UPI AS DIGITAL PUBLIC INFRASTRUCTURE: ANALYSIS OF INDIA'S CASHLESS PAYMENT ECOSYSTEM

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"Development requires not just economic growth, but expansion of access and capabilities – digital systems can play a transformative role in this process."

Amartya Sen

ABSTRACT

This research paper examines the development of Unified Payments Interface (UPI) and its impact on the Indian economic ecosystem within the country and across the border from 2016 to 2026. The study is empirical and analytical in nature and based on the secondary data collected from various sources such as the National Payments Corporation of India (NPCI), Reserve Bank of India (RBI) reports, the Ministry of Finance reports, the Indian Cyber Crime Coordination Centre, and various studies published by independent organisations. The study tracks the exponential J Curve growth of UPI, showing a 12,081-fold surge in the annual transaction volumes, sitting at 24,162 crores of annual transactions. The participation of 63% of the informal and unorganised sector from less than 5% in 2016-17 indicates how UPI has developed the systematic participation of all sections of the market. It analyses how UPI has successfully deployed over 32.58 Crores active QR codes in the informal sector. It has pushed the small vendors, small businesses, and daily wage workers into systematic banking transactions and saving schemes. On the international side, the study analyses the integration of the UPI system across borders with other agencies such as UPI PayNow (Singapore), UPI AANI (UAE) and the successful collection of ₹66.779 lakh crore over the period of ten years from 2016 to 2026. The paper also analyses the systematic decrease in the ATM withdrawal percentage from 11% in 2016 to 7.80% in 2026 despite the upward trajectory growth of cash circulation currency. The study highlights the future scope and challenges ahead of the expansion of UPI in the next decade, from the development of digital infrastructure to data security. This paper indicates UPI as an important tool for the integration of domestic as well as international economy and financial inclusion of all sections of society.

INDEX TERMS **– Unified Payments Interface (UPI), Digital Public Infrastructure (DPI), Financial Inclusion, Cross-Border Remittances, Unorganised Sectors, Data Security, Fraud Detections.**

1. INTRODUCTION

Two of the prominent inventors of the 18th century, Samuel Morse and Alfred Vail, patented an electromagnetic telegraph system in the United States. They developed the single-key transmitter that can send bursts of electric current down an iron wire. Later in 1844, the first commercial telegraph line was set up between Washington, D.C, and Baltimore, transmitting the first message "What hath God wrought". After the invention of the telegraph, in 1871, the Western Union Telegraph Company introduced the world's first Electronic Funds Transfer (EFT) system. This has transformed the global economy by bypassing the physical transference of the currency. Consequently, in 1973, the cross-border communication system SWIFT was developed for both domestic and international bank-to-bank transfer of money. The launch of the commercial World Wide Web during the 1990s has completely transformed the digital ecosystem. The invention of the payment gateway PayPal in 1998 by Confinity has further revolutionised peer-to-peer web transfer, allowing people to send money via an email address. During the period of the 2010s, many companies moved ahead with a digital wallet system and kept the money in a digital bank instead of real bank accounts for faster remittance.

However, in 2016, NPCI significantly transformed the payment ecosystem from private walled lockers to a public model by introducing Unified Payments Interface (UPI), which turned the bank accounts into open-access hubs. Instead of transferring money through multiple steps such as Bank Account à Private Wallet à Merchant Wallet Merchant Bank, UPI has centralised the system route from the user bank to the merchant bank directly. It has created a Virtual Payment Address (VPA) and interoperable QRs. It has created a single universal layout of QR code, which any bank can scan across the world.

UPI operates on the central routing system with a three-tiered public technology framework known as the India Stack. It has three layers. The first layer is the Identity layer (Aadhaar-linked), which enables biometric identification of the user. The second layer is the payment layer (UPI), which connects the remitter bank with the beneficiary bank through the use of a third-party application. The third layer is the Data layer (Account safety layer) which allows data protection and account safety through security-based system. The development of UPI has opened the doors for the inclusion of various sectors of the urban and rural economy into a single framework. This digital structure has also created various challenges for the government, such as handling large volume commands in real time, management of data security in a layered system from cyber syndicates, monetisation of the UPI system through Zero Merchant Discount Rate (MDR) and duopoly of the big foreign-based companies in the Indian market. The research will evaluate the role of UPI in the past 10 years, from 2016 to 2026 and its future expansion in the next 10 years.

2. OBJECTIVE OF THE STUDY

The objective of the study is to analyse the impact of UPI on the development of India's cashless ecosystem in the following ways: -

2.1. To analyse the growth trajectory of the UPI from 2016 to 2026.

2.2. To analyse the impact of UPI on small vendors and the transition of rural and informal sectors from cash to digital and hybrid structures.

2.3. To examine the relationship between the UPI and the cashless goal in the Indian economic structure.

2.4. To examine the impact of UPI in cross-border transactions and the growth of remittances for Indians abroad.

2.5. To identify the challenges, risks and future management of UPI transactions.

3. HYPOTHESIS OF THE STUDY

The following hypotheses are formulated based on the objective of the study and the data available for the adoption of a new electronic-based invoice system: -

3.1. Hypothesis 1 (H1): Growth Trajectory of UPI.

"The adoption of the new Unified Payments Interface (UPI) system has shown an upward trajectory of growth from 2016 to 2026 over a 10-year period."

