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Blockchain vs. generative artificial intelligence in India: A comparative study of adoption drivers, barriers, and diffusion trajectories

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Abstract

Blockchain and generative artificial intelligence (GenAI) are two contemporary emerging technologies that have exhibited different adoption trajectories since their inception. Blockchain technology traces its origins to 2008, when it was first conceptualized, whereas GenAI is a more recent development that entered the mainstream with the introduction of ChatGPT by OpenAI. India, as a developing economy, has consistently been at the forefront of technological innovations; however, the adoption patterns for these innovations have been notably different. Using secondary data retrieved from peer-reviewed research and systematic reviews, along with industry and market intelligence reports, this research revealed that blockchain, as a technology, adopts a bottom-up approach driven by financial inclusion imperatives and is inherently decentralized by design. GenAI, on the other hand, adopts a top-down approach, fueled by enterprise-driven adoption and rapid scaling across various sectors. Our findings suggest that the difference in their diffusion approaches is attributed to the persistent regulatory uncertainty and infrastructure constraints faced by blockchain, whereas GenAI has benefited from clearer policy support and lower entry barriers. This paper provides a framework-based, side-by-side comparison of two high-impact technologies in a single national context, linking micro-level adoption mechanisms to macro-level diffusion outcomes. These nuances could have significant implications for policymaking and recalibrating India's position in the global landscape.

Keywords: Blockchain adoption; Digital transformation; Emerging technologies; Generative artificial intelligence; India; Regulatory frameworks; Technology diffusion

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1. Introduction

Blockchain, a distributed ledger system that enables trustless peer-to-peer transactions (Crosby, 2016; Pilkington, 2016), has witnessed significant grassroots adoption in India despite regulatory uncertainty. In the cryptocurrency domain itself, India ranked first globally in the 2024 Chainalysis Global Crypto Adoption Index (Chainalysis Team, 2024), with over 35 million trading accounts and 12% of global blockchain developers concentrated domestically. Overall, the Indian blockchain market is expected to grow from US$657 million (2024) to US$61.5 billion (2033) with a compound annual growth rate (CAGR) of 66% (Imarc group, 2024a). On the other hand, generative artificial intelligence (GenAI)—which utilizes advanced neural frameworks to produce human-like content across different forms of communication (Cao et al., 2023; Goodfellow et al., 2020)—has also witnessed an exponential enterprise adoption, with the Indian GenAI market expected to grow from US$1.3 billion (2024) to US$5.4 billion (2033) with a CAGR of 15% (Imarc group, 2024c).

India, as the world's fastest-growing major economy with a digitally native demographic, presents a unique case study for examining emerging technology adoption patterns. While both technologies promise disruptive innovation, their adoption trajectories diverge significantly in speed and directionality. This raises some fundamental research questions:

(i) What are the factors underlying the differential adoption rates?
(ii) How do regulatory frameworks and infrastructure requirements shape technology diffusion patterns?
(iii) What implications do these patterns then hold for India's technological competitiveness?

Despite growing literature on blockchain adoption and the rapid emergence of GenAI studies, most of the studies examined these technologies in isolation and often used inconsistent dimensions and metrics, making cross-technology comparisons difficult—particularly in a national (in this case, Indian) context. Moreover, only a few studies have connected micro-level adoption mechanisms (e.g., perceived usefulness, trialability, legitimacy) to macro-level diffusion patterns, explaining why adoption trajectories diverge. Hence, this study aims to address this gap by applying a single, theory-grounded analytical framework to systematically compare the adoption of blockchain and GenAI in India.

This paper addresses these questions through a comparative analysis, contributing to the technology adoption literature by examining two concurrent yet divergent adoption patterns for emerging technologies within the same geographical context: India.

