A Socio-Technical Theory of Blockchain Alignment Under Institutional Fragmentation

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ABSTRACT

Blockchain technologies are frequently associated with decentralization, disintermediation, and systemic disruption. Yet adoption outcomes across sectors and jurisdictions remain highly uneven. Existing scholarship explains these outcomes primarily through technological capability, innovation diffusion, or market incentives, but lacks an integrated framework capable of explaining how blockchain infrastructures evolve within fragmented institutional environments.

This paper develops the Blockchain System Alignment Framework (BSAF) as a socio-technical theory of blockchain alignment under conditions of institutional fragmentation. The framework argues that blockchain adoption and infrastructural scaling depend on conjunctural alignment across three interdependent dimensions: technical viability, institutional compatibility, and economic incentive coherence. Rather than conceptualizing blockchain as an inherently disruptive technology, the paper argues that blockchain systems become system-reconfiguring only when governance structures, interoperability conditions, and stakeholder coordination mechanisms evolve in mutually reinforcing ways.

Drawing on comparative institutional analysis across stablecoins and central bank digital currencies (CBDCs), tokenized asset markets, and blockchain-enabled supply chains, the paper demonstrates how fragmented governance regimes, standards competition, and asymmetrical incentive structures shape adoption trajectories across domains. The analysis further shows that blockchain infrastructures not only operate within fragmented institutional environments but may also generate new forms of fragmentation through competing standards, governance architectures, and coordination asymmetries.

The paper contributes to socio-technical transition theory, institutional political economy, and digital infrastructure studies by reframing blockchain as a conditional coordination infrastructure embedded within evolving governance systems rather than as a universally transformative technology. More broadly, the findings suggest that the future trajectory of blockchain infrastructures will depend less on technological performance alone than on the capacity of institutions, governance regimes, and stakeholders to coordinate under conditions of geopolitical and institutional fragmentation.

Keywords: Blockchain; Socio-Technical Alignment; Institutional Fragmentation; Digital Infrastructure; Political Economy; System Reconfiguration; Institutional Compatibility; Tokenization; CBDCs

INTRODUCTION

Technological transformations rarely emerge from technical innovation alone. Historically, technologies that reshaped economic systems—including railways, electrification, containerization, and the internet—succeeded not simply because they improved efficiency, but because they became embedded within broader institutional, organizational, and governance structures that enabled coordination at scale. The developmental trajectory of transformative infrastructures therefore depends not only on technological capability, but on the extent to which institutional systems, regulatory frameworks, and incentive structures co-evolve alongside technological change.

Blockchain technology has emerged as one of the most contested candidates for such systemic transformation. Advocates portray blockchain as a foundational infrastructure capable of decentralizing trust, reducing transaction costs, and reorganizing economic coordination across finance, logistics, governance, and digital identity. Critics, however, point to persistent fragmentation, speculative volatility, governance failures, interoperability problems, and uneven adoption outcomes across jurisdictions and sectors.

This divergence reflects a deeper analytical problem within existing scholarship. Much of the blockchain literature remains organized around three relatively disconnected perspectives. Innovation-oriented approaches emphasize adoption dynamics and disruptive potential; platform and network economics focus on coordination and network effects; while institutional perspectives examine regulation, governance, and transaction-cost reduction. Although each offers valuable insights, existing research lacks an integrated framework capable of explaining why blockchain systems scale successfully in some domains while stagnating or fragmenting in others.

This paper argues that blockchain outcomes are best understood not through technological determinism or disruption narratives, but through the lens of socio-technical alignment under conditions of institutional fragmentation. Blockchain systems operate within complex institutional environments characterized by competing legal regimes, fragmented standards, asymmetrical incentives, uneven state capacity, and divergent governance architectures. Under such conditions, technological capability alone cannot generate systemic transformation.

To address this gap, the paper introduces the Blockchain System Alignment Framework (BSAF), which conceptualizes blockchain adoption as contingent upon conjunctural alignment across three interdependent dimensions:

1. Technical viability;

2. Institutional compatibility; and

3. Economic incentive coherence.

Economic incentive coherence refers not merely to the existence of aligned stakeholder interests, but to the political-economic conditions under which dominant actors perceive alignment as preferable to preserving asymmetric control over infrastructural coordination, data ownership, or value capture.

The central argument is that blockchain becomes system-reconfiguring only when these dimensions evolve in mutually reinforcing ways. Where alignment remains partial or fragmented, adoption stalls, hybridizes, or remains confined to pilot experimentation.

The paper contributes to the literature in four ways.

- First, it reframes blockchain from a disruptive technology to a socio-technical coordination infrastructure embedded within institutional systems.
- Second, it integrates insights from socio-technical transition theory, institutional political economy, and platform governance into a unified analytical framework.
- Third, it advances a configurational understanding of technological transformation, arguing that adoption outcomes emerge from conjunctural alignment rather than isolated technological advantages.
- Fourth, it contributes to debates on digital infrastructure governance by showing how institutional fragmentation conditions the trajectory of emerging technological systems.

The remainder of the paper proceeds as follows. Section 2 reviews the relevant literature and situates the BSAF within broader socio-technical transition and institutional governance debates. Section 3 outlines the comparative institutional methodology. Section 4 applies the framework across four blockchain domains.

Section 5 discusses the theoretical implications for digital infrastructure transformation and institutional co-evolution. Section 6 concludes.

Scope, Methodology, and Contribution

This paper applies the BSAF to key domains where blockchain adoption has produced divergent outcomes:

- **Payment systems (stablecoins, CBDCs)** – where technical viability (scalability, low fees) and institutional compatibility (regulatory sandboxes, licensing frameworks) have progressed relatively far, leading to high alignment and rapid growth.
- **Tokenized asset markets** – where incentive coherence (liquidity, fractional ownership) is strong, but institutional fragmentation (cross-border securities law, unclear custody rules) remains a barrier.
- **Supply chain and logistics systems** – where technical interoperability, SME readiness, and data standardisation challenges have limited adoption despite compelling early pilots (Ahmed & Rahman, 2025; Kashem et al., 2023).

By shifting the analytical focus from disruption to system alignment, this study contributes to a more nuanced understanding of blockchain's role in the evolving architecture of global markets. Rather than a universal solution, blockchain emerges as a contingent technology whose transformative potential depends on the extent to which it can align with—and reshape—the institutional and economic environments in which it is deployed.

LITERATURE REVIEW AND THEORETICAL FRAMEWORK

Existing scholarship on blockchain has largely evolved along three analytical strands: innovation theory, platform and network economics, and institutional economics. While each provides valuable insights, the literature remains fragmented, with limited integration into a unified explanatory framework for blockchain adoption outcomes.

Innovation Perspectives: Disruption, Adoption, and Divergent Expectations

Much of the early blockchain literature is rooted in diffusion of innovations theory (Rogers, 2003), emphasizing perceived advantages, compatibility, complexity, and observability as drivers of adoption. However, blockchain presents a unique case: it's perceived "disruptive potential" is highly contested. As García Sáez (2020) notes, among those who view blockchain as innovative, two opposing camps emerge: one sees it as a *foundational technology* (Iansiti & Lakhani, 2017) that enables efficiency without threatening incumbents; the other argues its decentralisation potential is inherently *disruptive* (Atzori, 2015; Catalini & Gans, 2017).