3.2. Hypothesis 2 (H2): Financial Inclusion of unorganised sector

"The digital UPI system has significantly increased the participation of unorganised and informal sector (like street vendors / micro merchants) in the banking system and adoption of digital frameworks."

3.3. Hypothesis 3 (H3): Replacement of Cash in the economy

"The new UPI system has grown exponentially in the past few years. It has developed a parallel coexisting space with physical currency while increasing the circulation of total currency."

3.4. Hypothesis 4 (H4): Cross-border remittance

"The UPI system has expanded across the globe. It has reduced the cost and time factor of cross-border remittance for the Indian diaspora."

4. RESEARCH METHODOLOGY

The present research paper adopts the Quantitative, Qualitative and Analytical design by using secondary data to analyse the growth and impact of Unified Payments Interface (UPI) on the social and economic structure of the Indian ecosystem. The data

was collected from various sources such as National Payments Corporation of India (NPCI) monthly product statistics, Reserve Bank of India reports and minutes, Database on Indian Economy (DBIE), Economic Council Meetings and Minutes, Ministry of Finance documents and various studies conducted by independent financial bodies. The analytical study covers the 10 years from the pilot launch in 2016 to 2026 and comprehensive trend analysis across pre-pandemic, during pandemic and post-pandemic phases. The correlation analyses is carried out to study the impact of the 'Cashless' objective on UPI transaction volumes and Currency in Circulation data. The comparative benchmark is also used to study the impact of UPI's performance against the global real-time payment systems of countries like Brazil (PIX system) and the USA (Fedwire system) to identify the advantages of the digital system.

5. SCENARIO BEFORE UPI SYSTEM

Before the introduction of the UPI system in India under a pilot project in 2016, India's financial ecosystem heavily relied on cash transactions for day-to-day activities. Cash was considered the undisputed king of the Indian market. The simple financial transactions demanded time, effort and long patience. For sending and receiving money, a person was required to physically visit the banks, fill out various forms and wait hours for the process and confirmation. The biggest hurdle in this non-digital system was that crores of Indians had no access to the banking system. The cheques and demand draft systems were running in parallel for small and big business transactions, but they were slow and only limited in accessibility. India also had the system of NEFT, RTGS and IMPS, but with various limitations like IMPS was accessible only to a limited number of registered users/companies, NEFT was working only during the banking hours, and RTGS was meant for large-volume transactions only. The system was so complicated and limited that even for a small transaction amount of ₹500, a formal banking procedure was required. The rural economy of the Indian villages suffered the most in the pre-UPI era. As per the RBI report 2012, over 95% of retail transactions in the Indian market were done in physical currency. Digital payments were limited to only urban elites. The detailed workflow of the system before UPI in Figure F1 and after UPI in Figure F2 is shown below.

Figure F1: Work flow of money transfer before UPI

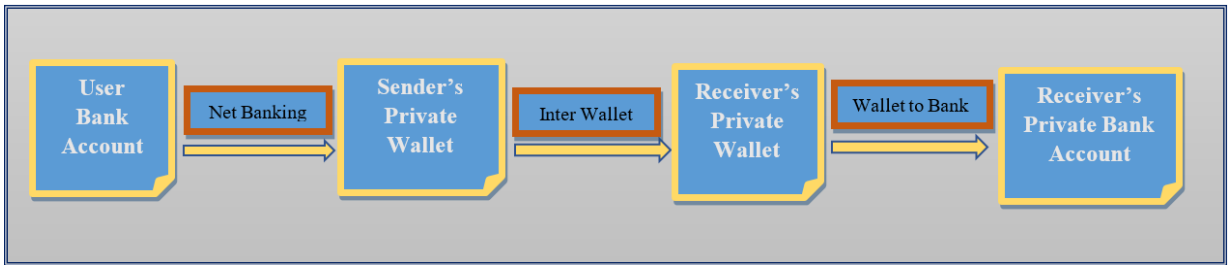
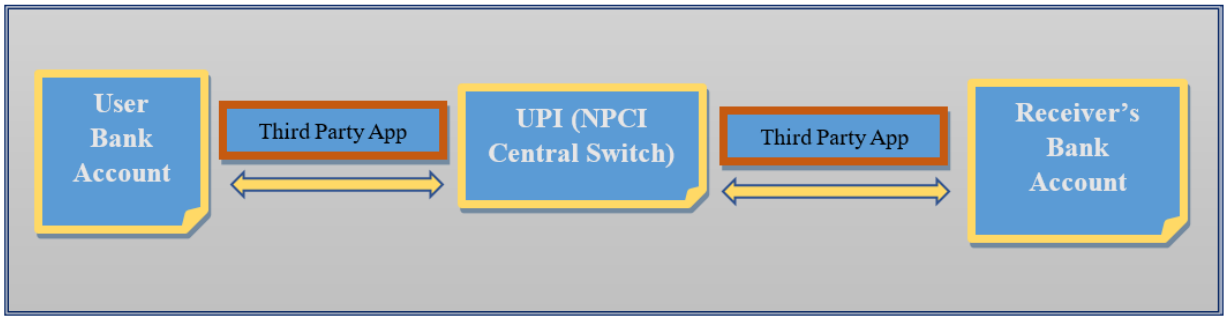


Figure F2: Work flow of money transfer after UPI



FOUNDATION AND DEVELOPMENT OF UPI

6.1. Blueprint of the UPI system: - The Reserve Bank of India (RBI) presented the vision of Unified Payments Interface (UPI) in its vision document 2012-2015 indirectly. RBI has strongly pushed for the need for an interoperable payment system for the development of a digital framework of the Indian economy. It suggested the standardisation of the payment system, which could be integrated with the digital infrastructure. RBI has further suggested the 'Mobile Centric Payment System' across the country. It gave the vision of a 'Less-Cash Society', which will reduce paper consumption and financial inclusion in society.

