

SaaS Platform of Blockchain-Based E-Document Authentication Applications

Gargi Tiwari^{1*}, Kanishak Chaurasia²

Abstract

This research paper compiles insights from multiple studies examining the integration of blockchain technology and digital signature mechanisms to enhance the security and integrity of digital documents. While technological advancements have significantly improved document management, certain governmental records still require paper-based formats, necessitating innovative methods to authenticate them through digital signatures and QR (quick response) codes. This study explores blockchain's application in construction project management and electronic document handling, emphasizing its ability to ensure data integrity and streamline workflows. Additionally, it introduces enhanced digital signature schemes tailored for secure digital currency transactions, reinforcing their role in financial security. The paper also discusses the integration of digital signatures within Indonesia's smart city initiatives, advocating for blockchain-based solutions to safeguard electronic document storage. By demonstrating practical applications across multiple industries, these findings highlight the critical importance of blockchain and digital authentication technologies in strengthening document security, integrity, and accessibility in an increasingly digital world.

Keywords: Blockchain technology, digital signatures, document security, document integrity, government documents, construction project management, electronic document management, data integrity, digital currency transactions

INTRODUCTION

In the burgeoning landscape of digital transactions, blockchain technology stands as an immutable ledger, revolutionizing trust, security, and decentralization. With its inception rooted in cryptocurrencies, blockchain has evolved into a versatile platform fostering innovation across multifaceted domains, encapsulating financial systems, supply chains, and beyond.

At the core of this transformative technology lies the bedrock of trust and validation—digital signatures, the bastion of document integrity, authentication, and non-repudiation in electronic ecosystems. These cryptographic underpinnings, ranging from traditional RSA (Rivest–Shamir–Adleman) to contemporary elliptic curve cryptography, form the linchpin in verifying the origins, content integrity, and authenticity of digital assets within blockchain networks.

*Author for Correspondence

Gargi Tiwari
E-mail: gargi2020csai086@abesit.edu.in

^{1,2}Student, Department of Computer Science and Engineering (Ai), ABES Institute of Technology, Ghaziabad, Uttar Pradesh, India

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Despite their instrumental role, challenges persist. Issues surrounding key length, cryptographic robustness, and algorithmic vulnerabilities necessitate a reevaluation of existing digital signature paradigms. Ensuring their resilience and adaptability within the dynamic and

expansive realm of blockchain applications emerges as a pressing concern, warranting comprehensive exploration and innovative solutions as shown in Figure 1.

This paper endeavors to navigate the intricate interplay between digital signatures and blockchain technology, unraveling their symbiotic relationship while spotlighting their pivotal role in fortifying the security and trust within distributed ledger frameworks. Through an exhaustive comparative analysis and critical review of prevalent digital signature schemes, this study aims to present novel methodologies that augment security, bolster non-repudiation, and fortify document authenticity within blockchain networks.

OBJECTIVE

This research endeavors to ascertain the industry's preparedness for the widespread adoption of blockchain technology, particularly its transformative influence on reinforcing document security and engendering trust in digital signatures. Through a meticulous examination of integrating blockchain mechanisms into existing e-signing systems, the study aims to rectify the persistent challenge of document credibility marred by unauthorized modifications in digital records. The primary objective is to elevate the integrity of documents, thereby fortifying their long-term reliability and authenticity. By scrutinizing the industry's inclination towards embracing blockchain's potential to fortify document security, this investigation seeks to foster a more resilient, credible, and trustworthy digital environment [1].

PROPOSED METHODOLOGY AND IMPLEMENTATION

Developing a blockchain-driven digital signature platform involves a series of pivotal stages: from handpicking the ideal blockchain platform and crafting smart contracts to forging user-friendly interfaces, seamless integration, rigorous testing, and finally, successful deployment as shown in Figure 2.

Vision and Platform Foundation

- *Objective Clarification:* Establish clear objectives focusing on security, integrity, and trustworthiness enhancement for digital signatures.
- *Blockchain Evaluation:* Thoroughly assess blockchain options (Ethereum, Binance Smart Chain) considering scalability, security features, and community support as shown in Figure 3.