2. Theoretical framework and literature review

Numerous theories of technology adoption have been proposed, providing foundational insights into the diffusion mechanisms of emerging technologies. Rogers' (1987) diffusion of innovation theory identifies perceived attributes—relative advantage, compatibility, complexity, trialability, and observability—as determinants of adoption rates. The technology acceptance model emphasizes perceived usefulness and ease of use (Davis, 1989), whereas the institutional theory highlights regulatory environments, normative pressures, and mimetic isomorphism in organizational adoption (DiMaggio & Powell, 1983). Recent blockchain adoption studies have extended these frameworks, identifying trust mechanisms, interoperability, scalability, and regulatory certainty as critical factors (Clohessy et al., 2020; Taherdoost, 2022; Queiroz & Wamba, 2019).

2.1. Blockchain adoption

Blockchain adoption research reveals distinct patterns across various sectors, depending on the specific use case. Kshetri (2018) demonstrates the efficacy of blockchain in enhancing supply chain transparency, whereas Casino et al. (2019) have conducted a systematic analysis of blockchain applications across healthcare, finance, and governance. In emerging economies, blockchain adoption is driven by financial inclusion initiatives, lack of or limited institutional trust, and leapfrogging opportunities (Kshetri, 2018; Ghode et al., 2020). However, blockchain adoption faces persistent barriers, such as scalability challenges (Eyal et al., 2016; Zheng et al., 2018), energy consumption concerns (Beck et al., 2016), regulatory ambiguity (Kiviat, 2015; Wright & De Filippi, 2015), and technical complexity in implementation (Mthimkhulu & Jokonya, 2022).

Indian blockchain adoption is an interesting landscape. It has support at the grassroots level via cryptocurrency enthusiasm, but interestingly, that coexists with regulatory hostility, in the form of a 30% capital gains tax and central bank skepticism equating cryptocurrencies to "speculative gambling" (Chainalysis Team, 2024). Despite these headwinds, India's blockchain market reached US$657 million (2024) and is projected to achieve US$61.5 billion by 2033 (65.6% CAGR) (Imarc group, 2024a). Government initiatives include the Vishvasya National Blockchain Framework, operationalizing Blockchain-as-a-Service (BaaS) infrastructure across three data centers, and state-level implementations in Telangana (land records), Jharkhand (agricultural supply chains), and Goa (public registries).

2.2. Generative artificial intelligence adoption

Generative AI literature focuses on enhancing productivity (Brynjolfsson et al., 2023; Noy & Zhang, 2023), creative augmentation (Epstein et al., 2023; Haase & Hanel, 2023), and organizational transformations (Budhwar et al., 2023; Korzynski et al., 2023). Unlike blockchain's infrastructure-heavy requirements, GenAI exhibits lower entry barriers through application programming interface-accessible models (Fui-Hoon et al., 2023; Su & Yang, 2023), enabling rapid organizational adoption. However, concerns regarding algorithmic bias (McGee, 2023), hallucinations (Alkaissi & McFarlane, 2023), intellectual property rights (Hacker et al., 2023), and labor displacement (Ponce, 2023) have an impact on its adoption trajectory.

India's GenAI adoption demonstrates unique characteristics of its own. Some examples that illustrate this are the development of a multilingual model (Hanooman supports 98 languages, including 12 Indian languages), sovereign AI initiatives (such as myShakti chatbot), and sector-specific applications across information technology (IT), healthcare, banking, and e-commerce. The Indian economy accounts for 6.1% of global GenAI revenue (2024), with enterprise adoption rates (73%) exceeding the United States (45%) and the United Kingdom (29%). A major difference here, compared to the case of blockchain adoption, has been the role of the government. Instead of a default skepticism for blockchain, the Indian government has been a big supporter of GenAI through the IndiaAI Mission (US$1.25 billion allocation), National Association of Software and Service Companies (NASSCOM)'s AI Adoption Index framework, and state-level AI policies, which created a conducive institutional environment, notably absent in the context of blockchain.