6.2. Formation of National Payments Corporation of India (NPCI): - The Indian Parliament passed the Payment and Settlement System Act in 2007, which gave RBI the authority to create payment systems, settlement systems and payment operators in India. Accordingly, under Section 4 of the PSS Act, RBI authorised the Indian banking system to adopt and create a non-profit body named National Payments Corporation of India (NPCI). The company follows the rules and regulations of the Companies Act, 2013. During the minutes of the Board of NPCI in 2009-2010, the new payment system named Immediate Payment Service (IMPS) was launched. Based on the IMPS engine, NPCI created the Unified Payments Interface (UPI) system and shifted the economy from bank-based to mobile-based. The biggest game changer in the creation of UPI was the introduction of Virtual Payment Address (VPA) instead of bank account number and IFSC Code for transfer of money.

6.3. Ministry of Finance vision of JAM Trinity: - Before the introduction of the UPI system, the biggest hurdles before the RBI were non-connection of people with the banking system, non-availability of digital tools and infrastructure and setting up of a connection between people and the banking system. The Government of India launched the massive campaign of JAM trinity (Jan Dhan, Aadhaar and Mobile) infrastructure. The government introduced the following financial, economic, and digital framework for the inclusion of people: -

6.3.1. Opening of Bank Accounts: - The government started the 'Pradhan Mantri Jan Dhan Yojna' for opening bank accounts for crores of people rapidly and free of cost.

6.3.2. Aadhaar Card System: - The Government sped up the nationwide biometric identity system under the Unique Identification Authority of India through the Aadhaar Card system.

6.3.3. Digital Infrastructure: - The Government focused on the manufacturing sector and the availability of digital devices such as mobiles at the grassroots level for the citizens.

Later on, JAM became one of the most important factors in the development of UPI and in making it accessible across the nation.

6.4. Watal Committee Report: - The Ministry of Finance constituted a high-level committee under the chairmanship of R.P. Watal, known as the Watal Committee, in 2016. The committee recommended the aggressive adoption of the digital payment economy and a reduction in cash dependency. It strongly emphasised the interoperability of payment system. Some of its recommendations, like expanding QR infrastructure and a low-cost acceptance system, later became the base for the development of a single QR system across all banks.

6.5. Nandan Nilekani and Philosophy of Public Digital Infrastructure (PDI): - In 2019, the Government of India constituted a committee on deepening of digital payments through RBI, headed by one of the co-founders of Infosys, Mr Nandan Nilekani. He strongly recommended the expansion of UPI and the digital India infrastructure. He recommended the development of interoperable, low-cost and open digital public infrastructure with the partnership of public as well as private sectors.

Technical Architecture of UPI

7. The Unified Payments Interface (UPI) works on a real-time, interoperable payment structure enabling the bank-to-bank transfer through mobile applications. UPI acts as a bridge between the mobile application and the bank's core server. The detailed five-layer structure of the functioning of the UPI is as follows: -

7.1. User layer (Customer Mobile Apps): - This layer of the structure consists of all the third-party applications (TPAPs) like Google Pay, PhonePe, etc. They help in various functions at the user end, such as user login, UPI pin generation, QR scanning, initiation of transactions, etc.

7.2. PSP layer (Payment Service Provider): - This layer of the structure connects the applications of the user layer to the UPI network. This layer consists of two parts. One is the bank's PSP, and the other is a third-party app PSP. The main functions of these layers are to verify the user's identity, generate payment requests and act as the interface between the user and NPCI.

7.3. NPCI switch layer (Central Routing System): - This is the main layer of the entire structure. It acts as a central routing system. NPCI switch, also known as the Common Library, acts as the traffic controller of the UPI ecosystem. Its main functions are routing of the transaction requests, identification of the sender and receiver banks, maintenance of the transaction logs and handling of the authentication messages.

7.4. Banking layer (Sender and Receiver Banks): - In this layer of the structure, two banks are involved in the ecosystem. One is the remitter bank, and the other is the receiver bank. The remitter bank debits the amount into the receiver bank within the time frame of a few seconds.

7.5. Security layer (Aadhaar / Mobile): - The security layer handles the two-factor authentication of the ecosystem. One is an Aadhaar-linked mobile, and the second is a UPI pin. The sensitive data involved in the process is protected by the end-to-end encryption and protects the transaction communication.

DATA ANALYSIS AND FINDINGS

8. The implementation of the UPI system in the year 2016 has opened the doors for the development of digital infrastructure in India.

