



Digital Public Infrastructure and Inclusive Digital Transformation in Indonesia: Insights from India Stack

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Abstract. Digital transformation is increasingly serving as a strategic pathway to expand financial inclusion and economic participation in emerging economies. However, unequal access to financial services and fragmented digital infrastructures continue to constrain participation, particularly among underserved populations and Micro, Small, and Medium Enterprises (MSMEs). This paper examines the role of Digital Public Infrastructure (DPI) in supporting inclusive digital transformation, using the India Stack as a comparative benchmark and Indonesia as an empirical case. Drawing on a qualitative comparative approach, the study analyzes how interoperable digital infrastructures reduce barriers to financial participation through digital identity systems, payment interoperability, and institutional governance. The findings suggest that India Stack, particularly Aadhaar and the Unified Payments Interface (UPI), demonstrates how interoperable infrastructures can reduce transaction frictions and support financial participation at scale. In Indonesia, QRIS and BI-FAST similarly illustrate the growing role of interoperable payment infrastructures in expanding financial access and MSME participation, while also revealing challenges related to digital readiness, financial literacy, and institutional coordination. This paper argues that effective DPI depends not only on technological deployment but also on institutional conditions supporting inclusive participation. Three conditions emerge as central to inclusive digital transformation in Indonesia: interoperability, institutional coordination, and inclusive governance.

Keywords: Digital Public Infrastructure, Financial Inclusion, Digital Transformation, India Stack, Indonesia.

1 Introduction

Digital transformation increasingly shapes how governments, financial institutions, and businesses coordinate economic activity and expand market participation. In emerging economies, governments and financial institutions increasingly use digital technologies to reduce barriers to financial inclusion by improving access to financial services and reducing transaction frictions. However, unequal access to financial systems and fragmented digital infrastructures continue to constrain participation, particularly among underserved populations and Micro, Small, and Medium Enterprises (MSMEs). As digital economies expand, attention has shifted from isolated technological

solutions to infrastructures that enable participation at scale. In this context, Digital Public Infrastructure (DPI) has emerged as a framework for understanding how interoperable digital systems support inclusive digital transformation. Rather than emphasizing standalone technologies, DPI focuses on foundational infrastructures, including digital identity systems, payment networks, and data-sharing mechanisms, that enable coordination among governments, financial providers, and digital market actors [1], [2].

India provides one of the most prominent examples of DPI implementation through Aadhaar and the Unified Payments Interface (UPI). By late 2024, UPI processed more than 15 billion transactions per month and accounted for over 80% of India's digital payment volume, illustrating how interoperable infrastructures can expand participation in digital economic activity [3]. At the same time, India's experience raises broader questions concerning governance, institutional coordination, and the transferability of DPI models across different socioeconomic contexts.

These questions are particularly relevant for Indonesia, where digital payment systems have expanded rapidly through QRIS and BI-FAST. By the first half of 2025, QRIS had reached approximately 57 million users and 39.3 million merchants, of which over 93% consisted of MSMEs [4]. Despite this progress, Indonesia continues to face challenges related to financial literacy, uneven digital readiness, and fragmented governance arrangements, raising questions regarding the conditions under which digital transformation produces inclusive outcomes.

Despite growing interest in DPI, researchers have paid limited attention to how different institutional environments shape the adaptation of DPI-based transformation models in emerging economies. Against this background, this paper examines how DPI supports inclusive digital transformation in Indonesia, using the India Stack as a comparative benchmark and Indonesia as an empirical case. Specifically, the paper asks: How can DPI support inclusive digital transformation in Indonesia, and under what conditions are its benefits most likely to be realized?

The paper first develops a conceptual framework on DPI, financial inclusion, and infrastructural governance. It then examines India Stack as a comparative benchmark before turning to Indonesia's payment ecosystem, focusing on QRIS and BI-FAST as emerging DPIs. Finally, the paper proposes three conditions for effective and inclusive digital transformation in Indonesia: interoperability, institutional coordination, and inclusive governance.