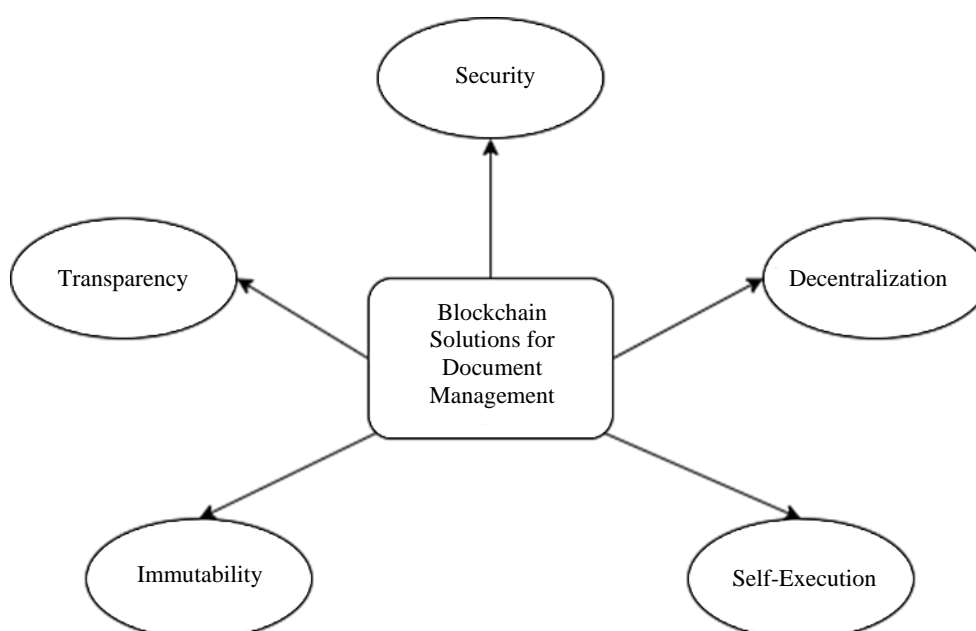


Figure 1. Blockchain solutions for documents management.

