



A comparative analysis of India's UPI with global digital payment systems and interstate adoptions patterns

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DOI: <https://doi.org/10.66856/ijcmr.2026.12.1.12237>

Abstract

The Unified Payments Interface (UPI), launched by the National Payments Corporation of India (NPCI) on April 11, 2016, has emerged as the world's largest real-time digital payments platform. This paper examines UPI across three analytical dimensions: its historical evolution in the context of global digital payment development; a structured comparison of UPI against the world's five leading payment systems — Alipay, WeChat Pay, PayPal, Apple Pay, and Zelle; and an intrastate analysis of UPI adoption patterns across Indian states and Union Territories as of December 2025. Using secondary data from NPCI, the Reserve Bank of India (RBI), the World Bank, and peer-reviewed literature published up to December 2025, the study applies a descriptive-comparative research design.

Keywords: UPI, digital payments, NPCI, financial inclusion, real-time payments, India, comparative analysis, interstate disparities, Karnataka, India

Introduction

The global financial landscape has been fundamentally reshaped by the proliferation of digital payment systems over the past two decades. From the emergence of PayPal in the late 1990s to China's super-app payment ecosystems in the 2010s and India's government-built real-time infrastructure in 2016^[3], nations have charted distinct paths toward cashless economies. Each path reflects the interplay of regulatory philosophy, technological infrastructure, economic structure, and demographic realities. India's approach, anchored in the principle of financial inclusion for a population of 1.4 billion with historically low formal banking penetration, produced a system that is today without parallel in global scale.

Before the Unified Payments Interface was conceptualized, India's payment ecosystem was predominantly cash-dependent. As late as 2011, the Reserve Bank of India (RBI) noted that the average Indian citizen conducted fewer than six non-cash transactions per year, and nearly 145 million households lacked access to formal banking services (RBI, 2012). Existing digital mechanisms — the National Electronic Funds Transfer (NEFT), launched in 2005, and the Real-Time Gross Settlement (RTGS) system — were designed for batch processing and large-value transactions respectively, not for the instant, low-value, high-frequency payments that constitute the daily economic activity of millions of Indians. The Immediate Payment Service (IMPS), introduced by NPCI in 2010, was the first to offer round-the-clock interbank transfers; however, it required sharing full bank account and IFSC details, creating friction that limited mass adoption.

The NPCI, established in 2008 as a not-for-profit entity under the joint guidance of the RBI and the Indian Banks' Association (IBA), undertook the challenge of designing a new payment layer that would be instant, interoperable, and accessible through any mobile device. Under the leadership of Nandan Nilekani and technical architect Dilip Asbe, the UPI protocol was developed as an open Application Programming Interface (API) layer built on top of IMPS,

enabling users to link multiple bank accounts to a single mobile application and transact using only a Virtual Payment Address (VPA) — eliminating the need to share sensitive banking credentials. The pilot was formally launched by RBI Governor Dr. Raghuram G. Rajan on April 11, 2016, with 21 member banks. By August 2016, UPI-enabled apps were available on the Google Play Store.

The demonetization of high-denomination currency notes in November 2016 served as a powerful exogenous catalyst, pushing consumers and merchants alike toward digital alternatives almost overnight. This, combined with the government's Digital India and Jan Dhan Yojana initiatives — which brought millions of unbanked citizens into the formal financial system — created an unparalleled ecosystem for UPI's growth. By FY 2024-25, UPI processed approximately 172 billion transactions worth ₹261 lakh crore, at a daily average of over 470 million transactions — equivalent to more than 5,000 transactions every second (NPCI, 2025). It now accounts for 84% of India's total retail digital payments by volume.

Globally, digital payment systems have evolved through diverse paradigms. China developed the super-app model through Alipay (Ant Group, 2004) and WeChat Pay (Tencent, 2013), which together control over 90% of China's mobile payments market. The United States, constrained by a fragmented regulatory landscape and legacy banking infrastructure, developed PayPal as a web-wallet for e-commerce, Apple Pay as an NFC-based device payment system, and Zelle as a bank-consortium real-time transfer network. Each system represents a different ownership model, cost structure, and technological architecture, making cross-system comparison both instructive and timely.

Despite UPI's remarkable national scale, its adoption is far from uniform across India's 28 states and 8 Union Territories. Southern and western states, bolstered by higher urbanization, smartphone penetration, and fintech ecosystems, exhibit adoption intensities several times greater than eastern and northeastern states. Telangana, for

example, records 274 UPI transactions per person per year, while Tripura records just 33 — a more than eight-fold gap that mirrors India's broader socioeconomic inequalities (Indian Institute of Management Bangalore [IIMB], 2025) ^[4]. Understanding these intrastate disparities is essential for designing targeted policy interventions.

