The case for network-level interoperability of QR codes in India's digital payments ecosystem

Received (in revised form): 30th August 2025

Mahadevan Balakrishnan
Postdoctoral Research Fellow, Centre for Digital Public Goods, Indian Institute of Management, India

Mahadevan Balakrishnan has been a pivotal figure in the digital transformation of payments in India, making significant contributions through leadership roles in major banks and at the National Payments Corporation of India (NPCI). As the Chief Operating Officer at NPCI, he played an instrumental role in developing innovative payment systems such as the Immediate Payment Service (IMPS) — which forms the foundation of Unified Payments Interface (UPI) and the instant payments ecosystem — Aadhaar-enabled payments, the National Automated Clearing House (NACH) and the RuPay domestic card scheme. The NPCI's neutral, not-for-profit and collectively governed model has since become a global standard for digital public infrastructure. Following his tenure at NPCI, Dr Balakrishnan advised over two dozen developing countries on enhancing financial infrastructure and digital payment ecosystems during his work with the World Bank. His career spans more than three decades and includes senior roles at leading financial institutions such as ABN AMRO, Barclays, Citibank, DCB Bank, as well as NPCI and the World Bank. This extensive experience positions him at the intersection of policy, technology and institutional design within the payments domain. Dr Balakrishnan holds multiple degrees, including an MBA in finance, a master's in political science and public administration, a master's in bank management and a PhD in finance and payments. Currently, he is a postdoctoral research fellow at the Centre for Digital Public Goods at the Indian Institute of Management Bangalore. He has published over 30 articles in national and international journals and serves on the editorial boards of two leading journals focused on payments and banking. His primary research interests encompass payments — particularly fast and instant payments — and the development of digital public infrastructure.

Centre for Digital Public Goods, Indian Institute of Management, Bangalore, Bannerghatta Road, Bangalore 560076, India
Tel: +919841040034; E-mail: mahadevan_balakrishnan@rediffmail.com

R. Srinivasan
Professor of Strategy and Chairperson of the Center for Digital Public Goods, Indian Institute of Management, India

R. Srinivasan is Professor of Strategy and Chairperson of the Centre for Digital Public Goods at the Indian Institute of Management Bangalore. His areas of research and teaching include digital public goods and digital public infrastructure, protocols and open networks and platform business models. He has published articles in international journals and books on strategy and platform businesses and engages with industry and the government on various consulting and policy assignments.

Center for Digital Public Goods (CDPG), Indian Institute of Management, Bangalore, Bannerghatta Road, Bangalore 560076. India
Tel: +919742221351; E-mail: srini@iimb.ac.in

Abstract India has achieved unprecedented success in digital payments, largely propelled by the Unified Payments Interface (UPI) and the widespread adoption of quick response (QR) code-based merchant payments. This paper analyses the unique factors driving UPI's growth — including its user-centric design, regulatory flexibility, zero merchant discount rate (MDR) policy and the proliferation of asset-light QR infrastructure. However, despite this remarkable progress, a crucial challenge persists: the lack of network-level interoperability in UPI QR codes. This structural limitation has led to systemic concentration, exposure to network outages and inconsistencies in merchant

onboarding, all of which constrain further financial inclusion and undermine the resilience of the digital payments ecosystem. Drawing lessons from successful QR interoperability models such as Singapore Quick Response code, Malaysia's DuitNow QR and Indonesia's efforts to enhance the Quick Response Code Indonesian Standard, this paper argues that true scheme- and network-level interoperability is not merely a technical upgrade but a strategic necessity. It would expand consumer choice, enhance merchant acceptance while reducing costs, strengthen system-wide resilience and foster inclusive innovation. The paper also highlights the crucial role of banks in the acceptance ecosystem and emphasises that their continued engagement is essential for achieving economies of scale, sustainable revenue models and infrastructure resiliency. We propose a road map of important policy actions, including the establishment of a unified QR code standard, mandatory network-level interoperability, infrastructure modernisation, scheme-agnostic security frameworks and enhanced regulatory oversight. The paper also recommends that the Reserve Bank of India urgently reconsider the licensing of new umbrella entities (NUEs) to mitigate the overall concentration risk in India's digital payment ecosystem. While acknowledging implementation challenges, the paper contends that India must act decisively to address existing gaps and evolve towards a more inclusive, competitive and future-ready digital payments architecture. These insights also hold important lessons for other countries building similar ecosystems, underscoring the importance of designing QR-based acceptance infrastructure with interoperability and public interest at the core.
This article is also included in **The Business & Management Collection** which can be accessed at https://hstalks.com/business/.

KEYWORDS: Digital payments, UPI, unified payments interface, QR codes, interoperability, network-level interoperability, financial inclusion, digital public infrastructure, DPI, payment system resilience, merchant acceptance, India, bank participation

DOI: 10.69554/XTGI3502

INTRODUCTION: EVOLUTION OF DIGITAL PAYMENTS IN INDIA AND SIGNIFICANCE OF UNIFIED PAYMENTS INTERFACE (UPI)

India's journey towards furthering retail digital payments began in the early 2000s with the expansion of the electronic funds transfer (EFT) system to the more functionally rich and widely available national electronic funds transfer (NEFT) system and electronic clearing services (ECS), which expanded to Centralised ECS. A major leap then came in 2008 with the formation of the National Payments Corporation of India (NPCI), which consolidated retail payment systems under a single umbrella. Subsequent improvements, enhancements and new product launches by NPCI included:

- Expansion of the National Financial Switch (NFS) to connect ATMs.
- Launch of the Immediate Payment Service (IMPS) in 2010 for 24/7 real-time fund transfers.
- Implementation of Aadhaar-enabled Payment Systems (Aadhaar Payment Bridge [APB] and Aadhaar-enabled Payment System [AEPS]) in 2012.
- Implementation of the National Automated Clearing House (NACH) for credit transfers and direct debits in 2013.
- Introduction of the RuPay domestic card network in 2013.

- Launch of the UPI in 2016 and its ongoing enhancement and functional enrichments.

These systems laid the foundation for India's digital payments ecosystem. From fewer than a billion total retail digital transactions across all instruments in 2010, India has seen exponential growth, with just one instrument, UPI, alone processing over 185 billion transactions in fiscal year (FY) 2024–25.[1–3] The growth of UPI in numbers is depicted in Figure 1.

Launched in April 2016 and continuously improved in terms of functionality, UPI became the fastest payment system in India to reach 1 billion annual transactions, achieving this milestone within its third full year of operation. UPI consists of two components: person-to-person (P2P) payments and person-to-merchant (P2M) payments. While P2P drove early adoption, P2M growth was catalysed by the widespread use of UPI QR codes, enabling even informal merchants to accept payments with minimal infrastructure.

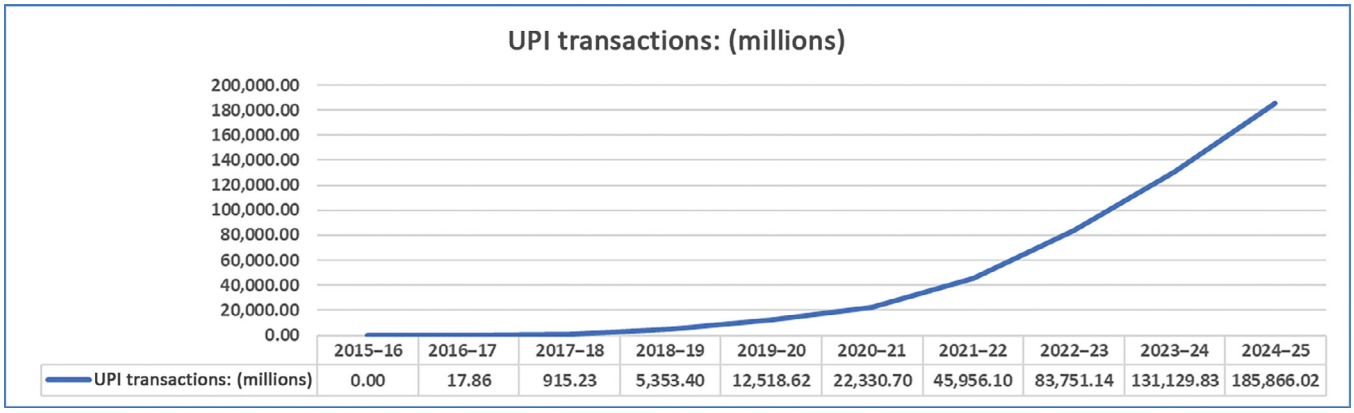
Balakrishnan identifies several important reasons for UPI's success:[4]

Simplicity and ease of use: UPI was designed to meet the criteria of the technology acceptance model (TAM) — perceived usefulness and perceived ease of use. It enables 24/7 instant transfers, supports both P2P and P2M transactions, allows proxy identifiers (eg virtual payment addresses), links multiple bank accounts and facilitates payments via mobile number or QR code — all contributing to its mass adoption.