2.3. Literature comparison

Across the two literatures, a consistent pattern emerges: blockchain adoption is frequently ecosystemdependent (requiring coordinated participation, governance, and standards), while GenAI adoption is often modular and individually trialable, enabling faster diffusion. Institutional legitimacy (DiMaggio & Powell, 1983) appears to operate differently: blockchain legitimacy is strongly influenced by regulatory interpretation and association with cryptocurrency markets (Kiviat, 2015), whereas GenAI legitimacy is increasingly shaped by responsible AI governance and sector-specific controls (Hacker et al., 2023).

3. Methodology

This comparative study employed mixed-methods analysis, integrating quantitative market data with qualitative policy analysis. Data sources include: (i) market reports from the Imarc group, Grand View Research, BlueWeave Consulting, and KPMG; (ii) adoption indices from Chainalysis, NASSCOM, and Statista; (iii) government policy documents, including Vishvasya framework, IndiaAI Mission guidelines, and Reserve Bank of India circulars; and (iv) academic literature encompassing blockchain and GenAI adoption research papers.

The analytical framework comprised four dimensions: (i) market trajectory analysis, which compares growth rates, market valuations, and sector penetration; (ii) regulatory environment assessments to evaluate policy clarity, institutional support, and compliance frameworks; (iii) adoption barrier identification categorized using the technical, economic, organizational, and social impediments; and (iv) use-case maturity to analyze deployment breadth and impact across sectors. Temporal scope spanned 2023–2033, capturing the current state and near-term projections. The geographic focus centered on India, with selective global comparisons provided for added context.

To operationalize this comparison, Figure 1 synthesizes insights from the technology acceptance model/diffusion of innovations theory, institutional theory, and a general-purpose technology (GPT) framing into four comparative dimensions, also marked as the core adoption factors (market trajectory, regulatory environment, infrastructure/entry barriers, and use-case maturity/risk) and the mediating adoption mechanisms indicated throughout the rest of the paper. Both of these, in combination, then drive the respective technology adoption trajectory in some scenarios, underpinning complementary synergies to adoption.

4. Comparative analysis: Adoption trajectories

4.1. Market growth dynamics

The blockchain and GenAI markets exhibit contrasting growth profiles, with nuances observed across their underlying sectors. As seen from Figure 2, India's blockchain market reached US$657 million (2024) with an expected projection to US$61.5 billion by 2033, representing 65.6% CAGR (Imarc group, 2024a; Imarc, 2024b). Blockchain fintech markets were valued at US$101 million (2024), growing to US$2 billion (2033) at a 39% CAGR. Conversely, GenAI demonstrated a US$1.3 billion (2024) baseline with projections of US$5.4 billion (2033), indicating an average 15% CAGR and varying further depending on sector inclusion.

This differential is characteristic of each technology's profile and respective maturation stages: blockchain remains early-stage with infrastructure buildout, pilot implementations, and regulatory navigation, while GenAI leverages existing cloud infrastructure and established machine learning pipelines, enabling rapid scaling. Blockchain adoption follows S-curve dynamics, characterized by prolonged early-adopter phases, whereas GenAI exhibits exponential growth, a characteristic of platform technologies with network effects (Arthur, 1989). However, in the long run, once the early-adopter phase has passed, it appears that blockchain will experience

