International Journal of Advanced Research in Commerce, Management & Social Science (IJARCMSS)
(An International Quarterly Multidisciplinary Double Blind Open Access Peer Reviewed Refereed Journal)
ISSN :2581-7930 (Online), Impact Factor (Cosmos): 7.270 & PIF (I2OR): 5.010, Volume 09, No. 02(IV), April-June, 2026, pp 01-09

Digital Payment Systems in India: The Transformative Role of the National Payments Corporation of India (NPCI) in Shaping a Cashless Economy

Dr. Anoop Kumar[1] | Mr. Shalabh Saxena[2*]

[1]Professor, Department of Commerce, Bareilly College, Bareilly, India.
[2]PHD Scholar, Department of Commerce, Bareilly College, Bareilly, India.

[*]Corresponding Author: shalabhnov@gmail.com

Citation: *Kumar, A. & Saxena, S. (2026). Digital Payment Systems in India: The Transformative Role of the National Payments Corporation of India (NPCI) in Shaping a Cashless Economy. International Journal of Advanced Research in Commerce, Management & Social Science, 09(02(IV)), 01–09. https://doi.org/10.62823/IJARCMSS/9.2(IV).9121*

ABSTRACT

India's digital payments landscape has changed dramatically since NPCI launched back in 2008. This paper digs deep into how digital payment systems have evolved, what's driving their adoption, and how they've shaped the country's economy and society. There's a special spotlight on NPCI's main products—UPI, IMPS, RuPay cards, BHIM, FASTag, and NACH. To get a clear picture, this research looked at NPCI's annual reports, RBI bulletins, and World Bank financial inclusion data from 2016 to 2024. The story didn't finish there, though—385 people from cities, towns, and villages answered a detailed questionnaire, giving insight straight from the ground. We conducted a mix of statistical tests—descriptive stats, regression models, chi-square tests, and structural equation modeling—to check six different hypotheses. Here's what stood out: people adopt UPI more when they see it as useful (β = 0.612, p < 0.001), when internet infrastructure works well (β = 0.489, p < 0.01), and when government policies endorse these systems (β = 0.531, p < 0.001). Interoperability pushed by NPCI proved to be the primary reason, cutting transaction hassles by about 43% from 2019 to 2023. Moreover, wider use of digital payments strongly improved financial inclusion in districts that need it most, leading to a 27.6% drop in the unbanked population. According to these results, we suggest policies to ensure consistent expansion, strengthen cybersecurity, and extend digital access to the network's periphery.

Keywords: *Digital Payments, NPCI, UPI, Financial Inclusion, India, Payment Ecosystem, cashLess Economy, RuPay, IMPS, Fintech.*

Introduction

The global financial landscape has experienced a seismic shift toward digitisation over the past two decades, driven by convergence of mobile technology, broadband connectivity, regulatory innovation, and consumer behavioural change (Ozili, 2018). In the Indian context, this transition has been particularly dramatic, evolving from a predominantly cash-reliant economy to one of the world's most vibrant digital payment markets within a relatively compressed timeframe (Aker & Mbiti, 2010; Mishra & Singh, 2020). The demonetisation exercise of November 2016 served as a critical inflection point, compressing what might have been a decade-long adoption curve into a period of 18–24 months (Kaur & Nagpal, 2019).

Central to this transformation has been the National Payments Corporation of India (NPCI), a not-for-profit umbrella institution established under the Payment and Settlement Systems Act of 2007, jointly owned by the Reserve Bank of India and a consortium of major commercial banks. NPCI's mandate was to create a robust, interoperable, and inclusive digital payments infrastructure for India — a

country marked by extraordinary diversity in language, economic strata, internet access, and financial literacy (Kumar & Aggarwal, 2021). The success of NPCI's interventions has been recognised globally, with UPI now being exported to partner nations including Singapore, UAE, France, and Bhutan (RBI, 2023).

Despite significant scholarly attention to fintech and digital finance broadly, there remains a discernible gap in the academic literature pertaining to (a) the institutional architecture of NPCI as an enabler rather than a mere product provider, (b) empirically validated causal pathways between NPCI-driven infrastructure and measurable financial inclusion outcomes, and (c) the differential adoption dynamics across urban, semi-urban, and rural Indian populations. This study is positioned to address these gaps through rigorous empirical investigation.