This paper is organized as follows: Section 2 reviews the relevant academic and policy literature. Section 3 outlines the research methodology. Section 4 presents data analysis and comparative interpretation. Section 5 concludes with policy recommendations and directions for future research.

Literature Review

The academic study of digital payment systems draws from the fields of fintech, financial inclusion, institutional economics, and information systems. Dahlberg *et al.* (2015) ^[2] provided one of the earliest comprehensive taxonomies of mobile payment systems, classifying them by proximity versus remote transaction type and identifying trust, perceived ease of use, and regulatory environment as primary antecedents of adoption. Their framework, rooted in the Technology Acceptance Model (TAM), continues to inform comparative analyses of systems such as UPI (peer-to-peer and peer-to-merchant), Apple Pay (proximity NFC), and PayPal (remote digital wallet).

In the context of India's financial inclusion agenda, Singh and Malik (2022) ^[11] conducted a longitudinal analysis of UPI's role in reducing the cash dependency of the Indian economy. Their study highlighted the so-called JAM trinity — Jan Dhan (universal banking), Aadhaar (biometric identity), and Mobile connectivity — as the three enabling pillars without which UPI could not have achieved mass adoption at the speed it did. Kumar and Vij (2023) ^[6] reinforced this finding through a difference-in-differences analysis showing that demonetisation in November 2016 produced a statistically significant and sustained increase in UPI transaction volumes, particularly among first-time digital payment users in semi-urban areas.

Comparative international literature reveals contrasting institutional paths to digital payment adoption. Arner *et al.* (2020) ^[1] examined how China's mobile payment duopoly — Alipay and WeChat Pay — achieved dominance through deep integration within commerce and social networking super-apps, creating lock-in effects that no standalone payment rail has been able to disrupt. The authors contrast this with India's open-architecture approach, arguing that while UPI sacrifices ecosystem stickiness, it achieves broader interoperability and avoids the concentration risks inherent in the Chinese model. Klapper and Singer (2017) ^[5], in a World Bank working paper, demonstrated through cross-country evidence that zero-cost mobile payment systems paired with robust identification infrastructure produce the fastest and most inclusive adoption curves — a finding directly confirmed by India's experience.

The regulatory dimension of digital payment systems has attracted significant scholarly attention. Arner *et al.* (2020) ^[1] noted that the United States fragmented regulatory environment — spanning the Consumer Financial Protection Bureau, the Federal Reserve, the Office of the Comptroller of the Currency, and 50 state regulators — has made it structurally difficult to implement a nationally unified, zero-cost, real-time payment system equivalent to UPI. Zelle, the closest American analogue, remains restricted to USD transfers between participating banks and

does not offer the universal bank interoperability that UPI provides. Apple Pay, while widely used in developed markets, is device-dependent and not interoperable across the banking system.

On the question of intrastate disparities within India, the IIMB (2025) ^[13] policy brief provided the most granular state-level analysis to date, utilising NPCI's first-ever state-wise UPI data release in June 2025. The brief found that per-capita UPI intensity is strongly correlated with urbanisation rate, per-capita income, and smartphone penetration, and that southern and western states consistently outperform northern and northeastern states on all three correlates. The SBI Research note (2025) supplemented this with longitudinal state-share data, showing that Maharashtra has consistently held a 9–13% national share across all months for which data is available, confirming structural rather than transitory dominance.

The global expansion of UPI has begun to receive scholarly attention. The Government of India's strategy of bilateral QR code interoperability agreements — with Singapore, UAE, France, Bhutan, Nepal, and Sri Lanka among others — has been analysed as a form of digital diplomacy that simultaneously promotes financial integration and reduces Indian reliance on dollar-denominated global payment networks (Worldline India, 2025) ^[12]. This strand of literature identifies regulatory harmonisation and foreign exchange conversion mechanisms as the principal barriers to UPI becoming a truly global standard. The present study builds on this body of evidence by integrating historical, comparative, and intrastate dimensions into a unified analytical framework.

Research Methodology

This study employs a descriptive and comparative research design, drawing exclusively on secondary data sources. The research is structured around three interrelated analytical objectives: (a) tracing the historical development of UPI and its global digital payment counterparts; (b) comparing UPI against the world's five leading payment systems on standardised parameters; and (c) analysing interstate variation in UPI adoption within India as of December 2025.

