# THE EMERGENCE OF CENTRAL BANK DIGITAL CURRENCY IN MODERN PAYMENT SYSTEMS: OPPORTUNITIES, CHALLENGES AND PROSPECTS

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## Abstract

The increasing digitalisation of financial systems has compelled Central Banks worldwide to explore new forms of sovereign digital money. Central Bank Digital Currency (CBDC) is a digital version of fiat currency issued and regulated by a Central Bank and it is regarded as a significant innovation in modern payment systems. It seeks to improve payment efficiency, promote financial inclusion, lower transaction costs and enhance the robustness of financial infrastructure. Reflecting this global shift, India has introduced the Digital Rupee (e₹) through the Reserve Bank of India. This paper is an attempt to study the conceptual foundations, operational architecture and policy rationale of CBDC. It further explores the opportunities and challenges associated with CBDC implementation in India, particularly, in relation to financial inclusion, technological infrastructure, regulatory frameworks and cross-border payment systems. The study highlights the strategic importance of the indirect distribution model adopted by the RBI and the integration of CBDC with existing digital payment platforms such as the Unified Payments Interface (UPI). The paper concludes that CBDC has the potential to significantly reshape the financial ecosystem, provided appropriate technological safeguards, legal frameworks and institutional coordination mechanisms are established.



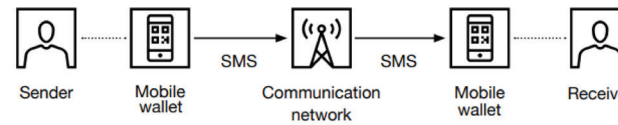
**Keywords**

Central Bank Digital Currency, Digital Rupee, Payment Systems, Financial Inclusion, Digital Economy


## Introduction

India's Central Bank Digital Currency (CBDC), known as the Digital Rupee (e₹), serves as a vital new rail within the Digital Public Infrastructure (DPI) framework. The concept of CBDC has gained significant prominence in the rapidly advancing digital financial ecosystem, as it holds the potential to fundamentally transform financial infrastructure and redefine the functioning of economies and financial systems. As these digital currencies become increasingly integral to modern economic systems, it is essential for professionals to develop a thorough understanding of their theoretical foundations, practical applications and prospects.

**Figure 1: Wallet to Wallet transfer**




Source: India's digital currency frontier: Envisioning the future of CBDC, PwC.

A Central Bank Digital Currency (CBDC) is a digital form of legal tender issued by a Central Bank,

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equivalent to physical fiat currency and exchangeable on a one-to-one basis, with the only distinction being its electronic form. The Digital Rupee (e₹) can be held and transacted through digital wallets offered by banks and non-bank entities, enabling both person-to-person and person-to-merchant payments. Merchant transactions can be carried out by scanning either a CBDC QR code or a UPI QR code at the point of sale. The e₹ wallet is compatible with both Android and iOS platforms, does not require a minimum balance and allows users to load, redeem or transfer funds seamlessly between their bank account and wallet at any time on a 24/7 basis.

A key distinction between CBDC and private cryptocurrencies lies in the nature of governance and regulatory oversight. Cryptocurrencies such as Bitcoin function on decentralized networks that are not governed by any single authority. While this decentralisation provides a degree of autonomy and transparency, it also creates challenges related to price volatility, consumer protection and financial regulation. In contrast, CBDCs are issued and supervised by national monetary authorities, ensuring stability, legal recognition and integration with existing financial systems. By combining the efficiency of digital transactions with the reliability of sovereign currency, CBDCs are designed to offer a safe and reliable alternative to both physical cash and privately issued digital assets. It operates on a centralized or blockchain-based digital ledger maintained by the Central Bank, ensuring security, transparency and reliability. CBDC provides individuals, businesses and financial institutions with a trusted medium of exchange, as the central bank oversees its issuance, administration and regulation. CBDC also has the potential to enhance financial inclusion by enabling access to digital payments for individuals without traditional bank accounts. Through secure digital wallets and user-friendly payment interfaces, it can expand the reach of financial services to underserved communities, especially in rural and remote regions.

The retail CBDC pilot launched in December 2022 marked an important milestone in India's digital currency journey. At present, the retail e₹ pilot is ongoing with 19 banks - State Bank of India, ICICI Bank, Yes Bank, IDFC First Bank, Bank of Baroda, Union Bank of India, HDFC Bank, Kotak Mahindra Bank, Punjab National Bank, Canara Bank, Axis Bank, IndusInd Bank, Federal Bank, Karnataka Bank, Indian Bank, IDBI Bank, UCO Bank, Bank of Maharashtra and Bank of India and 7 million users, enabling Person-to-Person (P2P) as well as Person-to-Merchant (P2M) transactions. Additionally, two non-bank entities- CRED and MobiKwik, have been permitted to join the pilot. They will be extending CBDC wallet services to users in the near future. Interoperability with UPI is also enabling wider adoption of the e₹ without compromising user convenience.

According to the report released by Bank for International Settlements (BIS), CBDCs can improve payment efficiency, reduce settlement risks and enhance financial inclusion. The Bank for International Settlements (BIS) defines CBDC as a digital form of central bank money that differs from balances held in traditional reserve or settlement accounts.