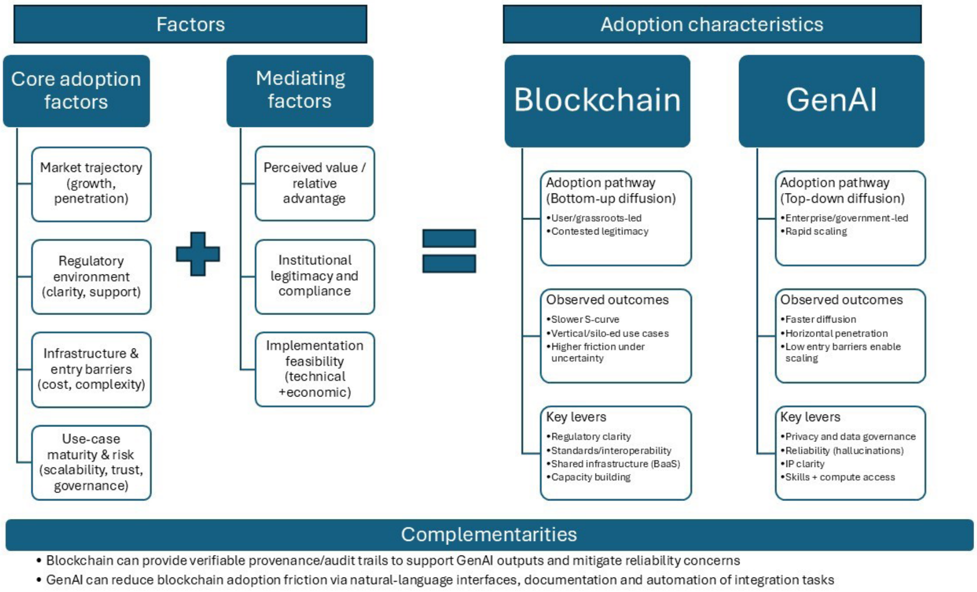

Figure 1. Conceptual framework summary for comparing adoption trajectories of blockchain vs. generative artificial intelligence (GenAI) in India

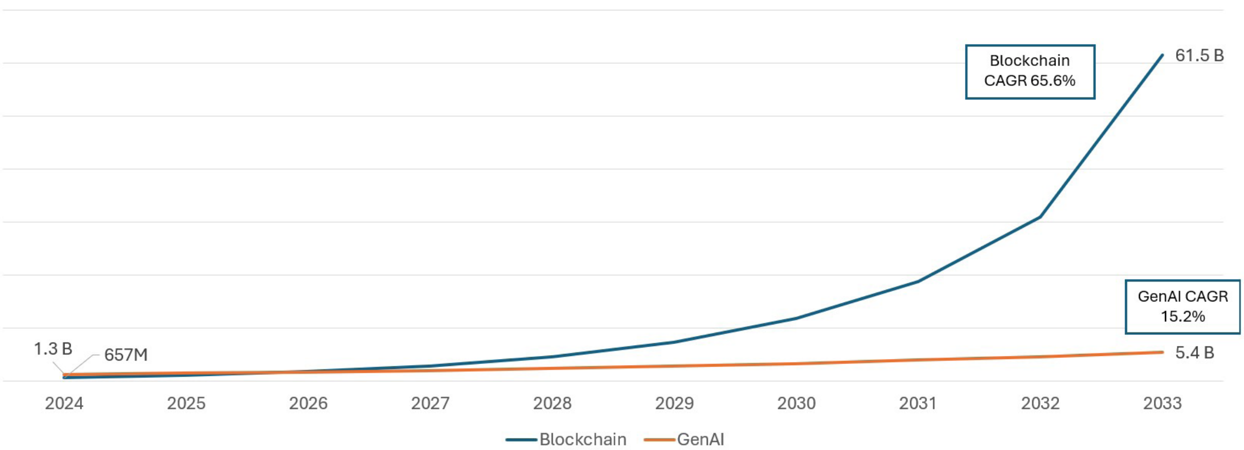

Figure 2. Blockchain vs. generative artificial intelligence (GenAI) growth projections (in United States Dollars). Data adapted from the Imarc group (2024a, 2024c).
Abbreviation: CAGR: Compound annual growth rate.

accelerated growth and overtake GenAI in adoption.

4.2. Sectoral penetration patterns

Blockchain adoption is concentrated in specific high-value use cases, including financial services (cross-border payments, DeFi protocols), supply chain management (pharmaceuticals tracking, agricultural provenance), state land registry systems (such as those in Telangana and Goa), and trade finance (as seen in the Reserve Bank of India Innovation Hub pilot). Adoption remains vertically silo-ed with limited cross-sector interoperability, reflecting Kshetri's (2018) observation that blockchain value propositions are use-case specific rather than universally applicable.