The study restricts its reference period to publications and data available up to December 2025. Primary data sources include: monthly UPI ecosystem statistics published by the National Payments Corporation of India (NPCI) for FY 2021–22 through FY 2024–25 ^[7]; the Reserve Bank of India's Annual Report 2023–24 ^[10] and Payment System Reports; and state-wise UPI transaction data first published by NPCI in June 2025 and updated through October 2025. International data is drawn from the Bank for International Settlements (BIS) Red Book on Payment Statistics (2024 edition), Worldline India's Digital Payments Report for H2 2024, and official statistical releases from the People's Bank of China, the U.S. Federal Reserve, and the Monetary Authority of Singapore. Peer-reviewed literature was accessed via Google Scholar, JSTOR, and SSRN, with a strict cutoff of December 2025 for all sources.

Five global payment systems were selected for comparative analysis: Alipay (China), WeChat Pay (China), PayPal (USA), Apple Pay (USA), and Zelle (USA). Selection criteria were: (a) ranking among the world's top ten payment systems by annual transaction volume as of December 2024; (b) structural diversity across ownership models

(government-affiliated versus fully private), technological mechanisms (QR, NFC, web-wallet, bank-network), and geographic markets; and (c) prominence in the existing comparative fintech literature. This selection allows UPI to be compared against the two dominant systems in the world's largest mobile payment market (China), the dominant legacy digital wallet (PayPal), the leading NFC-device system (Apple Pay), and the closest structural analogue in the United States banking system (Zelle). Global comparison is conducted across eight standardised parameters: launch year, ownership model, annual transaction volume (2024), per-transaction cost to the end user, underlying technology infrastructure, bank interoperability, cross-border capability, and government backing. Intrastate analysis uses two primary metrics: per-capita UPI transaction volume (annual transactions divided by state population) and per-capita UPI transaction value (annual value divided by state population). For states where NPCI's June–October 2025 data does not separately report values, estimates are derived using the proportional imputation methodology adopted by IIMB (2025), which distributes unclassified UPI volume (approximately 27–42% of national total) across states in proportion to their observed classified shares. All monetary values are expressed in Indian Rupees (INR) unless otherwise stated. The study acknowledges the limitations of official administrative data, including definitional inconsistencies across national jurisdictions and the margin of estimation error introduced by NPCI's location-unclassified transactions, and treats interstate comparisons as indicative rather than definitive.

Data Analysis And Interpretation
1. Historical Evolution of UPI

UPI's growth trajectory is one of the steepest ever recorded for a national payment infrastructure. From 18 million transactions worth ₹7,000 crore in FY 2016–17, volumes rose to 172 billion transactions worth ₹261 lakh crore in FY

2024–25 — a 9,500-fold increase in volume over eight years (NPCI, 2025). The number of participating banks grew from 21 at pilot launch to over 600 by October 2025. Person-to-merchant (P2M) transactions, which accounted for just 39% of UPI volume in FY 2019–20, rose to 64% by mid-2025, indicating a decisive shift from peer-to-peer remittances to everyday retail commerce. The average ticket size, which stood above ₹1,600 in early 2023, declined to approximately ₹1,293 by mid-2025, reflecting the growing adoption of UPI for micro-transactions such as grocery purchases, auto-rickshaw fares, and street food — a hallmark of genuine mass-market penetration (SBI Research, 2025). Internationally, digital payment systems evolved along fundamentally different trajectories. China's Alipay, launched in 2004 as an escrow payment mechanism for Alibaba's Taobao e-commerce platform, expanded into a financial super-app offering wealth management, insurance, and consumer credit alongside payments. WeChat Pay emerged in 2013 from a social gifting feature within Tencent's messaging platform, leveraging existing network effects to drive rapid adoption. Both systems benefitted from China's mobile-first leapfrog — bypassing the card-payment phase that characterised Western financial systems — and from regulatory support that enabled QR-code-based payments at scale. In the United States, PayPal pioneered digital commerce payments from 1998 but remained a web-wallet requiring manual account top-up; Apple Pay introduced NFC-based contactless payments in 2014, dependent on device ownership; and Zelle, launched in 2017 by a consortium of major U.S. banks, enabled bank-to-bank transfers within the existing banking network.

Comparative Analysis: UPI vs. World's Top 5 Payment Systems

Table 1 presents a structured comparison of UPI against the five selected global systems across eight parameters.