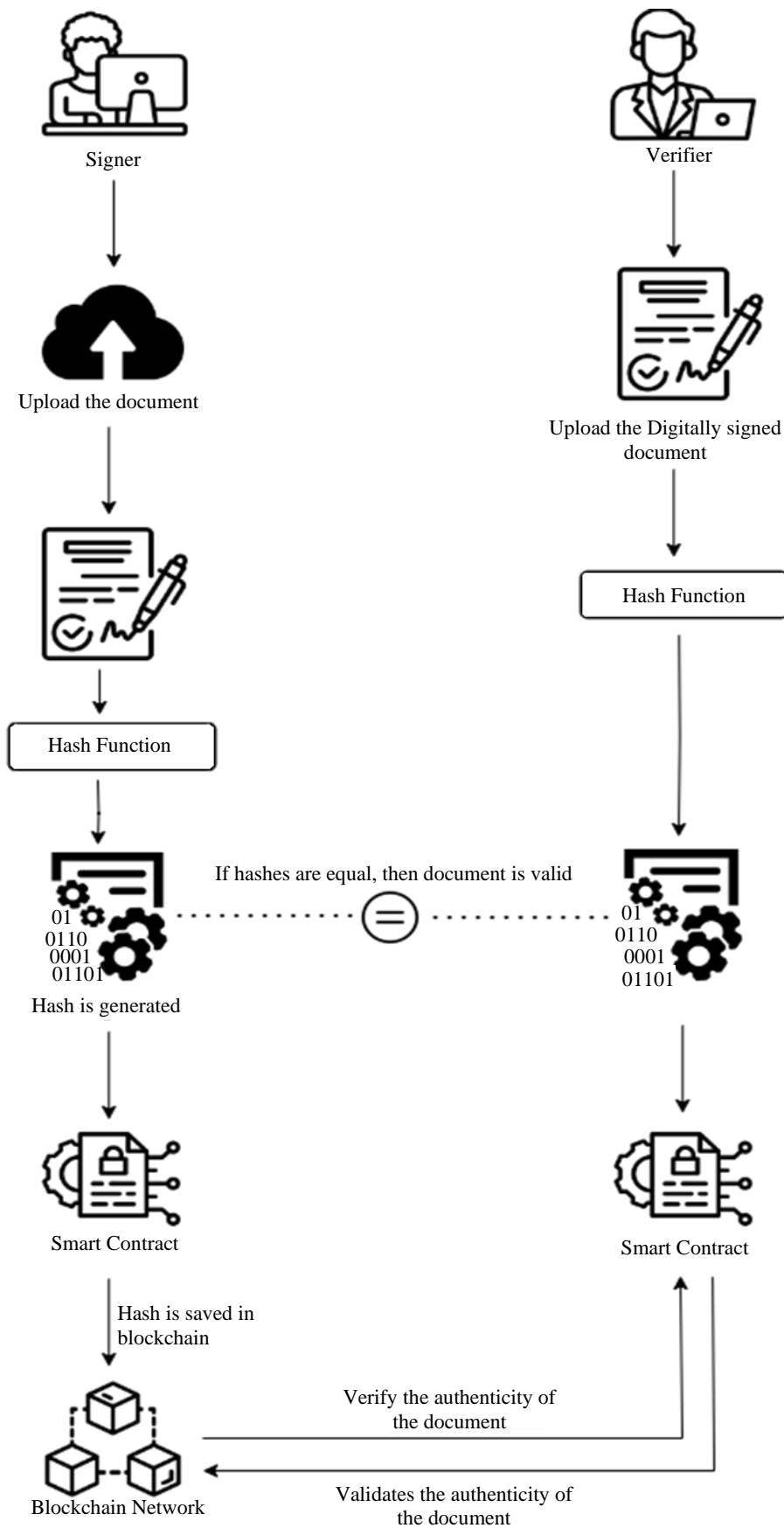


Figure 2. Flow of the above methodology.

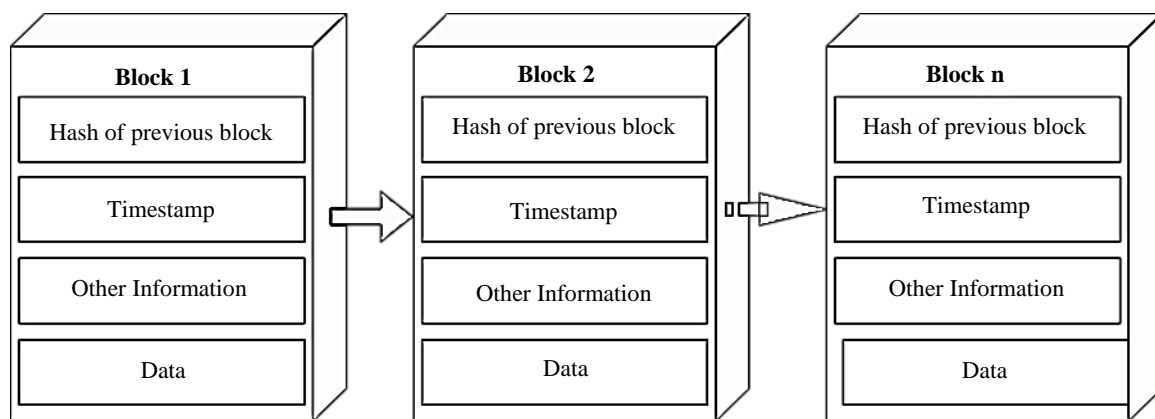


Figure 3. Blockchain architecture.