In contrast to this, GenAI demonstrates broader horizontal penetration: IT services (code generation, documentation), healthcare (diagnostic support, administrative automation), banking (customer service, fraud detection), e-commerce (personalization, recommendation engines), media (content generation), and education (adaptive learning platforms). This diffusion pattern closely aligns with the characteristics of GPT (Bresnahan & Trajtenberg, 1995), where foundational innovations enable diverse applications across sectors with minimal modification or customization.

4.3. Regulatory environment comparison

Regulatory certainty is also a critical differentiator. Blockchain faces sustained ambiguity and skepticism from stakeholders in India, as evidenced by ongoing discussions about cryptocurrency prohibition since 2018, the introduction of a 30% capital gains tax in 2022, the imposition of a 1% tax deducted at source on transactions, and actions by the Financial Intelligence Unit to shut down offshore exchanges. At the same time, some positive signals have emerged, particularly government-led initiatives in blockchain infrastructure development, such as Vishvasya. This regulatory dichotomy—embracing blockchain technology on one hand while suppressing cryptocurrency applications—creates adoption friction, particularly for private-sector initiatives, as they are unsure of creating future-proof applications. There is little confidence or certainty regarding the legality of such applications if they are developed.

Generative AI benefits from supportive policy architecture from the beginning, including IndiaAI Mission (2024) allocating US$1.25 billion for compute infrastructure, datasets, and application development, NASSCOM AI Adoption Index providing sector benchmarks, state governments (Karnataka, Telangana, Maharashtra) offering AI policy frameworks, and the absence of prohibitive regulations beyond current data protection and IT Act provisions. This permissive environment, combined with global AI governance uncertainty, positions India favorably for experimental deployment and rapid iteration in the field of GenAI, relative to blockchain.

4.4. Infrastructure requirements

Blockchain, as a technology, requires significant infrastructure investments, including distributed node networks, consensus mechanism implementations, cryptographic key management systems, interoperability protocols, and substantial energy resources (depending on the algorithms used, such as proof-of-work chains). Furthermore, public blockchain participation requires continuous uptime, bandwidth provisioning, and more stringent security controls. These requirements create high entry barriers, particularly for small to medium-sized enterprises and government agencies with legacy systems (Ghode et al., 2020; Mthimkhulu & Jokonya, 2022).

Generative AI instead leverages existing cloud infrastructure through application programming interface-accessible models (OpenAI, Google Gemini, Anthropic Claude), reducing upfront capital expenditure requirements. Organizations can implement GenAI applications with minimal infrastructure investment, relying on pay-per-use consumption models. India-specific initiatives (Yotta's Shakti Cloud, Airtel–Google Cloud partnership) further democratize access to GenAI through localized compute resources and multilingual model availability. These infrastructure advantages accelerate adoption not only among individual users but also across enterprises seeking to deploy these solutions at scale.

4.5. Adoption drivers and barriers

Blockchain drivers include: (i) financial inclusion addressing 190 million unbanked individuals, (ii) remittance efficiency for US$100+ billion annual inflows, (iii) supply chain transparency combating counterfeiting in pharmaceuticals and agriculture, (iv) land registry digitization reducing fraud in property transactions, (v) DeFi protocols enabling permissionless financial services, and (vi) developer ecosystem growth (12% global share) supporting talent density.

However, several can become barriers to blockchain adoption, such as (i) regulatory uncertainty deterring institutional investment, (ii) scalability limitations (Bitcoin: 7 transactions/second vs. Visa: 24,000+), (iii) energy consumption concerns contradicting sustainability commitments, (iv) user experience complexity requiring technical literacy, (v) interoperability challenges across blockchain platforms, and (vi) limited public awareness beyond cryptocurrency speculation.