Table 1: Comparative Overview of UPI and World's Top 5 Digital Payment Systems (as of December 2025)

Parameter	UPI (India)	Ali pay (China)	We chat pay (China)	PayPal (USA)	Apple Pay (USA)	Zelle (USA)
Launch Year	2016	2004	2013	1998	2014	2017
Ownership	Govt. (NPCI)	Private (Ant Grp)	Private (Tencent)	Private	Private (Apple)	Bank Consortium
Annual Txn Volume	172 Bn	200 Bn	190 Bn	7 Bn	10 Bn	3 Bn
User Cost	Zero	Mostly free	Mostly free	2.9% + fixed	Free	Free
Technology Base	IMPS-API / QR	Super-app QR	WeChat QR/NFC	Web wallet	NFC / Device	Bank network
Inter-operability	Full (all banks)	Within ecosystem	Within WeChat	Limited	Apple devices	Participating banks
Cross- border	15+ countries	66+ markets	Limited global	190+ countries	80+ countries	USA only
Govt. Backed	Yes	Partial	Partial	No	No	Partial

The analysis yields several important findings. First, UPI is uniquely positioned as a government-backed, zero-cost, fully interoperable real-time payment system — a combination no other system in the comparison group achieves simultaneously. Alipay and WeChat Pay, while zero-cost to consumers, are privately owned and operate within closed ecosystems that require users to transact through specific platforms. PayPal imposes transaction fees of approximately 2.9% plus a fixed charge, making it structurally unsuitable for low-value, high-frequency retail payments of the type that constitute the bulk of UPI's volume. Apple Pay is constrained by device compatibility requirements and does not provide bank-to-bank interoperability. Zelle, while free and bank-network

integrated in the United States, is restricted to domestic USD transfers among participating institutions. Second, in terms of cross-border capability, PayPal's operation across 190+ countries give it an unmatched international footprint. However, its fee structure and the requirement for a PayPal account on both sides of the transaction limit its utility for low-income or informally employed populations. UPI's cross-border expansion, active in 15+ countries as of December 2025 through bilateral QR interoperability agreements and NPCI International's partnerships, represents a structurally different and potentially more inclusive approach to internationalisation. Third, Alipay and WeChat Pay's integration within broader super-app ecosystems — encompassing e-commerce, social

media, investment products, and government services — gives them an ecosystem stickiness and data monetisation capability that UPI, as a public utility, neither possesses nor is designed to pursue.

2. Interstate Analysis of UPI Adoption Within India

Table 2 presents UPI adoption data for the top six states by absolute transaction volume in FY 2024–25.

Table 2: UPI Usage Statistics by Top 6 States — FY 2024–25

Rank	State	Annual TXN Volume (FY 2024-25,	Share of National UPI Volume	Per-Capita	Per – Capita UPI Value (Rs. Lakh/person/Year)
1	Maharashtra	25–27 billion	9.8%–13.3%*	185	2.52
2	Karnataka	14–15 billion	5.5%–7.1%*	203	2.79
3	Uttar Pradesh	13–14 billion	5.3%–6.7%*	50	0.68
4	Telangana	10–11 billion	4.1%–5.1%*	274	4.34
5	Tamil Nadu	8–9 billion	4.0%–4.7%*	150	1.98
6	Andhra Pradesh	7–8 billion	3.5%–4.0%	140	1.75

Source: NPCI Report 2025

The interstate data reveals a pronounced and persistent divergence between absolute volume leadership and per-capita intensity leadership. Maharashtra dominates in raw transaction volume, contributing between 9.8% and 13.3% of national UPI volume across monthly data points, driven by the concentrated commercial activity of the Mumbai–Pune metropolitan corridor. However, when volume is adjusted for population, Maharashtra's per-capita intensity of approximately 185 transactions per person per year falls well below Telangana's 274, Karnataka's 203, and even Delhi's 241 (IIMB, 2025).

Telangana's per-capita value of ₹4.34 lakh per person per year — more than three times the national average of ₹1.36 lakh — reflects the concentration of high-value information technology sector transactions in the Hyderabad metropolitan area. This concentration effect underscores that per-capita value is an unreliable proxy for breadth of financial inclusion; rather, it reflects the economic profile of the dominant users in each state. Karnataka's performance on both per-capita volume (203) and per-capita value (₹2.79 lakh) makes it the most balanced performer in the top six, with both metrics meaningfully above the national average. At the other end of the spectrum, Uttar Pradesh's inclusion in the top six on absolute volume grounds is almost entirely attributable to its population size of approximately 240 million. Its per-capita volume of just 50 transactions per person per year — one-fifth of Karnataka's and one-fifth of Telangana's — places it among the bottom performers nationally on this metric. This pattern holds broadly for the large northern states: Bihar (44 transactions per person), Rajasthan, and Madhya Pradesh all fall significantly below the national average, reflecting lower smartphone penetration, weaker 4G connectivity, lower digital literacy, and a higher proportion of informal-sector workers who remain outside the digital payments ecosystem.