Regulatory accommodation and third-party access: Unlike prior systems, UPI permitted non-bank third-party application providers (TPAPs) to initiate transactions in partnership with banks, without needing to be directly regulated by the Reserve Bank of India (RBI). This openness allowed large-scale participation from FinTechs and big tech firms, accelerating innovation and user acquisition.

Cashback and user incentives: UPI's early-stage adoption was supported by cashback programmes and incentives, particularly from non-bank payment service providers (PSPs). These promotional strategies helped onboard users and cement digital payment habits.

Booming FinTech ecosystem: Between 2016 and 2022, India emerged as Asia's FinTech leader, with over 7,400 start-ups and 25 unicorns. UPI and FinTechs reinforced



	2015–16	2016–17	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23	2023–24	2024–25
UPI transactions: (millions)	0.00	17.86	915.23	5,353.40	12,518.62	22,330.70	45,956.10	83,751.14	131,129.83	185,866.02

Figure 1 Growth of Unified Payments Interface (UPI) over the years

Source: National Payments Corporation of India (NPCI) retail payment systems statistics. Refer to references 1 and 2 for more details. Elaboration by authors.

each other's growth, creating a virtuous cycle of innovation, funding and adoption.

Bank participation at scale: Over 90 per cent of Indian bank accounts are now UPI-enabled. Even though most transactions are initiated by TPAPs, all transactions are settled through banks, which scaled up their infrastructure to support UPI's explosive growth.

Zero pricing for UPI (zero merchant discount rate [MDR]) and government incentives: A crucial policy impetus was provided by the government's move to mandate zero MDR for UPI and RuPay debit card transactions, starting on 1st January 2020. This policy was particularly transformative in the Indian context, where a vast informal sector and millions of small-value transactions meant that even a minimal MDR could have been a significant barrier to digital acceptance. This eliminated fees for both consumers and merchants, boosting merchant acceptance — especially for small-value transactions. To compensate PSPs and banks, the government instituted incentive schemes worth ₹13bn in FY 2021–22 and ₹26bn in FY 2022–23.

Growth of asset-light QR code infrastructure: The rapid spread of UPI QR codes created a low-cost, scalable acceptance model. By 2022, India had over 240 million QR code acceptance points. This enabled even small and informal merchants to accept digital payments.

Innovation of the 'sound box' device: PSPs introduced sound box devices that confirm successful transactions audibly. These devices increased merchant confidence and further accelerated adoption, especially in noisy or high-traffic retail environments.

Ubiquitous Mobile Penetration and Foundational Digital Identity: The widespread and rapidly increasing mobile penetration in India provided a crucial foundation for UPI's success. The design leveraging the mobile number as an important identifier, combined with the mass adoption of smartphones, made UPI instantly accessible. This digital readiness was further amplified by India's robust digital public infrastructure (DPI), particularly Aadhaar, which enabled the rapid opening of 'no-frills', no-fee and no-minimum-balance bank accounts for millions of unbanked citizens. This combination of widespread mobile access, a universal digital identity (Aadhaar) and accessible bank accounts (Jan Dhan Yojana) created the perfect storm for UPI's accelerated adoption and its unparalleled success in driving financial inclusion.

Availability of local tech talent: India's large pool of skilled technology professionals supported the rapid development of UPI apps, backend systems and innovations like penny-drop account validation and UPI-Lite.

Ongoing innovation and feature upgrades: UPI has continually evolved, introducing features such as UPI-Lite for offline micropayments and credit card linking.

Within UPI, P2M transactions have grown faster than P2P. The role of QR codes and zero pricing has been pivotal in enabling a low-cost, scalable merchant acceptance model. UPI P2P volume grew from 0.550 billion (April 2020) to 6.84 billion (March 2025), while P2M grew from 0.449 billion to 11.46 billion during the same period, a growth of 2452 per cent compared with 1144 per cent for P2P (Figures 2 and 3).[5] In fact, P2M grew at a compounded annual growth rate of 90 per cent.

Further, the contribution of UPI P2M to the total UPI volumes has been steadily growing over the years (Figure 4), increasing from 44 per cent in April 2020 to 62.62 per cent in March 2025.[6.]

In India, UPI is dwarfing the merchant payment options. While in the developed world, debit cards and credit cards at the

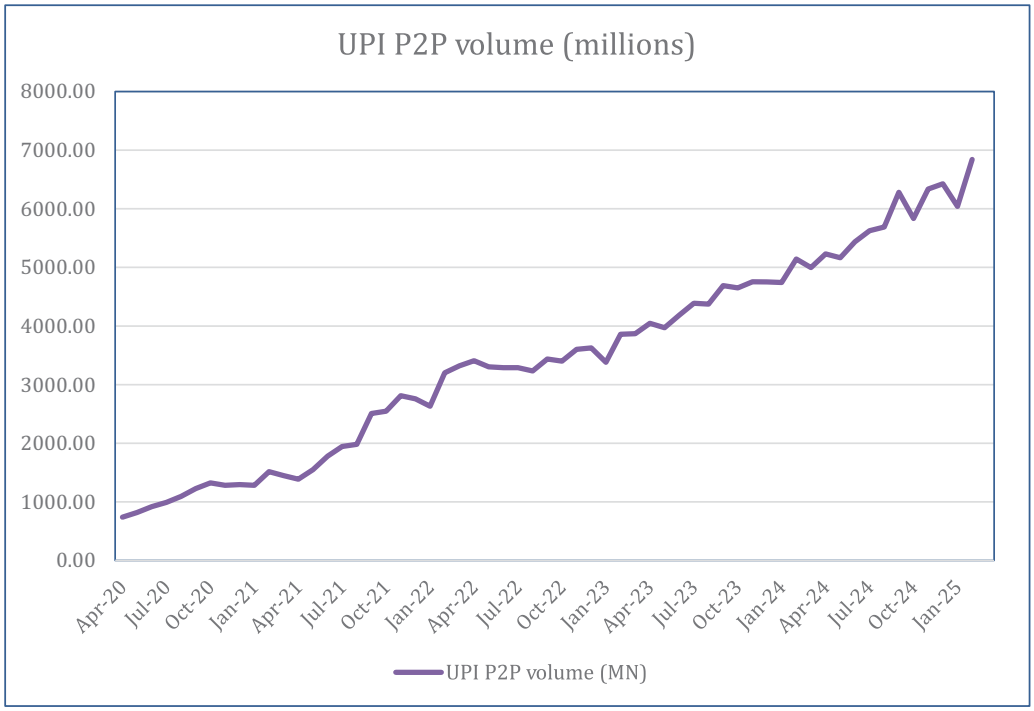


Figure 2 Unified Payments Interface (UPI) person-to-person (P2P) growth (April 2020–March 2025)

Source: National Payments Corporation of India (NPCI) UPI ecosystem statistics. Refer to references 1 and 2 for more details. Elaboration by authors.

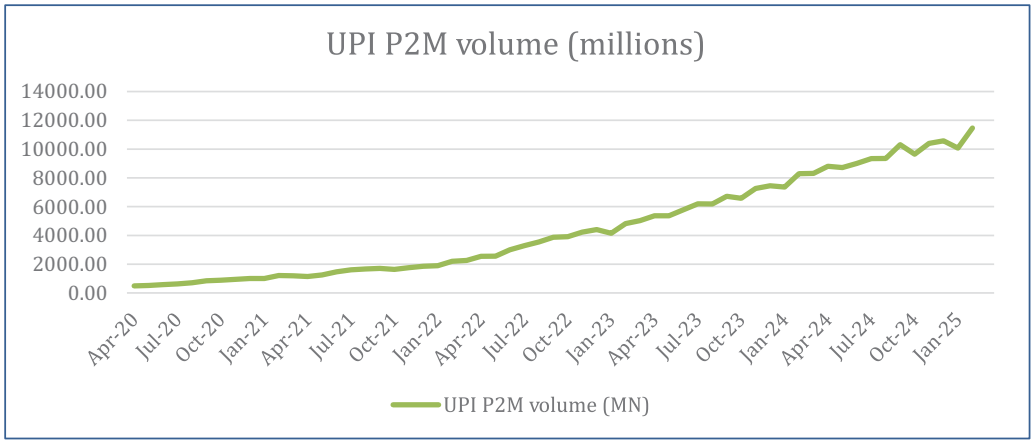


Figure 3 Unified Payments Interface (UPI) person-to-merchant (P2M) growth (April 2020–March 2025)

Source: National Payments Corporation of India (NPCI) UPI ecosystem statistics. Refer to references 1 and 2 for more details. Elaboration by authors.

point of sale (POS) and e-commerce are the most prominent, in India the growth of UPI P2M has outpaced debit and credit cards (Figure 5). As of March 2025, UPI P2M accounts for 95.19 per cent of merchant payments, debit cards are now only at 1 per cent and credit cards at 3.81 per cent, reflecting the dominance of UPI in merchant payments (Figure 6).