Generative AI drivers include: (i) productivity enhancement delivering a 3.7× return per dollar invested, (ii) content creation democratization through natural language interfaces, (iii) multilingual capability serving diverse linguistic demographics, (iv) cloud-native deployment reducing implementation timelines, (v) government support through IndiaAI Mission and sector policies, and (vi) global platform availability (ChatGPT, Gemini) providing immediate access.

Generative AI adoption also faces barriers, such as (i) data privacy concerns regarding sensitive information processing, (ii) algorithmic hallucinations compromising reliability in critical applications, (iii) talent shortages despite a large global AI workforce (approximately 50% based in the United States), (iv) energy-intensive training of large language models, (v) intellectual property ambiguities surrounding generated content, and (vi) quality control challenges requiring human oversight.

Overall, blockchain exhibits higher friction to adoption, driven by regulatory ambiguity, integration complexity, and a slower time-to-value. GenAI, on the other hand, has a generally faster time-to-value ratio, easier trialability, and a more modular approach to adoption; however, it is deterred by non-trivial governance or privacy concerns.

Figure 3 visualizes the adoption friction profile for both these technologies alongside these dimensions.

5. Discussion

5.1. Bottom-up vs. top-down adoption

Blockchain adoption in India exhibits bottom-up characteristics driven by individual users seeking financial autonomy, peer-to-peer transaction efficiency, and speculative investment opportunities. Grassroots adoption (Chainalysis Team, 2024) precedes institutional legitimation, creating tension with top-down regulatory frameworks. This inversion of typical technology diffusion—where institutional adoption precedes consumer uptake—reflects blockchain's disintermediation value proposition, which inherently challenges existing institutional power structures (Wright & De Filippi, 2015).

GenAI follows a traditional top-down diffusion pattern: large enterprises deploy GenAI for operational efficiency, followed by the adoption of GenAI by small and medium-sized enterprises through cloud platforms, and eventually, consumer applications. Enterprise adoption rates (73% in India) drive market expansion, with institutional actors shaping the evolution of use cases and best practices. This pattern enables regulatory co-evolution, where policymakers observe enterprise implementations before establishing governance frameworks, reducing adoption friction.

This aligns with diffusion theory (Davis, 1989), which posits that trialability and low perceived complexity accelerate early adoption, whereas dependencies, such as multi-actor coordination and those related to the ecosystem, slow down diffusion even when the potential value from adoption is high. This also entails legitimacy foundations, where technologies that are associated with higher uncertainty in regulatory matters often require stronger support to scale up.