The study done by Auer, Cornelli and Frost argue that CBDCs represent a natural evolution of payment systems in response to technological innovation and declining cash usage. Their study highlights that central banks are motivated by several factors, including maintaining control over monetary policy, improving payment resilience and addressing competition from private digital. The reports released by the Reserve Bank of India emphasise that CBDCs can complement existing digital payment systems rather than replace them. The RBI's concept note suggests that CBDC can function as a digital alternative to cash while leveraging India's well-developed digital payment infrastructure.

Thus, CBDCs are not merely technological innovations but represent a significant institutional development in the evolution of modern payment systems.

This paper examines the conceptual foundations, operational mechanisms and policy implications of CBDC, with particular emphasis on the Indian experience. It also examines the opportunities and challenges linked to the introduction of a sovereign digital currency and assesses its potential impact

on the future of payment systems in India as well as globally.

### Architecture and Operational Models of CBDC

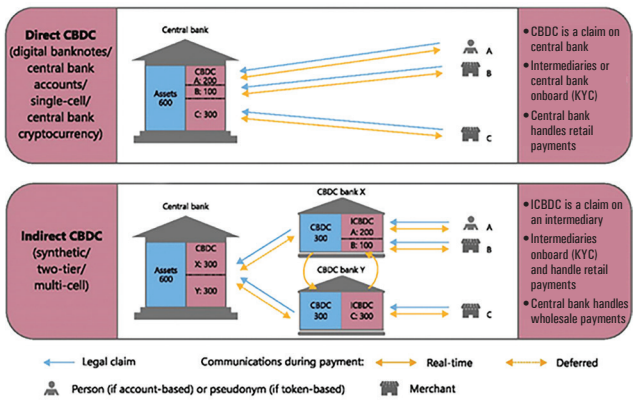
Central Bank Digital Currency (CBDC) is a digital representation of a nation's sovereign currency, issued and regulated by the Central Bank. It serves as legal tender and is fully interchangeable with physical cash, such as notes and coins, on a one-to-one basis. Unlike deposits maintained with commercial banks, CBDC constitutes a direct liability of the central bank.

### CBDCs are broadly classified into two types:

| **Wholesale CBDC (W-CBDC):** | **Retail CBDC (R-CBDC):** |
|---|---|
| Wholesale CBDC usage is limited to authorized wholesale market participants, including government entities, financial institutions, and others. It is designed for high-volume, high-value financial system transactions, includes wholesale payments, securities trading, and interbank settlements. Wholesale CBDC is designed to enhance the security, speed, and efficiency of inter-institutional financial transactions, thereby reducing systemic risks and improve the management of funds across the financial system to ensure liquidity is available where needed and operational risks are minimized. | The central bank issues R-CBDC, which the public, businesses, and individuals can purchase to hold and conduct transactions. It functions as a substitute for tangible currency and commercial bank deposits, offering a safe and practical means of transaction for routine affairs. R-CBDC facilitates the expansion of digital payment accessibility, specifically targeting unbanked and underbanked communities. It is compatible with established payment systems, such as mobile wallets and credit cards. |

There are two main approaches to issue and manage CBDCs based on their distribution framework. In the direct model, the central bank is responsible for all functions, including issuance, account maintenance and transaction processing. In contrast, the indirect model involves the central bank issuing the CBDC while delegating distribution and customer-related services to intermediaries such as commercial banks and payment service providers, each carrying out specific roles.

**Figure 2: Direct and Indirect CBDC**




Source: BIS

In this framework, the central bank issues CBDC to intermediaries, who in turn, provide it to consumers. Customer-related services and claims are managed by these intermediaries, while the central bank primarily deals with them at the wholesale level. This indirect approach closely resembles the existing currency management system, where banks are responsible for distributing cash, maintaining customer accounts, ensuring compliance with Know Your Customer (KYC) and Anti-money Laundering/ Countering the Financing of Terrorism (AML/CFT) regulations, preventing illicit financial activities and facilitating transaction verification.

### Examples from other countries

China's Digital Yuan (e-CNY) demonstrates the effectiveness of the indirect model, wherein, the People's Bank of China (PBoC) collaborates with commercial banks and fintech platforms such as Alipay and WeChat Pay for its distribution. This approach has enabled widespread adoption, streamlined onboarding and enhanced innovation and outreach. By mid-2025, this strategy attract users by simplifying onboarding (KYC) and utilizing private-sector innovation to reach rural and unbanked populations. This model has set a global benchmark, with e-CNY facilitating seamless transactions and supporting China's push for RMB internationalization. India can adapt similar strategies to accelerate e₹ adoption.

India has adopted the indirect distribution model, allowing the Reserve Bank of India to utilize established banking networks and digital payment platforms while maintaining regulatory oversight and scalability. The technological architecture of CBDC systems may involve centralized digital databases, Distributed Ledger Technology (DLT) or hybrid systems combining both approaches. The choice of technology depends on several factors, including transaction speed, cyber security, scalability and the overall resilience of the financial system.