While conceding UPI's undeniable achievements, marking a significant stride towards digital inclusion, this paper argues

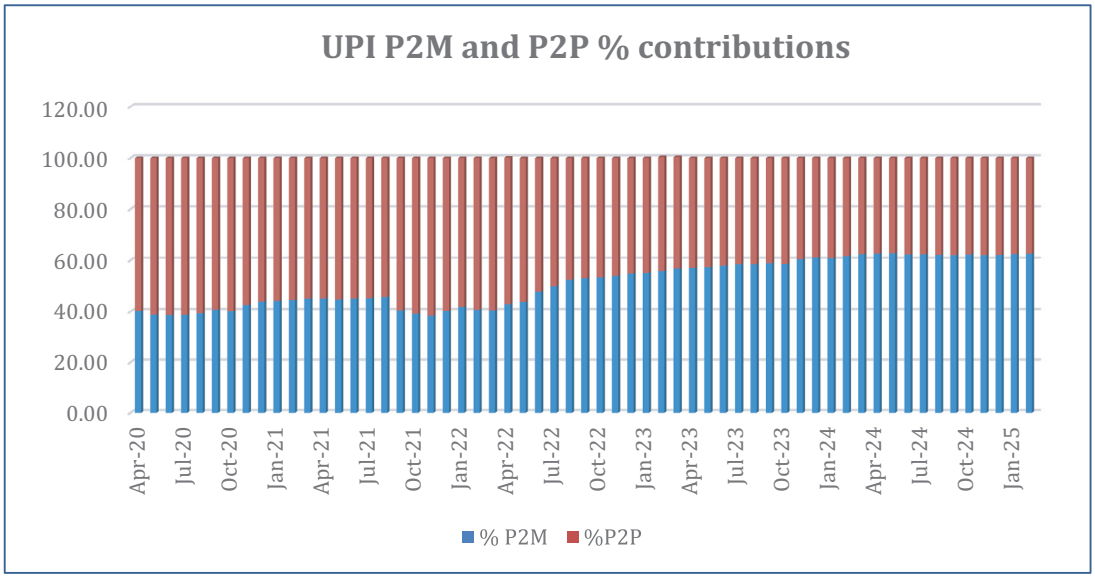


Figure 4 Person-to-merchant (P2M) share of total Unified Payments Interface (UPI) transactions (April 2021–March 2025)

Source: National Payments Corporation of India (NPCI) UPI ecosystem statistics. Refer to references 1 and 2 for more details. Elaboration by authors.

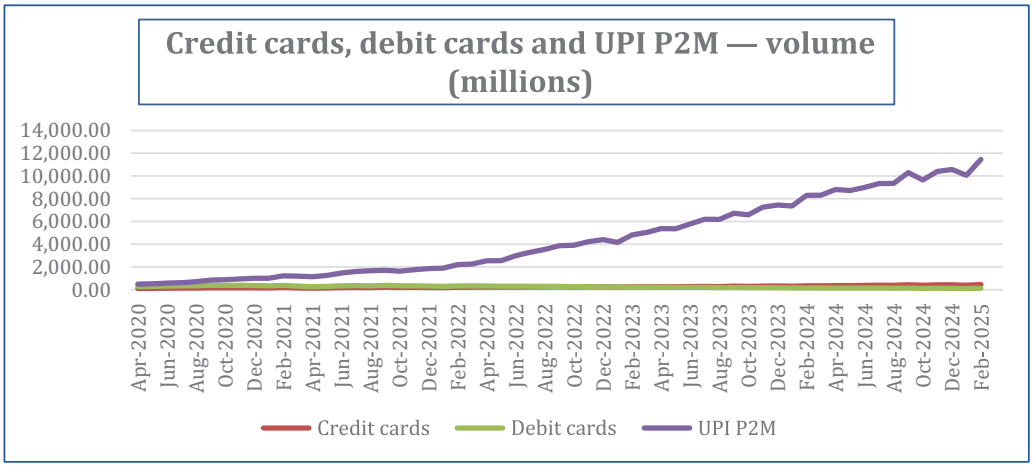


Figure 5 Credit card, debit card and Unified Payments Interface (UPI) person-to-merchant (P2M) share (April 2020–March 2025)

Source: Reserve Bank of India (RBI) payment system statistics and National Payments Corporation of India (NPCI) UPI ecosystem statistics. Refer to references 1–3 for more details. Elaboration by authors.

that the full potential of QR code-based digital payments in India remains unrealised owing to a crucial gap: the absence of comprehensive network-level interoperability. Despite the RBI's historical commitment to interoperability and UPI's strategic positioning as a DPI, the current QR code ecosystem is fragmented. This paper will highlight how this limited interoperability creates systemic risks, stifles competition and

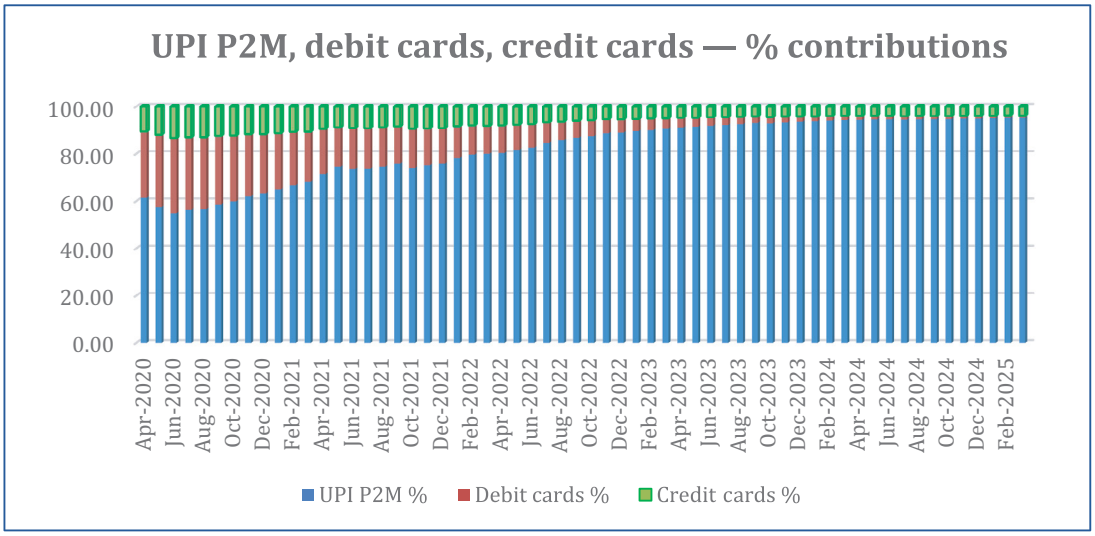


Figure 6 Percentage of credit card, debit card and Unified Payments Interface (UPI) payment-to-merchant (P2M) transactions (April 2020–March 2025)

Source: Reserve Bank of India (RBI) payment system statistics and National Payments Corporation of India (NPCI) UPI ecosystem statistics. Refer to references 1–3 for more details. Elaboration by authors.

presents a 'missed opportunity' for even more robust and resilient digital payment growth, drawing insights from global best practices and proposing a clear way forward.

QR CODE ADOPTION AND THE INTEROPERABILITY CHALLENGE

In his comprehensive analysis, Balakrishnan underscores that the successful digitisation of payments in an economy is intrinsically linked to the development and proliferation of a robust acceptance infrastructure.[7] Drawing on empirical data from both Committee on Payments and Market Infrastructure (CPMI) countries and specific detailed insights from India, his work highlighted the crucial need for creating a widely available, accessible acceptance infrastructure. The paper emphasises that while digital payment instruments are essential, their widespread adoption hinges on the ubiquitous availability of points where these payments can be readily accepted, arguing that a strategic focus on expanding and enabling merchant acceptance, alongside fostering user-friendly digital payment methods, is paramount for driving financial inclusion, improving transaction efficiency and achieving broad societal benefits from a digital economy (Table 1).

The ubiquitous presence of QR codes for merchant payments in India is undeniable, with UPI QR codes and their associated transactions forming the bedrock of this acceptance infrastructure, as elaborated in the preceding section. By March 2025, the sheer volume of UPI QR codes in circulation reached approximately 657.93 million (from 97 million in April 2021), dwarfing the 6.72 million Bharat QR codes (from 4.03 million in April 2021).[8] This significant imbalance highlights that only around 10 per cent of India's QR codes offer interoperability across schemes. Moreover, with the number of traditional POS terminals growing to only 11.10 million by the same period (from 4.52 million in April 2021),[9] it is clear beyond all doubt that the UPI QR code and the entire UPI ecosystem are the linchpin of India's digital merchant payment acceptance (Figure 7).