This divergence is not merely academic. In practice, incumbents (e.g., large financial institutions) typically pursue blockchain for efficiency and cost savings, whereas startups target new value creation and disintermediation (García Sáez, 2020). This misalignment of strategic objectives often leads to contradictory investment priorities and limits collaboration. Moreover, the high failure rate of blockchain projects—over 90% within the first year—suggests that technological superiority does not automatically translate into diffusion (García Sáez, 2020). Innovation theory alone underestimates the institutional constraints and coordination failures that block adoption.

A parallel but more macro perspective is offered by studies on the adoption of foundational technologies (e.g., internet). Blockchain adoption is expected to follow phases: single use, localised use, substitution, and transformation (Iansiti & Lakhani, 2017). Yet blockchain's path is complicated by cryptocurrency volatility, regulatory uncertainty, and a "digital divide" in infrastructure and literacy (García Sáez, 2020; Ahmed & Rahman, 2025). These factors mean that adoption is not a smooth logistic curve but a series of starts and stops, heavily mediated by external conditions.

Platform and Network Economics: Coordination, Incentives, and Network Effects

Blockchain-enabled platforms differ from traditional platforms (e.g. Uber, Airbnb) in a fundamental way: there is no central orchestrator (García Sáez, 2020). This shifts strategy from resource control to resource orchestration

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and from customer value to ecosystem value (Alstyne et al., 2016). Network effects—where value increases with the number of users—are central. However, blockchain platforms face a chicken-and-egg bootstrap problem that is often mitigated through token-based incentives, giving early adopters financial utility before application utility matures (Catalini & Gans, 2017).

Yet, as García Sáez (2020) empirically shows, incentive strategies remain exploratory. Many projects rush into tokenisation and Initial Coin Offerings (ICOs) without a clear governance model, leading to community fragmentation, "forks," and value destruction. Furthermore, the cost of networking—bootstrapping a decentralised platform—remains high, and interoperability between different blockchains and legacy systems is poor (Ahmed & Rahman, 2025). Platform economics literature often assumes the existence of effective governance, but in decentralised environments, governance is precisely the challenge: off-chain decision-making (e.g., Ethereum's Github forum) coexists with on-chain consensus, creating new forms of centralisation and conflict (García Sáez, 2020).

A deeper issue arises from the scalability trilemma (security, decentralisation, scalability), which forces trade-offs. Permissionless blockchains (e.g., Bitcoin, Ethereum) offer high decentralisation but low throughput; permissioned ledgers (e.g., Hyperledger, Corda) scale better but compromise on the very promise of blockchain (García Sáez, 2020). Consequently, many incumbents adopt hybrid or private blockchains—a pragmatic but ideologically contested move that blurs the line between "disruption" and "system optimisation."

Institutional Economics: Trust, Transaction Costs, and Governance

From an institutional economics perspective, blockchain is interpreted as a mechanism to reduce transaction costs and substitute for vertical trust (Coase, 1937; Catalini & Gans, 2017). By providing decentralised verification and immutability, blockchain could, in theory, render many intermediaries obsolete. However, empirical evidence consistently shows that blockchain does not eliminate the need for institutions; it interacts with and reshapes them.

This is most visible in the domain of regulatory adaptability. Studies across 42 economies (Celestin et al., 2025) find that regulatory flexibility strongly moderates blockchain's impact on financial system reinvention ($\beta = 0.12$, $p < 0.05$). Economies with adaptive policy frameworks achieve faster innovation diffusion and greater systemic stability. In contrast, fragmented or hostile regulatory environments lead to "forum shopping" (e.g., crypto-friendly jurisdictions like Switzerland, Malta) and legal uncertainty that stifles cross-border platforms (García Sáez, 2020; Ahmed & Rahman, 2025).

Moreover, blockchain's reliance on data integrity and standardisation exposes institutional gaps. As Ahmed & Rahman (2025) argue, supply chain resilience depends not only on technology but on data governance, interoperability standards, and legal recognition of digital documents. The absence of harmonised global rules—for electronic bills of lading, cross-border data flows, or smart contract enforceability—creates persistent friction. Thus, rather than replacing institutions, blockchain's success is contingent on institutional alignment and co-evolution.

BSAF within Socio-Technical Transition Theory

The Blockchain System Alignment Framework (BSAF) builds upon and extends socio-technical transition theory by conceptualizing blockchain adoption as a coordination process occurring across interacting technological, institutional, and governance systems.

Socio-technical transition scholarship has long emphasized that technological change is embedded within broader regimes of infrastructure, governance, user practices, market structures, and institutional norms (Geels, 2002; Geels & Schot, 2007). Technologies do not diffuse solely because they are technically superior; rather, they succeed when broader socio-technical systems reorganize in ways that support scaling, legitimacy, and coordination.

This perspective is particularly relevant to blockchain systems. Unlike conventional enterprise technologies, blockchain infrastructures require simultaneous coordination across multiple actors and institutional layers, including developers, validators, regulators, financial institutions, standards bodies, users, and transnational governance networks. Consequently, blockchain adoption is not merely a process of technological substitution but a process of institutional and infrastructural reconfiguration.

This perspective also aligns with Science and Technology Studies (STS) scholarship emphasizing the co-production of technological systems and social order (Jasanoff, 2004). From this perspective, infrastructures are not merely technical artefacts but institutionalized coordination systems embedded within broader political and governance arrangements (Star, 1999; Edwards, 2010). Blockchain systems therefore function simultaneously as technological infrastructures and governance architectures, shaping how authority, trust, interoperability, and coordination are distributed across digital environments.

The BSAF extends transition theory in three ways.

- First, it introduces institutional fragmentation as a central analytical condition. Existing transition frameworks often assume relatively coherent governance environments. Blockchain systems, by contrast, operate across fragmented jurisdictions characterized by competing regulatory models, uneven legal recognition, divergent standards regimes, and geopolitical contestation.
- Second, the framework conceptualizes alignment as conjunctural and configurational rather than linear. Sustained adoption does not emerge from any single factor, such as technological efficiency or market demand, but from mutually reinforcing complementarities between technical architecture, institutional governance, and economic incentives.
- Third, the BSAF reframes technological transformation as system reconfiguration rather than pure disruption. Blockchain systems rarely eliminate institutions outright; instead, they redistribute, hybridize, and reorganize governance functions across public and private actors.

From this perspective, blockchain becomes analytically significant not because it decentralizes systems automatically, but because it exposes the institutional coordination conditions necessary for large-scale digital infrastructure transformation.

Blockchain in Supply Chain Resilience: Visibility, Traceability, and Coordination Gaps

One of the most widely cited non-financial applications of blockchain is in supply chain management, where the technology promises enhanced traceability, reduced counterfeiting, and improved coordination among disparate actors. However, empirical evidence reveals a persistent gap between promise and performance. Ahmed, Rahman and Akter (2025) conducted a systematic review of 40 high-impact papers and found that while AI and blockchain can reduce supply chain disruptions, costs, and waste, successful deployment depends critically on data interoperability, stakeholder readiness, and integration with legacy systems.

