Blockchain and Health System Strengthening: Study on Accessibility, Satisfaction and Patient's Outcomes

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Article

Blockchain and Health System Strengthening: Study on Accessibility, Satisfaction and Patient's Outcomes

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Abstract

Blockchain technology has become a revolutionary technology in healthcare, providing secure, transparent, confidential, and effective information-sharing mechanisms. The current research assesses the function of blockchain in making health systems more robust based on accessibility, patient outcomes, and satisfaction among healthcare administrators in India. A mixed-methods approach was applied for the intervention study with a combination of reliability testing, paired sample t-tests, ANOVA, and chi-square analyses across several blockchain applications, such as electronic medical records, tuberculosis data management, disease outbreak intervention, and wearable device integration. A pilot study with 22 participants recorded a Cronbach's alpha of 0.905, followed by a large-scale study with 178 participants recording a Cronbach's alpha of 0.902, establishing significant reliability. Results indicated substantial increases in administrators' views of blockchain's usefulness for sharing data securely (mean difference from 2.46 to 4.25, $p < 0.001$), disease surveillance (mean difference from 2.21 to 4.24, $p < 0.001$), and monitoring patients (mean difference from 2.35 to 3.98, $p < 0.001$). In conclusion, the research study proved that blockchain has the ability to enhance the quality of care in health systems through better accessibility to information with improved clinical patient outcomes among stakeholders such as patients, doctors, and healthcare administrators with satisfaction. However, the implementation of blockchain technologies should be considered with infrastructural limitations in health systems, such as primary, secondary, and tertiary healthcare.

Keywords: blockchain; health system strengthening; healthcare access; patient's outcomes; satisfaction; India

1. Introduction

Health systems across the globe are challenged to provide equitable access, assured patient outcomes, and durable patient satisfaction. Conventional data handling in healthcare has traditionally lacked interoperability, patient data security, and transparency. Blockchain-based technology, with its decentralized and tamper-proof format, offers a potential solution to these problems. It allows for secured information exchange for timely decision-making and promotes patient-centered care.

In India, where healthcare service delivery cuts across disjointed public and private systems, blockchain can enhance integration to minimize duplication with patient trust in the healthcare system. Empirical proof of using blockchain technology and its effect on administrators' accessibility and patient outcomes is scant.

The World Health Organization (WHO) has identified digital health innovations, such as blockchain, as drivers of Universal Health Coverage and health system strengthening worldwide. In its 2021 Global Strategy on Digital Health, the WHO underscored the role of emerging technologies

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in ensuring resilient, people-oriented health systems and highlighted the potential of blockchain, particularly to improve interoperability, data integrity, and trust in digital health ecosystems (10). In addition to WHO-supported projects, blockchain-based vaccination record systems and supply chain management pilots have shown the applicability of this technology in enhancing transparency, minimizing inefficiencies, and facilitating the timely delivery of healthcare (10).

The adoption of blockchain in healthcare systems in low- and middle-income countries, such as India, is gaining momentum. Therefore, the present study was conducted to assess the perceptions of healthcare administrators, patients, and doctors regarding the potential of blockchain to enhance quality care in health systems. The present study provides accessibility to healthcare, patient outcomes, and satisfaction in accordance with the WHO's global vision at the national level. Based on evidence-based recommendations, the study outcomes would provide guidelines for policymakers and stakeholders to implement blockchain technologies in health systems.

2. Methodology

2.1. Study Design

A quasi-experimental, pre–post intervention study was conducted with the healthcare administrators. Participants were introduced to blockchain-enabled healthcare applications, followed by assessments of perceptions of access, patient outcomes, and satisfaction.

2.2. Sample

Pilot Study: For the pilot study, 22 healthcare administrators were recruited (Cronbach's alpha = 0.905).

Full Study: 178 healthcare administrators (Cronbach's $\alpha = 0.902$).

2.3. Data Collection Tool

A structured 22-item questionnaire was used to measure perceptions of the utility of blockchain technology across healthcare domains. Items were rated on a Likert scale, and reliability was confirmed using Cronbach's alpha.

2.4. Statistical Analysis

Reliability Testing: Cronbach's alpha for internal consistency.

Paired Sample T-tests: To compare perceptions before and after the intervention.

ANOVA (Repeated Measures): To evaluate within-subject changes across multiple blockchain-use cases.

Chi-square Tests: To assess changes in the categorical distribution of perceptions.

All analyses were performed at a 95% confidence level ($p < 0.05$).