Table 1: Comparative features of UPI QR and Bharat QR in India's payment ecosystem

Feature	UPI QR	Bharat QR
Launched by	NPCI (2016)	RBI/NPCI with card networks (Visa, Mastercard, RuPay, Amex) (2017)
Underlying rails	UPI (real-time bank account transfers)	Card networks (Visa, Mastercard, RuPay, Amex) linked to debit/credit cards
Interoperability	Within UPI ecosystem only (apps connected to NPCI)	Fully interoperable across participating banks and all major card networks
Acceptance scope	Merchants accepting UPI payments	Merchants with POS/e-commerce integration into card networks
Adoption scale	~658 million QR codes in circulation by March 2025	~6.7 million QR codes in circulation by March 2025
Consumer access	Any UPI-enabled app (Google Pay, PhonePe, Paytm, BHIM, etc)	Any cardholder with Visa, Mastercard, RuPay or Amex
Merchant integration	Asset-light, low-cost onboarding via QR stickers/apps	Requires POS/e-commerce integration; slightly higher onboarding/maintenance effort
Resilience implication	Reliant on NPCI's UPI network (single-operator concentration risk)	Diversified across multiple card networks, providing fallback if UPI is disrupted

Key: NPCI, National Payments Corporation of India; POS, point of sale; RBI, Reserve Bank of India, UPI, Unified Payments Interface.

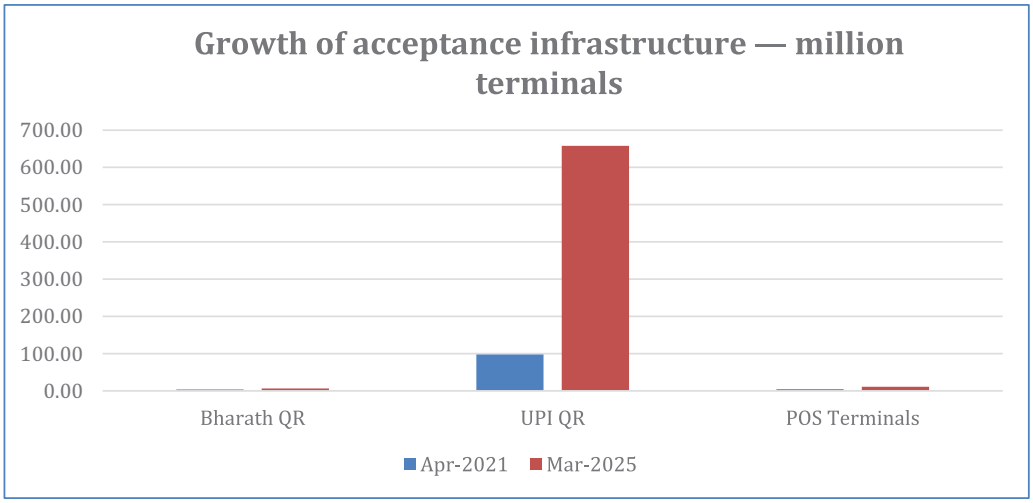


Figure 7 Growth of acceptance infrastructure (April 2021–March 2025)

Source: Reserve Bank of India (RBI) payment system statistics. Refer to references 1 and 2 for more details. Elaboration by authors.

The distinct roles of Bharat QR and UPI QR, and their implications for interoperability in India's payments ecosystem, are explained in detail in the section 'QR Code Adoption and the Interoperability Challenge'.

CURRENT IMPLEMENTATION AND LIMITATIONS

While UPI QR codes are interoperable among UPI-enabled apps, they do not extend interoperability to other payment schemes, such as card networks (eg Visa,

Mastercard) or the NPCI's own other schemes (eg IMPS). This siloed approach means that a merchant displaying a UPI QR code may not accept payments from non-UPI apps or cards, contrary to the RBI's vision of universal interoperability. While the RBI's directive on consolidating QR codes to UPI QR or Bharat QR was a crucial first step towards reducing fragmentation,[10] it achieved interoperability primarily within individual payment networks. This means that while a single QR code label might be present, the underlying payment acceptance mechanism still often remains tied to a specific scheme (eg UPI) rather than being universally capable of processing transactions from any payment product or service via that single QR. The RBI's directive sets the foundation for this level of interoperability, but full realisation requires collaborative efforts among all stakeholders in the payment ecosystem.

CONCENTRATION RISK AND LAYERED INTEROPERABILITY CHALLENGES

Currently, UPI QR codes overwhelmingly dominate merchant payments in India. While UPI offers seamless interoperability at the application layer (allowing any UPI-enabled app to scan any UPI QR code) and the bank layer (interconnecting all participating banks), its interoperability is inherently limited within the UPI ecosystem. This means true network/scheme-level interoperability — where a single QR code acts as a universal acceptance point that intelligently routes payments to their native schemes (eg UPI, card networks, IMPS) — is largely absent. This concentration of merchant acceptance around a single payment infrastructure (UPI, managed by the NPCI) and its dominant TPAPs creates significant systemic risk, as outlined in the Principles for Financial Market Infrastructures (PFMI).[11] The lack of diverse routing options at the acceptance point means that in the event of a widespread UPI network disruption, the entire digital payments ecosystem at the merchant POS becomes vulnerable, potentially affecting payment continuity and public trust. It is crucial to clarify that this envisioned interoperability does not imply that one network would process transactions for another (eg Visa processing a RuPay transaction). Rather, it focuses on the universal acceptance of diverse payment instruments at the QR code, with transactions being seamlessly routed to their respective, native payment networks for processing. This approach avoids the complexities of cross-network processing while still providing the essential fallback and choice for users and merchants.

In 2025, UPI experienced two to three significant outages in March and April.[12] These outages affected many users and merchants across the country, causing transaction delays and failures. One of the largest TPAPs, PhonePe, also faced a major problem during this period, where its UPI payment services were temporarily unavailable for several hours.[13] Such incidents highlighted the vulnerability of relying heavily on a single payment network or one or two large TPAPs for merchant transactions. The outages not only caused inconvenience but also underscored the importance of having interoperable payment systems that provide customers and merchants with alternative options during such failures to maintain trust and continuity in digital payments.

NPCI, which operates the UPI system, has acknowledged the systemic concentration risk posed by the dominance of a few TPAPs. In November 2020, NPCI introduced a market cap framework to limit any single TPAP to no more than 30 per cent of the total volume of UPI transactions, calculated on a trailing three-month basis. An initial compliance deadline was set for January 2023, but this has since been deferred multiple times, with extensions granted as recently as December 2024,

and a revised implementation timeline now targeting 31st December, 2026.[14] These repeated delays highlight both the challenges in enforcing structural safeguards in a rapidly growing ecosystem and the entrenched position of the leading UPI app providers. As of early 2025, the top four TPAPs — PhonePe (47.25 per cent), Google Pay (36.04 per cent), Paytm (7.82 per cent) and Amazon Pay (0.6 per cent)[15] — collectively account for over 96 per cent of UPI transaction volumes, underscoring the significant market concentration NPCI aims to address. Notably, three of these four players — PhonePe, Google Pay and Amazon Pay — are backed by or affiliated with non-Indian firms, which further underscores the strategic imperative of diversifying the ecosystem to ensure long-term sovereignty, resilience and competition. It is also important to note that NPCI itself was established with the strategic objective of developing and operating domestic digital payment systems in India, thereby reducing over-dependence on foreign players — a concern rooted not just in market competition but also in broader geopolitical and sovereignty considerations.

Furthermore, the PFMI principles clearly recognise concentration risk as a crucial operational risk in payment systems. Principle 7 specifically states that a Financial Market Infrastructure (FMI) must 'identify, monitor, and manage the risks that arise from a concentration of activities or exposures, including risks from reliance on a single third-party service provider for critical services'.[16] In the case of UPI, the heavy reliance on a single payment infrastructure managed by NPCI creates concentration risk. Such dependence means that any disruption in the UPI system can have a widespread impact across merchants and consumers, potentially causing large-scale payment failures. This highlights the importance of diversifying payment acceptance mechanisms and encouraging network-level interoperability to reduce systemic vulnerability and improve resilience in the digital payments ecosystem.

Full interoperability in payment systems is essential for creating an inclusive, efficient and resilient digital payments ecosystem. According to the World Bank, interoperability enables seamless connectivity between different PSPs, networks and instruments, reducing transaction costs and expanding access to financial services — especially for underserved populations.[17] Without interoperability, users face fragmented payment experiences, limiting their choice of payment instruments and providers, which ultimately constrains financial inclusion and economic participation. The World Bank's Global Payment Systems Survey[18] also highlights that interoperable payment systems are foundational to increasing digital payment adoption and building a robust financial infrastructure that supports economic growth.

The Bank for International Settlements (BIS) underscores that interoperability reduces systemic risks by enabling multiple payment systems to interconnect, thus avoiding over-reliance on a single infrastructure or network. In its 2021 report on payment aspects of financial inclusion, the BIS notes that interoperability fosters competition, innovation and resilience by allowing new entrants to participate and by giving users the flexibility to transact across different platforms and instruments.[19] Without full interoperability, payment ecosystems risk fragmentation, which can lead to inefficiencies, higher costs and vulnerabilities during network disruptions. This is especially crucial in rapidly digitising economies, where the reliability and inclusiveness of payment systems directly affect economic stability.

