

Blockchain-Cloud Hybrids: Strengthening Cybersecurity Across Sectors and Scalability Challenges

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Abstract-- Cloud computing delivers scalable data solutions but faces centralisation risks such as breaches and failures. Blockchain fortifies cybersecurity via decentralised, immutable mechanisms for data integrity, access control, and auditing.

This study synthesises 2021–2025 literature on integration models, applications, benefits, and challenges like scalability and interoperability, offering insights for hybrid systems to boost trust and efficiency in finance, healthcare, and e-commerce.

Keywords--Cloud Computing, Blockchain, Cybersecurity, Data Integrity

I. INTRODUCTION

Cloud adoption drives scalability, cost savings, and on-demand resources, reducing capital needs for organisations.

Key Studies

Centralised architectures, however, heighten threats like data breaches, outages, and trust erosion from attacks.

Blockchain counters these with decentralised ledgers, consensus mechanisms, and cryptographic security, enabling smart contract automation. Hybrids enhance data integrity and resilience.

This paper examines integration strategies for cybersecurity and risk management, aiding digital transformation in markets like India.

II. LITERATURE REVIEW

Blockchain-cloud research highlights hybrid architectures balancing security and scalability, with gaps in real-world deployment.

Study	Year	Focus	Key Findings
Zou et al.	2021	Architectures	Blockchain secures cloud services (integrity, access); cloud supports off-chain storage for throughput and immutability.
Khanna et al.	2022	BaaS Models	Permissioned blockchains excel in enterprise performance and privacy.
Ahmed	2025	Security	Healthcare platform reduced breaches 40% via access controls, improving integrity and efficiency.
Punia et al.	2024	Access Control	12 paradigms; decentralised outperforms centralised, limited by scalability.
Singh	2025	AI Synergies	108 studies (2012–2025); data consistency and AI threat detection for finance/healthcare.



Research Gaps

- Scarce empirical evidence from production environments beyond pilots.
- Underexplored scalability, energy use, and interoperability in hybrids.
- Limited attention to regulations and local adaptations (e.g., India's data laws).

Key Research Areas

- Layer-2 scaling and sharding optimisation.
- AI-enhanced predictive security for emerging markets.
- SME cost-benefit studies on permissioned BaaS.

III. APPLICATIONS AND USE

Hybrids enable secure operations across sectors.

Banking

Cloud manages transactions; blockchain provides fraud-proof settlements. Permissioned networks accelerate KYC, payments, and trade finance to seconds via smart contracts.

Education

Blockchain on cloud verifies credentials with fraud-proof digital diplomas, supporting global portfolios and private analytics.

Healthcare

Immutable audit trails secure cloud records, enabling consent management and 30% faster diagnostics through granular access.

Retail

Hybrids ensure supply chain provenance, reduce counterfeits, and drive NFT loyalty with secure micropayments

IV. KEY BENEFITS AND CHALLENGES

Cloud-blockchain integration yields sector-specific gains but faces distinct hurdles.

Sector	Primary Use	Benefit	Challenge
Banking	Payments/KYC	Speed, compliance automation	Regulatory alignment
Education	Credentialing	Fraud prevention, global access	Adoption barriers
Healthcare	EHR Sharing	Error reduction, privacy	Data scalability
Retail	Supply Chain	Traceability, loyalty	Integration expense

V. PROS AND CONS

Cloud-blockchain integration fuses scalability and security amid trade-offs.

Cloud-blockchain integration offers enhanced security through decentralised ledgers, preventing failures and breaches via immutability/cryptography, plus trust from audit trails, slashing fraud in banking/healthcare. It yields efficiency like sub-second payments and 30% faster diagnostics, spanning credentialing, EHRs, supply chains, and KYC. Drawbacks encompass scalability limits from energy consensus, interoperability mismatches, high SME costs, and regulatory gaps like India's laws.

VI. INFERENCES AND KEY FINDINGS

Hybrids mitigate cloud risks with blockchain trust, achieving 40% breach cuts and accelerations. Literature validates BaaS architectures, but pilots prevail over enterprise use. Scalability/regulatory gaps block SME scale-up; applications prove versatile yet costly.

VII. SUGGESTIONS AND RECOMMENDATIONS

Organisations should prioritise permissioned BaaS while piloting layer-2 sharding for throughput. Integrate AI for threat prediction in finance/healthcare. Perform India-specific audits and SME cost models. Advance interoperability via open-source hybrids

VIII. CONCLUSION AND FUTURE DIRECTIONS

Cloud-blockchain hybrids promise resilient cybersecurity despite scalability challenges, reshaping sector risk management.

Future research must validate long-term deployments, energy-efficient consensus, and quantum resistance. India-focused DPDP Act studies will steer adoption

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