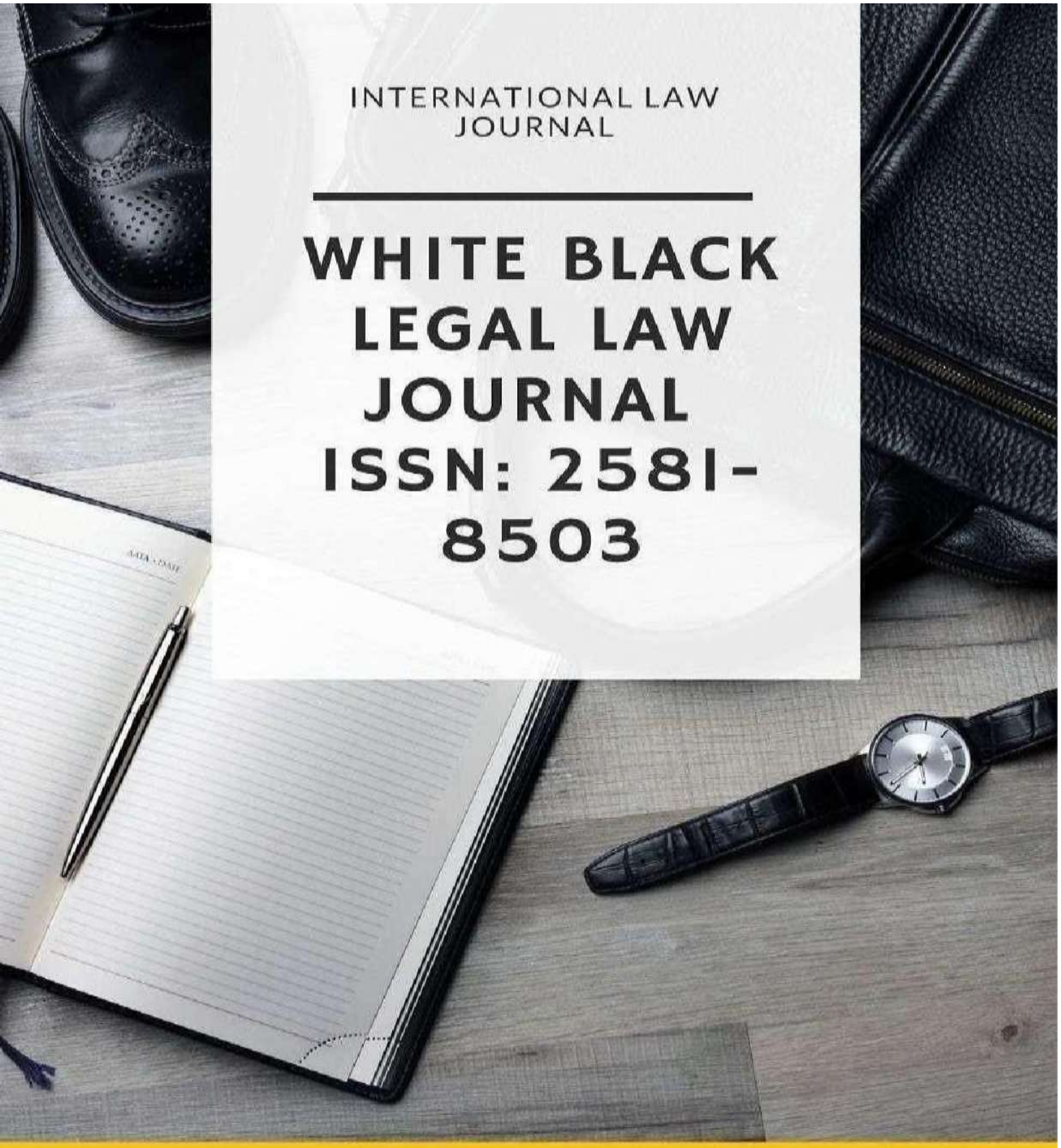

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WHITE BLACK LEGAL is an open access, peer-reviewed and refereed journal providededicated to express views on topical legal issues, thereby generating a cross current of ideas on emerging matters. This platform shall also ignite the initiative and desire of young law students to contribute in the field of law. The erudite response of legal luminaries shall be solicited to enable readers to explore challenges that lie before law makers, lawyers and the society at large, in the event of the ever changing social, economic and technological scenario.

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BLOCKCHAIN AND PUBLIC TRANSPARENCY: CAN DECENTRALIZED TECH FIX GOVERNMENT OPACITY?

AUTHORED BY - MAINAK GHOSH

Abstract

In democratic societies, openness in governance is both a fundamental principle and a practical requirement. In spite of constitutional guarantees and laws like the Right to Information Act, 2005, India still struggles with widespread government secrecy, bureaucratic arbitrariness, and entrenched corruption. Conventional methods of public accountability frequently struggle because of procedural inefficiencies, political opposition, and restricted public access to confirmable information[1]. In this scenario, blockchain technology has surfaced as a potentially revolutionary instrument providing unchangeable, decentralized, and transparent record-keeping features.

This paper examines the feasibility of blockchain as a legal-technical approach to tackle deep-rooted transparency issues in public administration. It assesses important blockchain attributes—like immutability, decentralized consensus, and smart contracts—and examines their relevance in improving transparency in land registries, public procurement, welfare allocation, and election financing. By examining case studies from India and similar regions such as Estonia and Dubai, the paper underscores both the potential and the challenges of implementing blockchain in governance.

Although blockchain has the potential to greatly enhance public oversight, the paper warns against relying solely on technology solutions and highlights the legal and ethical issues it brings—especially regarding privacy, gaps in regulation, and the risk of digital exclusion. The paper concludes by advocating for a measured strategy: incorporating blockchain into public systems via sandbox testing, legal acknowledgment, and strong legal protections to reconcile transparency with democratic responsibility.

[1] https://dspace.library.uu.nl/bitstream/handle/1874/34995/j.1467_9299.2008.00716.x.pdf?sequence=3&isAllowed=y

Key Words: Digital Trust, Public Sector Innovations, Decentralized Governance, Technological Ethics, Public Accountability

1. Introduction

Transparency serves as a core principle of democratic governance, guaranteeing that public institutions stay answerable to the citizens they assist[2]. It is not just a procedural formality but meaningful protection against corruption, inefficiency, and misuse of power. In India, the call for transparency has been officially acknowledged through constitutional provisions, court rulings, and legislative measures—particularly the Right to Information Act, 2005 (RTI Act), which enables citizens to obtain information from public bodies. Nonetheless, in spite of these normative improvements, government transparency remains lacking in numerous areas of public administration, such as land record management, public procurement, welfare distribution, and political financing.

Governance opacity is frequenty ingrained in its structure. The system is hindered by information asymmetries, bureaucratic obstacles, delays in revealing data, selective access to documents, and a widespread unwillingness to share information[3]. In numerous cases, even when data is provided, it is often either lacking, difficult for the average person to understand, or altered in ways that undermine the fundamental goal of transparency. The Digital India initiative's move towards digitized governance, although offering improved access and efficiency, has not fully addressed these issues[4]. Rather, it has added new layers of complexity, in which digital records are susceptible to manipulation, and public platforms face challenges related to trust and verification.

In this context, blockchain technology has surfaced as a potentially game-changing instrument in the legal and administrative discussions regarding transparency. Initially created as the core technology for cryptocurrencies such as Bitcoin, blockchain has transformed into a flexible framework that can safely record, verify, and exchange data without relying on centralized

[2] Schmidthuber, L., Ingrams, A., and Hilgers, D. (2020). Government Openness and Public Trust: The Mediating Role of Democratic Capacity. *Public Administration Review*, 81(1), 91-109. https://doi.org/10.1111/puar.13298
[3] Lencucha, R., and Bandara, S. (2021). Trust, risk, and the challenge of information sharing during a health emergency. *Globalization and Health*, 17(1). https://doi.org/10.1186/s12992-021-00673-9
[4] Prakash, A. (2015). E-Governance and Public Service Delivery at the Grassroots: A Study of ICT Use in Health and Nutrition Programs in India. *Information Technology for Development*, 22(2), 306-319. https://doi.org/10.1080/02681102.2015.1034639

authority[5]. Its key characteristics—immutability, decentralization, consensus verification, and built-in transparency—provide unique opportunities for establishing tamper-resistant public records and allowing real-time evaluations of government activities.