International bodies such as the CPMI also emphasise interoperability as an important principle in their PFMI framework. The CPMI advocates for payment systems to be designed with

connectivity and accessibility in mind, enabling participants across different systems to transact easily and safely. Moreover, the International Finance Corporation (IFC) highlights that fostering interoperability helps to create competitive markets by lowering barriers to entry and encouraging diverse innovation.[20] Taken together, these global authorities make it clear that full interoperability is not just a technical feature but a strategic imperative to achieve scalable, resilient and inclusive digital payments that serve the entire population effectively.

Interoperability is consistently highlighted as a cornerstone principle for DPI by international bodies and leading proponents. DPIs are fundamentally designed as shared digital systems that are 'secure and interoperable', built on open standards and specifications to deliver equitable access to public and/or private services at a societal scale. This inherent focus on interoperability ensures that diverse systems and components can seamlessly interact, fostering an ecosystem that drives inclusion, innovation and competition, while avoiding vendor lock-in and fragmentation. For instance, the G20, under India's presidency in 2023, explicitly recognised DPI as a 'set of shared digital systems that should be secure and interoperable, and can be built on open standards and specifications to deliver and provide equitable access to public and private services at societal-scale'.[21] The United Nations Development Programme (UNDP) also underscores that DPI systems are, by definition, 'interoperable (forms the underlying infrastructure for a variety of use cases alongside a range of tools, technologies, and service providers)' and can be 'built on open standards'.[22] Without this core attribute, a digital system cannot fully realise its potential as a true public good, because it would create silos that hinder seamless user experience, limit market entry for new innovators and undermine resilience against disruptions. Because UPI is being positioned strategically as a DPI, interoperability in UPI as DPI also requires network-level interoperability for core components beyond just within the UPI ecosystem. If UPI QR codes and payment acceptance infrastructure become interoperable across other payment networks — such as card schemes and Bharat QR — UPI would truly function as an open, universal DPI. This broader interoperability would reduce fragmentation, increase payment options for users and merchants and enhance resilience by providing alternative payment routes during disruptions. Achieving this level of interoperability is essential for UPI to fulfil its full potential as a foundational, inclusive and reliable DPI.

OTHER CHALLENGES

- Merchant and Consumer Confusion: The coexistence of multiple QR code types at merchant outlets often confuses consumers, causing friction during payment. Consumers may not know which app or payment method to use, reducing the seamlessness crucial to digital payments' success.
- Infrastructure and Technology Barriers: Merchant devices and POS terminals may not support all QR code standards or networks. Some apps do not accept card-based QR codes and vice versa. This technological mismatch reduces acceptance reach and merchant willingness to adopt digital payments.

  Disparate Merchant Onboarding Standards and Financial Inclusion Trade-offs: The current ecosystem exhibits varying degrees of rigour in merchant onboarding processes. An important factor in UPI's explosive growth and widespread adoption, particularly among small and informal merchants, has been its significantly lighter and more inclusive onboarding process. This asset-light approach, often merely requiring linkage to a savings or current account without extensive business or risk evaluation, has

been instrumental in extending digital payments to a vast, previously underserved merchant base, thereby accelerating financial inclusion. This beneficial simplicity, however, contrasts with the often more robust merchant evaluation processes required for Bharat QR, which integrates with international card schemes (Mastercard, Visa, RuPay, Amex, etc) to meet stringent compliance and security standards. This disparity in merchant vetting across QR code types, while having driven inclusion, poses challenges for unified risk management, compliance and maintaining a consistent level of trust across a fully interoperable QR infrastructure. Reconciling these different standards while retaining the inclusiveness of UPI's onboarding model is crucial for a future unified QR ecosystem.

- Security and Fraud Risks: Fragmented QR code systems increase the complexity of fraud prevention and detection. Without unified standards and cross-network monitoring, vulnerabilities may arise, exposing users and merchants to phishing and counterfeit QR code scams.
- Regulatory and Stakeholder Coordination Issues: Achieving network-level interoperability requires coordinated efforts between multiple stakeholders, including NPCI, card networks, banks, PSPs and regulators. Aligning interests and technical standards across a diverse ecosystem is a complex governance challenge.
- Need for Network/Scheme-Level Interoperability Achieving true interoperability requires that QR codes function across different payment networks and schemes. This means a single QR code should accept payments from UPI apps, card networks and other digital payment platforms. Such an approach would (a) enhance user convenience by reducing the need for multiple QR codes at merchant locations, (b) increase resilience by providing alternative payment options during network outages and (c) foster innovation by allowing new entrants to develop applications compatible with existing QR infrastructure.

UNDERSTANDING NETWORK/SCHEME-LEVEL INTEROPERABILITY AT ACCEPTANCE

Network/scheme-level interoperability refers to the ability of different payment networks or schemes — whether existing ones like UPI, RuPay, Visa and Mastercard or any new licenced scheme operator — to interact seamlessly with the same payment acceptance infrastructure. In practical terms, it means that a QR code displayed at a merchant location should not be limited to accepting payments only from apps connected to one specific network (eg UPI) but should also accept payments from apps built on other networks or schemes. Crucially, this does not imply that one network (eg Visa) would process transactions belonging to another (eg Mastercard or RuPay). Instead, it means the single QR code serves as a universal acceptance point that intelligently recognises the underlying payment instrument or scheme used by the customer's payment application.

Specifically, when a customer scans the unified QR code, their issuing bank or third-party mobile banking application would identify the appropriate payment network (eg UPI, RuPay, Visa, Mastercard, NEFT, IMPS) based on the customer's chosen payment method. The transaction would then be seamlessly routed and processed through its native, designated network/scheme. Similarly, for 'pull' transactions or those initiated by the merchant, the acquiring bank would route the payment to the appropriate network. It is important to emphasise that this intelligent routing by the acquiring bank or customer application ensures that a transaction initiated with a Visa card is always processed by the Visa network, a Mastercard transaction by

Mastercard and a UPI transaction by NPCI. There is no attempt for one network to process another's proprietary transactions for purchase transactions.

Think of it as a single POS terminal that readily accepts credit and debit cards from different networks such as Mastercard, Visa and RuPay. The RuPay domestic card network, launched in 2013, was significantly facilitated by the then-prevailing network-level interoperability already established at POS terminals for international card schemes. This existing interoperable infrastructure allowed RuPay to gain immediate acceptance across a wide merchant base, accelerating its adoption and highlighting the strategic advantage of shared acceptance mechanisms for new payment innovations. Thus, full interoperability enables a level playing field where multiple payment networks can coexist, compete and offer services to users and merchants using shared infrastructure like QR codes, POS terminals or e-commerce gateways. Such interoperability ensures broader reach, fosters innovation, reduces vendor lock-in and increases resilience in the payment ecosystem by allowing fallback options when one network experiences disruptions.

While India's NFS, operated by NPCI, offers a powerful example of network-level interoperability for ATM cash withdrawals — facilitating routing, clearing and settlement for RuPay, Visa and Mastercard cards domestically without relying on their global networks for these specific functions — this highly centralised model for direct interbank processing has historically not been extended to the more complex and commercially nuanced POS purchase transactions by the global card schemes. For retail purchase transactions at POS, where complexities of merchant categories, product types and varying commercial agreements (MDRs) are high, traditional card schemes (Visa, Mastercard) maintain direct control over their authorisation, clearing and settlement rails for their proprietary purchase transactions. Therefore, network- or scheme-level interoperability, as envisioned, should ensure that the QR code displayed is fully interoperable, akin to the Bharat QR standard but expanded to encompass all dominant payment methods. If the UPI app or network is not working, the customer should still be able to make payments using alternative methods such as debit cards, credit cards or other third-party applications — provided their bank supports these options or the third-party apps are compatible and installed on the customer's device. Furthermore, it should also be possible to initiate an IMPS or even NEFT transactions directly from the mobile application that scans the QR code, with the QR code containing all the necessary information to enable such transactions seamlessly.

RBI'S POLICY ON INTEROPERABILITY

The RBI has consistently prioritised interoperability in India's payment systems. This commitment has been evident right from its early initiatives, as far back as 2004, when it addressed the crucial need for interoperability with ATM accessibility. This concern directly led to the conceptualisation and launch of the NFS in 2004 for ATM transactions, spearheaded by the RBI-promoted Institute for Development and Research in Banking Technology (IDRBT). Before NFS, the ATM landscape was largely a collection of isolated networks; a customer was able to withdraw cash or check balances only from their own bank's ATMs or a select few with specific bilateral agreements, or the networks that banks were connected to. The RBI recognised that this lack of universal acceptance hindered financial inclusion and overall banking convenience. By establishing NFS, the RBI aimed to create a unified platform that would enable any ATM to accept any card, irrespective of the issuing bank or its network affiliation (like Visa or Mastercard). This forward-thinking step was instrumental

in democratising access to ATM services across India, significantly boosting the reach and utility of banking services. To further ensure universal access and discourage the continuation of fragmented systems, the RBI subsequently put an end to such bilateral arrangements for ATMs, thereby consolidating the interoperability framework. This also provided a crucial foundation by popularising debit cards, which in turn paved the way for their subsequent use in other digital transaction environments. Thus, network-level interoperability was a strategic objective and an established reality in India from 2004.