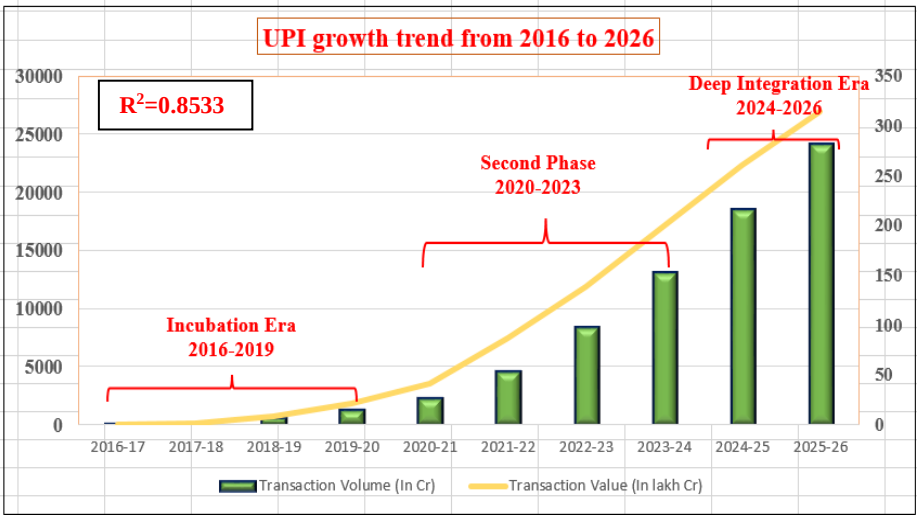
8.1. The growth of UPI in 10 years trend: - The UPI came into the system of the Indian economy in the year 2016, and it is in its 10th year of its inception in the Indian economy structure. According to the official release of the data from National Payments Corporation of India (NPCI) and Press Information Bureau (PIB), the year-wise growth data of UPI from 2016 to 2026 is as follows: -

Table T1 for growth of UPI from 2016 to 2026

Ser No	Financial Year	Annual Transactions Volume (In Crore)	% of growth	Annual Transactions Value (In Lakh Crore)	% of growth
1	2016-17	2	-	0.07	-
2	2017-18	92	4500	1.09	1457.14
3	2018-19	535	481.52	8.77	704.587
4	2019-20	1,250	133.64	21.32	143.101
5	2020-21	2,239	79.12	41.04	92.4953
6	2021-22	4,560	103.66	87.17	112.403
7	2022-23	8,375	83.662	139.10	59.5732
8	2023-24	13,116	56.609	199.89	43.7024
9	2024-25	18,586	41.705	260.40	30.2716
10	2025-26	24,162	30.001	314.00	20.5837

8.2. Analysis of the table T1: - The incubation era from 2016 to 2019 shows low volume and low-value transactions as the project was in its pilot phase only. The period saw the annual transactions of volume of about 2 Crores valued at 0.07 lakh crore. However, the period saw the 'Demonetisation', which pushed the numbers in the year 2017-18 to 92 Crores with an incredible growth of 97.83%. The second phase (2020-2023) post-COVID-19 pandemic shows the effect of government policies promoting the digital and contactless transactions at a rapid pace. The result of these digital policies and initiatives of the government to connect the last mile even in rural areas shows the annual transactions from 41.04 lakh crore in 2020-21 to 139.10 lakh crores in 2022-23 with a growth of 70.50%. During the deep integration era from 2024 to 2026, UPI has completely moved into the micro-commerce sector. It has captured over 85% market share in India's total domestic digital payments and about 49% of global real-time payment volumes, processing a daily average of about 66 crore transactions (Source RBI Annual Report 2017 to 2025 Payment and Settlement Chapters).

Graph G1 showing trend of UPI growth from the period 2016-2026



8.3. Analysis of graph G1: - The dual-axis graph G1 above shows the exponential growth trajectory. The 'J Curve' tracks both the annual transactions volume (green bars) and total transactions value (yellow trend line) from the year 2016 to 2026. The incubation era (2016-2019) for the first two years shows a flat trend line as the initiative was in pilot phase. The trend line shows a rapid upward trajectory of the growth of UPI, yielding a coefficient of determination (R^2) of 0.8533. During this period, the technology was advancing, and digital structures like apps, mobile banking, QR codes, etc., were being developed. During the second phase (2020-23), the annual transactions grow rapidly, and the yellow line shows a sharp increment curve. This was the phase where digital India was reaching its peak after the strong push from government policies. In the final deep integration era (2024-26), the digital India initiative touched the lives of the rural sectors. The banking system has reached the deep pockets of village economies. The spread of the internet at cheap rates has given the final push to the adoption of UPI across the country.