The main question addressed in this paper is if blockchain can serve as a viable legal-technical tool to enhance transparency and diminish opacity in public governance. In particular, it explores how blockchain could fill the voids created by current frameworks like the RTI Act, and whether it has the potential to alter the power relationships between state authorities and citizens through the facilitation of trustless verification systems. For this purpose, the article assesses blockchain-driven projects in India—including the digitization of land records in Andhra Pradesh and Telangana, blockchain usage in supply chain oversight for public welfare programs, and its possible use in electoral funding and public procurement.

Nonetheless, the potential of blockchain should be examined with careful evaluation. Its execution in public systems faces certain difficulties[6]. Concerns arise from issues such as the digital divide, lack of technological literacy, privacy breaches, scalability challenges, and the lack of a comprehensive legal structure to oversee blockchain use in the public sector. Additionally, the fundamental immutability of blockchain may clash with new data protection regulations, like the Digital Personal Data Protection Act, 2023, which provides individuals with the rights to erase and correct their data—rights that are challenging to align with the lasting characteristics of blockchain entries[7].

This study employs a doctrinal and comparative research approach, focusing on an in-depth examination of legal frameworks, court rulings, governmental policy materials, and best international practices. Comparative insights are gained from nations such as Estonia, which has adopted blockchain-based solutions in various areas of governance, and Dubai, which has pledged to a comprehensive city-wide blockchain strategy. These case studies offer essential standards for evaluating the practicality and flexibility of these technologies in the Indian legal environment.

[5] Gamage, H. T. M., Weerasinghe, H. D., and Dias, N. G. J. (2020). A Survey on Blockchain Technology Concepts, Applications, and Issues. *SN Computer Science*, 1(2). https://doi.org/10.1007/s42979-020-00123-0
[6] https://repository.tudelft.nl/file/File_08ab182f-15f2-4fff-9edd-ff38583aecbf
[7] Chousein, Z. et al. (2020). Tension between GDPR and Public Blockchains: A Data-Driven Analysis of Online Discussions. *13th International Conference on Security of Information and Networks*, 1-8. https://doi.org/10.1145/3433174.3433587

The document is organized in the following manner:

- Part 2 examines the notion of governmental opacity, its origins, and the constraints of current legal structures.
- Part 3 introduces blockchain technology, highlighting aspects important for public transparency.
- Part 4 examines practical implementations of blockchain in public administration by highlighting specific use cases.
- Part 5 presents a comparative examination of international frameworks incorporating blockchain into governance.
- Part 6 examines the theoretical inquiry: can blockchain genuinely address opacity, or does it pose a danger of being a technological cure-all?
- Part 7 wraps up with suggestions for incorporating blockchain into public transparency frameworks in India via legal acknowledgment, pilot initiatives, and interdisciplinary policy changes.

In conclusion, this paper argues that although blockchain is not a cure-all, it possesses significant potential as a means to actualize the constitutional principle of transparency in governance—if its adoption is supported by well-defined legal structures, strong institutional protections, and a citizen-focused implementation strategy.

2. Understanding Government Opacity

2.1 Defining Opacity in Governance

Opacity in governance signifies a consistent absence of transparency, understanding, and access to governmental data, decisions, and procedures. It appears through actions that either conceal truths or postpone the sharing of information vital to public awareness and involvement. Opacity hinders democratic accountability by facilitating obscure decision-making, covering up wrongdoing, and weakening institutional trust[8]. It contradicts the concept of open government, which expects public agencies to function with transparency, accountability, and legal obligation.

In a democratic setting such as India, where Article 19(1)(a) of the Constitution ensures the right to freedom of speech and expression, transparency is essential for impactful

[8] Schmidthuber, L., Ingrams, A., and Hilgers, D. (2020). Government Openness and Public Trust: The Mediating Role of Democratic Capacity. *Public Administration Review*, 81(1), 91-109. https://doi.org/10.1111/puar.13298

participation[9]. However, opacity frequently serves as a hindrance between citizens and the government, establishing power imbalances, wherein public authorities manage information dissemination to sustain bureaucratic control or political benefit.

2.2 Structural Causes of Opacity

Opacity in public governance stems from an intricate web of institutional, procedural, and political elements:[10]

- Bureaucratic Flexibility and Administrative Formalities: The Indian administration continues to be largely procedural and structured. Overly transferring decision-making authority without immediate accountability measures promotes lack of transparency.
- Poor Record-Keeping Methods: Numerous departments hold disjointed and old records, frequently in paper forms or non-searchable digital formats, complicating the retrieval of information.
- Political Secrecy and Electoral Motivations: Legislative protection, confidential records, and unclear electoral funding systems (e.g., electoral bonds) lead to intentional obscurity.
- Lack of Motivation for Transparency: Officials frequently lack the incentive to disclose information proactively because of concerns regarding scrutiny, potential legal repercussions, or internal bureaucratic resistance.
- Technological Disintegration: Although e-governance efforts are increasing, they are often executed in isolation, leading to non-interoperable data systems and restricted public accessibility.

2.3 Legal Frameworks and their limitations

India's most renowned legal reaction to secrecy is the Right to Information Act, 2005 (RTI Act). The Act requires public authorities to ensure prompt access to information they hold or oversee and establishes information commissions at both central and state levels. Nonetheless, in spite of its potential for transformation, the RTI framework has not escaped systemic shortcomings[11].

[9] Menon, S., and Hartz-Karp, J. (2019). Institutional innovations in public participation for improved local governance and urban sustainability in India. *Sustainable Earth*, 2(1). https://doi.org/10.1186/s42055-019-0013-x

[10] Sol, D. A. d. (2013). The institutional, economic and social determinants of local government transparency. *Journal of Economic Policy Reform*, 16(1), 90-107. https://doi.org/10.1080/17487870.2012.759422

[11] Berkeley, S. et al. (2020). A Snapshot of RTI Implementation a Decade Later: New Picture, Same Story. *Journal of Learning Disabilities*, 53(5), 332-342. https://doi.org/10.1177/0022219420915867

Main obstacles consist of:

- Delay in Handling RTI Requests: Findings from the Commonwealth Human Rights Initiative and Satark Nagrik Sangathan show that a large number of RTI requests are unresolved past the legal 30-day timeframe, particularly in matters concerning sensitive departments[12].
- Overreliance on Exemptions: Section 8 of the Act, detailing exemptions from disclosure, is often used to reject valid inquiries, particularly those concerning financial and administrative matters[13].
- Diminution of Information Commissions: The RTI Amendment Act of 2019 provided the central government with control over the terms and pay of Information Commissioners, consequently undermining their autonomy[14].
- Fear of Consequences: Numerous recorded cases exist where RTI activists encountered threats, harassment, or even assassination, deterring public involvement with the transparency framework[15].

2.4 Illustrative Case Studies of Opacity in India

A. Alteration of Land Records

A consistent source of public dissatisfaction is the absence of clear land ownership documentation. In spite of efforts towards digitization, interference with land records and unauthorized encroachments persists widely[16]. The unclear nature of "Record of Rights" and mutations enables fraudulent transfers, unlawful dispossession, and an excess of litigation. The Delhi Land Records Modernization Programme revealed inconsistencies in more than 20% of the digitized records because of human mistakes or alterations[17].