Recognising NFS's pivotal role in unifying the ATM network and its strategic importance, and to ensure its continued growth and broader adoption, the RBI handed over the operations of the NFS to the NPCI in December 2009. This transfer proved to be a significant catalyst for NPCI, providing it with a revenue stream from ATM transaction switching/processing. This stable financial base was crucial in enabling NPCI to invest in developing a multiple new retail payment products and systems, such as the IMPS, which was built on top of this robust foundation. The pre-existing network-level interoperability for POS terminals, combined with the comprehensive ATM network established by NFS, was also vital for the success of RuPay card — a domestic card scheme of India. Without this network-level interoperable acceptance infrastructure, allowing RuPay cards to be used seamlessly across virtually all ATMs and POS terminals in the country, the indigenous card scheme would not have achieved widespread adoption and relevance.

With respect to QR codes, concerned by the emergence of fragmented payment ecosystems that hindered broad digital adoption, the RBI took a decisive step towards achieving QR code interoperability. Following the recommendations of a committee established in December 2019, the RBI issued a crucial circular of October 2020,[23] effectively mandating a shift from proprietary QR codes to interoperable standards. This directive prohibited payment system operators (PSOs) from launching any new proprietary QR codes and compelled existing ones to migrate to either UPI QR or Bharat QR by 31st March, 2022. This move, with notable foresight, aimed to simplify the payment experience for both consumers and merchants: customers could now use any payment app to scan a single QR code, while merchants no longer needed to display multiple codes. By fostering a unified and seamless QR code acceptance infrastructure, the RBI reinforced the drive towards greater digital payments adoption, enhancing user convenience and overall system efficiency across India. By providing a choice of either UPI QR or Bharat QR code, the current implementation achieves interoperability primarily within individual payment networks, such as UPI, without fully extending across different payment schemes. If only RBI had enforced the true network-level full interoperability in that circular and enforced it by March 2022, we could have had all the new QR code from April 2022 fully interoperable — and that is a staggering number, ie 485 million fully interoperable QR codes. We lost a golden opportunity there.

RBI'S RECOGNITION OF CONCENTRATION RISK AND THE NEW UMBRELLA ENTITY (NUE) LICENSING EFFORT

The RBI has acknowledged the risks of concentration in India's digital payments infrastructure, especially given that most retail payment systems — including UPI, IMPS, NACH and RuPay — are operated by a single entity: the NPCI. In response, the RBI issued a framework in August 2020 inviting applications to set up NUEs to compete with NPCI in retail payments, with applications due by 31st March, 2021. The RBI demonstrated its seriousness by

requiring applicants to bring in 10 per cent of the proposed minimum capital of ₹500 crore upfront, even before licensing, clearly indicating a shift from earlier practices of bringing capital after licence issuance.[24] Several consortiums (reportedly six[25]) including groups led by Tata Group, Reliance Industries, Amazon and others applied under this framework. The RBI eventually shelved the NUE licensing process, citing the lack of product innovation among applicants as the rationale. 'Of the proposals that we received, we did not quite see any innovative or infrastructural solution that had come up', said RBI Deputy Governor, as reported in *Moneycontrol*.[26] This argument appears fundamentally flawed: the primary objective of the NUE policy was not to seek differentiated products but to mitigate systemic concentration risks. Even if these NUEs had offered offerings similar to the NPCI's portfolio, their existence alone would have created resilience through redundancy, just as POS networks support multiple card schemes despite similar functionalities.

In a paper referenced earlier on UPI analysis, Balakrishnan[27] highlighted this point and argued that the RBI should immediately licence two or three of the pending NUE applicants and allow them to replicate important NPCI products such as IMPS, NACH and UPI. These offerings must be made interoperable and portable through the use of common messaging standards and routing protocols. To ensure integration, all large banks (eg those with over 10 million customers) should be mandated to join all NUEs — much like the mandate requiring all regulated lenders to report to all four credit bureaus, but routing decisions taken by the banks purely on commercial terms that they are comfortable But, routing mechanisms should allow for dynamic switching to alternative NUEs in the event of systemic failures — via configurable routing tables and automatic failover protocols. This would have greatly addressed the concentration risk as well as improved infrastructure resilience of digital payments in India.

Despite a very innovative and practical suggestion to address the concentration risk through licensing multiple NUEs and ensuring interoperability and portability of core payment systems, no licences were ultimately issued. As a result, the concentration risk remains unresolved in India's digital payments ecosystem. The RBI must now prioritise QR code interoperability at the network level as a necessary step towards strengthening resilience, promoting competition and ensuring long-term sustainability.

BENEFITS OF NETWORK-LEVEL QR CODE INTEROPERABILITY IN INDIA'S DIGITAL PAYMENTS ECOSYSTEM

A QR code that is interoperable at the network and scheme levels provides significant benefits.

- Enhancing Consumer Convenience and Choice: Network-level interoperability enables consumers to use their preferred payment apps or wallets across different merchant QR codes without compatibility issues. This removes the need for multiple QR codes displayed at the POS and simplifies the payment experience, fostering higher digital payment adoption.
- Increasing Merchant Acceptance and Reducing Costs: Merchants benefit from interoperability as they can display a single QR code that accepts payments from multiple networks and schemes. This reduces operational complexity and costs associated with printing, managing and updating multiple QR codes. It also lowers onboarding barriers for merchants, especially small and micro enterprises. Furthermore, a unified, zero-MDR-aligned interoperable framework would continue to lower onboarding barriers for merchants, especially small and micro enterprises,

mitigating the impact that traditional MDR structures might have had on the widespread adoption observed today.

- Strengthening Payment System Resilience: By allowing payments across multiple networks and schemes through a single QR code that intelligently routes to native networks, network-level interoperability significantly reduces over-reliance on any single provider or payment network. This diversification of payment rails at the acceptance layer, enabled by true interoperability, is a crucial component of a robust and resilient payments ecosystem. Unlike the internal redundancies within a single card network (eg Visa having its own disaster recovery for Visa transactions), this proposed QR interoperability enables a consumer to seamlessly switch to a different payment instrument at the same merchant acceptance point, leveraging the multiple network connections typically maintained by acquiring banks. For instance, if the UPI network faces a disruption, a consumer can utilise the same unified QR to pay using their RuPay debit card or a Visa credit card, with the transaction being routed to the respective, operational card network. While comprehensive payment system resilience involves multiple layers (including robust infrastructure, disaster recovery, cybersecurity and operational redundancies across all participating entities), network-level interoperability for QR codes provides a crucial user-facing fallback mechanism and distributes transaction flow by enabling diverse routing options. This decentralisation enhances the overall resilience, ensuring continuous availability and reducing systemic risks and widespread failures during network outages or disruptions to a single dominant system.

The role of the NUE licensing framework in diversifying India's retail payments infrastructure and addressing concentration risk is discussed in detail in the section 'RBI's Recognition of Concentration Risk and the NUE Licensing Effort'.

- Promoting Competition and Innovation: Interoperability lowers entry barriers for new payment players and fosters a level playing field. It encourages innovation in payment solutions and customer service as providers compete on features and experience rather than limited access to merchants.
- Supporting Financial Inclusion: Network-level QR interoperability can extend digital payments into rural and underserved areas by enabling acceptance through a variety of providers, including regional banks, FinTech start-ups and payment aggregators. This inclusive infrastructure accelerates the shift from cash to digital, contributing to broader financial inclusion goals.
- Aligning with International Standards: Interoperability at the network level aligns with global best practices and recommendations from international bodies like the CPMI and BIS, which advocate for open, accessible and resilient payment infrastructures. This alignment reinforces India's position as a leader in digital payments and fosters greater trust and confidence among global stakeholders.

GLOBAL EXAMPLES OF NETWORK-LEVEL QR CODE INTEROPERABILITY

Several countries have successfully implemented network-level interoperability for QR code payments, offering valuable lessons and validation for India's path forward:

Singapore — SGQR Unified QR Code

Singapore's Smart Nation and Digital Government Group, in collaboration with the Monetary Authority of Singapore (MAS), introduced SGQR, the world's first nationally unified QR code standard.