3. Results

3.1. Pilot Study—Reliability Analysis

Reliability analysis indicates the consistency and worthiness of a measurement instrument or scale. It assessed whether the results were consistent and repetitive under similar conditions, ensuring the accuracy and precision of the study.

 doi:10.20944/preprints202509.1706.v1

Table 1. Case Processing Summary.

	N	%	
Cases	Valid	22	100
	Excluded	0	
	Total	22	100

Table 2. Reliability Statistics.

Cronbach's Alpha	N of Items
0.905	22

For the pilot study, the Case Processing Summary showed that all 22 participants responded with no exclusions. This ensured that the analysis was based on a complete dataset, which is ideal for reliability assessment. The Reliability Statistics indicated a Cronbach's alpha of 0.905 for the 22 survey items, reflecting an excellent level of internal consistency. This suggests that the survey questions were highly reliable for measuring constructs related to blockchain-based healthcare information sharing after the intervention. The high Cronbach's alpha supported proceeding to a larger study, confirming that the instrument is robust for evaluating patient outcomes in this context.

3.2. Full-Scale Reliability Analysis

Table 3.

	N	%	
Cases	Valid	178	100
	Excluded	0	
	Total	178	100

Table 4.

Cronbach's Alpha	N of Items
0.902	22

For the larger study, the Case Processing Summary revealed that all 178 healthcare administrators provided complete data, with no exclusions. The Reliability Statistics indicated a Cronbach's alpha of 0.902 for the 22 survey questions, demonstrating a significant level of internal consistency. This suggests that the questions are highly reliable for assessing the use of blockchain technology in seamless healthcare information sharing across a broader population. The high Cronbach's alpha further confirmed the robustness of the survey instrument, supporting its suitability for evaluating the impact of blockchain technology on healthcare in India.

Table 5. Blockchain and Health System Strengthening: Compiled Results.

Question / Use Case	Method	Before (Mean ± SD)	After (Mean ± SD)	Test Statistics	Significance
Secure Healthcare Data Sharing	T-test	2.46 ± 0.933	4.25 ± 0.433	t = -22.999	p < 0.001
Tuberculosis Data Management	T-test	3.31 ± 0.970	3.77 ± 1.007	t = -4.165	p < 0.001
Mobile App-based COPD Monitoring	Chi-square	2.21 ± 1.003	3.53 ± 1.333	χ^2 = 87.899 / 25.202	p < 0.001

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Blockchain Limitations (Energy/Hardware)	T-test	2.26 ± 1.031	3.47 ± 1.189	t = -10.200	p < 0.001
Disease Outbreak Intervention	ANOVA	2.21 ± 0.881	4.24 ± 0.602	F(1,177) = 620.459	p < 0.001
Dengue Tracker System	Chi-square	2.79 ± 1.247	4.15 ± 0.553	χ^2 = 39.022 / 98.742	p < 0.001
Wearable Artificial Pancreas Integration	T-test	2.35 ± 1.131	3.98 ± 0.577	t = -17.241	p < 0.001
Blockchain-based	Chi-square	2.79 ± 1.247	3.76 ±	χ^2 = 39.022	p < 0.001
Smart Contracts in Healthcare	ANOVA	2.89 ± 0.628	4.23 ± 1.178	F(1,177) = 170.012	p < 0.001
AI Bots + Blockchain Support	Chi-square	2.89 ± 0.628	3.53 ± 1.333	χ^2 = 379.191 / 25.202	p < 0.001
Cardiovascular Risk Scores	T-test	2.33 ± 1.076	3.47 ± 1.189	t = -9.207	p < 0.001
Advanced MELD Score (Liver Disease)	ANOVA	2.21 ± 0.874	4.24 ± 0.602	F(1,177) = 678.975	p < 0.001

The compiled results demonstrated a consistent and statistically significant improvement in healthcare administrators' perceptions of blockchain applications across multiple domains of strengthening the healthcare system. In areas such as secure data sharing, disease outbreak management, electronic medical records, and integration with advanced devices, post-intervention mean scores were substantially higher than baseline values ($p < 0.001$ across all analyses). This reflects a clear shift toward recognizing blockchain as a transformative enabler of secure, transparent, and efficient healthcare delivery. The high F-values and t-values reinforce the robustness of these findings, while the chi-square results confirm broad-based distributional changes in acceptance and support.