[12] Bhattacharjee, M., and Mysoor, D. (2015). "Unredressed" Grievances under RTE: Navigating the State Labyrinth. *Governance*, 29(1), 31-45. https://doi.org/10.1111/gove.12132

[13] AbouAssi, K., and Nabatchi, T. (2018). A Snapshot of FOIA Administration: Examining Recent Trends to Inform Future Research. *The American Review of Public Administration*, 49(1), 21-35. https://doi.org/10.1177/0275074018771683

[14] Yerramsetti, S. (2019). Not decided in the kitchen! Technocracy and the regulatory-welfare politics of India's Direct Benefits Transfer reform. *International Review of Administrative Sciences*, 87(4), 908-924. https://doi.org/10.1177/0020852319873708

[15] Zafarullah, H., and Siddiquee, N. A. (2021). Open government and the right to information: Implications for transparency and accountability in Asia. *Public Administration and Development*, 41(4), 157-168. https://doi.org/10.1002/pad.1944

[16] Abdulai, R. T. et al. (2007). Land registration and security of land tenure: *Case studies of Kumasi, Tamale, Bolgatanga and Wa in Ghana*. *International Development Planning Review*, 29(4), 475-502. https://doi.org/10.3828/idpr.29.4.7

[17] Jonnalagadda, I., Stock, R., and Misquitta, K. (2021). TITLING AS A CONTESTED PROCESS: Conditional Land Rights and Subaltern Citizenship in South India. *International Journal of Urban and Regional Research*, 45(3), 458-476. https://doi.org/10.1111/1468-2427.13002

B. Scheme for Electoral Bonds

Launched in 2017, the Electoral Bonds Scheme permits concealed contributions to political parties through instruments bought from the State Bank of India. The absence of donor disclosure and audit trails has faced criticism from the Election Commission of India and civil society organizations for compromising financial transparency[18]. Even requests under RTI concerning donor identities or sale information have been denied, referencing "commercial confidence[19]"

C. COVID-19 Statistics and Welfare Distribution

Throughout the COVID-19 pandemic, unclear data sharing methods influenced public confidence in government decision-making. The lack of transparency regarding CoWIN's backend architecture and inconsistencies in distributing oxygen, beds, and relief funds underscored the effects of an opaque governance model during crises[20].

2.5 The Digital Opacity Paradox

Interestingly, the shift towards digital governance has, in some cases, exacerbated opacity rather than resolving it. A phenomenon known as the "Digital Opacity Paradox" occurs when systems that are digitized are intentionally designed without transparency[21]. Government dashboards might provide substantial amounts of data; however, if this data isn't machine-readable, updated regularly, or meaningfully disaggregated, it does not effectively encourage genuine transparency[22]. Additionally, algorithmic opacity—where AI/ML systems are employed to make decisions affecting the public without clear explanations—complicates issues even more.

2.6 The Argument for Technological Solutions

Due to the constraints of traditional legal tools and digitization initiatives, there is increasing interest in employing technological solutions that make it fundamentally hard to maintain

[18] Kumar, A., Banerjee, S., and Dhar, S. (2020). Pathways of money: insights from the 2017 Gujarat assembly election. *India Review*, 19(5), 448-470. https://doi.org/10.1080/14736489.2020.1855012
[19] Raivola, V. et al. (2018). Blood donors' preferences for blood donation for biomedical research. *Transfusion*, 58(7), 1640-1646. https://doi.org/10.1111/trf.14596
[20] Vasudevan, V. et al. (2022). Assessment of COVID-19 data reporting in 100+ websites and apps in India. *PLOS Global Public Health*, 2(4), e0000329. https://doi.org/10.1371/journal.pgph.0000329
[21] Burrell, J. (2016). How the machine 'thinks': Understanding opacity in machine learning algorithms. *Big Data & Society*, 3(1). https://doi.org/10.1177/2053951715622512
[22] Murillo, M. J. (2014). Evaluating the role of online data availability: The case of economic and institutional transparency in sixteen Latin American nations. *International Political Science Review*, 36(1), 42-59. https://doi.org/10.1177/0192512114541163

opacity. Blockchain, due to its secure, unchangeable, and decentralized nature, offers a novel method for enhancing institutional transparency[23]. In regions susceptible to corruption or inaccurate reporting, blockchain can establish a public, verifiable audit trail that diminishes reliance on bureaucratic disclosures or retrospective accountability measures.

Nonetheless, implementing these technologies requires a fundamental reevaluation of public systems: shifting from restricted access to open verification, from voluntary disclosures to automatic transparency, and from after-the-fact investigations to immediate auditability[24].

Grasping the characteristics and continuation of government secrecy is crucial before suggesting any technological or legal remedies. The Indian transparency framework, though advanced in theory, suffers from execution shortcomings, institutional opposition, and systemic stagnation[25].

3. Blockchain Technology – A Primer

3.1 Conceptual Foundations of Blockchain

Blockchain is a distributed ledger technology (DLT) that enables data to be recorded, confirmed, and shared among a network of computers (nodes) in a way that is secure through cryptography, transparent, and resistant to tampering[26]. In contrast to conventional centralized databases overseen by one authority, blockchain operates on a decentralized framework where every participant holds a copy of the ledger and confirms new entries via consensus processes[27].

Every piece of data on a blockchain is contained within a "block," and these blocks are connected in sequence via cryptographic hashes, creating an unchangeable "chain." After data is recorded on the blockchain and validated by the network, changing it afterward is almost impossible without redoing all later blocks—an unfeasible task in typical situations[28].

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[23] Cui, Y., Gaur, V., and Liu, J. (2024). Supply Chain Transparency and Blockchain Design. *Management Science*, 70(5), 3245-3263. https://doi.org/10.1287/mnsc.2023.4851

[24] https://repository.tudelft.nl/file/File_8511f7f0-ccc4-4cb5-b9bc-86bad21fccd7

[25] Mathur, N. (2012). Transparent-making Documents and the Crisis of Implementation: A Rural Employment Law and Development Bureaucracy in India. *PoLAR: Political and Legal Anthropology Review*, 35(2), 167-185. https://doi.org/10.1111/j.1555-2934.2012.01197.x

[26] Gamage, H. T. M., Weerasinghe, H. D., and Dias, N. G. J. (2020). A Survey on Blockchain Technology Concepts, Applications, and Issues. *SN Computer Science*, 1(2). https://doi.org/10.1007/s42979-020-00123-0

[27] Zheng, X. R., and Lu, Y. (2021). Blockchain technology – recent research and future trend. *Enterprise Information Systems*, 16(12). https://doi.org/10.1080/17517575.2021.1939895

[28] Emmadi, N., and Narumanchi, H. (2017). Reinforcing Immutability of Permissioned Blockchains with Keyless Signatures' Infrastructure. *Proceedings of the 18th International Conference on Distributed Computing and Networking*, 1-6. https://doi.org/10.1145/3007748.3018280

The phrase "blockchain" became widely recognized with the emergence of Bitcoin in 2008, presented in Satoshi Nakamoto's white paper. Nonetheless, the application of blockchain has expanded from just cryptocurrencies to encompass supply chain monitoring, smart contracts, identity verification, healthcare, and—most importantly for this paper—public governance and transparency[29].

3.2 Key Characteristics Relevant to Public Transparency

The attraction of blockchain regarding public transparency is based on five fundamental characteristics:

1. Unchangeability

Once information is recorded on a blockchain, it cannot be changed or removed. This establishes a tamper-evident record system that prevents the retroactive alteration of public records—especially crucial in high-corruption contexts such as land records or procurement activities[30].

2. Decentralization

Blockchain eliminates the requirement for a central intermediary or reliable authority to authenticate transactions. In a public governance environment, this restricts bureaucrats' monopolistic hold over official data and lessens information asymmetry[31].

3. Clarity and Verifiability

Public blockchains possess inherent transparency: anyone can view the ledger and track past transactions. Private or permissioned blockchains can also be set up to allow citizens to read data while ensuring privacy safeguards for delicate information[32].

[29] Carter, L., and Ubacht, J. (2018). Blockchain applications in government. *Proceedings of the 19th Annual International Conference on Digital Government Research: Governance in the Data Age*. https://doi.org/10.1145/3209281.3209329

[30] Ramya, U. M. et al. (2018). Reducing Forgery in Land Registry System Using Blockchain Technology. *Communications in Computer and Information Science*, 725-734. https://doi.org/10.1007/978-981-13-3140-4_65

[31] Schmidthuber, L., Willems, J., and Krabina, B. (2023). Trust in public performance information: The effect of data accessibility and data source. *Public Administration Review*, 83(2), 279-295. https://doi.org/10.1111/puar.13603

[32] Elisa, N. et al. (2018). A framework of blockchain-based secure and privacy-preserving E-government system. *Wireless Networks*, 29(3), 1005-1015. https://doi.org/10.1007/s11276-018-1883-0

4. Agreement Processes

Blockchain transactions are verified using consensus mechanisms (e.g., Proof of Work, Proof of Stake, Practical Byzantine Fault Tolerance). These processes guarantee that only valid and consensual data is incorporated into the chain, reducing human discretion in verification[33].