### Opportunities with CBDC

Central Bank Digital Currency (CBDC) presents

several important opportunities for strengthening and modernising financial systems, while also posing certain challenges that must be carefully addressed.

The inclusion of Prepaid Payment Instruments (PPIs) in CBDC distribution opens avenues for growth, exemplified by players like eRoute Technologies, an RBI-authorized PPI issuer since 2021 offering solutions like OmniCard. By integrating PPIs into CBDC distribution, India can achieve financial inclusion for rural and unbanked populations while driving product innovation through offline and loyalty-based wallets.

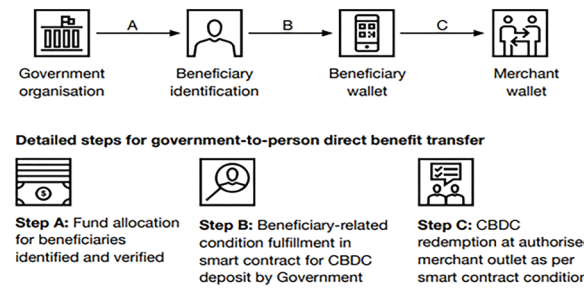
Strategic partnerships and merchant enablement for Small and Medium Enterprises (SMEs) create new revenue models and sector-specific solutions for transport or subsidies, ultimately boosting profitability through higher transaction volumes and incentives. This positions PPIs as key enablers in India's digital economy. India's Unified Payments Interface (UPI) is no longer a domestic phenomenon; it is a global export. Proved that high-velocity, low-cost micro-payments are viable at a continental scale.

CBDCs improve payment efficiency by enabling near-instant settlement of transactions, which reduces processing delays and lowers transaction costs for both consumers and businesses. This efficiency can significantly enhance the functioning of domestic payment systems and may also contribute to more streamlined international transactions. In the context of cross-border payments, CBDCs offer the possibility of simplifying remittance processes, which currently involve multiple intermediaries and often incur high fees. Through direct settlement between participating financial institutions, CBDCs can reduce transaction time and costs associated with international transfers. Furthermore, CBDCs have the potential to stimulate innovation within the digital finance ecosystem.

Emerging technological features such as programmable payments, smart contracts and the possibility of offline digital transactions can expand the capabilities of digital payment systems and support the development of new financial products and services.

***Examples of User-level programmability*** is when a parent provides monthly pocket money to a child in the form of CBDC tokens. To control spending, the parent can set conditions such that the tokens may only be used within the school premises (geofencing), for a specific purpose like buying snacks from the canteen and within a defined time period, such as that month. Transactions will be completed only if all these pre-set conditions are met.

**Figure 3: Programmability-based fund distribution to beneficiaries of CBDC**




Source: India's digital currency frontier: Envisioning the future of CBDC, PwC.

The integration of smart contracts into transactions, along with conditions such as geofencing and Merchant Category Codes (MCC), enables the programmability of CBDCs in India. This capability allows issuers to exert greater control over the use of funds, ensuring that payments are executed only when specified conditions are met, thereby, minimizing dependence on intermediaries.

Programmability also introduces capabilities that traditional money cannot offer, paving the way for more efficient and innovative financial services. In this context, the Government has identified Direct Benefit Transfer (DBT) as a key use case, leveraging programmability to deliver targeted subsidies. For instance, the Subhadra scheme in Odisha could become one of the first initiatives to utilize CBDCs, potentially benefiting over one crore women in the state.

CBDC token carries a unique and immutable identifier, enabling authorities to trace its complete wallet-to-wallet journey from origin to end use. This feature supports Anti-Money Laundering and Countering the Financing of Terrorism (AML/CFT) efforts by making it easier to detect and investigate activities such as fund diversion and tax evasion. For agreement-based payments, the programmable features of CBDCs can be used to time-lock transactions for a specified period. Execution would require authorization from all relevant parties and if the conditions are not met within the defined timeframe, the funds are automatically returned to the original owner. This mechanism helps prevent fraud and enables smoother resolution of payment-related disputes.

Money mulling, a form of financial fraud in which criminals use third-party accounts to transfer illicit funds, can also be addressed through CBDC features. Capabilities such as traceability and trackability, strong AML measures and programmability enhance monitoring and control, helping to detect and prevent misuse of mule accounts.

**The New Mandate for India's Digital Payments-Offline CBDC:** In a transformative leap for India's digital payments landscape, the Reserve Bank of India (RBI) has unveiled a groundbreaking innovation — the Offline Digital Rupee. This Central Bank Digital Currency (CBDC) enables secure digital transactions without internet or telecom connectivity. This new phase of the digital rupee — appropriately described as "Cash, but Digital" — merges the universal accessibility of physical cash with the efficiency and traceability of digital money, cementing India's leadership in the global fintech ecosystem. Unlike internet-dependent systems such as UPI, the Offline Digital Rupee operates through proximity-based technologies like Near-Field Communication (NFC) and QR codes, enabling wallet-to-wallet transfers directly between users. Transactions are settled instantly and irrevocably, mirroring a physical cash exchange — with the crucial distinction that each unit of the digital rupee is backed by the RBI. Even "digital change" is handled intelligently, making this a true evolution of cash for the modern age.