2 Digital Public Infrastructure and Financial Inclusion

2.1 Digital Public Infrastructure

As governments, businesses, and financial institutions increasingly rely on digital systems to coordinate economic activity, attention has shifted from isolated digital services to infrastructures that enable participation at scale. DPI provides a useful framework for understanding how interoperable digital systems support inclusive digital transformation. Rather than referring to a single platform, DPI encompasses interoperable infrastructures that enable individuals, businesses, and governments to access and exchange services securely [1]. According to the World Bank, DPI consists

of foundational building blocks that support digital services at the societal scale, particularly through digital identity systems, payment infrastructures, and data-sharing mechanisms [2].

A defining feature of DPI lies in interoperability and reusability. By enabling interactions among governments, financial providers, businesses, and consumers through shared infrastructures, DPI reduces fragmentation, lowers coordination costs, and improves efficiency across digital ecosystems [1], [2], [5]. Rather than implying exclusive state ownership, the public dimension of DPI reflects a public-interest orientation aimed at improving accessibility and participation [1]. This characteristic becomes particularly relevant in emerging economies, where fragmented infrastructures and unequal access continue to constrain participation in formal digital systems [6]. India Stack therefore provides a useful benchmark for examining how interoperable digital infrastructures may support financial inclusion at scale.

2.2 Financial Inclusion and Digital Transformation

In emerging economies, financial inclusion remains closely linked to digital transformation and broader economic participation. Access to affordable financial services, including payments, savings, credit, and insurance, plays an important role in reducing inequality and supporting economic resilience [7]. Beyond developmental concerns, financial access increasingly shapes individuals' and smaller enterprises' ability to participate in digital markets and formal economic systems [8].

Governments, financial institutions, and technology providers increasingly use digital transformation to reduce barriers in conventional financial systems, including limited physical access, geographic constraints, and costly onboarding processes [7]. Through digital financial services such as mobile payments and digital accounts, participation in formal financial systems may become more accessible while reducing transaction frictions for consumers and businesses.

However, digital transformation does not automatically generate inclusive outcomes. The effectiveness of digital financial services depends on supporting conditions such as digital literacy, internet accessibility, institutional readiness, and governance capacity [9]. In Indonesia, disparities in financial access continue to shape uneven economic participation [8]. Evaluating the inclusiveness of digital transformation therefore requires attention not only to technological availability but also to the institutional arrangements that shape access and participation.

2.3 Infrastructural Governance

Inclusive digital transformation depends not only on technological adoption but also on how infrastructures are designed and governed. Infrastructural governance refers to the institutional and technical arrangements through which digital systems shape access, participation, and coordination across economic ecosystems [1]. Rather than functioning as neutral tools, digital infrastructures influence who can participate, under what conditions access is enabled, and how participation is facilitated or constrained [10].

Interoperable and accessible infrastructures reduce transaction barriers, improve coordination, and broaden participation opportunities across digital ecosystems [1], [5].

By contrast, fragmented systems frequently generate inefficiencies and restrict participation by increasing operational complexity and limiting accessibility [5]. As a result, inclusion

outcomes depend not only on technological availability but also on institutional and infrastructural arrangements that enable participation [6].

3. India Stack as a Comparative Benchmark

3.1 What is India Stack?

India Stack represents one of the most prominent national-scale implementations of DPI. Rather than functioning as a single technological platform, India Stack integrates identity verification, payment transactions, and broader digital services within an interoperable digital architecture [11]. Its significance lies in its ability to coordinate economic participation through scalable, reusable infrastructure.

Two components are particularly central to its operation: Aadhaar and the UPI. Aadhaar is a biometric-based digital identity system that supports authentication and onboarding for financial and administrative services [11]. UPI, introduced by the National Payments Corporation of India (NPCI) in 2016, enables real-time, interoperable payments across financial institutions and digital platforms through mobile interfaces [3], [11].

Unlike fragmented payment environments, UPI enables interactions across banks, fintech firms, and third-party applications through a shared payment infrastructure [3]. Users can transact through interoperable QR codes, mobile numbers, and virtual payment addresses without relying on a single platform [3]. India Stack therefore serves as a useful benchmark for understanding how interoperable digital infrastructures may support financial participation at national scale.