3.3 Types of Blockchain Architectures and Their Use in Governance

Comprehending various blockchain frameworks is essential for evaluating their usefulness in the public domain:

A. Open (Unrestricted) Blockchains

These are accessible to everyone and provide the highest level of transparency. Instances consist of Bitcoin and Ethereum. Nevertheless, public blockchains could present data privacy issues in governance because of their open-access characteristics and reduced transaction speeds[34].

B. Private (Permissioned) Blockchain Systems

Access is limited to specific nodes, usually managed by an organization or consortium. These are more scalable and appropriate for sensitive government operations, like internal audits, land registries, or voting systems, while maintaining verifiability among authorized participants[35].

C. Collaborative Blockchains

These are hybrid systems overseen by a collective of stakeholders, including government bodies, NGOs, and private enterprises. They provide a balanced approach between decentralization and operational oversight, making them suitable for governance systems involving multiple stakeholders, such as smart cities or inter-departmental records[36].

In India, states such as Andhra Pradesh and Telangana have utilized permissioned blockchains to safeguard land ownership and registration information, showing promising outcomes in decreasing document forgery and providing public access to validated land titles.

[33] http://arxiv.org/pdf/1906.11461
[34] https://repository.tudelft.nl/file/File_08ab182f-15f2-4fff-9edd-ff38583aecbf
[35] Müller, J., and Truderung, T. (2023). A Protocol for Cast-as-Intended Verifiability with a Second Device. arXiv. https://doi.org/10.48550/ARXIV.2304.09456
[36] Brinkmann, M., and Heine, M. (2019). Can Blockchain Leverage for New Public Governance?. *Proceedings of the 12th International Conference on Theory and Practice of Electronic Governance*, 338-341. https://doi.org/10.1145/3326365.3326409

3.4 Blockchain vs. Traditional Digital Record Systems

Blockchain must be differentiated from conventional digital databases that power most of India's e-governance infrastructure. While digital databases are centralized, editable, and opaque to users, blockchain systems are distributed, immutable, and auditable[37]. This structural distinction has important implications for public law, especially in the context of the Right to Information and due process under Article 21.

Country	Sector	Blockchain Use Case	Transparency Contribution
Estonia	E-governance	KSI blockchain for public data	Real-time audits, citizen oversight
Georgia	Land records	Property title registration	Fraud prevention, public trust
Brazil	Procurement	Blockchain-based tendering	Contract integrity, citizen audit
UAE	Government finance	DubaiPay and smart contracts	Process automation, traceability
Sweden	Real estate	Blockchain property transaction pilot	Speed, document security
South Korea	Electoral processes	Blockchain voting system	Ballot integrity, digital inclusion

This comparison underscores why blockchain is seen not just as a digital tool but as a governance architecture that realigns incentives and constrains discretionary power.

3.5 Obstacles to Blockchain Implementation

Although the theoretical potential of blockchain is considerable, its practical application in the public sector is laden with difficulties:

- Scalability: Public blockchains encounter restrictions on throughput. Elevated transaction volumes, like those associated with providing identity or welfare services, demand improved scalability.
- Interoperability: Current public IT systems (such as Aadhaar, DigiLocker, or land registration portals) often lack compatibility with blockchain frameworks, necessitating expensive upgrades and alignment of policies.

[37] Nathan, S. et al. (2019). Blockchain meets database. *Proceedings of the VLDB Endowment*, 12(11), 1539-1552. https://doi.org/10.14778/3342263.3342632

- Legal Uncertainty: India does not have an established regulatory structure overseeing blockchain implementation in governmental operations. Without supportive legislation, the execution stays fragmented and reliant on pilot projects.
- Privacy Issues: The unchangeable aspect of blockchain could clash with privacy rights and new data protection standards set by the Digital Personal Data Protection Act, 2023, especially in terms of data removal and modification.
- Technological Literacy: Many citizens and frontline public officials frequently do not possess sufficient knowledge of blockchain systems, leading to worries about exclusion and potential misuse.

3.6 The Governance Potential of Blockchain as a Normative Tool

Notwithstanding these constraints, the use of blockchain in governance is increasingly gaining momentum worldwide. The World Bank, OECD, and United Nations Development Programme (UNDP) have promoted governance models based on blockchain in various areas including land management, supply chains, public procurement, and welfare distribution[38].

What sets blockchain apart from other digital innovations is its normative promise: it provides not only enhanced efficiency but also structural accountability by incorporating transparency into the technology itself[39]. By transferring verification authority from individuals to protocol, blockchain reduces unpredictability and rebuilds public confidence in governmental entities.

Blockchain, viewed as a "transparency infrastructure," contests conventional notions of information control in governance. It is not just a tool but a revolutionary constitutional design that can change the creation, verification, and access of public records[40].

4. Blockchain in Indian Public Administration

Despite being in its early stages within public administration, blockchain technology has started to see practical uses in several Indian states and governmental projects. These applications, although not widely adopted yet, offer important perspectives on how decentralized technologies can enhance transparency, minimize bureaucratic obscurity, and rebuild public

[38] Cunha, P. R. d., Soja, P., and Themistocleous, M. (2021). Blockchain for development: a guiding framework. *Information Technology for Development*, 27(3), 417-438. https://doi.org/10.1080/02681102.2021.1935453

[39] Zhang, T., Jia, F., and Chen, L. (2024). Blockchain adoption in supply chains: implications for sustainability. *Production Planning & Control*, 36(5), 699-722. https://doi.org/10.1080/09537287.2023.2296669

[40] Hicks, A. (2023). SoK: Log Based Transparency Enhancing Technologies. arXiv. https://doi.org/10.48550/ARXIV.2305.01378

confidence[41]. This part rigorously analyzes significant Indian use cases, organized by sectors including land governance, identity verification, procurement, public finance, and electoral reforms.

4.1 Management of Land Records and Property Titles

One of the initial and most important applications of blockchain in India has been in land record management—a field traditionally affected by corruption, fake registrations, and a lack of transparency.

Case Analysis: Andhra Pradesh and Telangana

Both states have collaborated with blockchain companies such as Zebi Data India and ChromaWay to create unchangeable land registries utilizing permissioned blockchain networks[42]. These initiatives seek to guarantee that land ownership titles are recorded in a secure ledger, available to all parties involved—buyers, sellers, government agencies, and banks[43].

- Effect: The system aids in decreasing land conflicts, simplifies property transaction verifications, and lowers the chances of title fraud.
- Constraints: Although technology has been implemented, the backend digitization and validation of historical data continue to be labor-heavy and politically delicate.
- Transparency Advantage: Blockchain guarantees that once property information is documented, it cannot be altered without agreement, deterring bureaucratic wrongdoing and land theft.

4.2 Management of Identity and Verification of Citizens

Trustworthy and clear identity verification is essential for effective governance. Although India has a centralized biometric identity system (Aadhaar), blockchain offers an alternative decentralized identity (DID) framework[44].

[41] https://repository.tudelft.nl/file/File_8511f7f0-ccc4-4cb5-b9bc-86bad21fccd7
[42] Yadav, A. S., and Kushwaha, D. S. (2021). Digitization of Land Record Through Blockchain-based Consensus Algorithm. *IETE Technical Review*, 39(4), 799-816. https://doi.org/10.1080/02564602.2021.1908859
[43] Yadav, A. S., and Kushwaha, D. S. (2021). Digitization of Land Record Through Blockchain-based Consensus Algorithm. *IETE Technical Review*, 39(4), 799-816. https://doi.org/10.1080/02564602.2021.1908859
[44] T, M., Makkithaya, K., and V G, N. (2022). A Blockchain Based Decentralized Identifiers for Entity Authentication in Electronic Health Records. *Cogent Engineering*, 9(1). https://doi.org/10.1080/23311916.2022.2035134

IIT Madras & IndiaStack's Research on Blockchain-based Identity

IIT Madras has been investigating blockchain-oriented digital identity systems in partnership with IndiaStack. The goal is to empower citizens with greater control over their personal information by enabling them to share and retract access to verified credentials (such as birth certificates and caste certificates) without revealing their complete data history[45].

- Application: Beneficial in distributing welfare, administering scholarships, and ensuring regulatory compliance.
- Increased Transparency: The auditability of blockchain guarantees that citizen data access is recorded and cannot be abused by authorities without leaving a trace.