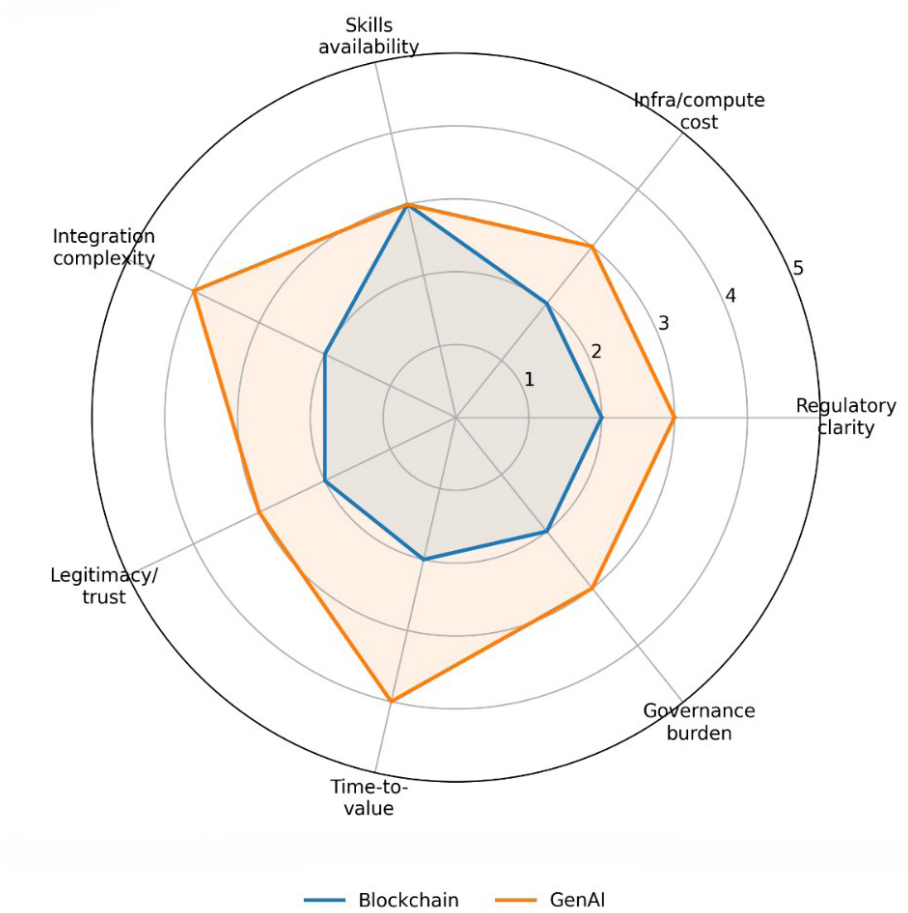

Figure 3. Adoption friction profile (higher score = more favorable)
Abbreviations: GenAI: Generative artificial intelligence; Infra: Infrastructure.

5.2. Technology maturity and use-case specificity

Blockchain's adoption trajectory reflects an early-stage technology with limited proven use cases beyond cryptocurrency. Despite its theoretical applicability across trust-intensive domains, practical implementations face challenges, including smart contract vulnerabilities (Casino et al., 2019), oracle problems connecting blockchain to real-world data (Zheng et al., 2018), and unclear value propositions compared to centralized databases for many applications. This maturity gap extends adoption timelines as organizations await definitive evidence of transformative value.

Generative AI demonstrates rapid maturity acceleration through foundation models, enabling diverse applications without fundamental architectural redesign. Single models (GPT-4, Gemini) support text generation, code writing, data analysis, image creation, and conversational interfaces, reducing deployment complexity. This generality contrasts with blockchain's application-specific implementations, which facilitate faster adoption cycles and iterative improvements based on user feedback.

These results are consistent with prior blockchain research, which emphasizes the "pilot-to-production" gap driven by scalability, interoperability, and governance constraints. In contrast, GenAI studies focus on modular development through standardized tools and platforms.

5.3. Global positioning and strategic implications

India's dual technology positioning presents strategic opportunities and risks. Blockchain leadership through grassroots adoption and developer concentration positions India as a potential hub for Web3 innovation, yet regulatory hostility toward cryptocurrencies undermines this advantage. Countries embracing clearer regulatory frameworks (United Arab Emirates, Singapore, Switzerland) may capture institutional blockchain development despite lower grassroots adoption.

The adoption of GenAI positions India among global leaders, thanks to government support and large talent pools that create competitive advantages. However, dependence on Western foundation models (OpenAI, Google, Anthropic) raises concerns about sovereignty. Indigenous model development (Hanooman, myShakti) addresses this vulnerability, but it requires sustained investment in computing infrastructure and research capabilities. The IndiaAI Mission's US$1.25 billion allocation signals governmental recognition of its strategic importance, yet it pales in comparison to the United States' US$109 billion in private investment (as of 2024) and China's AI funding.

From a strategic perspective, the findings support the diffusion of GenAI, given that it is easy to embed and diffuse horizontally across sectors, whereas blockchain tends to thrive in specific verticals where coordination can be enforced.

5.4. Socioeconomic implications

Blockchain adoption is concentrated among educated, urban, and technologically literate populations, with limited penetration in rural areas that lack digital infrastructure and financial literacy. This pattern risks exacerbating digital divides unless accompanied by targeted education and investment in infrastructure. DeFi protocols, in particular, exclude populations that are unable to navigate complex interfaces or lack cryptocurrency on-ramps.