Blockchain's contribution to supply chain resilience operates through three mechanisms: immutable traceability (verifying product provenance and chain of custody), smart contract automation (triggering payments or reorders automatically), and decentralised data sharing (reducing information asymmetry among buyers, sellers, logistics providers, and regulators) (Ahmed & Rahman, 2025; Kashem et al., 2023). In food supply chains, for example, IBM Food Trust and Walmart pilots demonstrated reduced traceability time from seven days to 2.2 seconds. Yet, scaling these pilots has been hampered by the unwillingness of small and medium enterprises (SMEs) to invest in new infrastructure, the absence of industry-wide data standards, and concerns over commercial data privacy (Ahmed & Rahman, 2025; Kashem et al., 2023).

From a system alignment perspective, supply chain blockchain applications typically fail on institutional compatibility (fragmented legal recognition of digital documents across borders) and incentive coherence (benefits are often asymmetric, favouring large retailers over small suppliers). As Ahmed and Rahman (2025) argue, over 60% of small suppliers remain digitally disconnected from downstream partners, creating a "digital divide" within supply chains that undermines network effects. Without coordinated investment and standardisation, blockchain risks reinforcing, rather than reducing, existing power imbalances.

Institutional Fragmentation and the Limits of Blockchain Scaling

The literature review confirms three persistent gaps. First, research remains siloed: supply chain, AI, and ESG studies rarely engage with each other or with the institutional and incentive dimensions highlighted in platform economics. Second, most studies are descriptive or pilot-focused, with limited longitudinal or comparative analysis of success and failure conditions. Third, there is no unified framework that explains why alignment succeeds in some domains (e.g., stablecoins) but fails in others (e.g., supply chains, AI governance).

The Blockchain System Alignment Framework (BSAF) directly addresses these gaps by providing a common analytical language for assessing technical, institutional, and incentive alignment across diverse application domains. The literature reviewed across innovation studies, platform economics, institutional governance, and socio-technical transitions reveals a recurring pattern: blockchain adoption outcomes are constrained less by isolated technological deficiencies than by fragmented coordination environments.

Across domains, institutional fragmentation increases interoperability costs, weakens governance coherence, and undermines the incentive structures necessary for sustained infrastructural scaling (North, 1990; Abbott & Snidal, 2001). Consequently, many blockchain initiatives remain confined to pilot experimentation despite substantial technical investment. This fragmentation is particularly visible in cross-border governance contexts where divergent regulatory standards, competing sovereignty claims, and inconsistent legal recognition generate coordination failures across digital infrastructures (Farrell & Newman, 2019). Blockchain systems therefore reveal broader tensions within the political economy of digital infrastructure transformation.

Existing scholarship remains insufficiently integrated to explain these dynamics. Innovation-oriented approaches focus primarily on diffusion; platform theories emphasize network effects; while institutional analyses examine governance adaptation largely in isolation. Few studies explain how these dimensions interact conjuncturally under fragmented institutional conditions. The Blockchain System Alignment Framework (BSAF) addresses this gap by conceptualizing blockchain adoption as a socio-technical coordination process dependent upon the simultaneous alignment of infrastructural viability, institutional compatibility, and stakeholder incentive coherence.

Mechanisms of Socio-Technical Alignment

While the Blockchain System Alignment Framework (BSAF) identifies the principal dimensions shaping blockchain adoption outcomes, it also implies a broader causal mechanism through which socio-technical alignment enables—or constrains—systemic transformation. Blockchain infrastructures operate within fragmented institutional environments characterized by divergent legal systems, uneven governance capacity, competing standards regimes, and asymmetrical stakeholder incentives. Such fragmentation increases coordination costs across actors and jurisdictions, constraining interoperability, weakening governance coherence, and limiting the network effects necessary for infrastructural scaling (North, 1990; Abbott & Snidal, 2001)

At the same time, blockchain systems are not merely embedded within fragmented institutional environments; they can also generate new forms of fragmentation through competing governance architectures, protocol forks, standards divergence, and rival coordination mechanisms. Institutional fragmentation should therefore be understood not only as an inherited structural condition, but also as an endogenous outcome of socio-technical reconfiguration processes.

Within this context, socio-technical alignment functions as a coordinating mechanism that reduces institutional friction and facilitates integration across technical, organizational, regulatory, and incentive domains. Where technical functionality aligns with institutional compatibility and stakeholder incentives, blockchain systems are more likely to achieve interoperability, trust formation, adoption scaling, and long-term governance stability. Conversely, misalignment across these dimensions generates coordination failures, regulatory conflict, fragmented adoption, and infrastructural instability, thereby constraining the transformative capacity of blockchain-based systems.

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The causal sequence proposed by the BSAF may therefore be conceptualized as follows:

Institutional fragmentation
↓
Higher coordination costs
↓
Reduced interoperability and governance coherence
↓
Weakened stakeholder incentive alignment
↓
Limited network effects and infrastructural scaling
↓
Constrained systemic reconfiguration

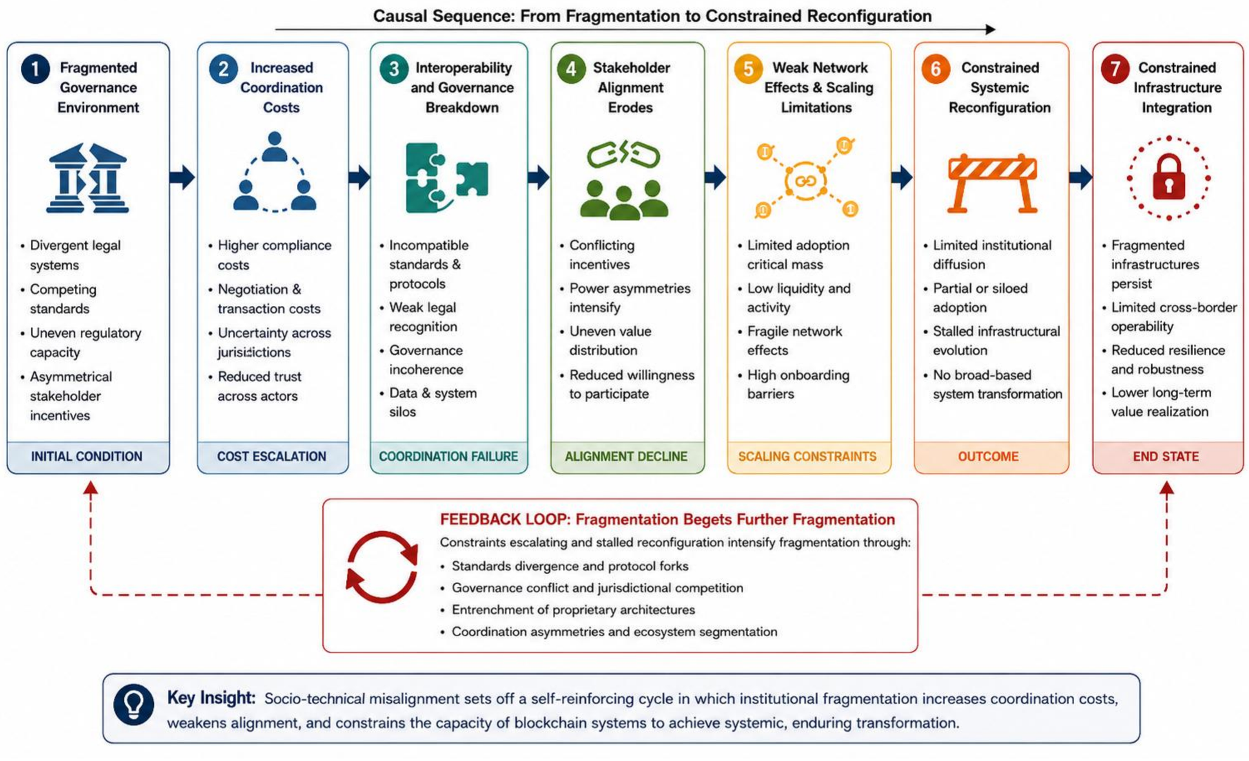
Conversely, where institutional coordination, technical interoperability, and incentive coherence evolve in mutually reinforcing ways, blockchain systems are more likely to achieve sustained infrastructural integration and broader socio-economic reconfiguration (Geels, 2002; Perez, 2002).