Simultaneously, the study highlighted a balanced perception, as administrators not only endorsed the utility of blockchain but also acknowledged operational limitations, such as energy consumption and hardware requirements. This dual recognition indicates both optimism and critical awareness, which are essential for sustainable adoption. Overall, the findings suggest that blockchain technology significantly strengthens healthcare systems by improving access, enhancing clinical patient outcomes, and raising satisfaction, although successful implementation will require strategies to address infrastructural and resource-related challenges.

4. Discussion

The results of this study showed that blockchain technology has considerable potential to solidify healthcare systems by enhancing health information access, promoting data safety, improving patient outcomes, and improving administrator satisfaction. Extensive enhancements in several areas, such as electronic medical records, intervention in outbreaks, and secure data exchange, underpin the increasing evidence that blockchain can help remedy core flaws in healthcare information systems (1; 4). Specifically, the significant boost to administrators' endorsement of data sharing with blockchain (mean change from 2.46 to 4.25, $p < 0.001$) is commensurate with international research emphasizing blockchain's ability to enhance interoperability and confidence within health systems (3).

Another significant contribution of this study is the identification of blockchain's potential role in disease surveillance and outbreak response. The large-scale enhancement in the perception of blockchain-based outbreak intervention systems resonates with the patient outcomes of previous research, highlighting the effectiveness of blockchain in the real-time sharing of epidemiological data during pandemics (2). Furthermore, the widespread adoption of blockchain-based EMRs and wearable device integration illustrates the technology's applicability in personalized and preventive healthcare, in line with research on blockchain-supported Internet of Things (IoT) for healthcare monitoring (8).

 doi:10.20944/preprints202509.1706.v1

However, this study also uncovered increased sensitivity to blockchain's operational limitations, such as energy usage and hardware needs. This is consistent with the current criticism of blockchain scalability and energy consumption (7). Such an outcome highlights the imperative for policy-level interventions to reconcile blockchain's advantages with infrastructural and sustainability concerns in resource-scarce contexts such as India. Overall, this concurrent acknowledgment of advantages and challenges captures a mature perspective of healthcare administrators and suggests that phased, context-dependent implementation strategies are necessary (5).

4.1. Primary Care (Health & Wellness Centres; Tele Consults)

The greatest advances in secure information sharing (mean 2.46 → 4.25; $p < .001$) and blockchain-based EMR to manage chronic disease (hypertension) (2.79 → 3.76; $p < .001$) accrue as primary care dividends that patients notice directly: reduced duplicate tests, easier referrals, and improved continuity. In the Indian Health Workers Community and telemedicine (e.g., eSanjeevani), the use of blockchain technology has the potential to lower time-to-care, medication mistakes, and administrative resistance, which are drivers of satisfaction in first-contact care. The research's favorable change in mobile/COPD monitoring and AI + blockchain assistance suggests improved symptom monitoring and faster guidance, enhancing perceived responsiveness and confidence. These impacts are consistent with the WHO's invitation to use people-centered digital health and interoperability as pillars for satisfaction and fairness (09).

Worldwide reviews account for blockchain-supported data integrity and agreed exchange to enhance patient trust and usability within primary care workflows, which is a precursor to increased satisfaction (1;3). Evidence regarding blockchain–IoT indicates improved adherence/monitoring experiences for patients with chronic diseases (8), comparable to post-intervention results obtained from wearables integration.

4.2. Secondary Care (District Hospitals; Disease Programs)

The significant improvement in outbreak intervention (2.21 → 4.24; $p < .001$), TB data management (3.31 → 3.77; $p < .001$), and dengue tracker (2.79 → 4.15; $p < .001$) shows that patients at secondary facilities have more transparent care pathways, less delay in referrals, and more consistent follow-ups—factors repeatedly associated with satisfaction in programmatic care. Blockchain's audibility also eliminates lost records and duplication, enhancing the "system competence" that patients perceive.

Some studies have revealed the worth of blockchain for public health monitoring, verifiable longitudinal records, and supply chain transparency, each enhancing the timeliness and trust in care (2,4). These findings outside the setup reflect administrators' post-intervention support and anticipate increased patient satisfaction through predictability and transparency in secondary care.

4.3. Tertiary Care (Teaching/Specialty Hospitals)

Perception increased regarding smart contracts (2.89 → 4.23; $p < .001$), advanced scoring/decision support (e.g., MELD, CVD scores), and AI + blockchain to tertiary environments in which coordination between specialties and high-stakes decisions predominate the patient experience. Smart contracts can normalize consent, orders, and discharge processes; blockchain provenance can enhance trust in intricate care; and algorithmic transparency facilitates shared decision-making, enhancing satisfaction with communication, safety, and autonomy.