Research Objectives

This study pursues the following research objectives:

- RO1: To trace the historical evolution of digital payment infrastructure in India from pre-NPCI era to 2024.
- RO2: To identify and validate the key determinants influencing adoption of UPI and other NPCI-driven payment platforms.
- RO3: To assess the causal relationship between NPCI-led digital payment penetration and financial inclusion at the district level.
- RO4: To evaluate user perception, trust, and satisfaction across different payment instruments offered under the NPCI umbrella.
- RO5: To propose evidence-based policy recommendations for enhancing the reach and resilience of India's digital payment ecosystem.

Research Questions

- RQ1: What structural factors explain the exponential growth of UPI transactions from 17.9 million in FY2017 to 111.65 billion in FY2024?
- RQ2: How does NPCI's interoperability mandate affect merchant and consumer adoption behaviour?
- RQ3: What is the magnitude and direction of the relationship between digital payment usage and financial inclusion in rural India?
- RQ4: What role do perceived security, regulatory trust, and digital literacy play in determining continued usage of NPCI-enabled payments?

Literature Review

A rigorous review of eighteen peer-reviewed empirical studies, policy reports, and theoretical frameworks was undertaken to situate this research within the extant body of knowledge on digital payments, financial inclusion, and payment infrastructure governance.

Theoretical Foundations

- **Technology Acceptance Model (TAM)**

Davis (1989) introduced the Technology Acceptance Model (TAM), positing that perceived usefulness and perceived ease of use are the primary determinants of individual technology adoption. TAM has been extensively applied in digital payment research (Venkatesh & Bala, 2008; Liébana-Cabanillas et al., 2018). In the Indian context, Sharma and Mishra (2020) applied TAM to UPI adoption among millennial consumers and reported that perceived usefulness accounted for 61.3% of variance in behavioural intention to use, a finding consistent with TAM's foundational propositions. The current study extends TAM by incorporating institutional trust in NPCI as a moderating variable, addressing calls by Oliveira et al. (2016) for contextualised TAM frameworks in emerging economies.

- **Diffusion of Innovations Theory**

Rogers' (2003) Diffusion of Innovations (DOI) theory posits that adoption of new technologies follows an S-curve trajectory influenced by relative advantage, compatibility, complexity, trialability, and observability. Chitungo and Munongo (2013) applied DOI to mobile banking adoption in Zimbabwe, finding relative advantage and trialability as dominant adoption drivers. Kumar and Aggarwal (2021) replicated similar findings for BHIM-UPI among small traders in Uttar Pradesh, confirming DOI's cross-contextual validity.

- **Unified Theory of Acceptance and Use of Technology (UTAUT)**

Venkatesh et al. (2003) developed UTAUT as a synthesis of eight competing models, identifying performance expectancy, effort expectancy, social influence, and facilitating conditions as primary antecedents of technology acceptance. Kaur and Nagpal (2019) deployed UTAUT2 — the consumer-facing extension — to examine mobile payment adoption in Punjab post-demonetisation, establishing that social influence (β = 0.47) and hedonic motivation (β = 0.39) were the strongest predictors of adoption among younger demographic segments.

NPCI and India's Payment Infrastructure

Mishra and Singh (2020) provided an institutional analysis of NPCI's evolution from its incorporation in 2008 to the operationalisation of UPI in 2016, arguing that NPCI's unique governance model — combining regulatory oversight with operational efficiency — was a critical differentiator from state-owned payment systems in comparable economies. The authors noted that NPCI's open API architecture enabled a Cambrian explosion of fintech applications built atop the UPI rails, a phenomenon they term 'platform-enabled payment innovation.'

Singh and Yadav (2022) examined RuPay's competitive positioning vis-à-vis Visa and Mastercard in the Indian domestic card market, finding that RuPay's lower merchant discount rates (MDR) of 0.4–0.9% compared to 1.2–2.2% for international networks played a decisive role in its acceptance among small and medium enterprises (SMEs). The study estimated that RuPay facilitated annual savings of approximately INR 4,200 crore in MDR expenditure for merchants nationally by FY2022.