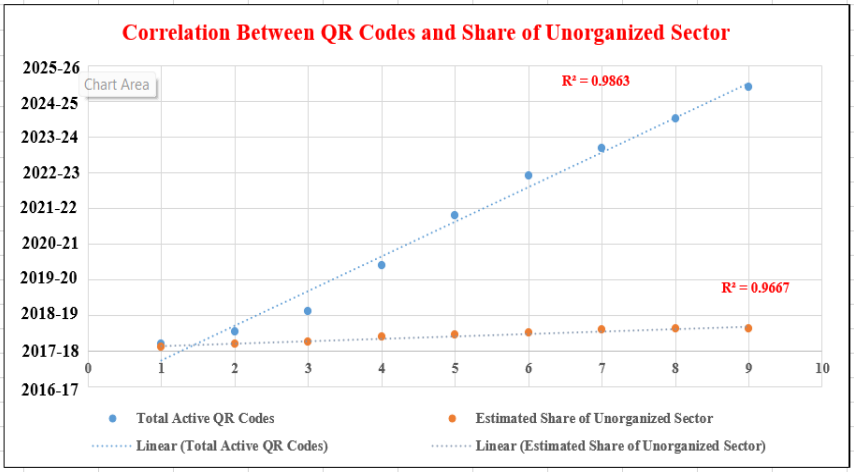
8.4. Participation of unorganized and informal sector: - The unorganised sector of the Indian economy consists of various small-scale vendors running day-to-day businesses such as street vendors, local kirana shops, daily wage earners, etc. These small-scale and informal merchants are tracked under the P2PM (Peer to Peer Merchant) category, specially created by the NPCI to distinguish between the small, informal and unorganised sector from large-scale businesses. The detailed data of P2PM transactions is given in the table T2 below as per the reports of RBI, Finance Ministry's Department of Financial Services and NPCI.

Table T2: Data on the usage of UPI by unorganized and informal sector from 2016 to 2026

Ser No	Financial Year	Total Active QR Codes (In Cr)	Estimated share of Unorganized sector (in %)
1	2016-17	<0.05	<5.0%
2	2017-18	0.20	12.0%
3	2018-19	0.55	18.5%
4	2019-20	1.10	26.0%
5	2020-21	2.40	38.0%
6	2021-22	3.80	45.50%
7	2022-23	4.90	52.00%
8	2023-24	5.68	58.00%
9	2024-25	6.50	61.50%
10	2025-26	7.40	63.00%

8.5. Analysis of table T2:- The participation of the unorganised sector in the UPI transactions in the initial phase was minimal. However, the Indian economists were sharp enough to understand the role of the small-scale vendors in generating massive volume but low-ticket value routing through verified bank accounts. The sharpest spike in active merchant endpoints occurred following the RBI's creation of the Payments Infrastructure Development Fund (PIDF). The distribution of free QR codes helped in the expansion of footprints up to 7.40 Cr merchants. The unorganised sector engagement of small merchants touched 63% penetration in the informal sector, which accounted for less than 20% of the aggregate transaction financial value. The estimated share values are derived through comparative analysis of merchant QR deployment and P2PM transaction distribution trends available in RBI and NPCI reports.

Graph G2 showing correlation between QR codes and share of unorganized sector



8.6 Analysis of G2 graph: - The above G2 graph evaluates the strong correlation between the QR code distribution and the share of the unorganised sector. This ordinary least squares (OLS) analysis uses the time period from 2016 to 2026. The upper trend line shows active QR code distribution, yielding a coefficient of determination (R^2) of 0.9863. It indicates that approximately 98.6% of the variance in digital infrastructure over the last decade. The lower regression trajectory tracks the estimated proportional volume shift in the unorganised sector with a coefficient of determination (R^2) of 0.9667. This strong value of R^2 shows that the integration of street vendors, small businesses, and the daily wage ecosystem into the UPI structure has made the Indian market formal and accountable.

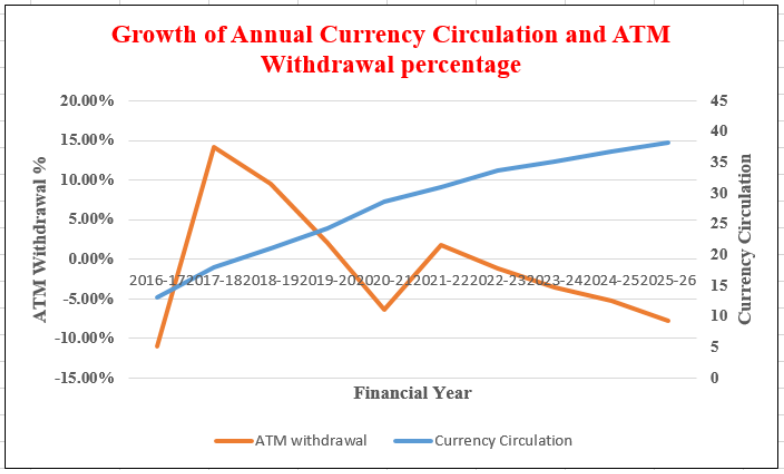
8.7. Transformation of Cash Usage: - After the introduction of the UPI system in India in 2016, many economists and even the government thought that cash currency would be replaced by digital currency. The logic behind this projection was also justified since India was rapidly moving towards a digital structure, even in rural areas. The UPI has completely changed the vision of transactions in day-to-day lives. However, even with a growing digital ecosystem, the cash currency circulation also grew exponentially every year. Overall, it appeared contradictory, but at the micro level, it reflected the unique structure of the Indian economy. The year-wise growth of the Currency in Circulation (CiC) alongside the Cash to GDP ratio and the declining frequency of the ATM withdrawal is as follows: -

Table T3 for total Currency in Circulation (CiC), Cash to GDP ratio and ATM withdrawal from 2016 to 2026