4.3 Government Procurement and Digital Governance

Public procurement in India represents around 20-30% of GDP and is frequently unclear, prone to bias, and affected by bid manipulation[46]. E-procurement systems powered by blockchain can remove a significant portion of the discretion that drives corruption.

Pilot: NITI Aayog's Proposal for Blockchain Procurement

In 2020, NITI Aayog suggested a blockchain-driven procurement system for government tenders to record each phase of the bidding process—tender issuance, bid submission, evaluation, and final awarding—on an unchangeable and timestamped chain[47].

- Possible Advantages: Improves audit capability, minimizes tender manipulation, and permits immediate public scrutiny.
- Challenges: Opposition from established stakeholders, compatibility issues with older systems, and unclear policies.

4.4 Monetary Transfers and Welfare Provision

Blockchain has the potential to transform the execution of direct benefit transfers (DBTs) under programs such as PM-KISAN, MNREGA, and Ujjwala Yojana by reducing leakage and

[45] T, M., Makkithaya, K., and V G, N. (2022). A Blockchain Based Decentralized Identifiers for Entity Authentication in Electronic Health Records. *Cogent Engineering*, 9(1). https://doi.org/10.1080/23311916.2022.2035134

[46] Bhagat, G. (2017). Public Procurement: A Competition Perspective. *Indian Journal of Public Administration*, 63(2), 176-186. https://doi.org/10.1177/0019556117699736

[47] Kaushik, A. (2020). New technology interventions including blockchain technology in land record and registry management in India. *Proceedings of the 13th International Conference on Theory and Practice of Electronic Governance*, 143-151. https://doi.org/10.1145/3428502.3428521

providing real-time verification[48].

Framework Concept: Tokenized Welfare Benefits

A blockchain-driven system can produce programmable digital tokens that are allotted to recipients only when eligibility criteria are met[49]. Intelligent contracts can streamline compliance verifications (e.g., property ownership, Aadhaar connection, attendance) and disburse funds without administrative holdups.

- Situation in India: Although research is ongoing, talks about Central Bank Digital Currency (CBDC) by the RBI may promote these blockchain-based welfare systems.
- Transparency Edge: Unchangeable ledger records for every rupee spent can guarantee financial responsibility and decrease phantom beneficiaries.

4.5 Integrity of Elections and Voting from a Distance

India's election systems, though strong, encounter logistical challenges and trust issues, particularly among migrant voters and in areas with low participation rates. Blockchain technology can improve the transparency of maintaining the electoral roll and also facilitate remote voting[50].

Project: Election Commission & IIT Madras Blockchain Voting Model

In 2020, the Election Commission of India partnered with IIT Madras to create a blockchain-based e-voting system that enables migrants to securely vote from distant places, utilizing their Aadhaar-linked identities[51].

- Security Advantage: A fully verifiable blockchain ledger guarantees that every vote is counted correctly and remains untouchable.
- Issues: The digital divide, potential coercion in remote voting settings, and cybersecurity threats must be addressed before widespread implementation.

[48] Singh, S. K. et al. (2020). A conceptual model for Indian public distribution system using consortium blockchain with on-chain and off-chain trusted data. *Information Technology for Development*, 27(3), 499-523. https://doi.org/10.1080/02681102.2020.1847024

[49] Pawar, R. S., Sonje, S. A., and Shukla, S. (2020). Food subsidy distribution system through Blockchain technology: a value focused thinking approach for prototype development. *Information Technology for Development*, 27(3), 470-498. https://doi.org/10.1080/02681102.2020.1841714

[50] https://downloads.hindawi.com/journals/mpe/2024/5591147

[51] Malathy, V. et al. (2020). Radio frequency identification based electronic voting machine using fingerprint module. *IOP Conference Series: Materials Science and Engineering*, 981(3), 032018. https://doi.org/10.1088/1757-899x/981/3/032018

4.6 Judicial System and Court Documents

India's judicial system, weighed down by case backlogs and procedural inefficiencies, could gain from blockchain-powered e-court platforms to monitor case developments, filings, and evidence submissions[52].

Pilot Talks: Supreme Court's E-Committee

Internal discussions have taken place regarding the use of blockchain technology for timestamping court filings and ensuring unalterable case records, particularly in commercial litigation and arbitration.

- Transparency Dividend: Stops the alteration of court documents, guarantees prompt access for litigants, and promotes fairness in procedures.

4.7 Difficulties in Various Use Cases

In spite of these varied uses, the integration of blockchain in Indian governance is still inconsistent and experimental because of:

- Absence of Cohesive Policy Structure: The lack of national standards and legal acknowledgment for blockchain records restricts scalability.
- Capacity Limitations: Government personnel frequently do not possess the technical expertise to oversee or evaluate blockchain systems.
- Significant Upfront Expenses: Although blockchain can provide cost savings over time, the initial investment in infrastructure, training, and legal adherence is considerable.

India's blockchain initiatives in governance signify a transition to algorithmic accountability, ensuring transparency is inherently integrated rather than reliant on bureaucratic goodwill[53]. These scenarios offer both a framework and a warning: although the technology has significant potential, its implementation must be legally sound, ethically constructed, and socially inclusive[54].

[52] https://storage.googleapis.com/jnl-up-j-ijca-files/journals/1/articles/391/submission/proof/391-1-1832-1-10-20210506

[53] Ning, X., Ramirez, R., and Khuntia, J. (2021). Blockchain-enabled government efficiency and impartiality: using blockchain for targeted poverty alleviation in a city in China. *Information Technology for Development*, 27(3), 599-616. https://doi.org/10.1080/02681102.2021.1925619

[54] Solarova, S. et al. (2022). Reconsidering the regulation of facial recognition in public spaces. *AI and Ethics*, 3(2), 625-635. https://doi.org/10.1007/s43681-022-00194-0

5. Comparative International Methods for Blockchain and Transparency

Governments around the globe are progressively embracing blockchain technology to address lack of clarity, improve transparency, and simplify administrative procedures[55]. This segment explores international case studies to comprehend the various applications of blockchain in public administration and the possible insights these nations provide for India.

5.1 Estonia: Leading the Way in Blockchain-Enabled E-Governance

Estonia is a leader in digital governance, incorporating blockchain technology into multiple essential public services since 2008. The Estonian government adopted the Keyless Signature Infrastructure (KSI) blockchain, created by Guardtime, to protect national data[56]. This blockchain system guarantees that alterations to public records are recorded with timestamps and stored on decentralized nodes, making it easy to identify tampering[57].

The KSI blockchain is implemented in essential areas like e-health, e-judiciary, digital identity, and land registration. Estonian citizens can monitor who has viewed their medical information or legal documents, ensuring complete transparency in governmental activities[58]. Estonia's strategy illustrates how blockchain effectively facilitates real-time audits and enables citizens to manage their personal information. The effectiveness of Estonia's e-governance system is based on its institutional dedication, initial investment in digital infrastructure, and established legal frameworks, aspects that India should embrace to achieve comparable results[59].

5.2 Georgia: Obtaining Land Titles through Blockchain

In 2016, Georgia was the first nation to implement blockchain technology for land title registration. In partnership with Bitfury, the National Agency of Public Registry (NAPR) established a blockchain system for documenting property ownership and transaction

[55] https://repository.tudelft.nl/file/File_08ab182f-15f2-4fff-9edd-ff38583aecbf
[56] Buldas, A., Kroonmaa, A., and Laanoja, R. (2013). Keyless Signatures' Infrastructure: How to Build Global Distributed Hash-Trees. *Lecture Notes in Computer Science*, 313-320. https://doi.org/10.1007/978-3-642-41488-6_21
[57] Rohrer, E., Heidel, S., and Tschorsch, F. (2020). Enabling Reference Verifiability for the World Wide Web with Webchain. *ACM Transactions on Internet Technology*, 20(4), 1-23. https://doi.org/10.1145/3392097
[58] Nøhr, C. et al. (2017). Nationwide citizen access to their health data: analysing and comparing experiences in Denmark, Estonia and Australia. *BMC Health Services Research*, 17(1). https://doi.org/10.1186/s12913-017-2482-y
[59] Gupta, R., Muttoo, S. K., and Pal, S. K. (2020). Regional E-governance Development Index for Developing Nations. *Digital Government: Research and Practice*, 1(3), 1-26. https://doi.org/10.1145/3386163

information[60]. By linking the cryptographic hash of every property transaction to the Bitcoin blockchain, Georgia guaranteed that ownership records remained unchangeable and resistant to tampering[61].