**Challenges Ahead**

The model offers vast potential but requires addressing hurdles:

The strict KYC, AML and data privacy standards for all intermediaries, should be enforced. There is a need to strike a balance between transparency for oversight and privacy for users, while ensuring that all intermediaries—banks, fintech firms and payment service providers—adhere to uniform standards.

**Accounting and Dealing in Tax Matters:** Digital currencies represent a significant innovation in the payments landscape. However, a key challenge is the lack of universally accepted accounting standards and clear classification, particularly regarding whether digital currencies should be treated as assets, liabilities or other financial instruments. Resolving this ambiguity is critical before CBDCs can be properly recognized as financial instruments, which generally involve transferable rights to assets and corresponding obligations.

This uncertainty limits consistency in accounting practices and affects how digital currencies are reported in financial statements. A thorough understanding of blockchain technology is, therefore, essential for developing appropriate accounting, taxation and regulatory frameworks for the evolving digital currency ecosystem.

**Technical complexity:** The e₹ ecosystem must seamlessly integrate with existing banking systems, Prepaid Payment Instruments (PPIs) and digital platforms. Achieving this requires standardized protocols, real-time processing capabilities, robust cyber security measures and strong interoperability across banks, PPIs and CBDC platforms.

Distributed Ledger Technology (DLT), including blockchain, underpins this framework with key features such as decentralization, security, transparency, consensus-driven validation and

flexibility. Blockchain ensures that data is tamper-resistant, preventing unauthorized alterations or falsification. Its consensus mechanisms build trust by enabling collective validation of transactions rather than relying on a single central authority. Additionally, because the ledger is shared and distributed among network participants, recorded transactions are highly resistant to manipulation.

However, despite these advantages, challenges associated with blockchain technology must be addressed, including concerns related to security, scalability, regulatory compliance, system complexity and energy consumption.

**Legal Implications of CBDC:** The legal considerations surrounding the introduction of CBDCs largely depend on their operational and technological design. Different implications arise based on whether the CBDC is account-based or token-based. Account-based CBDCs, similar to traditional bank money, are treated as "book money" reflected as credit balances in accounts. In contrast, token-based CBDCs function as digital cash, where the central bank's liability is embedded directly within the token.

Another important concern relates to financial stability. If CBDCs become widely adopted by the public, individuals may prefer holding digital currency issued directly by the central bank instead of depositing money in commercial banks. This shift could reduce bank deposits and potentially affect the ability of banks to provide loans and credit to the economy.

Since bank deposits are a key source of funding for lending, any significant shift toward CBDCs could reduce deposit levels in banks. This, in turn, may impact their ability to extend credit to businesses and households, thereby, influencing the overall functioning of the financial system.

**Lack of awareness:** Raise awareness of e₹ benefits to boost adoption. Many individuals, particularly in rural and semi-urban areas, may lack awareness or trust in digital financial systems. Building digital literacy and trust is key to encourage individuals and small businesses to transition from cash-based to digital transactions. There is a need to raise awareness of e₹ benefits to boost adoption.

**Merchant Infrastructure:** Develop acceptance tools for rural and semi-urban businesses. Many small merchants, especially in rural and semi-urban regions, lack the infrastructure to accept digital payments. Investment is needed in affordable and user-friendly tools such as QR code systems, mobile-based payment solutions and offline transaction capabilities.

**Offline CBDC** transactions present distinct regulatory and operational challenges. The key risks include double spending, device compromise and delays in detecting fraudulent activity. To address these concerns, regulators typically impose transaction limits, require secure hardware environments and mandate periodic synchronization with the central system.

From a regulatory standpoint, offline CBDC must comply with existing frameworks related to anti-money laundering, consumer protection and operational risk management. Banks and intermediaries are expected to implement strong safeguards, effective monitoring systems and user awareness initiatives.

It highlights benefits like security and transparency but ignores potential drawbacks such as cost, complexity and regulatory challenges. The role of blockchain is mentioned, but there is no explanation of how it actually works in accounting systems. The risks like input manipulation and system vulnerabilities can still exist to cyber security threats, technical failures or data breaches.

Therefore, establishing a robust and resilient cyber security infrastructure is essential for maintaining trust and operational stability.

**Future Prospects of CBDC in India**

As per the recent amendments, the income tax rules applicable to cash transactions and withdrawals, will also apply to CBDCs. Accordingly, a user's identity may be established by authorities when funds are transferred from a bank account to a CBDC wallet, in line with banks' KYC requirements. A key benefit of CBDCs is their strong potential to enhance financial inclusion by expanding access to digital financial services.

India's digital payments revolution is no longer merely a technology success story—it is the central nervous system of the national economy. Platforms such as UPI, Immediate Payment Service (IMPS) and Aadhaar Enabled Payment System (AEPS), operated under the National Payments Corporation of India (NPCI) framework and regulated by the RBI, now process billions of transactions every month, underpinning consumption, credit delivery, welfare transfers and financial inclusion at population scale. In this environment, the cyber "attack surface" is no longer a defined perimeter. It is pervasive, real-time and deeply interconnected—cutting across banks, fintechs, Third-Party Application Providers (TPAPs), technology service providers and Digital Public Infrastructure (DPI).

