



“An Analysis of digital payment system in India”

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ABSTRACT

The rapid growth of digital payment systems has revolutionized the global financial ecosystem by offering fast, secure, and efficient alternatives to traditional cash-based transactions. This study provides an in-depth analysis of digital payment systems and their settlement mechanisms, focusing on the infrastructure that enables seamless financial transactions. Key components of the digital payment ecosystem, including payment gateways, tokenization, encryption, and distributed ledger technologies, are examined to understand their role in ensuring operational efficiency and data security. The research explores various settlement modes such as real-time gross settlement (RTGS), net settlement, and block chain-based settlements, highlighting their impact on transaction speed, cost reduction, and financial inclusion. Additionally, the study evaluates the challenges posed by cyber security threats, system interoperability, and user adoption, alongside the regulatory frameworks supporting digital payment infrastructure. The findings emphasize the critical role of robust first-layer infrastructure, including communication networks, cloud computing, and API integrations, in supporting the scalability and reliability of digital payment systems. This paper contributes to understanding the digital transformation of financial transactions and offers insights into designing future-proof payment systems that balance innovation, accessibility, and security.

Key words: Digital, RTGS, Retail digital payment, PoS and ATMs

I. INTRODUCTION:

The global economy is undergoing a rapid digital transformation, with the financial sector at the forefront of this evolution. Digital payment systems have revolutionized the way monetary transactions are conducted, marking a significant departure from traditional cash-based systems. These systems refer to electronic methods of transferring money between parties, leveraging technologies such as mobile devices, the internet, and contactless payment mechanisms. Digital payment platforms include mobile wallets (e.g., Paytm, Google Pay), internet banking, point-of-sale systems, and advanced technologies like blockchain and cryptocurrencies.

The rise of digital payment systems can be attributed to several factors, including advancements in technology, increased internet penetration, and the proliferation of affordable smartphones. Governments and financial institutions worldwide have also played a crucial role by implementing policies and infrastructure to promote cashless transactions. For instance, initiatives such as India's Digital India campaign and the widespread adoption of the Unified Payments Interface (UPI) have significantly contributed to the digital payment revolution.

Digital payment systems offer numerous advantages over traditional methods. They provide convenience by enabling users to make payments anytime and anywhere, thereby saving time and effort. The speed and efficiency of digital payments reduce transaction times, while the transparency and traceability of these systems enhance accountability and help combat issues like fraud and tax evasion. Moreover, digital payment systems are instrumental in driving financial inclusion, allowing underserved populations to access financial services without needing physical banking infrastructure.

Despite their benefits, digital payment systems face challenges that need to be addressed for their

sustainable growth. Cyber security risks, including data breaches and fraud, are significant concerns. The lack of digital literacy and trust in technology among certain sections of society further hinders adoption. Additionally, the digital divide, characterized by unequal access to technology and the internet, poses barriers to the inclusive adoption of digital payment systems, particularly in rural and remote areas.

This research paper aims to provide a comprehensive analysis of digital payment systems, through Real-Time Gross Settlement (RTGS) and retail digital payment system (include Credit Transfers, Debit Transfers and Direct Debits, Card Payments), and digital payment modes includes Mobile Payments (mobile app based), internet Payments (Netbanking / Internet Browser Based, Cash Withdrawal at ATMs, Cash Withdrawal at PoS and Cash Withdrawal at Micro ATMs). The study also analysis about the digital payment infrastructures such as Cards, PPIs, AMTs, Micro ATMs, PoS Terminals, Bharat and UPI QRs. By understanding the multifaceted aspects of digital payment systems, this research seeks to contribute to the broader discourse on the role of technology in shaping the modern economy and fostering financial inclusion. It underscores the need for collaboration among governments, financial institutions, technology providers, and other stakeholders to create a secure, inclusive, and efficient digital payment ecosystem that benefits all segments of society.

Conceptual background of Digital Payment Systems:

The digital payment system is an ecosystem that enables electronic transactions, replacing cash-based payments with digital modes. It operates through various mechanisms such as real-time settlement systems, retail payment platforms, and supportive infrastructure to facilitate fast, secure, and convenient monetary exchanges. Below is a detailed conceptual understanding of the key components of the digital payment system:

- **Real-Time Gross Settlement (RTGS):** The RTGS is a high-value, real-time payment system primarily used for large-value transactions. It enables immediate settlement of funds between banks on an individual basis without netting. The main purpose for designed this is to interbank and high-value transactions to ensure prompt and risk-free settlement. Real-time processing of transactions. Operates during defined hours on business days and irrevocable and final settlement are the main features of the RTGS.
- **Retail Digital Payment system:** The payment and settlement other than RTGS are called retail digital payment system in the banking transactions. It includes Credit Transfers (AePS, APBS, IMPS, NACH Cr, NEFT and UPI), Debit Transfers and Direct Debits (BHIM Aadhaar Pay, NACH and NETC) and Card Payments (Credit and Debit Cards),
- **Retail Digital Payment Modes:** Retail digital payment systems focus on low-value transactions for individuals and businesses the mode of payment are as below:
 1. Mobile payments: It includes payments made via mobile wallets (e.g., Google Pay, Paytm) or mobile banking apps. for intra bank and inter bank payment settlement, Facilitates peer-to-peer (P2P) and business-to-consumer (B2C) payments. Supports services like QR code scanning and UPI-based payments.
 2. Internet Payments(Intra bank and Inter bank): Online banking services (e.g., NEFT, IMPS) and e-commerce payment gateways. Used for bill payments, online shopping, and fund transfers.
 3. ATM and Micro-ATMs :ATM (Automated Teller Machine): Enables cash withdrawals, fund transfers, and balance inquiries and Micro-ATM: A portable version of ATMs, used in rural and remote areas to provide banking services like withdrawals and deposits.
 4. Point-of-Sale (PoS) Payments (using credit cards and pre-paid cards): PoS machines allow card-based and QR code-based payments at retail outlets.Types include physical PoS, mobile PoS (mPoS), and virtual PoS systems.
- **Digital Payment System Infrastructure:** The success of digital payment systems depends on the seamless integration of payment modes with supporting infrastructure. For example:
 1. Cards (Debit, Credit, Prepaid): Widely used tools for digital payments, linked to banking accounts or preloaded with funds. Enable transactions at ATMs, PoS terminals, and online platforms.
 2. Prepaid Payment Instruments (PPI):Include mobile wallets, gift cards, and prepaid cards.Used for specific purposes like shopping, travel, or bill payments.
 3. ATM Infrastructure: Provides cash-based support to the digital payment system. Includes cash recyclers for deposits and withdrawals.
 4. Bharat QR Code: Unified QR code standard introduced in India for interoperable payments. Works across multiple payment networks (Visa, Mastercard, RuPay).
 5. Unified Payments Interface (UPI): A real-time payment system enabling instant fund transfers via mobile devices. Integrates multiple bank accounts into a single app and allows seamless P2P and P2M (person-to-merchant) transactions.

6. UPI QR Codes: UPI-based QR codes streamline payments at retail outlets by linking transactions directly to the merchant's bank account.
7. A mobile payment initiated via a Bharat QR code uses UPI as the backend for instant fund settlement.
8. An ATM withdrawal complements card-based or mobile wallet services, ensuring liquidity within the system.

The digital payment system is a dynamic ecosystem that combines various modes of payments (RTGS, mobile payments, PoS, ATMs) with a robust infrastructure (cards, UPI, QR codes). Together, they create a secure and efficient financial landscape, driving financial inclusion and enabling a cashless economy.

OBJECTIVES OF THE STUDY: The objectives of the study are as follows

1. To Analyze the digital payment systems and settlement of transactions
2. To analyze the modes of digital payment systems.
3. To analyze the infrastructure of digital payment system.
4. To study the conceptual background of digital system.

II. LITERATURE REVIEW:

The digital payment system has been extensively studied in recent years due to its transformative role in modern economies. Various research papers and studies have explored the evolution, adoption, impact, and challenges of digital payment systems, providing valuable insights into the field. In this backdrop, a review of a few important earlier studies is made and presented below.

Numerous studies have chronicled the growth of digital payment systems over the past decades. A study by Sultana and Kumar (2020) highlights the transition from traditional cash transactions to digital payment modes driven by technological advancements and policy initiatives. The authors emphasize the role of mobile payment technologies and internet banking in accelerating this shift. Similarly, KPMG (2019) in their report, discuss how global trends such as the proliferation of fintech companies and the rise of digital currencies are reshaping payment ecosystems. Research on consumer adoption of digital payment systems often focuses on factors such as convenience, security, and ease of use. Dahlberg et al. (2015) in their meta-analysis identify trust, perceived ease of use, and perceived usefulness as critical determinants of adoption. They also highlight the role of government and financial institutions in fostering trust among users.

In the context of India, Gupta and Arora (2017) analyze the adoption of mobile wallets post-demonetization and find that the government's push for a cashless economy played a significant role. Similarly, Rao and Jhingan (2021) investigate digital payment adoption in rural areas, emphasizing that digital literacy and network infrastructure are pivotal factors influencing usage.