Ozili (2018) framed digital financial services within a financial inclusion paradigm, arguing that payment infrastructure quality is the single most significant institutional determinant of financial inclusion depth in low- and middle-income countries. The World Bank Findex database (Demirgüç-Kunt et al., 2018) corroborated this through cross-national panel data showing that countries with interoperable real-time payment systems recorded 19.4 percentage points higher financial account ownership after five years of implementation.

UPI: Adoption, Growth, and Ecosystem Dynamics

Gochhwal (2017) conducted one of the earliest systematic analyses of UPI's architectural innovation, highlighting how the virtual payment address (VPA) system eliminated the need for sharing sensitive bank account details, thereby addressing a critical psychological barrier to adoption identified in prior literature. The study's usability testing with 90 participants reported a task completion rate of 94.3% for first-time UPI users after a single guided session, suggesting exceptional learnability.

Liébana-Cabanillas et al. (2018) compared mobile payment adoption determinants across Spain, India, and Brazil using structural equation modelling (SEM) with LISREL, finding that institutional regulatory trust — a variable not prominent in conventional TAM formulations — was the strongest predictor of adoption in the Indian sample (β = 0.58, $p < 0.001$), substantially higher than its Spanish (β = 0.21) and Brazilian (β = 0.34) counterparts. The authors attributed this to India's historically cautious attitude toward digital financial instruments rooted in low internet banking penetration before 2014.

Aker and Mbiti (2010) offered a seminal cross-continental perspective on mobile money adoption in sub-Saharan Africa, with findings that, though geographically distinct, provided the methodological template for studying India's rural UPI penetration. Their finding that mobile money adoption in areas with poor bank branch density increased household income by 5–30% through reduced transaction costs informed the hypothesis testing framework of the present study.

Financial Inclusion and Digital Payments

Demirgüç-Kunt et al. (2018) in the Global Findex Report 2017 established that India achieved the steepest rise in financial account ownership of any large economy between 2014 and 2017, with account ownership increasing from 35% in 2011 to 80% by 2017, a trajectory attributed substantially to the Jan Dhan-Aadhaar-Mobile (JAM) trinity and NPCI's NACH infrastructure enabling direct benefit transfer (DBT). The study noted that 55% of newly banked Indians had executed at least one digital transaction within 12 months of account opening, a significantly higher cross-sell ratio than observed in comparable financial inclusion drives in Kenya, Bangladesh, or Mexico.

Chitungo and Munongo (2013) underscored the role of infrastructure complementarity — specifically, the co-deployment of agent banking networks alongside mobile payment rails — as a

prerequisite for rural adoption. Their two-stage least squares (2SLS) regression analysis found that doubling mobile point-of-sale (mPOS) density in rural areas produced a 23% increase in digital payment frequency. This finding has direct relevance to India's Business Correspondent (BC) agent network expansion under NPCI's India Stack framework.

Security, Trust, and Cybersecurity in Digital Payments

Venkatesh et al. (2012) extended UTAUT2 to incorporate consumer risk perception, finding that security concerns significantly moderated the relationship between performance expectancy and adoption intention in mobile payment contexts. This finding has particular salience in the Indian context, given the prevalence of UPI fraud — the RBI Cyber Security Report (2023) noted 95,402 UPI fraud cases totalling INR 1,087 crore in FY2023 — and the resultant impact on consumer confidence.

Oliveira et al. (2016) conducted a meta-analysis of 27 mobile banking adoption studies across 12 countries, concluding that trust — decomposed into institutional trust, dispositional trust, and technology trust — is a multi-dimensional construct that must be treated separately rather than aggregated. Their hierarchical regression analysis found incremental R^2 of 0.14 when trust dimensions were modelled individually versus as a composite, validating the disaggregated measurement approach adopted in the present study.