3.2 How India Stack Enables Inclusion

The relevance of India Stack lies less in technological deployment than in its ability to reduce barriers to financial participation. In many emerging economies, high transaction costs, limited banking access, fragmented payment systems, and burdensome onboarding procedures continue to reinforce financial exclusion. India addressed these constraints by integrating digital identity systems with interoperable payment infrastructures [11].

Aadhaar simplified identity verification processes that traditionally constrained access to financial systems among underserved populations [11]. However, broader inclusion depended significantly on UPI's ability to lower barriers to digital payments. Through interoperable QR systems and unified payment interfaces, UPI enables real-time transactions across financial providers without requiring conventional banking procedures or provider-specific systems [3]. This accessibility particularly benefits smaller merchants and informal economic actors, whose participation in digital markets depends on low-cost, accessible payment systems.

Empirical evidence illustrates the scale of this transformation. By late 2024, UPI processed more than 15 billion transactions per month and accounted for approximately 81.8% of India's digital payment volume [3]. Evidence further suggests that adoption increasingly shifted toward lower-value and higher-frequency transactions, indicating widespread use for routine economic activity [12].

Viewed through the framework developed in Section 2.3, India Stack demonstrates how interoperable infrastructures can reduce participation barriers, improve accessibility, and expand participation in both digital commerce and formal financial systems. At the same time, the scale of India's payment ecosystem raises broader questions regarding governance and institutional oversight.

3.3 Governance Trade-offs

Despite its achievements, India Stack also reveals important governance trade-offs associated with large-scale digital infrastructures. While interoperable systems may improve efficiency and expand participation, their scale and integration also raise concerns regarding privacy, surveillance, market concentration, and institutional accountability. Critics argue that integrated identity and payment infrastructures may increase state visibility into economic activity while also deepening institutional dependence on digital intermediaries, thereby raising concerns regarding data governance and citizen privacy. [13].

Large-scale digital infrastructures may also create new forms of dependency within payment ecosystems. Although UPI is regulated, transaction activity remains concentrated among a limited number of dominant providers [3]. Such concentration raises broader questions regarding competition, ecosystem dependency, and the long-term governance of interoperable payment systems.

These trade-offs suggest that policymakers and institutions should not treat DPI as a universally neutral solution to financial inclusion challenges. Rather, effective digital transformation requires balancing scalability and efficiency with safeguards related to accessibility, accountability, and public trust. India Stack therefore provides a useful benchmark for understanding the governance conditions shaping inclusive digital transformation.

4. Indonesia's Digital Transformation Through DPI

4.1 Indonesia's Digital Transformation Landscape

Indonesia's digital transformation has accelerated significantly in recent years, particularly through the modernization of payment systems and financial infrastructure. As one of Southeast Asia's largest digital economies, Indonesia is increasingly positioning digital financial services as a mechanism to improve transaction efficiency and expand financial inclusion [14]. Indonesia has accelerated payment system modernization through QRIS and BI-FAST, which are increasingly shaping the country's digital payment ecosystem [14], [15].

The rapid expansion of digital payments illustrates the scale of Indonesia's payment system modernization. By the first half of 2025, QRIS had reached approximately 57 million users and processed around 6.05 billion transactions totaling Rp579 trillion in value [4]. However, expanding payment access does not necessarily ensure meaningful financial inclusion. Persistent disparities in digital readiness, financial literacy, and infrastructure accessibility continue to shape uneven participation across geographic and socioeconomic groups [16], [17]. Indonesia's experience therefore suggests that

digital transformation involves not only technological expansion but also the challenge of ensuring broad-based participation.

4.2 QRIS as an Emerging Form of Digital Public Infrastructure

Although QRIS primarily operates as a payment standard, its role increasingly extends beyond transaction facilitation [18]. Viewed through a DPI lens, QRIS increasingly resembles a shared payment infrastructure that connects banks, fintech firms, merchants, and consumers through interoperable QR-code payments [19], [20].

Prior to QRIS, merchants frequently relied on fragmented payment arrangements requiring multiple QR codes and provider-specific systems. By establishing a common payment standard, QRIS reduces fragmentation and lowers barriers to participation across Indonesia's digital payment ecosystem [18], [20].