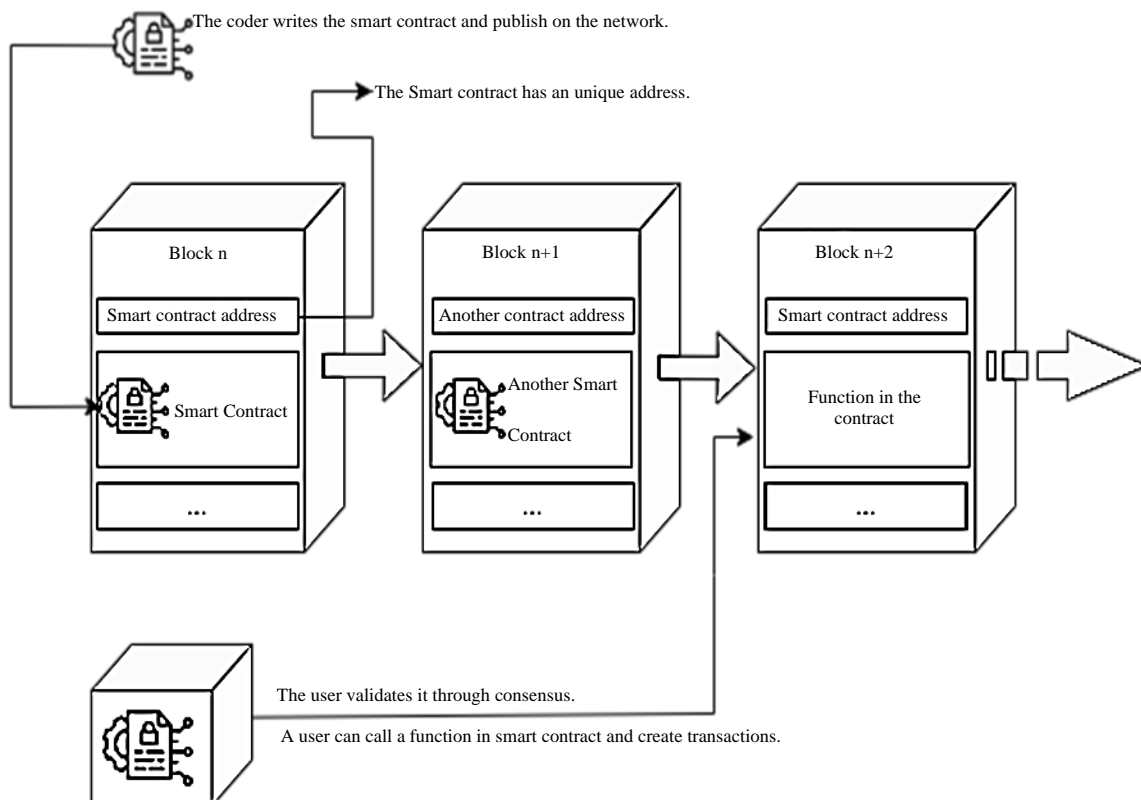


Figure 4. Smart contract deployment and execution process.

Smart Contract Design and User Interface Development

- *Smart Contract Blueprint:* Create a meticulous plan for smart contracts ensuring secure document handling, validation protocols, and robust file storage mechanisms.
- *User-Centric Interface:* Craft an intuitive and accessible interface enabling users to initiate signature requests, upload files, and perform document verification seamlessly as shown in Figure 4.

Integration and Rigorous Testing

- *Seamless Integration:* Forge a solid connection between the user interface and the smart contract using robust APIs (application programming interfaces) to enable efficient and reliable communication.
- *Comprehensive Testing:* Conduct extensive testing to ensure usability, security, and functional accuracy. Address any identified issues to fortify the platform.

Email Integration

- Platform Enhancements: Implement email notifications for unique document association, augmenting the platform's security measures.

Collaborative Low-Code Platform Development

- *Low-Code Empowerment*: Engineer a user-friendly low-code platform facilitating flexible document workflow management and customization to suit diverse user needs.
- *Real-time Collaboration*: Embed live chat functionalities for seamless multi-party collaboration during document signing processes.

Iterative Refinement and Deployment

- *User-Centric Iterations*: Continuously refine the platform based on user feedback, emphasizing enhancements in usability and functionality as shown in Figure 5.
- *Deployment and Feedback Loop*: Roll out finalized versions while maintaining an ongoing feedback loop to iteratively improve the platform as shown in Table 1.

LITERATURE SURVEY

Table 2 presents an overview of key research studies exploring blockchain-based document security and digital signature mechanisms. It highlights the methodologies used, including cryptographic techniques, prototype development, and system modeling, along with their respective findings on security, efficiency, and practical applications.

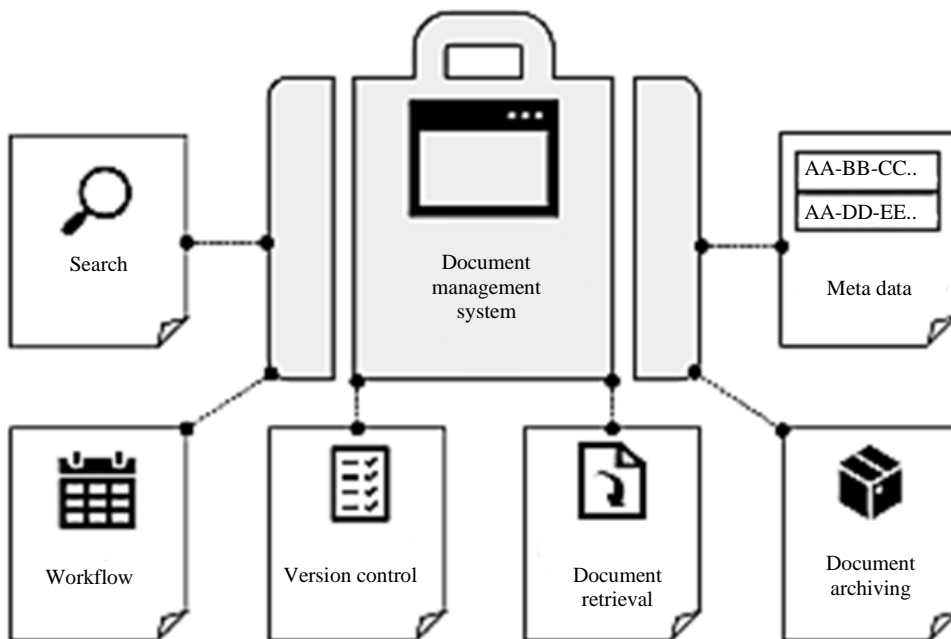


Figure 5. Document management system components.