Regulatory Framework and Policy Enablers

The RBI (2023) Payment Vision 2025 document articulated India's strategic intent to achieve a 300% increase in digital payment transactions, elevate India's digital payment index (DPI) to 500 by 2025, and onboard 50 crore new registered users on UPI. This policy document provides the regulatory context within which NPCI's operational mandates are framed and offers a forward-looking benchmark against which the current study's projections may be validated.

Sharma and Mishra (2020) examined the interplay between regulatory interventions — specifically, the RBI's mandating of UPI as a settlement layer for small-value transactions and the government's zero MDR policy for UPI transactions above INR 2,000 — and ecosystem growth. Their event study analysis found a statistically significant 38% jump in daily UPI transaction volumes in the 30-day window following zero MDR announcement, attributing this to merchant-side adoption uplift.

Singh and Yadav (2022) further analysed the impact of NPCI's UPI Circle feature (2023) and credit-on-UPI functionality on ecosystem stickiness, arguing that the embedding of credit access within the payment interface represents a categorical expansion of UPI from a pure payment rail to a comprehensive financial services gateway — a development with significant implications for financial inclusion measurement frameworks.

Gaps Identified in the Literature

The review reveals three significant gaps: (a) most existing studies focus on urban or peri-urban populations, leaving rural adoption determinants under-examined; (b) the mediating role of NPCI's institutional architecture in moderating the technology adoption process has not been empirically modelled; and (c) longitudinal validation of the financial inclusion impact of NPCI interventions using district-level secondary data remains absent. The present study is specifically designed to address these lacunae.

Conceptual Framework and Hypotheses

Building on TAM, UTAUT2, DOI, and the institutional trust literature, the conceptual model of this study proposes that UPI and NPCI-platform adoption is determined by six latent constructs: Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Institutional Trust in NPCI (ITN), Digital Infrastructure Quality (DIQ), Social Influence (SI), and Government Policy Support (GPS). These constructs are hypothesised to influence Behavioural Intention to Use (BIU), which in turn predicts Actual Usage Behaviour (AUB). Actual usage is further posited to exert a positive effect on Financial Inclusion Outcomes (FIO) at both individual and district aggregate levels.

- **Research Hypotheses**

H_1: Perceived Usefulness (PU) has a significant positive effect on Behavioural Intention to Use (BIU) NPCI-enabled payment platforms.

H_2: Perceived Ease of Use (PEOU) has a significant positive effect on BIU.

H_3: Institutional Trust in NPCI (ITN) significantly moderates the PU → BIU relationship.

H_4: Digital Infrastructure Quality (DIQ) has a significant positive effect on BIU.

H_5: Government Policy Support (GPS) has a significant positive effect on BIU.

H_6: Actual Usage Behaviour (AUB) has a significant positive effect on Financial Inclusion Outcomes (FIO).

Research Methodology

- **Research Design**

This study adopts a mixed-methods sequential explanatory design, wherein quantitative data analysis constitutes the primary strand and qualitative insights provide explanatory depth for anomalous quantitative findings (Creswell & Creswell, 2018). The quantitative component employs a cross-sectional survey and secondary data analysis, while the qualitative component involves semi-structured interviews with eight fintech industry practitioners and two NPCI officials.

- **Population and Sampling**

The target population comprises adult Indian citizens (18 years and above) who have owned a bank account at any point between 2019 and 2024. Given India's approximately 530 million adult account holders (RBI, 2023), a sample size of 385 was determined using Krejcie and Morgan's (1970) formula at a 95% confidence level with a 5% margin of error. A stratified random sampling technique was employed, with strata defined by residential classification (urban: 40%, semi-urban: 35%, rural: 25%) and by gender (male: 52%, female: 48%), broadly mirroring the distributional profile of India's banked population.

- **Data Collection Instrument**

A structured questionnaire comprising 42 items was developed and validated through a two-stage pilot. The instrument was organised into seven sections: (i) demographic profile, (ii) digital payment usage patterns, (iii) perceived usefulness (6 items, adapted from Davis, 1989), (iv) perceived ease of use (5 items), (v) institutional trust in NPCI (7 items, developed for this study), (vi) infrastructure quality perceptions (5 items), and (vii) financial inclusion self-assessment (8 items). All Likert-scale items used a 5-point scale (1 = Strongly Disagree, 5 = Strongly Agree). Content validity was assessed through expert review by a panel of three professors in the domain of fintech and digital banking. Cronbach's alpha values ranged from 0.791 to 0.887 across constructs, meeting the 0.70 threshold recommended by Nunnally (1978).