**From Cyber Risk to Cyber Resilience:** As we enter 2026, a decisive strategic shift is underway. India's payments ecosystem is moving beyond cyber security as wall-building to cyber resilience as systemic shock absorption - the ability to withstand attacks, recover rapidly and continue operating without disrupting trust or liquidity. Traditional cyber security models are built on the assumption that threats can be identified, blocked and neutralised. Cyber resilience starts with a more pragmatic regulatory truth: breaches are inevitable. This thinking is already visible in regulatory signals. The RBI's evolving supervisory posture-across Digital Payment Security Controls, IT Frameworks for NBFCs and Banks, Outsourcing Guidelines and Cyber Incident Reporting norms - is steadily shifting from checklist-based compliance to outcome-based resilience. For real-time payment systems like UPI and IMPS, the regulatory objective is zero incidents or near-zero disruption and rapid restoration of trust. The RBI has introduced several systemic controls, including: The Mule Hunter framework to identify and prevent misuse of bank accounts, Real-time fraud monitoring systems, enhanced KYC and transaction authentication norms and stronger incident reporting requirements.

This can broaden access to Government benefits, digital payments and basic financial services, thereby, strengthening economic participation and reducing dependence on cash-based transactions. Another major benefit is incorporating PPIs into retail CBDC distribution signals a major evolution in India's financial system. These agile players, alongside banks and fintechs, bring innovation and reach to realize RBI's inclusive digital economy goals. With robust regulations and ongoing collaboration, India is well-positioned to lead in CBDC deployment globally, potentially prioritizing sovereign digital infrastructure over stablecoins.

India's established payment infrastructure makes the indirect model ideal. This approach leverages familiar user interfaces to drive adoption and encourages competition among players to foster innovation. Reserve Bank of India has officially constituted the Payment Regulatory Board under the Payment Regulatory Board Regulations, 2025, which came into force in 2025, marking a strategic institutional upgrade by replacing the erstwhile Board for Regulation and Supervision of Payment and Settlement Systems. Looking ahead to FY26, the RBI plans to scale programmable and cross-border features to fully integrate the CBDC into the global economy.

**ISO 20022: Standardizing the Global Financial Dialect:** The migration to ISO 20022 represents

more than a technical upgrade; it is the adoption of a universal data language. By aligning with this global standard, India has eliminated the "data silos" that historically led to reconciliation errors.

ISO 20022 is an international standard for electronic data interchange between financial institutions, developed by the International Organization for Standardization. It provides a common language and structured messaging format (based on XML and increasingly JSON) that enables banks, payment systems and financial entities to exchange information in a consistent, rich and machine-readable way. Unlike traditional messaging standards such as Society for Worldwide Interbank Financial Telecommunication (SWIFT) MT formats, ISO 20022 allows for significantly more detailed data to be included in each transaction. This includes information on the sender, receiver, purpose of payment and regulatory details, which enhances transparency, improves compliance with Anti-Money Laundering (AML) and Know Your Customer (KYC) requirements and reduces errors in processing.

ISO 20022 is widely used across various financial domains, including payments, securities, trade finance and foreign exchange. It is also being adopted globally for modern payment infrastructures such as Real-Time Gross Settlement (RTGS) systems and cross-border payment networks. In the context of emerging technologies, ISO 20022 is particularly important for integrating innovations like Central Bank Digital Currencies (CBDCs), as it ensures interoperability, scalability and efficient data exchange within digital financial ecosystems.

The Metadata Advantage: One of the most powerful features of ISO 20022 is its ability to carry rich and structured metadata along with every financial transaction. Unlike legacy systems, ISO 20022 carries detailed remittance information, invoice references and tax identifiers-directly within the payment message. This transparency reduces manual intervention, drastically lowering the cost of doing business across borders. This legal change provides formal statutory recognition for the issuance of CBDC by the Reserve Bank of India, thereby, creating the necessary legal foundation for the development and operation of a sovereign digital currency within the Indian financial system.

By using Central Bank Digital Currencies (CBDCs), India can facilitate atomic settlement—where the exchange of currency and the transfer of ownership happen simultaneously. This eliminates settlement risk and frees up billions in liquidity that was previously trapped in nostro/vostro accounts.

The future of cross-border payments is defined by three pillars: Velocity, Visibility and Volition. India's advantage lies in its unique "Trifecta":

- Scale: A massive, tech-savvy user base.
- Regulation: A Sandboxed approach that encourages innovation while maintaining systemic stability.
- Infrastructure: A modular and Application Programming Interface (API) - first architecture that is plug-and-play for the rest of the world.

The goal is no longer just moving money; it is the seamless integration of India into the global value chain.

**Conclusion - A Paradigm Shift in Finance**

Central Bank Digital Currency represents a significant milestone in the evolution of global payment systems. India's Digital Rupee initiative reflects the nation's commitment to developing a modern digital financial ecosystem that enhances efficiency, transparency and financial inclusion.