Ser No	Financial Year	Total Currency in Circulation (CiC) (In lakh crore)	Cash to GDP ratio (%)	Annual ATM withdrawal growth (%)
1	2016-17	13.10	8.7%	+11.00%
2	2017-18	18.03	10.70%	+14.20%
3	2018-19	21.10	11.20%	+9.50%
4	2019-20	24.21	12.00%	+2.10%
5	2020-21	28.57	14.40%	-6.40%
6	2021-22	31.05	13.70%	+1.80%
7	2022-23	33.78	12.80%	-1.20%
8	2023-24	35.15	11.80%	-3.50%
9	2024-25	36.80	11.10%	-5.20%
10	2025-26	38.20	10.10%	-7.80%

8.8. Analysis of table T3: - The major proof that the cash displacement can be observed is the decreasing percentage of the ATM withdrawal in the above table. In the UPI pilot project era 2016-2020, the ATM withdrawal was seen in the positive territory. However, after the full-fledged government implementation of UPI and various schemes to develop the digital infrastructure, the ATM withdrawal capacity moved into negative territory over the years. On similar lines, the cash-to-GDP ratio has also declined significantly from 14.40% in 2020-21 to 10.10% in 2025-26. This shows the speed of the development of digital infrastructure in the Indian economy.

Graph G3 for Currency Circulation Vs ATM Withdrawal



8.9. Analysis of Graph G3: - The Currency in Circulation (CiC) has shown an upward trajectory over the years. This might indicate that the effect of UPI was limited in the replacement of the cash factor. However, the real story is not cash replacement but the development of a parallel system along with cash circulation. To understand the full story behind the increment in cash circulation is macroeconomics and the co-evolution of GDP, Digitisation, and Formalization. To understand the underlying economics behind this cash circulation growth despite UPI development, the factor of ATM withdrawal needs to be considered. This factor gives the underlying trend and shows how UPI has impacted the common people by limiting the ATM withdrawal limits from +14.20% in 2017-18 to - 7.80% in 2025-26. However, the effect of some of the factors responsible for showing an upward trajectory of cash circulation despite the growth in UPI is as follows: -

8.9.1. Expansion of economy: - The Indian economy grew rapidly between 2016 and 2026. The nominal GDP expanded from ₹153.90 Lakh Crore to ₹346.50 Lakh Crore in 2025-26. It is one of the main reasons for the increase in the cash currency circulation in the Indian market. The details of the expansion of the Indian economy are given in Table T4 below: -

Table T4 Growth of Nominal GDP from 2016 to 2026

Ser No	Financial Year	Nominal GDP Growth (in Lakh Crore)	% of Growth
1	2016-17	153.90	9.95
2	2017-18	170.90	9.53
3	2018-19	188.90	6.07
4	2019-20	201.10	-1.5
5	2020-21	198.10	15.6
6	2021-22	234.70	13.7
7	2022-23	272.00	7.92
8	2023-24	295.40	8.03
9	2024-25	321.20	7.3
10	2025-26	346.50	9.95

8.9.2. Analysis of table T4: - The above table shows the growth of Indian Nominal GDP from ₹153.90 lakh crore to ₹346.50 lakh crore in 2025-26. This growth in the GDP is one of the main factors for the increase in currency circulation in the Indian market despite the rapid growth of UPI.

8.9.3. Development of parallel system: - The UPI has shown significant growth over the years and has been established as a parallel system along with the cash economy. A large part of the Indian economy still operates under the informal sector, which consists of small traders, daily wage workers, small vendors, rural markets, etc., and these people in the unorganised sector still trust cash as the most convenient factor, along with the UPI. The people of India shifted to the digital economy, but still use cash currency in the same numbers for day-to-day work.

8.10 Cross-border expansion: - The Indian diaspora is one of the largest groups in the world. Historically, it has relied on the financial systems such as SWIFT, Wire transfer, exchange houses, etc. to send the personal remittance across the border. These channels were charging very high rates in the name of transfer fees, around 5% to 7% and a settlement period of around 2 to 5 days. The government has replaced these channels by linking UPI with real-time payment rails and lowering the cost and friction of inbound flow. The year-wise impact data of the average transaction cost and inbound remittance via UPI channel over the past 10 years is as follows: -

Table T5 Cross-Border Growth of UPI

Ser No	Financial Year	Total inbound remittance in India (in lakh crore)	Total inbound remittance via UPI (in lakh crore)	Average Transaction Cost for Diaspora (in %)	Share of UPI in total remittance (in %)
1	2016-17	4.35	0.00	6.80%	0.00%
2	2017-18	4.50	0.00	6.20%	0.00%
3	2018-19	4.90	0.00	6.09%	0.00%
4	2019-20	5.30	<0.01	6.01%	<0.20%
5	2020-21	5.92	0.02	5.96%	0.33%
6	2021-22	6.70	0.09	5.90%	1.34%
7	2022-23	7.42	0.25	5.40%	3.36%
8	2023-24	8.30	0.68	3.80%	8.19%
9	2024-25	9.15	1.30	2.50%	14.20%
10	2025-26	10.25	2.15	1.80%	20.97%

8.11. Analysis of table T5: - The evolution of UPI has been indicated as the major tool for inbound cross-border remittances. The strategic bypassing of networks like SWIFT, wire transfer, etc., and integration of UPI has developed the digital system for such foreign remittances. During the first five fiscal years, the UPI remittance share was 0.00% of the total inbound remittance. Further, the average money transfer charges were also high at 6.80% in the year 2016-17. The biggest reason for increase in share of UPI from 2020-21 and reduction of the money transfer charges was integration of UPI and Singapore's PayNow network. This network has reduced the average transaction cost for diaspora and reduced the transfer cost to 1.80% in 2025-26.