The framework therefore conceptualizes blockchain transformation not as a technologically deterministic process, but as a conjunctural socio-technical dynamic in which governance systems, infrastructural architectures, and stakeholder coordination mechanisms co-evolve over time (Jasanoff, 2004; Geels & Schot, 2007). This perspective shifts analytical attention away from isolated technological performance toward the institutional, political, and organizational conditions under which digital infrastructures scale successfully across fragmented environments.

Figure 2 visualizes the recursive causal dynamics proposed by the BSAF, illustrating how institutional fragmentation increases coordination costs that subsequently constrain interoperability, stakeholder alignment, infrastructural scaling, and systemic reconfiguration. The figure also highlights the recursive nature of fragmentation, whereby constrained scaling may itself generate additional governance and standards fragmentation over time.

Figure 1. Causal Dynamics of Socio-Technical Misalignment in Blockchain Systems

Institutional fragmentation initiates a causal chain of coordination failures that constrains systemic reconfiguration.



Description: The figure illustrates the causal sequence through which institutional fragmentation constrains blockchain-enabled systemic transformation. The process begins with fragmented governance environments characterized by divergent legal systems, competing standards, uneven regulatory capacity, and asymmetrical stakeholder incentives. These conditions increase coordination costs across actors and jurisdictions, leading to reduced interoperability, weakened governance coherence, and declining stakeholder alignment. The resulting coordination failures weaken network effects and infrastructural scaling capacity, ultimately constraining systemic reconfiguration and long-term infrastructural integration. A feedback loop illustrates how constrained scaling may further intensify fragmentation through standards divergence, governance conflict, and competing coordination architectures.

Why Blockchain?

Although the BSAF may offer broader insights applicable to digital infrastructures generally, blockchain systems possess several distinctive characteristics that make them analytically significant for socio-technical transition research.

- First, blockchain infrastructures rely on decentralized validation mechanisms rather than centralized verification authorities. This redistributes trust and governance functions across dispersed actors and creates novel coordination challenges absent in conventional centralized platforms (Catalini & Gans, 2017).
- Second, blockchain systems enable programmable governance through smart contracts, allowing rules, transactions, and institutional procedures to be embedded directly within digital infrastructures. Consequently, governance becomes partially infrastructuralized, blurring the distinction between technical architecture and institutional regulation (Jasanoff, 2004).
- Third, blockchain infrastructures depend heavily on interoperability and distributed consensus across heterogeneous institutional environments. Unlike conventional enterprise software systems, blockchain platforms frequently operate across jurisdictions characterized by divergent regulatory frameworks, legal standards, and governance models.
- Fourth, tokenized coordination mechanisms introduce new forms of economic incentivization that directly link infrastructural participation, governance, and financial value creation. This creates complex political-economic dynamics involving platform power, stakeholder asymmetries, and network concentration (Srnicek, 2017).

Unlike conventional digital infrastructures, blockchain systems integrate verification, governance, coordination, and incentive mechanisms within a shared programmable architecture, thereby increasing their potential to reorganize institutional relationships across distributed environments. These characteristics make blockchain systems especially useful for examining how socio-technical alignment operates under conditions of institutional fragmentation and geopolitical contestation.

METHODOLOGY

Research Design and Rationale

This study adopts a comparative institutional and socio-technical analytical approach combining:

- structured domain comparison;
- comparative case interpretation;
- and synthesis of existing empirical findings.

The objective is theory development rather than causal estimation. The paper therefore prioritizes analytical generalization over statistical generalization.

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Theoretical Sampling and Case Selection

Three domains were selected using theoretical sampling (Yin, 2018), chosen because they exhibit contrasting alignment outcomes:

Domain	Expected Alignment	Rationale
Stablecoins / CBDCs	High (partial)	Technical scalability improving; regulatory sandboxes emerging; strong liquidity incentives
Tokenised asset markets	Moderate	Strong investor incentives but fragmented cross-border securities law
Supply chain blockchain	Low	Technical interoperability gaps; weak SME incentives; limited legal harmonisation

These cases are not intended to be statistically representative but to provide analytical generalisability (Yin, 2018) for the BSAF's propositions.

Data Sources

To support a comparative institutional and socio-technical analysis, this study draws on a multi-dimensional synthesis of qualitative and secondary sources that capture the interaction between technological architecture

and governance. The data is categorized by its capacity to inform theory development:

- **Quantitative Macro-Indicators and Policy Reports**: Documentation from the IMF Fintech Index (2023), World Bank FinReg Dataset (2024), and the BIS Payment Systems Report (2024) is utilized to interpret regulatory adaptability and the evolution of cross-border financial standards.
- **Market Dynamics and Thematic Case Literature**: Trends in tokenized assets and digital trade are sourced from the OECD Digital Finance Report (2024) and PwC Tokenization Index (2023). These are synthesized with conceptual research on supply chain resilience and Digital Product Passports to identify evidence of institutional fragmentation.
- **Empirical Synthesis and Practitioner Insights**: The study integrates the structural modeling findings of Celestin et al. (2025) regarding fintech synergies with the qualitative practitioner insights from García Sáez (2020). These sources identify recurring governance challenges and incentive misalignments that traditional statistical generalizations may overlook.

Operationalizing the BSAF through Comparative Institutional Analysis

Rather than treating alignment as a purely quantitative construct, this study operationalizes the BSAF through structured qualitative comparison and comparative institutional analysis.

The framework evaluates blockchain domains across three interdependent dimensions:

1. Technical viability;
2. Institutional compatibility; and
3. Economic incentive coherence.

Each domain is assessed comparatively using triangulated evidence relating to:

- institutional coordination and stakeholder alignment;

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- governance coherence and regulatory adaptation;
- infrastructural compatibility and interoperability conditions;
- •geopolitical fragmentation pressures;
- and documented adoption outcomes.

The analysis does not seek to generate predictive numerical scores. Instead, the objective is interpretive and comparative: to identify how different configurations of socio-technical alignment shape the developmental trajectory of blockchain systems across institutional environments.

Accordingly, domains are assessed qualitatively as exhibiting:

- relatively high alignment,
- partial alignment,
- fragmented alignment,
- or persistent misalignment.

This comparative institutional approach is more appropriate for analyzing emergent technological systems whose trajectories remain historically contingent, politically mediated, and institutionally uneven.

Analytical Strategy: Comparative Socio-Technical Interpretation

The analytical strategy prioritizes **analytical generalization**—using specific cases to illustrate and refine the Blockchain System Alignment Framework (BSAF)—rather than seeking causal estimation. The process follows four interpretive steps:

1. **Contextual Mapping and Institutional Coordination**: For each domain, we synthesize evidence from sources like Ahmed & Rahman (2025) to identify "binding constraints" and the degree of coordination between novel ledgers and legacy institutional frameworks.