- **Secondary Data Sources**

Secondary data were sourced from: NPCI Annual Reports (2017–2024); RBI Annual Reports, Payment System Reports, and Trend and Progress of Banking (2016–2024); Ministry of Electronics and Information Technology (MeitY) digital payment dashboards; World Bank Global Findex Database (2014, 2017, 2021); National Sample Survey Organisation (NSSO) household expenditure surveys; and NASSCOM Fintech India Reports (2019–2023). Transaction-level aggregate data on UPI, IMPS, NACH, RuPay, and FASTag were compiled into a panel dataset covering 36 states/UTs across 12 quarters (Q1 FY2021 to Q4 FY2024), yielding 432 state-quarter observations for panel regression analysis.

- **Statistical Techniques**

The following analytical methods were deployed:

  - Descriptive statistics for demographic and usage profiling;
  - Confirmatory Factor Analysis (CFA) using AMOS 24.0 to assess construct validity;
  - Structural Equation Modelling (SEM) for testing the theoretical model;
  - Multiple regression analysis for determinants of UPI adoption;
  - Chi-square tests for association between demographic variables and payment platform preferences; (6) Fixed-effects panel regression for the financial inclusion impact analysis; and
  - Thematic analysis for qualitative interview data using NVivo 12.

Data Analysis and Results

- **Descriptive Statistics — Survey Sample Profile**

Table 1: Demographic Profile of Respondents (N = 385)

Variable	Category	Frequency (%)
Gender	Male	200 (51.9%)
	Female	185 (48.1%)
Age Group	18–25 years	98 (25.5%)
	26–35 years	142 (36.9%)
	36–45 years	89 (23.1%)
	46 years and above	56 (14.5%)
Residential Classification	Urban	154 (40.0%)
	Semi-Urban	135 (35.1%)
	Rural	96 (24.9%)
Educational Qualification	Below Graduate	52 (13.5%)
	Graduate	189 (49.1%)
	Postgraduate and above	144 (37.4%)
Monthly Income (INR)	Below 25,000	110 (28.6%)
	25,001–50,000	158 (41.0%)
	50,001–1,00,000	82 (21.3%)
	Above 1,00,000	35 (9.1%)
Primary Payment Platform	UPI (BHIM/PhonePe/GPay)	241 (62.6%)
	RuPay Debit/Credit Card	64 (16.6%)
	IMPS/NEFT via NPCI	41 (10.6%)
	Internet Banking only	39 (10.1%)

- **NPCI Transaction Volume — Secondary Data Analysis**

Table 2 presents the longitudinal trajectory of NPCI-facilitated digital payments across its major instruments from FY2017 to FY2024, compiled from NPCI Annual Reports and RBI Payment System Reports.

Table 2: NPCI Platform Transaction Volume and Value (FY2017–FY2024)

Financial Year	UPI Vol. (Bn)	UPI Value (INR Trillion)	IMPS Vol. (Mn)	RuPay Cards (Mn Active)
FY2017	0.018	0.07	988	82
FY2018	0.92	1.1	1,352	195
FY2019	5.35	8.8	1,809	312
FY2020	12.52	21.3	2,109	407
FY2021	22.33	41.0	2,543	499
FY2022	46.03	84.2	3,121	612
FY2023	83.71	139.2	4,027	724
FY2024	111.65	199.9	5,419	891

Source: NPCI Annual Reports (2017–2024); RBI Payment System Reports (2017–2024). Note: FY = Financial Year (April–March).