This effort has greatly diminished fraud and corruption within the land registry system. It additionally enhanced the efficiency of real estate deals, lowering both the time and expenses associated with property title transfers. In a nation such as India, where land conflicts and deceitful transactions are common, Georgia's approach may act as a scalable framework for enhancing transparency and responsibility in property transactions, especially in rural regions where documentation is frequently inadequately maintained[62].

5.3 Brazil: Blockchain for Transparency in Procurement

Brazil, affected by prominent corruption scandals like Operation Car Wash, has utilized blockchain to enhance transparency in government purchasing. The b-Procurement platform created by the Brazilian Ministry of Planning logs tendering and bidding information on a blockchain, forming an unchangeable record of public contracts[63].

The implementation of blockchain in public procurement has resulted in multiple significant results. It has aided in preventing corruption, minimizing administrative delays, and allowed immediate public access to procurement processes, encouraging public oversight. Brazil's experience shows that blockchain can serve as a powerful instrument in reforming systems after a crisis, restoring public confidence in governance[64] (Tavares et al., 2020). For India, which encounters persistent issues in public procurement, Brazil's method presents a viable and expandable framework for incorporating blockchain into the tendering and contract awarding processes to diminish corruption and inefficiency.

[60] Yadav, A. S., and Kushwaha, D. S. (2021). Digitization of Land Record Through Blockchain-based Consensus Algorithm. *IETE Technical Review*, 39(4), 799-816. https://doi.org/10.1080/02564602.2021.1908859
[61] Konashevych, O., and Poblet, M. (2018). Is Blockchain Hashing an Effective Method for Electronic Governance?. arXiv. https://doi.org/10.48550/ARXIV.1810.08783
[62] Yadav, A. S., and Kushwaha, D. S. (2021). Digitization of Land Record Through Blockchain-based Consensus Algorithm. *IETE Technical Review*, 39(4), 799-816. https://doi.org/10.1080/02564602.2021.1908859
[63] Ferreira, I., and Amaral, L. A. (2016). Public e-Procurement. *Proceedings of the 9th International Conference on Theory and Practice of Electronic Governance*, 9-12. https://doi.org/10.1145/2910019.2910089
[64] Corrêa Tavares, E. et al. (2020). Blockchain in the Amazon: creating public value and promoting sustainability. *Information Technology for Development*, 27(3), 579-598. https://doi.org/10.1080/02681102.2020.1848772

5.4 Emiratos Árabes Unidos: Blockchain para Servicios Gubernamentales Integrales

The United Arab Emirates (UAE) is aiming for an ambitious goal of shifting 50% of governmental transactions to blockchain by 2030. Through the Dubai Blockchain Strategy, the UAE government is integrating blockchain technology across various sectors, such as public finance, real estate, and visa issuance[65]. A notable instance is the DubaiPay Blockchain Settlement System, which streamlines the reconciliation of financial transactions among government agencies.

The UAE's initiatives to implement blockchain on such a large scale demonstrate its dedication to intelligent governance. By transferring intergovernmental transactions to a blockchain, the UAE has reduced human mistakes, boosted efficiency, and improved financial transparency[66]. Nonetheless, this widespread use of blockchain necessitates significant interdepartmental coordination, a difficulty for nations such as India that have decentralized governance systems and intricate bureaucracies. The UAE's experience emphasizes the significance of interoperability and advanced digital infrastructure in facilitating effective blockchain implementation[67].

5.5 Sweden: Using Blockchain in Real Estate Deals

Sweden is experimenting with blockchain technology for real estate transactions via a pilot initiative spearheaded by the Swedish Land Registry (Lantmäteriet), in partnership with ChromaWay and Telia. The system employs smart contracts to streamline real estate transactions, including contract signing, identity verification, and mortgage distribution, while updates are tracked in real time on the blockchain[68].

The pilot has already resulted in notable enhancements in transaction speed and transparency. Real estate transactions, which used to be a tedious and fraud-attracting procedure, are now finalized in days instead of months. Sweden's blockchain system enhances legal certainty by

[65] Ismail, L. et al. (2019). Towards a Blockchain Deployment at UAE University. *Proceedings of the 2019 International Conference on Blockchain Technology*. https://doi.org/10.1145/3320154.3320156
[66] Al Shanti, A. M., and Elessa, M. S. (2022). The impact of digital transformation towards blockchain technology application in banks to improve accounting information quality and corporate governance effectiveness. *Cogent Economics & Finance*, 11(1). https://doi.org/10.1080/23322039.2022.2161773
[67] Ismail, L. et al. (2019). Towards a Blockchain Deployment at UAE University. *Proceedings of the 2019 International Conference on Blockchain Technology*. https://doi.org/10.1145/3320154.3320156
[68] Krupa, K. S., and Akhil, M. S. (2019). Reshaping the Real Estate Industry Using Blockchain. *Lecture Notes in Electrical Engineering*, 255-263. https://doi.org/10.1007/978-981-13-5802-9_24

guaranteeing that all transaction records are unchangeable and can be easily audited[69]. This model may be especially useful in India, where land records frequently face manipulation and fraud, especially in rural regions. By embracing Sweden's flexible, expandable method, India can tackle its land registration issues and minimize the involvement of intermediaries in property dealings.

5.6 South Korea: Blockchain in Voting Systems and Public Security

South Korea has adopted blockchain technology across multiple sectors, such as food safety oversight and electoral systems. A primary focus of its efforts is the creation of a mobile voting system utilizing blockchain technology, partnering with ICONLOOP[70]. This system aims to guarantee the integrity and safety of the voting procedure, rendering it impervious to fraud and interference.

The voting system based on blockchain improves citizen engagement by facilitating secure, transparent, and tamper-resistant voting. In a nation characterized by elevated digital literacy and public confidence in technology, the pilot initiative has effectively showcased blockchain's capability for ensuring electoral transparency[71]. India, as it investigates electronic voting systems, may learn important lessons from South Korea's experience, especially in terms of voter security, anonymity, and trust. Although the digital divide in India poses difficulties, pilot initiatives focused on urban migrant groups or specific states might provide a solution[72].

5.7 Summary of Comparisons

A comparative examination of the blockchain projects in Estonia, Georgia, Brazil, UAE, Sweden, and South Korea uncovers several shared themes and key takeaways:

- Modular Pilot Strategies: Estonia, Georgia, and Sweden initially implemented targeted blockchain solutions in particular areas (such as land registration, real estate deals, and

[69] Sachan, S., and Liu (Lisa), X. (2024). Blockchain-based auditing of legal decisions supported by explainable AI and generative AI tools. *Engineering Applications of Artificial Intelligence*, 129, 107666. https://doi.org/10.1016/j.engappai.2023.107666

[70] Huang, J. et al. (2021). The Application of the Blockchain Technology in Voting Systems. *ACM Computing Surveys*, 54(3), 1-28. https://doi.org/10.1145/3439725

[71] Alam, M., Yusuf, M. O., and Sani, N. A. (2020). Blockchain technology for electoral process in Africa: a short review. *International Journal of Information Technology*, 12(3), 861-867. https://doi.org/10.1007/s41870-020-00440-w

[72] Sindakis, S., and Showkat, G. (2024). The digital revolution in India: bridging the gap in rural technology adoption. *Journal of Innovation and Entrepreneurship*, 13(1). https://doi.org/10.1186/s13731-024-00380-w

procurement) and grew them according to their success[73]. India ought to explore pilot initiatives focused on areas with significant opacity, like land records or public procurement, before rolling out blockchain more broadly.