While CBDCs offer substantial advantages, their effective implementation demands careful attention to technological, legal and institutional considerations. Strong cyber security measures, well-defined regulatory frameworks and close collaboration

among central banks, financial institutions and fintech firms will be crucial to unlocking the full potential of CBDCs.

As digital financial ecosystems continue to evolve, the Offline Digital Rupee is not just a new payment system — it is a philosophical shift in how we understand and use money. By combining the trust and universality of cash with the efficiency and intelligence of digital technology, the RBI has reimagined money for the 21st century. This innovation promises a future where financial access is not limited by geography or connectivity — a future where every Indian, everywhere, can transact with confidence.

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India's digital currency frontier: Envisioning the future of CBDC, PwC.

# INDIA'S DIGITAL ECONOMY: INNOVATIONS, CHALLENGES AND REGULATORY EVOLUTION

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## Abstract

The primary objective of the study is to study India's evolving Digital Public Infrastructure. It will highlight the importance of Unified Payments Interface, Unified Lending Interface and Central Bank Digital Currency along with recent advancements, the successful integration of RuPay and FASTag. This paper also examines the robust governance mechanisms implemented by Reserve Bank of India, including the Payment Regulatory Board and mandatory two-factor authorization. Continuous vigilance is required against growing cyber security threats and an urgent need to close the significant digital literacy gap threatening consumer trust. The key focus is the system's potential to accelerate national economic growth, along with the financial inclusion of marginalized populations. The study focuses on strategies for India to successfully manage its "digital-first" economy by addressing the complexities of scale and security.

**Keywords**

Digital Economy, UPI, ULI, CBDC

### Introduction: India's Digital Public Infrastructure (DPI)

The Indian FinTech sector has undergone a major transformation as the country rapidly moves toward a digital-first economy. Key initiatives like the Unified Payments Interface (UPI) have revolutionized how people transfer money instantly and securely. The emerging Unified Lending Interface (ULI) aims to simplify and speed up credit access through digital platforms. The digital currency issued by Reserve Bank of India, the Central Bank Digital Currency (CBDC) issued is also a new initiative in this direction. Together, these systems form a strong Digital Public Infrastructure (DPI) that promotes transparency, interoperability and financial inclusion. India's model is now being recognized globally for its scale and innovation. This paper explores the latest developments, challenges and regulatory measures shaping India's digital payment ecosystem as of late 2025.

### Recent Advancements in Core Payment Systems

The digital payment strategy of India focused on simultaneous innovations in the areas of credit, payments and currency systems to create a robust financial ecosystem. The speed, transparency and accessibility of financial transactions are ensured by the integration of UPI, ULI and CBDC. These advancements together strengthen India's position as a global leader in digital finance.

#### *Unified Payments Interface (UPI)*

UPI remains India's biggest success story and is now the world's largest real-time payment system by volume. In August 2025, UPI crossed 20 billion

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transactions in a single month, with a total value of over ₹24.85 lakh crore, making up more than 85% of all digital transactions in India by June 2025 (PBI, 2025). The transaction limit for Person-to-Merchant (P2M) payments in selected verified categories has been increased to ₹10 lakh per day, supporting high-value digital commerce. The UPI is being studied by the International Monetary Fund (IMF) as a model for other nations and it is also gaining importance within the BRICS group. The services of UPI is available in countries like France, United Arab Emirates (UAE), Singapore, Bhutan, Nepal, Sri Lanka and Mauritius. Additionally, the integration of RuPay credit cards with UPI has enabled credit-linked payments, increasing its use cases and average transaction values.

***Central Bank Digital Currency (CBDC) - Digital Rupee (e₹)***

The Reserve Bank of India (RBI) is carefully expanding the Central Bank Digital Currency (CBDC) pilot to build trust and ensure ease of use. By March 2025, the retail e-Rupee pilot grew to over 6 million users and 17 banks, with the total value of e-Rupee in circulation increasing by 334% year-over-year (Giottus, 2025). New features such as offline functionality have been added so that the digital rupee can be used even in areas with poor or no internet access. The CBDC now also supports programmability, allowing conditional and purpose-specific transfers that make Direct Benefit Transfers (DBT) more effective and secure. Moreover, the RBI has demonstrated interoperability between the CBDC and UPI, allowing both systems to work smoothly together for payment settlements.

***Unified Lending Interface (ULI)***

The Unified Lending Interface (ULI) is emerging as the next major digital platform aimed at making credit access more inclusive. It is a technology framework built to bring openness and interoperability to credit markets. ULI allows the secure and consent-based sharing of digital information—such as land records and other data—from different service providers to lenders. This helps reduce the time needed for credit appraisal, especially benefiting small borrowers and micro-entrepreneurs. Although it is sometimes referred to as the Unified Ledger Interface for connecting various payment systems on a single ledger. Its main goal is to transform the lending process, making borrowing easier, more transparent and accessible to all.

**The Wider Digital Ecosystem: RuPay and FASTag**

India's wider digital ecosystem is strengthened by homegrown innovations like RuPay and FASTag, both managed by the National Payments Corporation of India (NPCI). These systems play a vital role in promoting financial inclusion and driving the country's digital transformation.