SGQR merges multiple payment schemes — such as PayNow, Network for Electronic Transfers (Singapore) (NETS), GrabPay, Alipay and credit card networks — into a single EMVCo-compliant QR code, enabling merchants to accept payments from various bank apps and digital wallets without displaying multiple QR codes. This network-level interoperability simplifies merchant onboarding and enhances customer convenience. SGQR is widely regarded as a model for full-spectrum QR code interoperability.[28]

Malaysia — DuitNow QR

Malaysia's DuitNow QR, developed by Payments Network Malaysia (PayNet) under the Interoperable Credit Transfer Framework (ICTF) of Bank Negara Malaysia, serves as the country's standardised QR code system. It integrates multiple payment schemes — spanning banks, e-wallets and card-based systems — into a single EMVCo-compliant QR code. This infrastructure ensures that a merchant accepting DuitNow QR can receive payments from any participating bank or e-wallet, achieving full domestic interoperability. The model improves efficiency, reduces duplication at the POS and supports inclusive digital payments.[29.]

Indonesia — QRIS

Indonesia's QR code payment system, QRIS, launched in 2019 by Bank Indonesia (BI) in collaboration with the Indonesian Payment System Association (ASPI), is built on the EMVCo merchant-presented QR code standard and has achieved full domestic interoperability across banks and major e-wallets such as OVO, GoPay, DANA, ShopeePay and LinkAja. QRIS enables merchants to accept payments from any participating app using a single, standardised QR code, facilitating real-time, low-cost transactions, particularly for micro, small and medium enterprises (MSMEs). QRIS is currently interoperable primarily within the national account- and wallet-based ecosystem, however, and does not yet include card schemes like Visa and Mastercard in its QR structure. Recognising this limitation, BI is working to achieve full network-level interoperability by progressively integrating international card schemes into QRIS and enhancing cross-border payment linkages under the Association of Southeast Asian Nations (ASEAN) Payment Connectivity Initiative. Recent bilateral agreements with Singapore (PayNow), Malaysia (DuitNow), Thailand (PromptPay) and Cambodia (KHQR) demonstrate this cross-border push. Additionally, BI aims to align QRIS with its BI-FAST instant payment infrastructure, incorporate multi-scheme co-residency in QR codes and deepen interoperability across remittances, utilities and P2P/G2P use cases.[30]

United States — X9 Unified QR Code Standard

In the United States, recent developments signal a shift towards establishing a unified QR code standard to support instant payments. The Accredited Standards Committee X9 has introduced the *X9 payment QR code standard*, which provides a common, secure and extensible framework for encoding payment data in QR codes. This initiative is designed to enable interoperability across multiple payment systems, including FedNow, real-time payment (RTP) and automated clearing house (ACH), while covering diverse use cases such as P2P, person-to-business (P2B) and business-to-business (B2B) transactions. Industry stakeholders argue that this missing common layer of encoding is crucial for scalability, security and interoperability in US faster payments adoption. Early demonstrations using FedNow have already showcased merchant-presented QR codes for real-time transactions, underscoring the viability of this approach in closing the 'last mile' of instant payment adoption in the United States.[31,32]

IMPLICATIONS FOR INDIA

These global examples demonstrate the practical feasibility and significant benefits of QR code interoperability when backed by strong regulatory leadership, effective standardisation efforts and collaborative stakeholder engagement. India, given its robust payment ecosystem and the leadership of the NPCI, can adapt and build on these international best practices to create an even more resilient, inclusive and innovative digital payments landscape. Such comprehensive interoperability could also effectively address some of the concentration risks currently associated with NPCI processing over 80 per cent of retail digital payments in India by volume.

POLICY RECOMMENDATIONS AND WAY FORWARD FOR QR CODE INTEROPERABILITY IN INDIA

To propel digital payments adoption even further in India, particularly through QR codes, India should consider the following policy recommendations. As UPI is being strategically positioned as a DPI, it is imperative that all its components, including QR code acceptance, rigorously meet the stringent full interoperability requirements inherent to DPI principles.

- Establishing a Unified QR Code Standard: The NPCI and regulators should drive the adoption of a single, unified QR code standard that seamlessly supports multiple payment networks and schemes (including UPI, RuPay, IMPS, Mastercard and Visa) under one QR code. Leveraging international standards like EMVCo QR specifications can ensure global compatibility and robust security. At a minimum, India should ensure that the unified QR code provides basic information for any interbank transfers — such as name, account type, legal status, Indian Financial System Code (IFSC) and account number, as the case may be. This foundational data would enable any payment app to scan and initiate digital payments through appropriate instruments, regardless of the underlying scheme.
- Mandating Network-Level Interoperability: Regulators must explicitly mandate that all payment apps and wallets accept QR codes issued by any network or scheme. This stringent requirement would dismantle existing silos, allowing consumers and merchants to transact freely across networks and apps, thereby significantly improving system resilience and expanding consumer choice.
- Encouraging Infrastructure Upgrades: Support for merchant POS devices and backend systems to enable multi-network QR code acceptance is essential. These infrastructure upgrades are not merely for convenience but are fundamental to building a more resilient digital payment architecture that can withstand disruptions by routing transactions through diverse pathways. Incentives, subsidies or technical assistance could accelerate merchant onboarding to this comprehensive interoperable QR code infrastructure. As the umbrella retail payment organisation, NPCI, despite not being a for-profit company, has generated sufficient surplus to support the growth of digital payments in India. Therefore, it is ideally positioned to take the lead in ensuring India converges to a single, fully interoperable QR code at all levels.
- Strengthening Security Frameworks: It is crucial to develop and enforce robust security and fraud detection mechanisms at the network level to protect users across all interoperable QR code transactions. This includes standardising customer authentication protocols, enhancing transaction monitoring capabilities and implementing real-time alerts.
- Promoting Consumer and Merchant Awareness: Coordinated awareness campaigns are vital to educate consumers and merchants about the benefits and

proper usage of interoperable QR codes. Clear guidance and consistent support can reduce confusion and significantly encourage widespread adoption.

CHALLENGES TO IMPLEMENTATION

Implementing these policy recommendations, while crucial, will face considerable challenges. Significant resistance may arise from dominant payment app providers and banks that currently benefit from their entrenched market positions and could perceive full interoperability as a threat to their user base or competitive advantage. Technically, migrating millions of existing QR codes and upgrading merchant POS infrastructure to support a truly unified standard will demand substantial investment and highly coordinated effort across the entire ecosystem. This also involves addressing the complex operational realities of intelligently routing transactions to their native networks and managing the associated, potentially varying, routing costs and settlement charges for different schemes (eg card networks versus UPI), while ensuring overall cost efficiency aligns with India's payment ecosystem goals. Moreover, ensuring robust governance and stringent regulatory enforcement will be crucial to overcome inertia and align the diverse interests of banks, FinTechs and network operators. Finally, while promoting consumer and merchant awareness is vital, overcoming deeply ingrained habits and ensuring a seamless user experience during any transition period will be essential to maintain trust and sustain the adoption of digital payments.

IMPLICATIONS FOR OTHER COUNTRIES AND THE ROLE OF BANKS IN QR CODE ACCEPTANCE

As countries across the globe expand their digital payment ecosystems — particularly through QR code-based merchant acceptance — India's experience serves as a cautionary tale. While QR codes enable rapid and cost-effective payment digitisation, especially for small merchants and informal sectors, the absence of network-level interoperability can lead to structural inefficiencies and systemic risks. A single, scheme-agnostic QR code standard that works across banks, wallets, card networks and RTP systems is essential to maximise scale, inclusiveness and resilience. Countries should prioritise this from the outset to avoid costly retrofits and vendor lock-ins. India's Bharat QR and global models like Singapore's SGQR and Malaysia's DuitNow offer ready blueprints.

It is equally crucial that banks that are invested or are planning to invest in the acceptance business remain active in this space. Their presence ensures that QR-based infrastructure is widely adopted, interoperable and embedded in the broader regulated financial system. By leveraging shared acceptance rails, banks can achieve economies of scale and scope, generate new revenue from acquiring services and contribute to system resilience. Most importantly, their involvement keeps the infrastructure aligned with national policy goals, mitigating risks of excessive reliance on a few non-bank entities. Banks should not view the acceptance layer as peripheral — it is a strategic lever for deepening inclusion and sustaining digital payment growth.

CONCLUSION

India has achieved remarkable progress in digital payments, largely driven by the UPI and the widespread adoption of QR code-based merchant payments. This paper has highlighted the crucial role of the UPI's unique ecosystem — from its user-friendly design and regulatory accommodation to the strategic impact of zero MDR and asset-light QR infrastructure — in propelling India's digital transformation. However, a significant challenge remains: the lack of full

network-level interoperability for QR codes. This fragmentation poses risks related to concentration, systemic vulnerabilities and disparate merchant onboarding standards, ultimately limiting the potential for broader financial inclusion and resilience.