Generative AI demonstrates broader accessibility through natural language interfaces and support for vernacular languages, making it more accessible to a wider audience. Multilingual models (such as Hanooman's 98 languages) enable rural populations to interact with AI systems in native languages, potentially democratizing access to information, education, and services. However, algorithmic biases encoded in training data may perpetuate existing inequalities, requiring careful governance to ensure equitable outcomes.

6. Conclusion

This comparative analysis reveals fundamentally divergent adoption trajectories for blockchain and GenAI technologies in India. Blockchain follows a contested pathway characterized by grassroots enthusiasm, regulatory ambiguity, infrastructure challenges, and concentrated use-case deployment, resulting in measured growth despite its leadership in global adoption. GenAI demonstrates accelerated diffusion enabled by supportive policy frameworks, low entry barriers, broad sectoral applicability, and established cloud infrastructure, positioning it for rapid scaling across the Indian economy.

These differential trajectories reflect underlying technological characteristics: blockchain's trust infrastructure proposition requires fundamental reimagining of transactional architectures, while GenAI augments existing workflows through intelligent automation. Blockchain disrupts intermediaries, generating regulatory resistance; GenAI enhances organizational capabilities, attracting institutional support. Blockchain demands specialized technical expertise and infrastructure investment; GenAI provides accessible interfaces with pay-per-use models.

For policymakers, these findings suggest the need for nuanced technology governance, recognizing distinct adoption dynamics. Blockchain requires regulatory clarity, striking a balance between encouraging innovation and protecting consumers, moving beyond binary prohibition–acceptance frameworks toward risk-based regulation, and acknowledging the diverse applications of blockchain beyond cryptocurrency speculation. GenAI necessitates proactive governance that addresses algorithmic accountability, data privacy, intellectual property, and labor market disruption, while maintaining an innovation-conducive permissiveness.

For organizational strategists, the analysis highlights strategic imperatives. Blockchain adoption requires patience, pilot-scale experimentation, and contingency planning for regulatory evolution; GenAI demands rapid experimentation, ethical frameworks, and talent development to capture first-mover advantages in a fast-evolving landscape. Organizations pursuing both technologies should recognize the complementarities—blockchain provides verifiable data provenance that addresses GenAI hallucination concerns, GenAI enables natural language blockchain interfaces, and reduces adoption barriers.

In terms of limitations, this study relied on secondary sources and qualitative synthesis; hence, it did not estimate causal effects or statistically test the results. The analysis focused on India, which may limit generalizability to other emerging economies with different regulatory regimes and digital infrastructure. Finally, both technologies are evolving rapidly; therefore, some findings—particularly those related to regulation, model capability, and enterprise adoption practices—may shift as new policies and products emerge.

Future work could validate and refine the framework using primary data (e.g., surveys/interviews), sector-level adoption datasets, or longitudinal case studies. Some potential examples can include: (i) longitudinal adoption studies tracking blockchain and GenAI diffusion across organizational types and geographic regions, (ii) hybrid architectures combining blockchain verification with GenAI capabilities, (iii) regulatory effectiveness analysis comparing jurisdictions with varying governance approaches, (iv) socioeconomic impact assessments measuring technology effects on employment, inequality, and access to services, and (v) comparative studies examining adoption trajectories in other emerging economies.

India's position at the intersection of grassroots blockchain adoption and enterprise GenAI leadership presents unique opportunities to shape global technology governance, develop indigenous capabilities, and leverage digital transformation for inclusive economic growth. Realizing this potential requires coordinated action across government, industry, and civil society, balancing innovation imperatives with equity concerns and sovereignty objectives in an increasingly technology-mediated world.

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The authors declare no conflict of interest.

Author contributions

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Formal analysis: All authors
Investigation: All authors
Methodology: All authors
Writing–original draft: All authors
Writing–review & editing: All authors

Availability of data

Data will be made available upon request to the corresponding author.

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