2. **Structured Cross-Domain Pattern Matching**: We contrast alignment configurations to identify combinations of dimensions associated with sustained adoption or failure.

3. **Synthesis of Empirical Moderation**: The findings of Celestin et al. (2025) regarding "Regulatory Adaptability" ($\beta = 0.12$) are used illustratively rather than deterministically. The coefficient functions primarily as a theoretical anchor supporting the BSAF's qualitative interpretation that governance flexibility may condition infrastructural scaling under fragmented institutional environments. The present study does not seek to validate causal statistical relationships but to develop a comparative socio-technical explanation of alignment dynamics across domains.

4. **Framework Refinement and Theory Development**: Drawing on the survival conditions and qualitative thresholds identified by García Sáez (2020), we refine the BSAF's propositions to account for socio-technical boundary conditions like geopolitical fragmentation and digital sovereignty.

Validity and Limitations

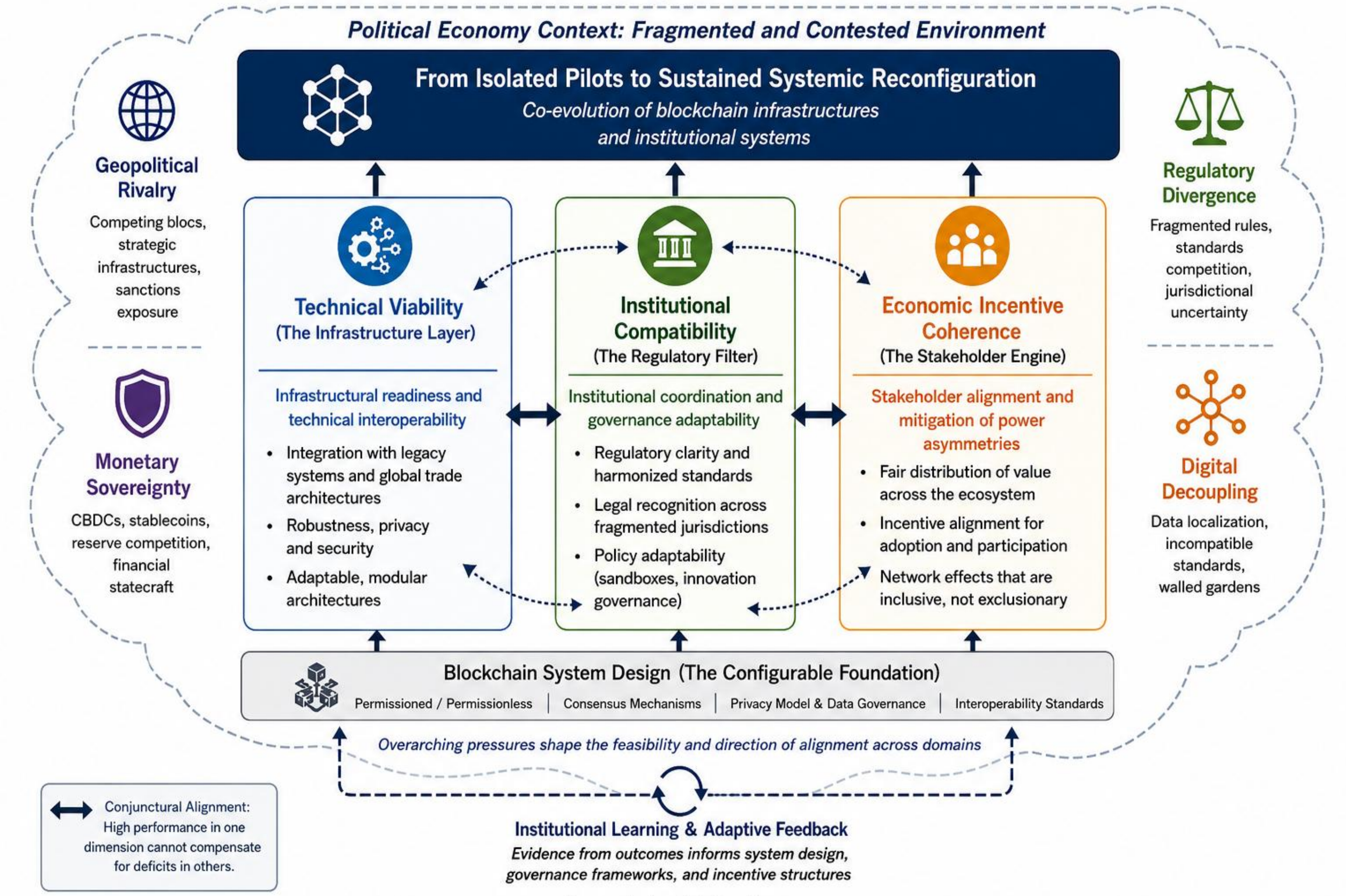
Internal validity is supported by triangulation across multiple data sources and by using established theoretical constructs (e.g., regulatory adaptability from IMF/World Bank). External validity is limited by the small number of domains analysed; future research should apply the BSAF to additional sectors (e.g., healthcare, energy, digital identity). Reliability is enhanced through explicit operationalisation of each BSAF dimension and transparent case selection criteria.

Limitations include reliance on secondary data (with potential reporting biases), the absence of primary data collection, and the fast-evolving nature of blockchain technology, which may render some findings time-sensitive. The framework is offered as an analytical tool for comparative research, not a predictive algorithm.

Conceptual Framework Diagram (BSAF)

The BSAF is represented visually in Figure 2.

Figure 2. The Socio-Technical Alignment and Reconfiguration Model (BSAF)



Source: Authors' elaboration.

Description: The framework is depicted as a socio-technical architecture situated within a broad "Political Economy Context" characterized by institutional fragmentation, geopolitical contestation, and uneven governance environments. The model consists of the following structural components:

Core Dimensions of Alignment:

Three interconnected vertical pillars represent the core dimensions of socio-technical alignment:

- **Technical Viability (The Infrastructural Layer):** Focuses on infrastructural readiness and technical interoperability, including integration with legacy systems, robustness, security, modularity, and adaptable architectures capable of operating across diverse digital environments. .
- **Institutional Compatibility (The Regulatory Filter):** Emphasizes institutional coordination and governance adaptability including regulatory clarity, legal recognition across jurisdictions, harmonized standards, and adaptive policy mechanisms such as regulatory sandboxes and innovation frameworks.

- **Economic Incentive Coherence (The Stakeholder Engine):** Addresses stakeholder alignment and the mitigation of power asymmetries to ensure inclusive network effects, equitable value distribution, and sustainable participation across the ecosystem.

Conjunctural Interdependence:

Double-headed arrows between the pillars indicate conjunctural interdependence, emphasizing that strengths in one dimension cannot compensate for deficiencies in another. Sustained system transformation therefore depends on the simultaneous alignment of technological, institutional, and incentive structures.

Configurational Foundation:

A horizontal foundational base labelled **Blockchain System Design (The Configurable Foundation)** supports the pillars and represents underlying architectural choices, including permissioned versus permissionless systems, consensus mechanisms, privacy models, data governance arrangements, and interoperability standards. These design choices are configured in relation to specific institutional and governance environments.