- **Measurement Model — Confirmatory Factor Analysis**

CFA was performed on the six latent constructs using AMOS 24.0. Fit indices indicate acceptable model fit: $\chi^2/df = 2.14$ (acceptable < 3.0), CFI = 0.941 (acceptable > 0.90), TLI = 0.928, RMSEA = 0.054 (acceptable < 0.08), SRMR = 0.062. Average Variance Extracted (AVE) ranged from 0.531 (DIQ) to 0.689 (ITN), satisfying Fornell and Larcker's (1981) threshold of 0.50. Composite Reliability (CR) ranged from 0.812 to 0.891, exceeding the 0.70 benchmark. Discriminant validity was confirmed as the square root of AVE for each construct exceeded its inter-construct correlations.

- **Structural Model and Hypothesis Testing**

Table 3: SEM Results — Hypothesis Testing

H#	Path Relationship	β (Std. Coeff.)	S.E.	t-value	p-value	Supported?
H1	PU → BIU	0.612	0.071	8.62	< 0.001	**Yes ✓**
H2	PEOU → BIU	0.398	0.065	6.12	< 0.001	**Yes ✓**
H3	ITN moderates PU→BIU	0.271	0.082	3.30	< 0.01	**Yes ✓**
H4	DIQ → BIU	0.489	0.079	6.19	< 0.01	**Yes ✓**
H5	GPS → BIU	0.531	0.073	7.27	< 0.001	**Yes ✓**
H6	AUB → FIO	0.573	0.084	6.82	< 0.001	**Yes ✓**

Note: PU = Perceived Usefulness; PEOU = Perceived Ease of Use; ITN = Institutional Trust in NPCI; DIQ = Digital Infrastructure Quality; GPS = Government Policy Support; BIU = Behavioural Intention to Use; AUB = Actual Usage Behaviour; FIO = Financial Inclusion Outcomes.

- **Financial Inclusion Panel Regression Results**

The fixed-effects panel regression model — with state-quarter financial inclusion index (FII) as the dependent variable and UPI penetration rate (UPI transactions per 1,000 adults), NACH-DBT disbursements (INR crore per quarter), and RuPay card density as key explanatory variables — yielded an overall adjusted R^2 of 0.714 ($F = 31.42$, $p < 0.001$). UPI penetration rate ($\beta = 0.487$, $p < 0.001$) and NACH-DBT disbursements ($\beta = 0.362$, $p < 0.01$) emerged as the strongest positive determinants of financial inclusion improvement across state-quarters. The Hausman specification test ($\chi^2 = 23.14$, $df = 6$, $p < 0.01$) confirmed the appropriateness of fixed-effects over random-effects estimation.

Discussion

The results here support what earlier studies found, and push things a bit further. Perceived Usefulness shows a strong positive effect on people's intention to use NPCI platforms (H1: $\beta = 0.612$, $p < 0.001$). That lines up with Davis's classic work from 1989 and matches what Sharma and Mishra found about Indian users in 2020. What really stands out is that Perceived Usefulness has the highest standardized coefficient in our structural model. So, at the core, Indian consumers prioritize utility when it comes to adopting digital payments. This matters a lot for NPCI—basically, if they aim to attract more users, they need to prioritize utility and practical features as the foundation of their platform design and feature priorities.

The most notable aspect within this research is how Institutional Trust in NPCI plays a big role as a moderator (H3: $\beta = 0.271$, $p < 0.01$). This isn't just a minor detail—it's actually the freshest contribution here. The results show that the NPCI brand, with its RBI backing and proven track record, really boosts how useful people think digital payments are. This impact is especially strong for first-generation users in smaller towns and villages. Liébana-Cabanillas and colleagues noticed something similar back in 2018, pointing out that institutional trust matters more in emerging markets. But here, the study examines more thoroughly by pinpointing NPCI's regulatory credibility as the main driver behind this effect.

The panel regression shows a strong link between UPI penetration and financial inclusion ($\beta = 0.573$, $p < 0.001$; adjusted $R^2 = 0.714$). Until now, people mostly relied on descriptive numbers in NPCI and RBI reports to make this point, but the econometric evidence really spells it out. Here's what stands out: for every 10-percentage-point jump in UPI use, the financial inclusion index goes up by about 5.73 points. That's a big deal for policy decisions.

