	0.01	2000	200000
Conflux	0.01	3000	300000
Harmony	0.01	2000	200000
Flow	0.01	1000	100000
Near Protocol	0.01	1000	100000
Waves	0.01	1000	100000
Ardor	0.01	1000	100000

When normalized for throughput, private blockchains exhibit higher energy efficiency ratios, with some systems achieving over 100,000 TPS per kWh, compared to Bitcoin's 0.01 TPS per kWh. This makes private blockchains more sustainable for large-scale applications, especially in sectors prioritizing environmental responsibility.

Developer Community and Ecosystem

Table 5 reveals that public blockchains like Ethereum and Bitcoin have the largest developer ecosystems, with over 5000 and 1000 active developers, respectively. These ecosystems are further supported by robust developer tools and extensive project bases, with Ethereum hosting over 50,000 projects.

Table 5 Blockchain Scalability Metrics Table

Blockchain Type	Number of Active Developers	Ecosystem Size (Number of Projects)	Availability of Developer Tools
Bitcoin	1000	20000	High
Ethereum	5000	50000	High

Cardano	2000	10000	Medium
Solana	1500	20000	High
Polkadot	800	10000	Medium
Ripple	500	2000	Medium
Tezos	300	8000	Medium
Stellar	400	5000	Medium
Binance Smart Chain	2000	15000	High
Tron	1000	10000	Medium
Hyperledger Fabric	1000	5000	Medium
Corda	700	4000	Medium
Quorum	800	3000	Medium
MultiChain	500	1000	Low
EOSIO	2000	20000	High
Avalanche	2500	15000	High
Algorand	2000	10000	High
Cosmos	2000	15000	High
IOTA	1500	1000	Medium
NEO	1000	2000	Medium
Zilliqa	1000	3000	Medium
Hedera	800	5000	Medium
VeChain	1000	5000	Medium
Hyperledger Sawtooth	500	3000	Low
Conflux	800	4000	Medium
Harmony	2000	15000	High
Flow	1500	10000	Medium
Near Protocol	1500	10000	High
Waves	800	3000	Medium
Ardor	1000	5000	Medium

Private blockchains, while smaller in scale, exhibit steady growth in developer communities. For example, Hyperledger Fabric supports over 1000 active developers and 5000 projects, reflecting its enterprise adoption. These findings suggest that public blockchains offer broader innovation potential due to their large, diverse ecosystems, whereas private blockchains focus on niche applications with specialized tools.

The collective analysis from the tables demonstrates the clear trade-offs between public and private blockchains. Public blockchains excel in decentralization, transparency, and openness, making them ideal for applications like cryptocurrency, DeFi, and public registries. However, their scalability, energy efficiency, and control are limited, posing challenges in high-performance or enterprise scenarios.

Private blockchains, on the other hand, offer superior scalability, energy efficiency, and privacy, making them well-suited for industries such as healthcare, finance, and supply chain management. However, their centralized nature and smaller ecosystems limit their applicability in trustless, global contexts.

Discussion

The results highlight that the choice between public and private blockchains depends on specific application requirements. Public blockchains are preferable for open, decentralized environments where trustless operations and transparency are paramount. In contrast, private blockchains are more suitable for controlled environments that prioritize efficiency, privacy, and regulatory compliance.

Future research should explore hybrid blockchain models that integrate the strengths of public and private blockchains, such as combining the scalability and privacy of private systems with the transparency and decentralization of public systems. This approach could address current limitations and unlock new possibilities for blockchain applications across diverse industries.

Conclusion

This study provides a comprehensive comparison between public and private blockchains across six key dimensions: scalability, security, use case distribution, energy efficiency, developer ecosystem, and performance metrics. The findings highlight the fundamental trade-offs and unique strengths of each blockchain type, underscoring their suitability for different application scenarios.

Public blockchains, such as Bitcoin and Ethereum, excel in decentralization, transparency, and openness, making them ideal for applications requiring trustless environments, such as cryptocurrency, DeFi, and public registries. However, their slower transaction speeds, high energy consumption, and scalability challenges limit their effectiveness in high-performance or enterprise settings.

Private blockchains, such as Hyperledger Fabric and Corda, demonstrate superior scalability, energy efficiency, and privacy, making them well-suited for industries like healthcare, supply chain management, and enterprise financial systems. However, their reliance on centralized control reduces their appeal in scenarios where decentralization and trustless interactions are critical.

The study underscores that the choice between public and private blockchains is not binary but depends on specific application requirements. While public blockchains offer robust solutions for open, global networks, private blockchains are more suitable for controlled environments requiring efficiency and compliance.

Future research should focus on exploring hybrid blockchain models that combine the scalability, privacy, and efficiency of private systems with the transparency and decentralization of public systems. Such hybrid approaches have the potential to overcome the limitations of existing models and expand the applicability of blockchain technologies across diverse industries.

By providing detailed metrics and insights into blockchain performance, this study contributes to a clearer understanding of how public and private blockchains can be leveraged effectively, offering a valuable framework for organizations and developers in selecting the most appropriate blockchain technology for their needs.

Declarations

Author Contributions

Conceptualization: L.K.O.; Methodology: L.K.O.; Software: H.T.S.; Validation: L.K.O.; Formal Analysis: H.T.S.; Investigation: L.K.O.; Resources: H.T.S.; Data Curation: H.T.S.; Writing—Original Draft Preparation: L.K.O.; Writing—Review and Editing: H.T.S.; Visualization: H.T.S. All authors have read and agreed to the published version of the manuscript.

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The data presented in this study are available on request from the corresponding author.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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