Systemic Reconfiguration Outcome:

Above the pillars, a top bar labelled **From Isolated Pilots to Sustained Systemic Reconfiguration** represents the co-evolution of blockchain infrastructures and institutional systems. Rather than depicting transformation as a binary outcome, the model conceptualizes reconfiguration as an iterative process through which digital infrastructures and governance systems continuously adapt to one another.

Political Economy Context:

Encapsulating the framework is a surrounding **Political Economy Context** cloud representing broader external pressures, including geopolitical rivalry, monetary sovereignty, regulatory divergence, and digital decoupling. These macro-environmental forces shape the feasibility, direction, and stability of socio-technical alignment across domains and jurisdictions.

Institutional Learning and Adaptive Feedback:

A dashed circular feedback loop labelled **Institutional Learning & Adaptive Feedback** connects system outcomes back to blockchain system design and governance structures. The loop illustrates iterative adaptation, regulatory learning, institutional experimentation, and the continuous refinement of socio-technical architectures over time.

COMPARATIVE PATTERNS OF SOCIO-TECHNICAL ALIGNMENT

Domain Analysis and Institutional Dynamics

The following table interprets the alignment configurations across the focal domains, focusing on the quality of coordination rather than numerical rankings.

Domain	Institutional Coordination	Governance Coherence	Infrastructural Compatibility	Geopolitical Fragmentation Pressure	Alignment Pattern
Stablecoins / CBDCs	High: Active central bank engagement and emerging licensing frameworks.	Increasing: Embedding of private issuers into formal oversight.	High: Rapidly improving scalability through layered architectures.	High	**High:** Sustained growth driven by institutional legitimacy.
Tokenized Assets	Moderate: Progress in specific hubs but	Moderate: Maturing	Improving: Bridging mechanisms	Moderate	**Moderate-High:** Growing

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	fragmented cross-border law.	custody and secondary market governance.	between private and public ledgers.		liquidity limited by legal friction.
Supply Chain	Low: Fragmented recognition of digital documents; no global standards.	Low: Fragmented consortia with conflicting data-sharing rules.	Low: Severe legacy ERP fragmentation; SME disconnection.	Moderate	**Low:** Pilot-heavy; constrained by stakeholder asymmetries.

Interpretation: Fragmentation and Path Dependency

The comparative analysis reveals that institutional coordination acts as the primary binding constraint for systemic transformation (North, 1990; Williamson, 1985). While payment systems have benefited from a path-dependent inheritance of financial legitimacy, centralized coordination structures, and relatively mature regulatory oversight (IMF, 2023; OECD, 2024), supply chain applications continue to suffer from institutional fragmentation, where the absence of harmonized rules for electronic bills of lading, digital documentation, and cross-border data governance constrains scaling and interoperability (Ahmed & Rahman, 2025; Keskin, 2026).

Incentive structures similarly exhibit highly uneven distributions of value and coordination capacity. Within supply chain systems, incentive asymmetries persist because large retailers and lead firms capture the majority of benefits associated with traceability, compliance verification, and logistical optimization, while SMEs disproportionately absorb digitisation and implementation costs (Ahmed & Rahman, 2025; Kashem et al., 2023). These asymmetries weaken network effects and reduce participation incentives across fragmented stakeholder environments (Alstyne et al., 2016).

From a socio-technical perspective, these findings suggest that alignment is not a static equilibrium but a co-evolutionary process shaped by institutional adaptation, infrastructural coordination, and governance capacity (Geels, 2002; Geels & Schot, 2007). Sustained system reconfiguration therefore requires active institutional intervention capable of balancing stakeholder interests, reducing coordination frictions, and enabling interoperability across fragmented governance systems (Ostrom, 1990; Perez, 2002).

DISCUSSION

From Disruption to Systemic Reconfiguration

The Blockchain System Alignment Framework (BSAF) provides a coherent lens for interpreting the divergent outcomes observed across blockchain applications. Rather than treating blockchain as a uniformly disruptive or overhyped technology, the BSAF suggests that adoption outcomes are shaped by the interaction of technical architectures, institutional environments, and economic coordination mechanisms operating across fragmented governance systems (Geels, 2002; North, 1990; García Sáez, 2020). In this respect, blockchain systems are better understood as socio-technical infrastructures embedded within broader institutional and political-economic configurations rather than as isolated technological innovations (Geels & Schot, 2007; Perez, 2002).

Institutional Compatibility as a Socio-Technical Filter

Blockchain adoption outcomes emerge from the interaction between technological architectures and fragmented institutional environments (North, 1990; Williamson, 1985). The BSAF reframes “disruption” as systemic reconfiguration, where technology redistributes and reshapes institutional roles rather than eliminating intermediaries outright (Geels, 2002; Catalini & Gans, 2017). Systemic transformation depends not on decentralization alone, but on the capacity of socio-technical systems to coordinate governance, interoperability, and legitimacy simultaneously (Geels & Schot, 2007; Ostrom, 1990).

As illustrated in Figure 2, the conjunctural interdependence between technical viability, institutional compatibility, and economic incentive coherence means that deficiencies in any single dimension may constrain broader infrastructural scaling. For example, blockchain-enabled supply chain systems may possess functional traceability architectures while still failing to scale due to fragmented legal recognition, weak interoperability standards, or asymmetrical incentive structures affecting SME participation.

This dynamic is particularly visible in the uneven institutionalization of blockchain infrastructures across jurisdictions. Economies with adaptive governance frameworks and regulatory experimentation mechanisms—such as sandboxes and phased licensing regimes—have generally enabled faster diffusion and greater institutional integration (Celestin et al., 2025; IMF, 2023). Conversely, fragmented legal recognition, competing standards, and uncertain liability regimes continue to constrain scaling across sectors such as supply chains systems (Ahmed & Rahman, 2025; Keskin, 2026).

The Political Economy of Digital Infrastructure

A critical dimension of alignment is the emergence of infrastructural power and digital sovereignty (Zysman & Kenney, 2020; Mazzucato, 2013). Blockchain infrastructures increasingly function not merely as transactional technologies, but as contested governance architectures embedded within geopolitical competition and institutional fragmentation.

Geopolitical Fragmentation

The rise of CBDCs and stablecoins is increasingly linked to struggles over monetary sovereignty and strategic autonomy. Competing regulatory blocs are gradually creating differentiated and partially incompatible digital financial ecosystems, raising the prospect of fragmented "walled gardens" of digital finance (IMF, 2023; OECD, 2024). China's e-CNY initiative, debates surrounding the digital euro, and regulatory tensions surrounding dollar-backed stablecoins illustrate how blockchain infrastructures are becoming intertwined with broader geopolitical competition over financial governance and infrastructural control (Keskin, 2026).

Blockchain infrastructures increasingly operate within conditions of infrastructural geopolitics in which standards, payment systems, and digital governance architectures become instruments of strategic state power (Farrell & Newman, 2019). Competing regulatory approaches to stablecoins, CBDCs, cross-border data governance, and digital identity systems increasingly reflect broader struggles over monetary sovereignty, technological autonomy, and infrastructural dependency. From this perspective, blockchain infrastructures are not neutral transactional systems but politically embedded architectures capable of reinforcing or reshaping global distributions of economic and regulatory power (Mazzucato, 2013; Srnicek, 2017).