- Regulatory Structures and Institutional Backing: Estonia's achievements were significantly influenced by a solid institutional dedication and a comprehensive legal structure for digital administration. India needs to guarantee that the adoption of blockchain is backed by transparent regulations that affirm the legal standing of blockchain records, particularly in areas like land registration and public procurement.
- Public Trust and Citizen Access: Estonia and South Korea emphasize the significance of citizen-focused design in blockchain-oriented systems[74]. India must focus on enhancing digital literacy and accessibility to guarantee that blockchain solutions are inclusive and broadly embraced by the populace.
- Interdepartmental Coordination: The UAE's comprehensive strategy necessitates substantial interdepartmental collaboration[75]. India's decentralized framework may pose difficulties in achieving interoperability among different state and central government agencies, yet this can be addressed through pilot projects and incremental integration.

5.8 Important Takeaways for India

Drawing from the experiences of Estonia, Georgia, Brazil, UAE, Sweden, and South Korea, various important lessons can be identified for India. The effectiveness of blockchain in enhancing transparency within public governance relies on initiating targeted, scalable pilot projects, establishing robust legal and institutional structures, fostering citizen engagement, and encouraging collaboration between departments[76]. By adjusting these worldwide best practices to address India's specific challenges, the nation can make considerable progress in enhancing transparency and minimizing corruption within public administration.

[73] Ølnes, S., and Jansen, A. (2018). Blockchain technology as infrastructure in public sector. *Proceedings of the 19th Annual International Conference on Digital Government Research: Governance in the Data Age*, 1-10. https://doi.org/10.1145/3209281.3209293

[74] Toros, K. et al. (2020). Co-creation of social services on the example of social hackathon: The case of Estonia. *International Social Work*, 65(4), 593-606. https://doi.org/10.1177/0020872820904130

[75] Elbanna, S. (2013). Processes and Impacts of Strategic Management: Evidence From the Public Sector in the United Arab Emirates. *International Journal of Public Administration*, 36(6), 426-439. https://doi.org/10.1080/01900692.2013.772629

[76] https://repository.tudelft.nl/file/File_08ab182f-15f2-4fff-9edd-ff38583aecbf

6. Dangers, Constraints, and Moral Issues of Blockchain in Governance

Although blockchain offers a hopeful solution for enhancing transparency and efficiency in governmental systems, its use in public governance comes with risks and constraints. The difficulties of deploying blockchain in governance are complex, involving technical, legal, social, and ethical issues[77]. This part examines the dangers linked to blockchain technology and its possible constraints, along with the ethical challenges it could present in the realm of public governance.

6.1 Technical Constraints of Blockchain in Governance

Blockchain technology is inherently decentralized and depends on a network of distributed nodes to authenticate and document transactions. This decentralized characteristic, although beneficial for encouraging transparency, also presents various technical difficulties[78]. Initially, scalability continues to be a major issue. Blockchain networks, especially those utilizing proof-of-work consensus protocols, can demand significant resources and might find it difficult to manage high transaction volumes, presenting obstacles for governments managing millions of daily activities, like tax submissions, voting, or distributing public services.

Moreover, the energy usage linked to sustaining a blockchain, particularly with cryptographic methods such as Bitcoin's proof-of-work, can be considerable. This energy usage poses a significant challenge for governments aiming to adopt blockchain sustainably and in an environmentally friendly way[79]. In nations with restricted digital infrastructure or expensive energy, like India, this may render blockchain implementation both economically and environmentally impractical at a national level.

Another technical constraint is the challenge of interoperability. Governments frequently employ various IT systems and making sure these systems integrate smoothly with blockchain-based solutions can be a challenging endeavor[80]. Without adequate integration, blockchain could fall short of delivering the anticipated advantages regarding efficiency and transparency. India, due to its varied administrative and technological environment, may encounter significant obstacles in achieving a seamless integration of blockchain with current government

[77] https://repository.tudelft.nl/file/File_08ab182f-15f2-4fff-9edd-ff38583aecbf
[78] https://repository.tudelft.nl/file/File_08ab182f-15f2-4fff-9edd-ff38583aecbf
[79] Tanwar, S. et al. (2021). A taxonomy of energy optimization techniques for smart cities: Architecture and future directions. *Expert Systems*, 39(5). https://doi.org/10.1111/exsy.12703
[80] https://repository.tudelft.nl/file/File_08ab182f-15f2-4fff-9edd-ff38583aecbf

systems[81].

6.2 Challenges in Legal and Regulatory Frameworks

The incorporation of blockchain into public administration necessitates meticulous consideration of legal and regulatory matters. In numerous regions, the legal standing of blockchain records is still unclear, particularly regarding their acceptance in court proceedings[82]. In contrast to conventional paper records, blockchain records are digital and cannot be altered, leading to inquiries regarding their legal acknowledgment. Numerous legal structures were not created to support such decentralized, immutable records, posing challenges for courts and government bodies to adjust to blockchain's distinct features[83].

Moreover, the absence of consistent regulations among jurisdictions makes the implementation of blockchain more challenging. In India, where regulatory systems are frequently disjointed between central and state levels, executing blockchain solutions would necessitate aligning laws and creating a cohesive regulatory strategy[84]. This process can be lengthy and politically difficult, especially in matters concerning data privacy, intellectual property, and public procurement.

Data sovereignty presents another legal issue. Authorities might worry about how data is stored and managed on decentralized networks, particularly if the blockchain operates in a different jurisdiction. The recent discussions surrounding the global applicability of laws such as the General Data Protection Regulation (GDPR) in the EU underscore the intricacies of data sovereignty, particularly within a progressively globalized digital environment[85]. For India, overcoming these legal hurdles would necessitate a strong legal system that tackles the overlap between domestic laws and global blockchain regulations.

[81] Kaushik, A. (2020). New technology interventions including blockchain technology in land record and registry management in India. *Proceedings of the 13th International Conference on Theory and Practice of Electronic Governance*, 143-151. https://doi.org/10.1145/3428502.3428521
[82] Dwivedi, V. et al. (2021). Legally Enforceable Smart-Contract Languages. *ACM Computing Surveys*, 54(5), 1-34. https://doi.org/10.1145/3453475
[83] Dwivedi, V. et al. (2021). Legally Enforceable Smart-Contract Languages. *ACM Computing Surveys*, 54(5), 1-34. https://doi.org/10.1145/3453475
[84] Dwivedi, V. et al. (2021). Legally Enforceable Smart-Contract Languages. *ACM Computing Surveys*, 54(5), 1-34. https://doi.org/10.1145/3453475
[85] Korobenko, D. (2024). Associated data underlying the study 'Towards Privacy- and Security-Aware Framework for AI Ethics'. Zenodo. https://doi.org/10.5281/ZENODO.10451282

6.3 Ethical Issues

Blockchain can democratize access to information and enhance transparency, yet it also presents notable ethical dilemmas. A major ethical concern is the risk of breaches of data privacy. The transparency of blockchain can reveal private personal details to the public, particularly when people's identities are linked to transactions[86]. Even though blockchain transactions are pseudonymous, the data recorded on them can reveal personal identities, especially in contexts involving public services or voting information.

In places such as India, where privacy is a significant issue, the use of blockchain in public governance may conflict with privacy safeguards. For instance, the Right to Privacy as outlined in Article 21 of the Indian Constitution, which was upheld by the Supreme Court in its significant 2017 ruling, might be jeopardized if blockchain technologies accidentally reveal citizens' information. Consequently, the responsible application of blockchain in governance must guarantee that individual privacy is not compromised for the sake of transparency[87].

Additionally, the use of blockchain may reinforce inequality if its deployment favors certain groups in society more than others. Blockchain solutions demand significant digital proficiency and access to technology. In remote and underprivileged areas, the implementation of blockchain governance systems may disconnect citizens lacking the essential tools or skills to engage with digital platforms[88]. This might worsen the digital divide and obstruct inclusive governance, particularly in a nation such as India, where technology access remains inconsistent.

6.4 Risks Related to Society and Politics

The incorporation of blockchain into governance could also bring social and political dangers. The unchangeable nature of blockchain indicates that once a record is added, it cannot be easily modified. Although this is usually viewed as beneficial for fraud prevention, it may create

[86] Cui, Y., Pan, B., and Sun, Y. (2019). A Survey of Privacy-Preserving Techniques for Blockchain. *Lecture Notes in Computer Science*, 225-234. https://doi.org/10.1007/978-3-030-24268-8_21

[87] Elisa, N. et al. (2018). A framework of blockchain-based secure and privacy-preserving E-government system. *Wireless Networks*, 29(3), 1005-1015. https://doi.org/10.1007/s11276-018-1883-0

[88] Ning, X., Ramirez, R., and Khuntia, J. (2021). Blockchain-enabled government efficiency and impartiality: using blockchain for targeted poverty alleviation in a city in China. *Information Technology for Development*, 27(3), 599-616. https://doi.org/10.1080/02681102.2021.1925619

difficulties when adjustments are necessary[89]. For instance, inaccurate entries or mistakes made during the initial phase of a blockchain setup could become lasting elements in the public record, resulting in serious legal and societal impacts.