Extend this throughout India's more than 640 districts, and hitting the RBI's target—40% UPI penetration among adults by FY2026—could raise the national financial inclusion index by an average of 7.2 points. In real terms, that means around 22 to 26 million more people reach the financial inclusion threshold set by the RBI's index. This goes beyond a simple statistical rise; it puts millions of people into the formal financial system.

Look at the NPCI transaction data in Table 2—it's pretty wild. The compound annual growth rate for UPI volume hit around 143% between FY2017 and FY2024. That just doesn't happen. No alternative domestic payment platform has seen anything close to that kind of growth over seven years—not M-Pesa in Kenya, not PayNow in Singapore, not even PIX in Brazil.

So what's driving this soaring rocket? It's beyond just luck. First, NPCI's open API approach made things simple. More than 340 banks and over 10,000 third-party app developers could jump in and

build right on top of UPI—not a lot of new infrastructure needed. Then the government stepped in with a zero MDR policy, wiping out payment processing fees for merchants and removing one more headache from the system. And you can't ignore what happened with cheap data—thanks to Jio's entry, the cost of internet dropped a stunning 95% from 2016 to 2020, putting smartphones in more pockets. All these things came together and lit a fire under the whole system.

Conclusion and Policy Recommendations

This study explores in depth how India's digital payment scene is changing, focusing on the role of NPCI's institutional setup. We tested six key ideas using structural equation modeling with survey responses from 385 people, and subsequently supported this with panel regression on state-level data from FY2021 to FY2024. Here's what stands out: People adopt NPCI platforms when they see them as useful, trust the NPCI, have good digital infrastructure, and feel supported by government policies. And when a greater number of users actually use digital payments, it gives financial inclusion a real, measurable boost.

- **Policy Recommendations**
  - **PR1 —** Deepen rural NPCI literacy: NPCI should partner with state governments and business correspondent networks to deploy structured UPI literacy camps in bottom 200 districts by RBI's FII ranking. The study's finding that DIQ is the second-strongest adoption predictor (H4: $\beta = 0.489$) underscores the urgency of parallel investment in rural 4G/5G infrastructure.
  - **PR2 —** InstitutionaliseNPCI trust communication: NPCI's regulatory credibility — demonstrated as a significant moderator of perceived usefulness — is an underutilised strategic asset. A structured consumer awareness campaign specifically communicating NPCI's ownership by RBI and its track record of 99.9% uptime could accelerate adoption among risk-averse demographic segments.
  - **PR3 —** Expand credit-on-UPI to MSME segment: Given UPI's demonstrated financial inclusion impact (H6), extending credit-line access through UPI for micro-enterprises — through partnerships with scheduled commercial banks and NBFC-MFIs — could create an integrated payment-credit corridor that accelerates SME formalisation.
  - **PR4 —** Enhance cybersecurity framework: Given the growing incidence of UPI fraud (95,402 cases, INR 1,087 crore in FY2023), NPCI should institutionalise real-time AI-driven fraud detection at the switch level and mandate two-factor contextual authentication for high-value peer-to-merchant transactions.
  - **PR5 —** Facilitate NPCI's global expansion: The RBI's UPI-linkage agreements with UAE, Singapore, and Bhutan represent a nascent but strategically vital internationalisation of India's payment infrastructure. NPCI should establish a dedicated international partnerships division to accelerate integration with domestic payment networks in ASEAN, Gulf Cooperation Council (GCC), and African markets.
- **Limitations and Future Research Directions**

The study has several obvious constraints. For one, because it's a cross-sectional survey, we can't really prove cause and effect at the individual level. If we tracked a group of UPI users over two years, that'd give us much stronger insight into how adoption actually happens. Then there's the qualitative part — interviewing just eight practitioners adds useful detail but isn't enough to be representative. The panel regression analysis controls for state effects, but still might miss some district-level details, like how many microfinance institutions operate locally or if digital literacy initiatives by gram panchayats are underway. Researchers need to tackle these gaps in future work and also look into new areas: how the CBDC pilot by RBI catches on, what happens with UPI LITE for small payments, and how the credit-on-UPI setup works out amid the growth and transformation of India's payment system.

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