While the RBI has historically championed interoperability — a cornerstone principle evident in its pioneering efforts with the NFS and the success of the RuPay card — a crucial opportunity for comprehensive QR code interoperability was missed. The RBI's 2020 circular, while aiming to rationalise QR code formats, allowed a choice between UPI QR and Bharat QR, inadvertently promoting siloed interoperability within individual networks instead of across them. Had the RBI mandated true network-level interoperability by March 2022, India might have had a unified acceptance infrastructure comprising nearly 658 million interoperable QR codes (as of March 2025), rather than the current fragmented landscape. It is especially notable that the NPCI, which benefited from interoperable infrastructure that enabled RuPay's adoption at POS terminals, did not extend the same principle in its rapid expansion of UPI QR codes. Despite UPI being globally showcased as a model DPI, its underlying QR code acceptance layer still falls short of embodying the core DPI values of openness, competition and non-discrimination. Further, despite calling for new applicants for NUE licensing to address concentration risk and resiliency challenges, RBI has still not issued the licences, and that again is a missed opportunity. At least in this case, since the RBI has not abandoned the NUE licensing and has kept it only in abeyance, they could revive and issue licences.

Drawing lessons from successful interoperable QR ecosystems in Singapore and Malaysia, and ongoing efforts in Indonesia, this paper underscores that achieving true network- and scheme-level interoperability is not merely a technical upgrade — it is a strategic imperative. Such interoperability would enhance consumer convenience, increase merchant acceptance while lowering costs, improve systemic resilience, foster innovation and accelerate financial inclusion.

In parallel, banks must remain active participants in the acceptance ecosystem. Their role is crucial in maximising infrastructure utilisation, achieving economies of scale and scope, generating sustainable revenue and strengthening the overall resilience of the system. Bank-led involvement also ensures that acceptance infrastructure remains aligned with public policy objectives, avoids excessive dependence on a handful of private players and embeds trust within regulated institutions. The acceptance layer of digital payments should not be outsourced entirely — banks must see it as a strategic domain central to financial deepening and sovereignty.

While the path to full interoperability presents challenges — including vested interests, technical complexity and coordination gaps — the policy recommendations outlined in this paper offer a clear and actionable road map. By addressing these issues decisively and embracing a unified, scheme-agnostic QR code infrastructure, India can reinforce the foundational strength of its DPI, reduce concentration risks and build a more inclusive, resilient and future-proof payments ecosystem.

India's experience offers timely and important lessons for countries seeking to build or expand their digital payment ecosystems. As they roll out QR code-based merchant acceptance infrastructure, it is essential to prioritise network-level and scheme-level interoperability from the outset. While QR codes provide an asset-light, cost-effective and scalable acceptance model, relying on a single scheme or closed-loop

network can create hidden systemic risks, limit consumer choice and hinder long-term competition. A single, interoperable QR code standard — capable of accepting payments from all regulated networks, including cards, wallets, fast payment systems and bank apps — maximises inclusion, ensures resilience and future-proofs the national payments infrastructure. India's early successes and missed opportunities serve as both a blueprint and a cautionary tale for others.

References

(1) National Payments Corporation of India (2025) 'Retail–Payments–Statistics', available at https://www.npci.org.in/PDF/npci/statics/Retail-Payments-Statistics-May25.pdf (accessed 31st May, 2025).
(2) National Payments Corporation of India (2025) 'UPI Ecosystem Statistics', available at https://www.npci.org.in/what-we-do/upi/upi-ecosystem-statistics (accessed 31st May, 2025).
(3) Reserve Bank of India (2025) 'Database on Indian Economy', available at https://data.rbi.org.in/ (accessed 10th November, 2025).
(4) Balakrishnan, M. (2023) 'The Unified Payment Interface and the Growth of Digital Payments in India: An Analysis', *Journal of Payments Strategy & Systems*, Vol. 17, No. 3, pp. 250–70.
(5) National Payments Corporation of India and Reserve Bank of India, refs 1–3 above.
(6) *Ibid*.
(7) Balakrishnan, M. (2017) 'The Importance of Digitising Payments and the Role of Acceptance Infrastructure — Part 2', *Journal of Digital Banking*, Vol. 1, No. 4, pp. 358–77.
(8) National Payments Corporation of India and Reserve Bank of India, refs 1–3 above.
(9) *Ibid*.
(10) Reserve Bank of India (2020) 'Digital Payment Transactions — Streamlining QR Code Infrastructure: RBI/2020-21/59 DPSS.CO.PD. No.497/02.14.003/2020-21', available at https://rbi.org.in/Scripts/BS_CircularIndexDisplay.aspx?Id=11987 (accessed 12th September, 2025).
(11) Bank for International Settlements and Committee on Payments and Market Infrastructures (2012) 'Principles for Financial Market Infrastructures', available at https://www.bis.org/cpmi/publ/d101.htm (accessed 31st May, 2025).
(12) Outlook Money (15th April, 2025) 'UPI Outage Attributed to Surge in API Calls from Banks, Says NPCI', available at https://www.outlookmoney.com/banking/upi-outage-attributed-to-surge-in-api-calls-from-banks-says-npci (accessed 31st May, 2025).
(13) 'PhonePe UPI Payments Disrupted as New Data Centre Fails to Handle Rush' (12th May 2025), *The Economic Times*, available at https://economictimes.indiatimes.com/tech/technology/phonepe-reports-outage-other-upi-apps-also-hit/articleshow/121115497.cms?from=mdr (accessed 31st May, 2025).
(14) 'NPCI Extends 30% UPI Market Share Cap Deadline on 3rd Party Apps to December 2026' (31st December, 2024), *Business Today*, available at https://www.businesstoday.in/tech-today/news/story/npci-extends-30-upi-market-share-cap-deadline-on-3rd-party-apps-to-december-2026-459171-2024-12-31 (accessed 31st May, 2025).
(15) National Payments Corporation of India and Reserve Bank of India, refs 1–3 above.
(16) Bank for International Settlements and Committee on Payments and Market Infrastructures, ref 11 above.
(17) World Bank (2021) 'Digital Financial Services', World Bank, Washington, DC.
(18) World Bank (2024) 'Global Payment Systems Survey 2023: Sixth Edition', World Bank, Washington, DC.
(19) Bank for International Settlements (2021) 'Payment Aspects of Financial Inclusion', BIS Bulletin No. 52, available at https://www.bis.org/cpmi/publ/d198.htm (accessed 31st May, 2025).
(20) International Finance Corporation (n.d.) 'Digital Payments', available at https://www.ifc.org/en/what-we-do/digital-finance/digital-payments (accessed 31st May, 2025).
(21) G20 Digital Economy Ministers' Meeting (19th August, 2023) 'G20 Digital Economy Ministers' Meeting (DEMM) Concluded with Adoption of the G20 Digital Economy Outcome Document and Chair's Summary', Press Information Bureau, Ministry of Electronics & IT, Government of India, available at https://www.pib.gov.in/PressReleasePage.aspx?PRID=1950443 (accessed 31st May, 2025).
(22) United Nations Development Programme (27th February, 2025) 'Digital Public Infrastructure: A Practical Approach for Africa', Carnegie Endowment for International Peace, available at https://carnegieendowment.org/research/2025/02/digital-public-infrastructure-a-practical-approach-for-africa?lang=en (accessed 31st May, 2025).
(23) Reserve Bank of India, ref 10 above.
(24) Reserve Bank of India (August 2020) 'Framework for Authorisation of Pan-India Umbrella Entity for Retail Payments', available at https://rbidocs.rbi.org.in/rdocs/Content/PDFs/NUE10082020.pdf (accessed 12th September, 2025).
(25) Business Standard (1st April, 2021) 'Six Consortiums Apply for RBI's NUE License', available at https://www.business-standard.com/article/economy-policy/six-consortiums-apply-for-rbi-s-nue-license-including-reliance-tata-121040101028_1.html (accessed 12th September, 2025).
(26) Moneycontrol (6th April, 2023) 'NUE Plan at a Standstill; RBI Says Hasn't Received Innovative

Proposals', available at https://www.moneycontrol.com/news/business/nue-plan-at-a-standstill-rbi-says-hasnt-receive-innovative-proposals-10378211.html (accessed 12th September, 2025).
(27) Balakrishnan, ref 4 above.
(28) Smart Nation Singapore (n.d.) 'SGQR', available at https://www.smartnation.gov.sg/sgqr/ (accessed 31st May, 2025).
(29) Payments Network Malaysia (PayNet) (n.d.) 'Customer — DuitNow QR', available at https://www.duitnow.my/QR/index.html (accessed 31st May, 2025).
(30) Bank Indonesia (25th June, 2025) 'QRIS: Quick Response Code Indonesian Standard', available at https://www.bi.go.id/id/fungsi-utama/sistem-pembayaran/qris/Contents/Default.aspx (accessed 31st May, 2025).
(31) Netto, C. (7th August, 2024) 'A Unified Standard for QR Codes Is the Next Step in Real-time Payments', *American Banker*, available at https://www.americanbanker.com/opinion/a-unified-standard-for-qr-codes-is-the-next-step-in-real-time-payments (accessed 12th September, 2025).
(32) Digital Transactions (September 2024) 'QR Codes Make a Splash in the Real-time Payments Pool', available at https://www.digitaltransactions.net/qr-codes-make-a-splash-in-the-real-time-payments-pool/ (accessed 12th September, 2025).