The absence of centralized control in blockchain systems might also weaken government power. In certain instances, governments might hesitate to implement a system that diminishes their authority over essential processes. For example, during elections, governments might be reluctant to adopt blockchain voting systems if it reduces their control over the management of the election process.

There is a possibility that harmful individuals could take advantage of blockchain's pseudonymous characteristics to engage in unlawful activities like money laundering, tax evasion, or corruption. Blockchain can offer anonymity, which might be exploited for illegal activities, leading to concerns regarding technology's contribution to enhancing good governance[90]. In a nation such as India, where corruption persists at multiple government levels, there is a valid worry that blockchain might be exploited to hide illegal activities instead of preventing them.

6.5 Addressing the Risks and Ethical Issues

In spite of these obstacles, there are methods to alleviate the risks and ethical issues related to implementing blockchain in governance. One method is to create blockchain systems that include privacy protection, like incorporating zero-knowledge proofs or utilizing private blockchains for sensitive information. These methods enable the transparency and unchangeability of blockchain while safeguarding the privacy of each user[91].

From a legal perspective, governments should create explicit regulations to clarify the legal status of blockchain records and make certain they align with national data protection and

[89] Al-Furiah, S., and Al-Braheem, L. (2009). Comprehensive study on methods of fraud prevention in credit card e-payment system. *Proceedings of the 11th International Conference on Information Integration and Web-based Applications & Services*, 592-598. https://doi.org/10.1145/1806338.1806450

[90] Brinkmann, M., and Heine, M. (2019). Can Blockchain Leverage for New Public Governance?. *Proceedings of the 12th International Conference on Theory and Practice of Electronic Governance*, 338-341. https://doi.org/10.1145/3326365.3326409

[91] Satybaldy, A., and Nowostawski, M. (2020). Review of Techniques for Privacy-Preserving Blockchain Systems. *Proceedings of the 2nd ACM International Symposium on Blockchain and Secure Critical Infrastructure*, 1-9. https://doi.org/10.1145/3384943.3409416

privacy regulations[92]. The establishment of regulatory sandboxes might facilitate experimentation with blockchain in public governance while managing possible legal concerns in a regulated setting.

Ultimately, the digital divide should be tackled by implementing inclusive digital literacy initiatives and providing access to technology[93]. It is crucial to provide all citizens with the resources to engage with blockchain systems to avoid exacerbating current inequalities.

Blockchain possesses significant potential to improve transparency, accountability, and efficiency within governmental systems[94]. Nonetheless, its incorporation into public governance involves considerable technical, legal, ethical, and social risks. Tackling these issues necessitates meticulous planning, legislative change, and considerate execution[95]. By actively tackling these challenges, governments can take advantage of blockchain's benefits while reducing its downsides, guaranteeing that it aids in fostering more transparent, accountable, and equitable governance[96].

7. Summary and Future Perspectives

Blockchain technology has surfaced as a groundbreaking influence across multiple sectors, and its capacity to revolutionize public governance is indisputable. With increased transparency, security, and efficiency, blockchain can profoundly change how governments function, engage with citizens, and oversee public resources. This study has examined the possibility of blockchain to tackle government transparency issues and its capacity to foster a system of public governance that is more transparent, accountable, and efficient.

7.1 Overview of Results

Incorporating blockchain into governance frameworks could fundamentally change the interaction between the government and its people. By promoting transparency in public

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[94]https://repository.tudelft.nl/file/File_08ab182f-15f2-4fff-9edd-ff38583aecbf
[95] Petrovan, S. O. et al. (2021). Post COVID-19: a solution scan of options for preventing future zoonotic epidemics. *Biological Reviews*, 96(6), 2694-2715. https://doi.org/10.1111/brv.12774
[96] https://repository.tudelft.nl/file/File_08ab182f-15f2-4fff-9edd-ff38583aecbf

records, improving accountability in governmental operations, and minimizing chances of corruption, blockchain could serve as a viable solution to the ongoing challenge of governmental obscurity. Governments, especially in developing nations such as India, can benefit from utilizing blockchain technology in sectors like land registration, tax collection, public voting mechanisms, and social welfare initiatives.

Nonetheless, the path to effectively adopting blockchain in governance faces various hurdles. The technical constraints of blockchain, including scalability, energy usage, and interoperability, present substantial challenges for widespread adoption. Moreover, the legal and regulatory structures for blockchain are still developing, and the lack of a distinct legal status for blockchain records might impede its broad utilization in public governance. The ethical issues, including breaches of privacy and the risk of exacerbating the digital divide, need to be tackled to guarantee that blockchain technology benefits all citizens, particularly marginalized and underserved populations.

7.2 Prospective View

In spite of these difficulties, the outlook for blockchain in governance seems bright. Numerous governments around the globe are currently investigating blockchain's potential in sectors like public finance, voting mechanisms, and identity management. The United Arab Emirates (UAE), for example, aims to introduce blockchain-based solutions in a range of government services by 2023, which will include smart contracts for governmental transactions. In India, the Telangana Government has been exploring blockchain technology in land records and supply chain management, showcasing the nation’s increasing enthusiasm for utilizing blockchain in public administration.

The increasing progress in blockchain research and development is expected to produce solutions that tackle numerous existing technical shortcomings, including enhanced consensus mechanisms that are more energy-efficient and scalable. Furthermore, regulatory structures will develop to embrace the distinct traits of blockchain, offering more precise directions for its application in public governance. As additional case studies arise, governments will have a chance to gain insights from both effective implementations and setbacks, allowing them to tailor blockchain solutions to their distinct legal, cultural, and social situations.

7.3 Suggestions

To enable blockchain to effectively aid in diminishing government opacity, various essential suggestions should be considered:

- Legal and Regulatory Frameworks: It is essential for governments to create clear legal structures that acknowledge the validity of blockchain records, while also guaranteeing adherence to privacy and data protection regulations. Creating regulatory sandboxes to evaluate blockchain technologies in practical governance situations will aid in pinpointing potential issues and improving regulatory strategies.
- Partnership with the Private Sector: Governments ought to partner with blockchain firms to create innovative solutions designed for public governance. Collaborations between public and private sectors can promote the advancement of safer, more scalable, and efficient blockchain systems tailored to the specific requirements of public administration.
- Accessible Digital Literacy Initiatives: It is crucial to guarantee that all individuals, especially those from underrepresented groups, can access the resources and information needed to interact with blockchain technology. Authorities ought to invest in digital literacy initiatives that enhance the skills needed to operate blockchain platforms, guaranteeing fair involvement in the digital governance ecosystem.
- Blockchain Models that Preserve Privacy: Governments ought to focus on creating blockchain models that protect privacy, including zero-knowledge proofs and private blockchains, to ensure the security of individuals' data while upholding transparency in public records. This will guarantee that blockchain provides transparency advantages while maintaining the privacy of citizens.
- Scalability and Energy Efficiency: To tackle the scalability and energy usage challenges of blockchain, it's essential to investigate green blockchain technologies and different consensus mechanisms. Governments ought to promote research on sustainable blockchain solutions that can manage large-scale applications while minimizing environmental impact.

7.4 Summary

In summary, blockchain technology could transform public governance by increasing transparency, boosting efficiency, and lowering corruption. Although there are considerable obstacles to its implementation, these obstacles can be overcome. By incorporating appropriate

legal, technical, and ethical factors, blockchain has the potential to serve as an effective instrument in enhancing good governance and tackling the persistent problem of government transparency.

As blockchain technology advances, governments across the globe must actively interact with this developing technology, taking measures to guarantee its integration is both effective and ethical. By utilizing blockchain in governance, countries can advance toward a future that is more transparent, accountable, and participatory, ultimately enhancing the trust between administrations and their citizens.