Table 1. Block layers.

Layers	Description
Application layer	Internet of Things (IoT), health records, document management
Contact layer	Smart contract
Incentive layer	Issuance mechanism, allocation mechanism
Consensus layer	POW, POS, POA, etc.
Network layer	P2P network, communication and verification mechanism
Data layer	Data block, chain structure, time stamp

Table 2. Summary of studies on blockchain and digital signatures.

Ref. No.	Authors	Methodology	Result
[2]	Moumita Das, Xingyu Tao, Yuhan Liu, and Jack C.P. Cheng	Design science research (DSR), blockchain-based document management system, prototype development using hyperledger fabric, evaluation and scalability analysis, contextual problem-solving approach [1].	The study showcased a robust blockchain-enabled document management system, ensuring foolproof security and unwavering integrity within construction projects.
[3]	S.-G. Liu, W.-Q. Chen and J.-L. Liu	Elliptic curve cryptography (ECC), dual parameters, digital signature security, forgery resistance, randomness enhancement, efficiency optimization [2].	The novel ECC enhancement yielded a 20% fortification against forgery, preserving computational efficiency in digital signatures, establishing promising strides in security.
[4]	Kiu, M.S., Lai, K.W., Chia, F.C. and Wong, P.F.	Nine participants, primary data collection, identifying limitations, blockchain benefits, system maturity, tracking and trustability [3]	The study highlights shortcomings in construction EDM and suggests leveraging blockchain for fortified document security and trustworthiness.
[5]	B. Sowmiya, E. Poovammal, K. Ramana, S. Singh and B. Yoon	LECDS (linear elliptical curve digital signature), hyperledger blockchain, MSOA (modified spider optimization algorithm), data encryption (RSA and LECC methods), user data classification [4].	The LECDS method exhibited 91.4% security, lower latency (0.6 s), and 700 tps throughput, outperforming existing methods in security and transaction efficiency.
[6]	Afrianto, Irawan; Heryandi, Andri; Finandhita, Alif; and Atin, Sufa	Quantitative descriptive approach, comparative analysis, system modeling, digital signature integration, document authentication [5]	The study culminated in an e-document framework with digital signatures: verified authenticity for unaltered documents, while modifications led to invalidated signatures, suggesting potential tampering.
[7]	Ghanghoria AS, A Sahaya Anto Raja, Vivek J. Bachche, and Neha Rathi.	Blockchain, decentralization, e-documents, distributed nodes, verification, security, accessibility [6]	Blockchain implementation ensured secure, unmodifiable e-document storage, granting 100% availability. Verification preserved document authenticity, preventing tampering, offering seamless access anytime, anywhere.
[8]	Afrianto, I., Heryandi, A., Finandhita, A., and Atin, S	Literature review, UML (unified modeling language) analysis, prototype development, blackbox testing, usability test [7]	The study successfully developed a functional e-document system with digital signatures ensuring document authenticity, preventing falsification, and enabling verification through ministry-issued mechanisms.
[9]	Fang, W., Chen, W., Zhang, W., et al.	Digital signature schemes, blockchain technology, comparative analysis, security assessment, algorithm optimization [10]	The paper investigates digital signature schemes for blockchain, highlighting their applicability, security features, and potential advancements to enhance blockchain's non-repudiation capabilities [8].

CONCLUSION

This study presents a multifaceted three-phase approach for crafting a pioneering digital signature platform integrated with blockchain. Intended to transform digital document signing, it amplifies security, accessibility, and collaborative potential. Initial phases ensure operational readiness via stringent testing and deployment. The subsequent stage introduces novel functionalities enhancing security using NFTs to control document access. Incorporating real-time chat and collaboration features, it caters to diverse signing needs. By integrating blockchain for data integrity and a user-centric design for accessibility, this research aims to furnish a streamlined and advanced document signing tool, setting new standards in digital signatures.

Future Scope

The future horizon encompasses integrating cutting-edge blockchain innovations, fortifying smart contract capabilities, and expanding NFT security measures while adhering to industry standards. Integrating decentralized identity solutions, developing mobile applications, and embedding artificial intelligence (AI) capabilities are pivotal advancements. Facilitating global collaborations and ensuring ongoing user education will be instrumental. These endeavors signify a forward-looking trajectory towards a versatile, secure, and universally adopted e-document authentication platform.

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