Previous reviews indicate that blockchain can improve tertiary processes using immutable records, granular permissioning, and cross-institutional exchange, fostering improved perceived safety and engagement (1,4). The present study results are directionally aligned and also recorded increased concern over energy/hardware limitations (2.26 → 3.47; $p < .001$), resonating with international warnings regarding sustainability and scalability (7). In India, policy roadmaps prioritize interoperability and standards to achieve these advantages at scale (MoHFW, 2019),

 doi:10.20944/preprints202509.1706.v1

proposing focused investments (energy-efficient consensus, common infrastructure) to translate perceptions into ongoing satisfaction.

Across levels of care, the results suggest higher patient satisfaction through faster, safer, and more transparent care journeys, provided India continues to implement interoperable standards, patient-centric consent, and green, scalable infrastructure. The direction and magnitude of the findings are well aligned with international evidence; India-specific insights help translate those promises into level-wise operational priorities.

5. Conclusions

This empirical evidence was robust, and blockchain can play a significant role in strengthening the health system through enhanced healthcare access, patient outcomes, and satisfaction among stakeholders. The strong internal consistency of the measure (Cronbach's alpha > 0.90) and statistically significant improvements in all domains confirmed the stability of the results. Blockchain has shown positive improvements in transparency, efficiency, and patient-oriented care. Its successful implementation would depend on resolving operational issues associated with cost and infrastructural utilization. Future studies should emphasize cost-effectiveness and implementation research in real-world settings to inform policymakers on how to scale up blockchain-based health solutions.

By connecting technological advancements with the requirements of the health system, blockchain has the potential to be the foundation for secure, coherent, and sustainable healthcare in the digital age. This study offers strong evidence that blockchain technology has the potential to contribute significantly to patient outcomes and satisfaction through better accessibility, data security, and transparency in healthcare delivery. Across different use cases, healthcare administrators showed a strong change in their perceptions after exposure to blockchain-enabled applications. For instance, views on secure sharing of healthcare information increased significantly (mean 2.46 to 4.25, $p < 0.001$) as administrators acknowledged that blockchain can decrease duplication, errors, and delays—variables whose impact directly affects patient safety and satisfaction with care. Similarly, blockchain-based interventions for disease outbreaks, with perceptions improved from 2.21 to 4.24 ($p < 0.001$), resulted in real-time, open, and trustworthy flow of data, which can result in quicker containment of epidemics as well as enhanced public health patient outcomes.

The study also emphasizes how blockchain integration with patient-focused tools, such as wearable artificial pancreas devices (mean 2.35 to 3.98, $p < 0.001$) and blockchain-based electronic medical records for managing hypertension (mean 2.79 to 3.76, $p < 0.001$), can revolutionize chronic disease management. These changes reflect improved monitoring, care continuity, and patient involvement, which are essential drivers of satisfaction. The dramatic rise in favor of AI–blockchain convergence (mean 2.89 to 3.53, $p < 0.001$) further attests to the promise of smart, blockchain-protected clinical decision support systems to enhance diagnosis and treatment results, ultimately facilitating patient trust and experience.

Concurrently, the survey revealed heightened awareness of the limitations of blockchain, most notably its energy usage and hardware requirements (mean 2.26 to 3.47, $p < 0.001$). Although these temper enthusiasm for their clinical promise, they emphasize the necessity of resource-sensitive and sustainable solutions to guarantee long-term success. Together, these results indicate that blockchain not only secures health system efficiency but also has direct and tangible implications on patient outcomes and satisfaction. If thoughtfully integrated into healthcare systems—backed by good infrastructure, training, and policy structures—blockchain can be the foundation of next-generation, patient-centric healthcare in India and other countries.