FUTURE SCOPE OF UPI IN INDIA

9. The UPI has changed the ecosystem of the Indian economic sector. The next decade of UPI, i.e. 2026 to 2036, will be defined by deeper credit integration and AI-driven payment system. The expansion front in terms of users is reaching its saturation point, and the government, along with RBI and NPCI, is planning the model for the next few years in the functioning of UPI. Some of the major areas of working for the expansion of UPI across the globe are as follows: -

9.1. Credit linkage Scheme with UPI: -Historically, UPI has functioned on the debit mechanism. The money used in the UPI facility is debited from the accounts of the users. The next major evolution in UPI is moving from debit to a credit use facility. RBI, along with NPCI, is planning to integrate the Pre-Sanction Credit lines on UPI. This will allow users to link their UPI facility with the pre-approved credit facility directly linked to their Virtual Payment Address (VPA).

9.2. AI Driven Payment Mechanism: -The expansion of UPI has been across the country and into the rural areas. The government has tried to push the system up to the last mile. The point of saturation has been reached, where maximum coverage has already been done. Now, the government is moving to make UPI more advanced. Features such as voice commands, face activation, small-sized gadgets, Language Models (LLMs) trained in regional languages, etc., under an AI-driven mechanism have been under development. These features will also cover the group of people who are illiterate and short on technology.

9.3. Multi-lateral Network: - Another milestone for the next decade will be the expansion of UPI across the globe. The government is building bilateral networks like UPI PayNow (Singapore), UPI AANI (UAE) for the direct cross-border infrastructure. Similar projects are in the developmental stage for the Europe zone, the America zone and the African subcontinent zones. This cross-border network will boost real-time remittances and preserve the domestic currency integrity at the international level.

CHALLENGES AHEAD

10. Unified Payments Interface (UPI) has been proven as a benchmark towards the development of digital infrastructure from scratch. The rapid scaling in the last 10 years showed that it will be one of the major key factors of the Indian economy in the coming decade ahead. To continue the spread of the UPI network across the globe, the government, RBI, NPCI and other players have to work together to overcome upcoming challenges. Some of the major challenges ahead of UPI expansion are as follows: -

10.1. Quality Infrastructure: - The one cycle of a UPI transaction requires real-time round-trip communication from the user to banks and back to the user again. The communication loop pings the core banking servers of both the remitter and beneficiary bank. Therefore, a high-quality Core Banking System (CBS) server system is required to function continuously for real-time processing. The public sector banks were designed to handle limited entries in the previous decades. Now, after UPI, millions of requests are generated daily and require handling in real time. The old system needs to update the servers for high-frequency micro settlements. This will help in the reduction of Technical Decline (TD) rates and periodic server outages during peak traffic hours.

10.2. Zero MDR sustainability: - The Government of India has mandated a Zero Merchant Discount Rate (MDR) for UPI transactions for the inclusion of every sector under this umbrella. Due to this policy, third-party applications like Google Pay, PhonePe, etc., and banks cannot charge transactional processing fees. The government is providing annual subsidies against these transactions. This financial model lacks revenue generation for companies for the development of infrastructure, such as servers, storage units, security requirements, etc. Therefore, in the upcoming decade, both the government and companies are planning to upgrade the revenue model without losing millions of users.

10.3. Made in India structure: - Two of the major players having over 78% of market share in UPI are foreign companies, Google Pay and PhonePe. Despite having over 700 banks integrated under the UPI system, the duopoly of these companies has kept the Indian economy on its toes. There is a strong need to shift the Made in India models to the lines of China. The major issue of this duopoly is data security. The private data of billions of Indians is always at risk. Strong policies like capping of foreign company shares to a minimum are required to be on the agenda list of the expansion policy of UPI.

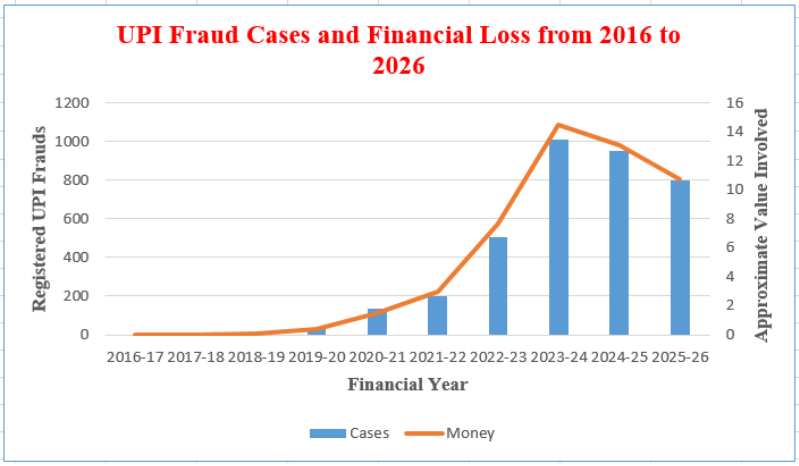
10.4. Data Security and Rural Expansion: - The present UPI structure is under heavy encryption and data security, yet India has registered almost 10.64 lakh UPI fraud cases in 2025-26, up to November. With the pace at which India is growing and the expansion of digital footprints to rural sectors, the need for heavy data security will be at an all-time high. The details of the UPI fraud from 2016 to 2026 are as follows: -