A further implication of blockchain-enabled governance architectures concerns the infrastructuralization of governance itself. As smart contracts and protocol rules become embedded directly within digital infrastructures, governance functions increasingly shift from negotiable institutional procedures toward technically encoded coordination mechanisms. While this may reduce transaction costs and improve procedural consistency, it also raises important political and normative questions concerning accountability, transparency, and democratic oversight (Winner, 1980; Jasanoff, 2004).

Infrastructuralized governance may create "black box" coordination systems in which critical governance decisions become difficult to contest, interpret, or modify once embedded within technical architectures. Consequently, blockchain systems do not merely redistribute economic coordination; they may also redistribute political authority by transferring governance capacity from public institutions and deliberative processes toward technical protocol designers, platform operators, and infrastructural gatekeepers. This reinforces the importance of institutional compatibility and governance adaptability within the BSAF framework.

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Standards Competition

The emergence of Digital Product Passports (DPPs) under the European Green Deal further demonstrates how blockchain-enabled infrastructures can project regulatory power across global value chains (Öztürk, 2026; Keskin, 2026). In this context, standards are not merely technical specifications but instruments of institutional coordination and market access governance. Blockchain infrastructures therefore become vehicles through which states and regional blocs extend regulatory influence internationally (North, 1990; Zysman & Kenney, 2020).

Standards competition also reflects broader dynamics of transnational governance in which technical standards function as mechanisms of regulatory coordination and market ordering across jurisdictions (Abbott & Snidal, 2001). Consequently, interoperability standards increasingly become instruments of infrastructural power capable of shaping participation within global digital ecosystems.

Regulatory Adaptability

Regulatory adaptability functions as a force multiplier for innovation diffusion by reducing the friction associated with legal uncertainty and institutional incompatibility (Celestin et al., 2025; García Sáez, 2020). Sandboxes, innovation offices, and phased compliance regimes enable institutional learning alongside technological experimentation, thereby facilitating socio-technical co-evolution rather than adversarial regulation (Geels & Schot, 2007).

Endogenous Fragmentation and Recursive Reconfiguration

While blockchain systems frequently operate within fragmented institutional environments, the analysis also suggests that blockchain infrastructures may themselves generate new forms of fragmentation. This dynamic introduces a recursive dimension to socio-technical alignment in which blockchain systems simultaneously respond to and reshape the institutional environments within which they operate.

Fragmentation therefore should not be understood solely as an exogenous constraint imposed by divergent legal systems, uneven governance capacity, or geopolitical competition. Blockchain deployment may also intensify fragmentation through protocol forks, competing interoperability standards, rival governance architectures, token-based coordination conflicts, and asymmetrical control over infrastructural access (García Sáez, 2020; Srnicek, 2017).

This dynamic has been visible in several prominent blockchain governance conflicts. The Ethereum/Ethereum Classic fork following the 2016 DAO (Decentralized Autonomous Organization) governance crisis demonstrated how disagreements over protocol governance and legitimacy can generate parallel infrastructures with competing governance philosophies. Similarly, competing supply chain consortia and interoperability disputes surrounding platforms such as TradeLens revealed how proprietary governance architectures may fragment rather than unify digital trade ecosystems.

This recursive dynamic is particularly visible in blockchain governance ecosystems where competing technical standards and governance mechanisms fragment network coordination rather than consolidate it. In supply chain systems, for example, dominant retailers may support proprietary blockchain consortia that reinforce rather than reduce infrastructural asymmetries, thereby limiting interoperability across broader ecosystems (Ahmed & Rahman, 2025).

Similarly, competing CBDC architectures and stablecoin regulatory regimes may produce fragmented monetary infrastructures characterized by incompatible technical standards, divergent compliance frameworks, and regionally segmented payment ecosystems (Farrell & Newman, 2019).

From this perspective, socio-technical alignment is not a static achievement but an ongoing process of institutional negotiation and infrastructural reconfiguration. Blockchain systems may therefore simultaneously:

- reduce some coordination frictions,while:
- generating new governance conflicts and interoperability divisions.

The BSAF consequently conceptualizes fragmentation as both:

1. an inherited institutional condition; and
2. an endogenous outcome of infrastructural transformation processes.

This significantly deepens the framework.

Technical Viability: From Feature to Infrastructure

Across all domains, technical viability acts as a necessary but insufficient condition for transformation (Iansiti & Lakhani, 2017; Catalini & Gans, 2017). In payment systems, scalability has improved through second-layer solutions and more efficient consensus mechanisms, enabling broader transaction throughput and lower costs (Celestin et al., 2025). However, supply chain applications remain constrained by infrastructural readiness, particularly heterogeneous data formats, interoperability limitations, and the absence of standardized IoT integration (Ahmed & Rahman, 2025; Kashem et al., 2023).

These findings suggest that technical functionality alone does not generate systemic transformation unless broader institutional and infrastructural conditions support coordination at scale.

Economic Incentive Coherence: Managing Stakeholder Asymmetry

Economic incentive coherence functions as a coordination mechanism that determines whether socio-technical alignment can be sustained over time (Alstyne et al., 2016; Catalini & Gans, 2017). In tokenized asset markets, incentive coherence is strengthened through fractional ownership, liquidity expansion, and secondary market participation, which align investor returns with platform performance and network growth (Celestin et al., 2025; OECD, 2024).

However, supply chain infrastructures continue to face significant asymmetry problems. Large retailers often capture the majority of value through enhanced traceability and logistical efficiency, while SMEs absorb disproportionate implementation costs without commensurate returns (Ahmed & Rahman, 2025). These asymmetric configurations weaken network effects and undermine participation incentives, contributing to stalled adoption and fragmented scaling trajectories (Kashem et al., 2023).

Without subsidy mechanisms, coordinated standards, or institutional interventions that redistribute costs and benefits more evenly, socio-technical alignment remains unstable and difficult to sustain across fragmented stakeholder environments (Ostrom, 1990).

Theoretical, Practical, and Policy Implications

The BSAF extends existing theory by shifting analytical attention from firm-level disruption toward system-level reconfiguration occurring under conditions of institutional fragmentation (Geels, 2002; Perez, 2002).

Theoretical Implications

The framework contributes to socio-technical transition theory and institutional political economy by conceptualizing blockchain adoption as a conjunctural alignment process rather than a technologically deterministic outcome (Geels & Schot, 2007; North, 1990). The observed moderating role of regulatory adaptability further supports a co-evolutionary perspective in which governance flexibility shapes the trajectory of technological diffusion and infrastructural transformation (Celestin et al., 2025).

Practical Implications

For managers and platform architects, the BSAF provides a diagnostic framework for assessing institutional compatibility, interoperability constraints, and stakeholder incentive asymmetries prior to deployment (García Sáez, 2020). This suggests that successful blockchain implementation depends as much on governance design and coordination capacity as on technical functionality.

Policy Implications

For policymakers, the analysis underscores the importance of adaptive governance mechanisms such as regulatory sandboxes, innovation offices, and harmonized digital standards frameworks (IMF, 2023; Keskin, 2026). Addressing incentive asymmetries—particularly those affecting SMEs within global supply chains—may be essential for reducing the digital divide and enabling more inclusive participation in emerging digital infrastructures (Ahmed & Rahman, 2025).