RuPay is India's own domestic card payment network and an important tool for expanding banking access. It serves as the main card under the Pradhan Mantri Jan Dhan Yojana (PMJDY), helping bring unbanked citizens into the formal financial system (NPCI, 2025). The integration of RuPay credit cards with UPI has been a major milestone, allowing users to make credit-based payments through UPI's vast merchant network and thereby, increasing the use of credit cards across the country.

FASTag is an example of how digital adoption has been successfully implemented in the transport sector. Using the National Electronic Toll Collection (NETC) system, it enables 100% digital toll payments, reducing waiting times, saving fuel and improving overall logistics efficiency. It stands as a clear success story in digitizing a high-volume and everyday transaction segment across India's highways.

**Economic Impact and Financial Inclusion**

UPI, ULI and CBDC are acting as powerful catalysts for national economic growth and the financial inclusion of marginalized people.

**Table 1: Benefits for Marginalized Groups and Economic Growth**

| Payment System | Primary Benefits for Marginalized Groups | Support for Economic Growth |
|---|---|---|
| UPI | Enables universal, low-cost access, empowering small vendors and micro-entrepreneurs to accept digital payments. | Creates a digital trail that curbs tax evasion and corruption, leading to an increased tax base. |
| ULI | Bridging the credit gap by providing data-driven, formal credit to the new-to-credit segments (MSMEs, rural borrowers) who lack traditional collateral. | Eliminates friction and delays in the lending process, increasing business productivity and capital access. |
| CBDC (e₹) | Features like Programmable CBDC (p-CBDC) ensure Government grants and targeted subsidies are used only for their intended purpose, drastically reducing fraud and leakage. | Reduces the high cost associated with printing, storing and transporting physical currency, enhancing system efficiency. |

Source: Compiled by Author

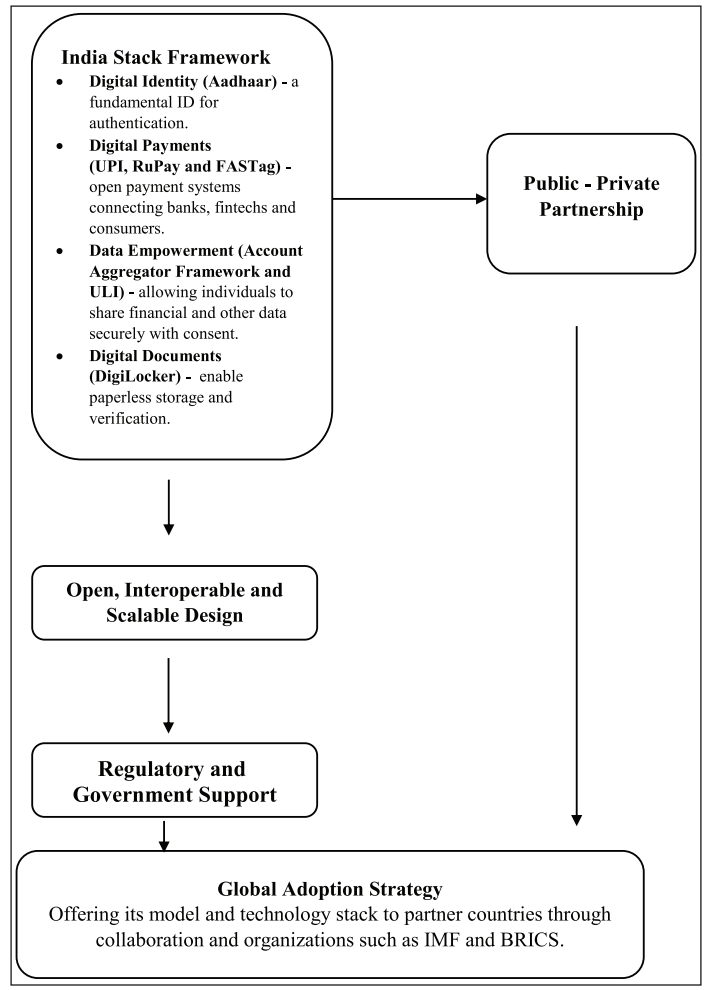
### Global Ambitions and International Expansion

The Government of India promoted DPI with an intention to strengthen country's global presence and economic stability. The international expansion of systems like UPI and the digital rupee reflects India's ambition to become a leader in digital innovation. The global use of UPI is helping to make international money transfers faster and cheaper. This is especially important for India, which is the world's largest recipient of remittances, as it helps boost foreign exchange reserves and supports families receiving money from abroad. In addition, the Reserve Bank of India is conducting cross-border CBDC trials with countries such as the UAE and Singapore. These efforts simplified international payments, reduced the number of intermediaries and decreased transaction costs. The growing success of UPI and other DPI components also enhances nations soft power, positioning the country as a global example in building inclusive and efficient digital systems.