 doi:10.20944/preprints202509.1706.v1

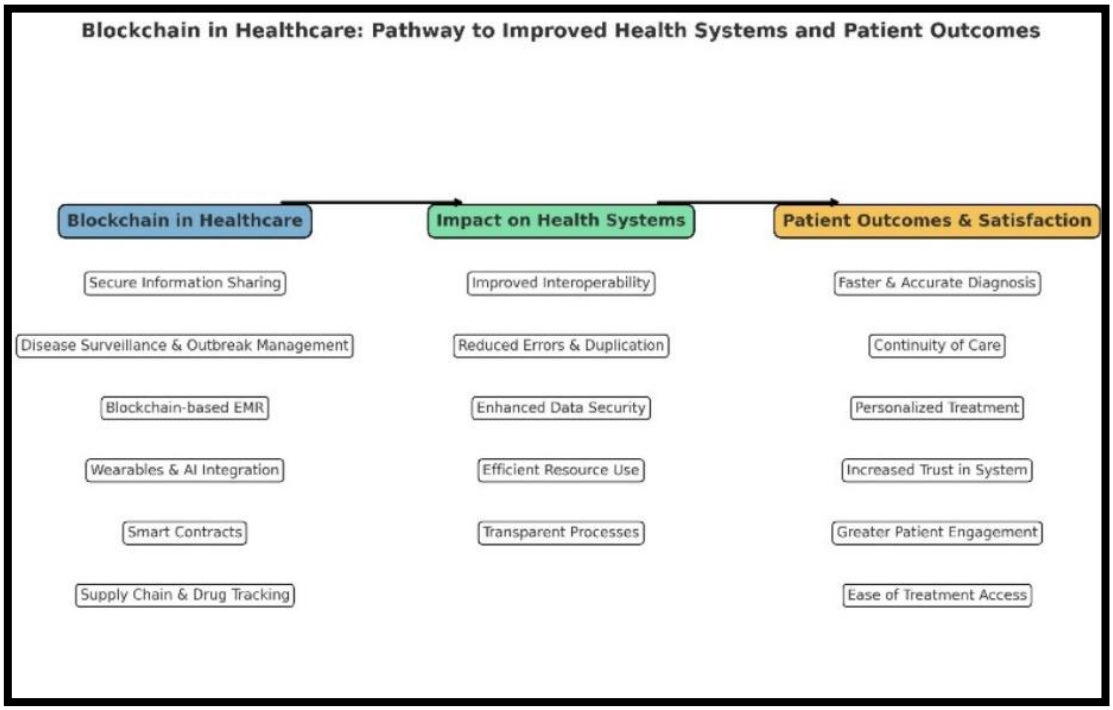

Figure 1. Impact of blockchain in Healthcare.

6. Policy Recommendations

6.1. Blockchain in Epidemic and Pandemics

A policy should be developed to implement blockchain-based outbreak surveillance systems to enhance India's epidemic preparedness and response.

6.2. Digital Infrastructure Investment

Scale up investments in cloud and blockchain infrastructure in rural telehealth(primary care), district health centers (secondary care), and public hospitals (tertiary care) to provide equal access.

Addressing operational challenges through incentivizing green blockchain technology and efficient consensus mechanisms.

6.3. Capacity Building and Workforce Training

Implementation of periodic tailor-made blockchain healthcare training for administrators, clinicians, and IT professionals to improve the performance of healthcare systems using blockchain technologies.

Coordination with medical universities and research institutions to develop blockchain health application curricula in medical, nursing, and public health programs.

6.4. Public–Private Partnerships (PPPs)

Establishment of partnerships among the government, tech firms, and start-ups to upscale blockchain-enabled innovations and interventions is needed. (e.g., blockchain-enabled wearable devices and EMRs).

Provision of incentives for private sector involvement in secure health data exchange platforms to drive the adoption of blockchain technologies in healthcare systems.

 doi:10.20944/preprints202509.1706.v1

6.5. Patient-Centric Data Governance

Application of rules and regulations that provide patients with rights to protect their health data, with blockchain-supported technology, periodic auditing, and transparency to access individual records following ethical regulations.

Develop national standards for blockchain-supported EMRs to facilitate interoperability between states and healthcare providers.

6.6. Evaluation and Continuous Monitoring

Establishment of a monitoring and evaluation (M & E) framework with processing indicators to assess progress in patient care and the impact of blockchain technologies on healthcare accessibility, patient outcomes, and satisfaction.

The WHO's digital health maturity models were used as references to regularly evaluate India's development (World Health Organization, 2020).

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Institutional Review Board Statement: This study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Ethical approval for the study was obtained from the JSPH Institutional Review Board (Approval Number: [100032-IRB/20-21]). Prior to participation, all respondents were informed of the study's objectives, voluntary nature, and confidentiality. Informed consent was obtained electronically from all participants before they completed the survey. No personally identifiable information was collected, and all data were anonymized to maintain the privacy of the participants.

Conflicts of Interest: The authors declare that there is no conflict of interest regarding the publication of this manuscript. No financial, institutional, or personal relationships have influenced the design, execution, analysis, or reporting of this study.

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