This transformation is particularly relevant for MSMEs, which frequently encounter barriers to formal financial participation and digital market integration. By mid-2025, approximately 39.3 million merchants had adopted QRIS, of which 93.16% consisted of MSMEs [4]. By lowering transaction frictions and simplifying payment acceptance, QRIS expands opportunities for MSMEs to integrate into digital commerce [21]. Nevertheless, access to payment systems alone does not necessarily ensure broader financial inclusion, particularly where digital capabilities and formal financial integration remain uneven [16], [17].

In addition, QRIS increasingly relies on complementary infrastructure, particularly BI-FAST, which enables real-time transfers and strengthens coordination across Indonesia's payment ecosystem [15]. Indonesia's payment modernization therefore relies not on isolated financial technologies, but on increasingly integrated digital payment infrastructures.

4.3 Adapting DPI Across Institutional Contexts

The comparison between Indonesia and India highlights both the opportunities and limitations of adapting DPI-based transformation models across emerging economies. Like India, Indonesia faces challenges of financial exclusion, fragmented payment systems, and uneven participation in formal financial services. Both countries also possess geographically dispersed populations and substantial informal sectors, making scalable digital payment infrastructures particularly relevant for broader economic participation [3], [11].

However, important institutional differences shape how digital transformation unfolds. India developed a highly integrated digital architecture linking identity systems, interoperable payments, and broader digital services within a relatively unified framework [11]. The integration between Aadhaar and UPI enabled India Stack to scale rapidly across financial and administrative domains while reducing onboarding frictions [3], [11].

Indonesia, by contrast, demonstrates a more decentralized and adaptive pathway. While QRIS and BI-FAST reflect important progress toward payment integration, Indonesia has not developed an equivalent identity-payment architecture comparable to Aadhaar and UPI [14], [15]. Institutional coordination remains distributed across multiple regulatory and financial actors, resulting in a comparatively gradual trajectory of payment-system modernization.

These differences suggest that Indonesia should not seek to replicate India Stack directly. While India demonstrates how tightly integrated infrastructures can rapidly scale participation, Indonesia's institutional diversity and uneven digital readiness may require a more adaptive approach. For Indonesia, the more relevant lesson lies not in institutional replication, but in understanding how interoperable infrastructures reduce participation barriers when adapted to domestic conditions.

4.4 Current Challenges

Despite considerable progress, several challenges continue to constrain the inclusiveness of Indonesia's digital transformation. Uneven levels of digital readiness and literacy continue to shape unequal participation within Indonesia's digital economy [17]. Financial literacy also remains a persistent concern, as many users continue to struggle to effectively use digital financial services despite expanded access [16].

Institutional coordination presents an additional challenge. Although QRIS and BI-FAST represent important progress toward payment integration, implementation remains uneven across regions and institutional contexts [17]. Indonesia's experience suggests that expanding digital payment infrastructures alone is insufficient to ensure inclusive participation. Although QRIS and BI-FAST improve payment accessibility, uneven digital readiness and financial capability may limit the extent to which expanded access translates into meaningful participation. In this sense, digital transformation risks reproducing existing inequalities if the institutional and social conditions that support it evolve unevenly.

5. Discussion: Conditions for Inclusive Digital Transformation

The comparison between India and Indonesia suggests that DPI does not automatically produce inclusive outcomes. India demonstrates how interoperable systems can rapidly scale participation, while Indonesia illustrates how uneven readiness and fragmented coordination may constrain inclusion despite expanding payment infrastructure.

5.1 Interoperability as the Foundation of Scalable Participation

The first condition concerns interoperability, which this paper identifies as a foundational characteristic of effective DPI. Fragmented systems frequently increase transaction costs, generate inefficiencies, and constrain participation by requiring users and merchants to navigate disconnected infrastructures [5]. By contrast, interoperable payment systems reduce barriers and enable coordination across financial ecosystems.