### The Architecture of India's Digital Economy

The DPI in India is built on the "India Stack" model that brings together a set of digital platforms. Its components include Aadhaar for digital identity, RuPay and FASTag for payments, the Account Aggregator Framework and ULI for secure data sharing and DigiLocker for storing and verifying documents digitally. This system is designed with an open and scalable structure that allow banks, FinTechs and other countries to connect easily using standards. The Government builds the main digital framework, while the private companies creating apps and services on top of it. This process reduces costs and encourages innovation. The RBI and NPCI oversee standards, security and interoperability that maintain trust of the system. The DPI diplomacy of India, partnering with countries like UAE, Singapore and Mauritius and working with IMF and BRICS, helps other nations to adopt similar systems.

**Figure 1: Architecture of India's Digital Economy**




Source: Author's own work

## Critical Challenges and Mitigation Initiatives

The rapid scaling of digital payments is accompanied by critical challenges related to security and inclusion.

### *Cyber security and Fraud*

According to a report presented in the Lok Sabha in February 2025, the number of fintech cyber fraud cases reached 1.13 million in 2023, resulting in losses ₹ 7,488.6 crore (Business Standard, 2024). The fintech ecosystem now faces new and complex threats, including synthetic identity fraud and advanced AI-powered cyber-attacks. To address new risks, the RBI has updated its Master Direction to include offline payment aggregators under the same regulations as online aggregators. For better consumer protection, measures like zero customer liability in specific fraud cases and faster grievance redressal systems have been introduced to build confidence and ensure user safety in digital transactions.

While QR code payments offer a seamless and cost-effective digital transaction mode, they present significant challenges due to their "black box" nature. Users cannot verify a link's destination until they scan the code. Fraudsters create a primary security

hurdle called QR-phishing by embedding malicious links in emails or posters to harvest sensitive banking credentials. In public spaces, criminals often employ overlay fraud, where they paste counterfeit stickers over legitimate merchant codes to redirect payments into their own accounts. Additionally, scammers frequently exploit social engineering; they convince victims that they must scan a code to receive money, using this common myth to authorize unauthorized debits from the victim's account. To mitigate these risks, experts encourage users to use in-app scanners that provide URL previews and to treat any signs of physical tampering on a QR stand as a major red flag.

***Digital Literacy and Inclusion***

The success of India's digital system depends on how quickly we improve the digital literacy. Government programs like the Pradhan Mantri Gramin Digital Saksharta Abhiyan (PMGDISHA) play a major role in promoting digital awareness and training people in rural areas. To make digital tools more inclusive, it is essential to provide payment apps and CBDC wallets in all major Indian languages so that language does not become a barrier. At the same time, projects like BharatNet are working to bring broadband internet to every Gram Panchayat, ensuring that people across the country have reliable access to the digital world.

***Legal and Regulatory Framework Updates***

The Reserve Bank of India (RBI) has strengthened its legal and regulatory framework to balance digital innovation with strong consumer protection. A major step in this direction is the creation of the Payments Regulatory Board (PRB), a six-member body chaired by the Governor, RBI and including Government representatives. The Payment Regulatory Board is responsible for improving security, preventing fraud and ensuring transparency in all digital transactions. The PRAVAAH Portal (Platform for Regulatory Application, Validation and Authorization) portal became mandatory from May 1, 2025. It serves as a single-window online system for all regulated entities to submit applications for licenses and approvals, ensuring efficiency, processing speed and transparency.

In 2025, the RBI introduced new Security and Authentication Directions requiring at least two distinct factors of authentication for all digital payment transactions, with one being dynamic for non-card-present payments. Additionally, all entities must fully comply with the Digital Personal Data Protection Act, 2023, to safeguard users' personal and financial data. Further, the RBI issued updated regulations for Digital Lending and Payment Aggregators. The Digital Lending Directions mandate that loans will be directly credited to borrowers' bank accounts (not through lending service providers) and that all customer data be stored only on servers located in India (RBI, 2025). The Payment Aggregator Regulation introduced uniform rules for both online and offline aggregators, ensuring stricter merchant verification, stronger fund protection and better overall transparency in the digital finance ecosystem (Mondaq, 2025).

**Conclusion and Recommendations**

India's digital payment system, led by UPI, ULI and the CBDC, has become strong, innovative and fast-evolving. The Government and the Reserve Bank of India (RBI) are working together to manage this large-scale growth while ensuring proper regulation and consumer protection. A key priority is cyber security, which requires constant investment in research and development to fight Artificial Intelligence (AI)-driven cyber threats. Specific focus must be placed on mitigating "black box" risks like QR-phishing and overlay fraud, ensuring that technical convenience does not come at the cost of user security. It is equally important to have quick and effective systems for handling user complaints to maintain public trust in digital payments. Another recommendation is to create a sustainable UPI revenue model. This means developing fair incentives for banks and Payment Service Providers (PSPs), moving beyond the current zero-Merchant Discount Rate (MDR) model, so that the system remains financially viable in the long-term. Lastly, expanding digital literacy is crucial. Public

awareness campaigns should be organized against the common myths, such as the misconception that scanning a QR code is required to receive funds, to protect vulnerable users from social engineering. Campaigns in all major Indian languages, especially for people in rural areas and older citizens, will help close the digital divide and promote true financial inclusion. With these efforts, India's integrated digital public infrastructure is well-placed to deepen financial inclusion, remove long-standing barriers and strengthen the nation's position as a global leader in the digital economy.

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