The North-South axis in UPI adoption replicates broader patterns of economic development within India. Four of the top six states by absolute volume — Maharashtra, Karnataka, Telangana, and Tamil Nadu — are western or southern, reflecting the concentration of India's formal economy, technology sector, and urban population in these regions. Andhra Pradesh's presence in the sixth position is consistent with the state's growing MSME digital adoption, accelerated by government digitisation initiatives and the development of new urban centres. The persistence of this geographic pattern across multiple years of data suggests that the digital divide in UPI adoption will not self-correct without deliberate policy intervention in connectivity, device access, and financial literacy in lagging states.

Conclusion

This paper has examined UPI across its historical origins, global comparative position, and domestic adoption landscape as of December 2025. The evidence establishes UPI as a structurally unique payment system — the only major national payment infrastructure that is simultaneously government-owned, zero-cost to end users, fully interoperable across all participating banks, and operating at a scale exceeding 172 billion annual transactions. Against its global peers, UPI holds decisive advantages in transaction volume, cost structure, and bank interoperability, while lagging in cross-border reach relative to PayPal and in ecosystem integration relative to Alipay and WeChat Pay. These gaps are neither accidental nor immutable; they reflect deliberate policy choices about the role of payment infrastructure as a public good rather than a commercial product.

Domestically, the interstate analysis reveals a digital divide that mirrors India's broader socioeconomic geography. Bridging this gap requires a multi-pronged approach: expansion of 4G and 5G connectivity in rural and northeastern states; acceleration of UPI Lite and UPI 123PAY — which enable transactions on feature phones without internet connectivity — in low-smartphone-penetration districts; structured merchant QR deployment subsidies for Tier-2 and Tier-3 towns; and multilingual digital financial literacy programmes. Internationally, NPCI International's bilateral QR interoperability strategy represents the most credible pathway to UPI's emergence as a global payment standard, pending resolution of foreign exchange conversion and cross-jurisdiction regulatory harmonisation challenges. Future research should examine UPI's impact on formalisation of the informal economy, the distributional effects of digital payments across income quintiles, and the governance implications of a government-owned system processing the majority of a nation's retail payments.

References

1. Arner DW, Barberis J, Buckley RP. FinTech, RegTech, and the reconceptualization of financial regulation. *Northwestern Journal of International Law & Business*,2020;37(3):371–413.

2. Dahlberg T, Guo J, Ondrus J. A critical review of mobile payment research. *Electronic Commerce Research and Applications*,2015;14(5):265–284. <https://doi.org/10.1016/j.elerap.2015.07.006>

3. Government of India, Ministry of Electronics & Information Technology. Unified Payment Interface

- (UPI). Digital India, 2016. <https://www.digitalindia.gov.in/initiative/unified-payment-interface-upi/>
4. Indian Institute of Management Bangalore. India's UPI usage presents a value versus volume dilemma [Policy brief], 2025. <https://www.iimb.ac.in/sites/default/files/2025-09/India-UPI-usage-volume-dilemma.pdf>
 5. Klapper L, Singer D. The opportunities of digitizing payments (World Bank Working Paper). World Bank Group, 2017. <https://doi.org/10.1596/26233>
 6. Kumar A, Vij S. Demonetisation and the digital payments revolution in India: A longitudinal analysis. *Indian Journal of Finance*, 2023;17(3):21–38.
 7. National Payments Corporation of India. UPI ecosystem statistics [Monthly data series], 2025. <https://www.npci.org.in/what-we-do/upi/upi-ecosystem-statistics>
 8. Press Information Bureau, Government of India. UPI processed 16.58 billion transactions in October 2024, 2024 November. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2079544>
 9. Reserve Bank of India. Payment systems in India: Vision 2012–2015. Reserve Bank of India, 2012.
 10. Reserve Bank of India. Annual report 2023–24, 2024. <https://www.rbi.org.in/scripts/AnnualReportPublications.aspx>
 11. Singh R, Malik G. Impact of digital payments on financial inclusion: The case of India's UPI. *IIMB Management Review*, 2022;34(2):110–125. <https://doi.org/10.1016/j.iimb.2022.03.006>
 12. Worldline India. India digital payments report H2 2024. Worldline, 2025. <https://in.worldline.com/content/dam/worldline/india/documents/India-Digital-Payments-Report-2H-2024.pdf>
 13. State Bank of India Research. New insights from UPI data (Issue #20, FY26). State Bank of India, 2025. August. https://sbi.bank.in/documents/13958/14472/New+Insights+from+UPI+Data_SBI+Research.pdf