Table T6 : Data for UPI frauds and amount of money involved from 2016 to 2026

Ser No	Financial Year	Registered UPI Fraud Cases (In lakhs)	% growth	Approximate Value of Money Involved (In Cr)	% growth
1	2016-17	0	-	0	-
2	2017-18	0.05	0	2	0
3	2018-19	0.12	140	9	350
4	2019-20	0.45	275	32	255.6
5	2020-21	1.80	300	114	256.3
6	2021-22	2.68	48.9	224	96.49
7	2022-23	6.72	151	573	155.8
8	2023-24	13.42	99.7	1087	89.7
9	2024-25	12.64	-5.81	981	-9.752
10	2025-26	10.64	-15.8	805	-17.94

10.5. Analysis of table T6: - The table T6 shows the growth in the UPI fraud cases along with the expansion of the digital network across the country. The fraud cases reached their peak in the decade from 2016 to 2026 in the financial year 2023-24, logging 13.42 lakh cases and an approximate fraud of ₹1087 Crores. In the year 2023-24, the digital fraud under UPI was at its peak, highlighting the importance of digital literacy among people and businesses. However, these fraud cases declined after the strict government policies and focus on the importance of data security.

Graph G4 : UPI Fraud Cases and Financial Loss Involved from 2016 to 2026



10.6. Analysis of graph G4: - With the expansion of the UPI umbrella, the number of fraud cases has also been growing. On the same lines, the amount of money involved has also shown an upward trajectory. In the past 10 years, a total of 48.52 lakh cases has been registered with a loss of ₹3,827 crores. After the peak fraud cases in 2023-24, the government has introduced the real-time monitoring system and mule account cracking. The multilayer security has been effective, and the number of cases and money involved has been showing a downward trajectory after 2023-24. The financial system has blacklisted over 24.6 lakh suspect fraud accounts used by the cyber syndicates. All the data in table T6 and graph G4 has been fetched from Ministry of Finance (Department of Financial Service) written submission in Lok Sabha in 2024-25, Indian Cyber Crime Coordination Center (I4C), Ministry of Home Affairs, National Crime Record Bureau (NCRB), cybercrime reports.

CONCLUSION

11. The introduction of the UPI system in India in 2016 has transformed the structure of the Indian economy. The growth of UPI has improved the real-time transaction speed across the globe and accessibility across various sectors of society, especially rural and unorganised sectors. India has become one of the leading economies across the world, with daily UPI transactions of over 75 Crores and approximately ₹96,766 crore daily transaction value. The statistical validation of H1 shows a strong correlation, a coefficient of determination (R^2) of 0.8533, indicating strong growth of the UPI digital system with the expansion of the Indian economy. The paper has examined the systematic inclusion of the unorganised and informal sector, scattered under cash transactions over the years. The increase in the active QR codes among the unorganised sector from less than 0.05 Crores to 7.40 Crores shows a strong growth in the inclusion of the unorganised sector under UPI infrastructure. The share of the unorganised sector has reached approximately 63% in 2025-26 from less than 5% in 2016-17, indicating strong validation of H2. The H3 hypothesis indicates that India has been able to create a parallel system along with the cash currency instead of replacing it completely. The total value of Currency in Circulation (CiC) in 2016-17 was 13.10 lakh crore and has increased to 38.20 lakh crore in 2025-26. However, the ATM withdrawal rate has decreased from 11% in 2016-17 to 7.80% in 2025-26, which indicates the hidden story of UPI expansion in India. Further, the Cash to GDP ratio has also been trending downwards from 14.40% in 2020-21 to 10.10% in 2025-26 after the COVID-19 period and use of digital currency in place of physical cash. The growth of 135.63% in the inbound remittance from 4.35 lakh crore in 2016-17 to 10.25 lakh crore in 2025-26 validates the H4. The reduction in the transfer fees amount has also significantly reduced from 6.80% in 2016-17 to 1.80% in 2025-26 due to the large volume of transactions across the border. The research has also examined how the rapid growth of UPI has put stress on the limited digital infrastructure and the need to develop it for the upcoming decade expansion. The average UPI fraud cases of 4.85 lakh per year over the 10-year time period and average financial loss of 382 crore per year indicate the need for strong government-driven policies for the protection of the financial resources of the country. Therefore, after the first decade of expansion of UPI, it has been established as a powerful tool for the global digital economy. India needs to develop the digital infrastructure, open loop interoperability and strong data protection policies through everyone's coordination globally. The second phase of UPI will be AI-driven technology and a definitive blueprint for macroeconomics formalisation and the ability of the institutions to maintain trust, security and pace of the evolving digital financial ecosystem.

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