Institutional Fragmentation and the Political Economy of Digital Infrastructure

Blockchain adoption is shaped not only by technological capability or market incentives but by the fragmented structure of contemporary institutional environments. Digital infrastructures operate across jurisdictions characterized by divergent regulatory philosophies, competing standards regimes, and geopolitical rivalry. Under these conditions, blockchain systems face coordination problems that are simultaneously technological, institutional, and political.

This is evident in the emerging fragmentation of global digital finance, where competing approaches to stablecoin regulation and CBDC architecture reflect broader struggles over monetary sovereignty and strategic technological autonomy. Alignment becomes increasingly difficult as governance systems diverge, raising coordination costs and reducing interoperability. Consequently, blockchain infrastructures must be understood as contested governance architectures embedded within evolving geopolitical and institutional orders.

Boundary Conditions and Scope Conditions of the BSAF

While the Blockchain System Alignment Framework (BSAF) provides a useful analytical framework for understanding blockchain adoption outcomes, its explanatory scope is subject to important boundary conditions.

- First, the framework is most applicable to blockchain systems that function as coordination infrastructures spanning multiple institutional actors, jurisdictions, and governance environments. Applications operating entirely within centralized organizational hierarchies may depend less on institutional interoperability and stakeholder coordination than on conventional enterprise integration dynamics.
- Second, the framework is most relevant where distributed governance, interoperability, and cross-institutional coordination constitute core operational requirements. Technologies whose functionality depends primarily on computational performance or isolated organizational deployment may require different explanatory frameworks.
- Third, the BSAF does not assume that socio-technical alignment necessarily produces decentralization or institutional transformation. In some contexts, blockchain infrastructures may reinforce existing asymmetries of power, strengthen incumbent control, or generate hybrid governance arrangements rather than systemic disruption (Winner, 1980; Srnicek, 2017).
- Finally, the framework is analytically oriented toward understanding emergent digital infrastructures operating under conditions of institutional fragmentation and geopolitical complexity. Consequently, its explanatory strength is greatest in contexts characterized by regulatory divergence, standards competition, and contested governance architectures.

CONCLUSION

This paper set out to answer a fundamental question: why do some blockchain implementations succeed while others fail, despite similar technological foundations? Sustained value creation is not an inherent property of blockchain but a contingent outcome of socio-technical and institutional alignment (Geels, 2002; North, 1990). This paper demonstrates that technical viability constitutes a necessary but insufficient condition for systemic transformation; technological capability must be coupled with institutional coordination, governance adaptability, and coherent economic incentives operating across fragmented regulatory and infrastructural environments (Catalini & Gans, 2017; Celestin et al., 2025).

The analysis further shows that blockchain systems evolve not through technological disruption alone, but through processes of institutional co-evolution and infrastructural reconfiguration shaped by governance structures, interoperability conditions, and stakeholder coordination mechanisms (Geels & Schot, 2007; Perez, 2002). By conceptualizing blockchain as a conditional system-reconfiguring technology embedded within broader political-economic systems, researchers and policymakers can better understand the transition from isolated pilot projects toward resilient and scalable digital infrastructures (García Sáez, 2020; Keskin, 2026).

SUMMARY OF FINDINGS

The Blockchain System Alignment Framework (BSAF) posits that blockchain generates sustained value only when technical viability, institutional compatibility, and economic incentive coherence are jointly achieved (Catalini & Gans, 2017; North, 1990). Comparative patterns across four domains support this proposition.

Stablecoins and CBDCs

High coordination between protocol design and active central bank engagement has enabled rapid growth and institutional integration (IMF, 2023; OECD, 2024; Celestin et al., 2025).

Tokenized Asset Markets

Strong investor incentives and maturing custody solutions have produced significant liquidity gains, though fragmented cross-border securities laws continue to limit scaling (Celestin et al., 2025; OECD, 2024; Keskin, 2026).

Supply Chain Blockchain

Despite substantial technical investment, institutional fragmentation and incentive asymmetries between large retailers and SMEs have confined most projects to isolated pilot phases (Ahmed & Rahman, 2025; Kashem et al., 2023).

Theoretical Contributions

The BSAF makes three primary theoretical contributions.

From Disruption to Reconfiguration

The framework extends disruptive innovation theory by shifting analytical attention from firm-level disruption toward system-level reconfiguration, recognizing that blockchain infrastructures often redistribute and reshape institutional roles rather than eliminating them outright (Christensen, 1997; Geels, 2002; Perez, 2002).

Institutional Moderation

The analysis identifies regulatory adaptability as a limited but suggestive moderating effect shaping technological diffusion and institutional integration. Prior empirical studies reporting a modest moderating relationship between regulatory adaptability and blockchain diffusion (Celestin et al., 2025) provide limited but suggestive support for the broader co-evolutionary interpretation advanced by the BSAF.

Interdisciplinary Synthesis

The framework bridges previously fragmented literatures—including innovation theory, platform economics, socio-technical transitions, and institutional economics—into a unified analytical model for understanding digital infrastructure transformation (Geels & Schot, 2007; Catalini & Gans, 2017; Williamson, 1985).

Practical and Policy Implications

For managers and platform architects, the BSAF provides a diagnostic framework for assessing institutional compatibility, governance risks, and stakeholder incentive asymmetries prior to deployment (García Sáez, 2020). For policymakers, the study underscores the importance of regulatory adaptability facilitated through sandboxes, innovation offices, and coordinated standards frameworks (IMF, 2023; Keskin, 2026). Furthermore, addressing incentive asymmetries—such as requiring large buyers to support SME adoption—is essential for aligning private incentives with broader systemic resilience and reducing the digital divide within global supply chains (Ahmed & Rahman, 2025; Ostrom, 1990).

Limitations and Future Research

Limitations of this study include the relatively small number of domains analyzed and reliance on secondary evidence within a rapidly evolving technological landscape (Bryman & Bell, 2015; Yin, 2018). Future research should extend the BSAF into a more dynamic and process-oriented framework capable of incorporating organizational learning, institutional adaptation, and the cognitive dimensions of socio-technical alignment. In particular, future studies may investigate forms of "cognitive alignment," examining how the mental models, risk perceptions, and governance assumptions of regulators, managers, and institutional actors shape the willingness to adopt decentralized coordination architectures. Such research may further illuminate how socio-technical transitions depend not only on infrastructural compatibility and incentive structures, but also on evolving institutional cultures and interpretive frameworks.

Concluding Remarks

This paper has argued that blockchain adoption outcomes are best understood through the lens of socio-technical alignment under conditions of institutional fragmentation (Geels, 2002; North, 1990). Rather than viewing blockchain as an inherently disruptive technology, the analysis demonstrates that sustained adoption depends upon the co-evolution of technological architectures, governance systems, and economic coordination mechanisms (Geels & Schot, 2007; Perez, 2002).

The BSAF reframes blockchain as a system-reconfiguring infrastructure embedded within broader institutional environments. In doing so, it shifts analytical attention away from technological determinism toward the institutional and political conditions under which digital infrastructures scale, hybridize, or fragment (Williamson, 1985; Zysman & Kenney, 2020). More broadly, the findings suggest that the future of digital economic systems will be shaped less by the emergence of individual technologies than by the capacity of institutions and governance regimes to coordinate under conditions of increasing geopolitical complexity and infrastructural fragmentation (Mazzucato, 2013; Keskin, 2026).

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