The experiences of both India and Indonesia illustrate the importance of interoperability. India's UPI enables seamless transactions across providers through a shared payment infrastructure [3]. Similarly, QRIS standardizes QR-based payments across providers, lowering operational barriers for merchants and consumers in Indonesia [18], [19]. For MSMEs, interoperable systems may improve access to payments and facilitate broader participation in digital commerce [21]. Interoperability should therefore be understood not merely as a technical feature, but as an infrastructural condition shaping scalable economic participation. While interoperable systems reduce fragmentation and lower transaction barriers, they also increase reliance

on shared payment infrastructures and institutional coordination. For Indonesia, strengthening interoperability therefore requires not only technical integration but also governance arrangements that support accessibility, resilience, and long-term participation.

5.2 Institutional Coordination and Ecosystem Governance

The second condition concerns institutional coordination. Digital transformation outcomes depend not solely on technological innovation but also on governance arrangements capable of coordinating infrastructures across institutions [1]. In fragmented ecosystems, technological advancements may fail to produce meaningful outcomes when regulators, financial institutions, and payment providers remain poorly aligned.

India's experience demonstrates how coordinated infrastructures linking identity systems and interoperable payments enabled rapid scaling across financial ecosystems [3], [11]. Indonesia, by contrast, demonstrates a more distributed governance environment in which digital transformation unfolds across multiple institutional actors [14]. Indonesia's more decentralized approach should not necessarily be interpreted as institutional weakness. However, fragmented governance may limit the inclusiveness of digital transformation when regulatory coordination, payment infrastructures, and broader digital systems evolve unevenly. As payment ecosystems expand, stronger coordination among regulators, financial institutions, fintech providers, and complementary digital initiatives becomes increasingly important to reduce fragmentation and sustain participation at scale.

5.3 Inclusive Governance and Sustainable Participation

The third condition concerns inclusive governance. Although digital infrastructures may improve accessibility and efficiency, the benefits of digital transformation are unlikely to be distributed equally without attention to social inclusion and accessibility. Evidence from Indonesia suggests that disparities in financial literacy, digital readiness, and regional infrastructure continue to shape uneven participation within digital financial ecosystems [16], [17].

This challenge highlights an important distinction between formal inclusion and meaningful participation. Expanded access to financial services does not necessarily ensure effective use when users continue to face barriers related to literacy, digital capability, or accessibility [16]. At the same time, governance concerns surrounding privacy, surveillance, and institutional concentration, as illustrated by debates over the India Stack, highlight the importance of balancing innovation with accountability and public trust [13].

Taken together, these findings suggest that governments and institutions can use DPI to support inclusive digital transformation only when they develop interoperable systems, strengthen institutional coordination, and maintain governance arrangements attentive to accessibility and long-term participation.

6 Conclusion

This paper examined the role of DPI in supporting inclusive digital transformation in emerging economies, using India Stack as a comparative benchmark and Indonesia's payment modernization efforts as an empirical case. The findings suggest that digital transformation outcomes depend not solely on technological adoption but on the institutional design, interoperability, and governance of underlying infrastructures.

The comparison between India and Indonesia shows that interoperable digital infrastructures can reduce participation barriers and expand financial inclusion, but their effectiveness depends heavily on the institutional context. India demonstrates how coordinated infrastructures linking identity systems and interoperable payments can scale participation across financial ecosystems. Meanwhile, Indonesia illustrates a more gradual, adaptive pathway through QRIS and BI-FAST, while continuing to face challenges related to digital readiness, financial literacy, and fragmented institutional coordination.

Building on these findings, this paper identified three conditions for effective and inclusive digital transformation in Indonesia: interoperability, institutional coordination, and inclusive governance. Together, these conditions suggest that the success of DPI depends not only on technological capability but also on institutional arrangements that translate digital innovation into meaningful and sustainable economic participation.

This paper focuses primarily on digital payment infrastructures as an entry point for examining DPI in Indonesia. Broader dimensions of DPI, including digital identity systems, cross-sector interoperability, and sector-specific applications, remain beyond the scope of the present analysis. Future research may therefore examine how DPI evolves across sectors and institutional settings, particularly in relation to digital identity integration, public service delivery, and broader organizational transformation.

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