Studies have also examined how digital payment systems contribute to financial inclusion by providing access to financial services for underserved populations. Jack and Suri (2014) analyze the impact of M-Pesa, a mobile money service in Kenya, and conclude that it significantly improved financial access for rural and low-income households. Demirgüç-Kunt et al. (2018) in the Global Findex Report highlight that digital payments have reduced the gender gap in financial access, particularly in developing countries. The economic implications of digital payments have been widely studied. Ozili (2020) reviews how digital payment systems enhance economic efficiency by reducing transaction costs and increasing transparency. Similarly, McKinsey (2016) reports that a shift to digital payments can boost GDP by formalizing economic activities and reducing inefficiencies in cash management. Challenges such as cyber security, fraud, and the digital divide are recurring themes in the literature. Suri and Shaw (2020) explore the risks associated with cybersecurity breaches and emphasize the need for robust encryption and authentication technologies. Ramaswamy (2019) highlights the digital divide in rural and semi-urban areas, pointing out that inadequate infrastructure and lack of digital literacy hinder adoption.

Moreover, Singh et al. (2021) investigate privacy concerns related to digital payment systems and discuss how regulatory frameworks, such as GDPR, are shaping data protection in digital transactions. Future Trends and Technologies Emerging technologies such as blockchain, artificial intelligence (AI), and biometrics are increasingly integrated into digital payment systems. Nakamoto (2008) introduced blockchain technology as the backbone of Bitcoin, paving the way for decentralized and secure digital transactions. Bansal and Agarwal (2020) discuss the integration of AI in fraud detection and customer personalization in digital payment platforms. Additionally, Chen et al. (2019) explore the use of biometric authentication to enhance security and user convenience in payment systems. Government policies play a critical role in the adoption of digital payment systems. Bhaskar and Kumar (2018) analyze India's Unified Payments Interface (UPI) and highlight its role in streamlining peer-to-peer transactions and fostering a digital economy. Similarly, G20 (2019) reports emphasize how international frameworks and collaboration are essential to address cross-border payment challenges.

The existing literature on digital payment systems underscores their transformative potential in fostering convenience, financial inclusion, and economic efficiency. However, challenges such as cyber security, privacy concerns, and the digital divide remain significant barriers. The literature also highlights the importance of government initiatives, consumer trust, and technological advancements in driving the adoption and success of digital payment systems. Future research should focus on addressing these challenges and exploring the integration of emerging technologies to further enhance digital payment ecosystems.

METHODOLOGY:

For the achieving of objectives of the study, necessary data are collected from the secondary sources including published research works, books, journals and annual reports of the banks and financial institutions. Further, the five year annual reports from 2019-20 to 2023-24 of RBI are collected and the statistical tools were used for the purpose of analyzing the data.

ANALYSIS AND INTERPRETATION OF DATA:

This study focuses on analysis of digital payment and settlement system in India, which provides data about the performance of various payment systems such as RTGS, retail digital payments, and paper-based instruments, along with their respective growth rates. It contains data segmented into "Volume (Rs. Lakhs)" and "Value (Rs. Crores)" of digital payment system from 2019-20 to 2023-24.

Table-1: Digital payment and settlement system on the basis of volume(Lakhs)

Year	RTGS	Growth Rate (%)	Retail Digital Payments	Growth Rate (%)	Paper-based Instruments	Growth Rate (%)	Total Payments	Growth Rate (%)
2019-20	1507	-	341947	-		-	343454	-
2020-21	1592	5.64	435478	27.35	67048	-	504151	46.79
2021-22	2078	30.53	717690	64.81	6999	-89.56	726862	44.18
2022-23	2426	16.75	1136956	58.42	7109	1.57	1146566	57.74
2023-24	2700	11.30	1641602	44.39	6632	-6.71	1650990	43.99
CAGR	21.46		68.70		#DIV/0!		68.77	
Min	1507		341947		6632		343454	
Max	2700		1641602		67048		1650990	
Range	1193		1299655		60416		1307536	
Avg	2061		854735		21947		874405	
SD	517		537661		30068		528659	
CV	25		63		137		60	
Skew	0.11		0.80		2.00		0.80	

Source: Compiled from the annual report from 2019-20 to 2023-24 of RBI.

From observation of content of the above table shows that RTGS maintains its relevance for large-value transactions, showing steady growth in volume and it steadily increased from 1,507 lakhs in 2019-20 to 2,700 lakhs in 2023-24 which indicates wider adoption of RTGS for high-value transactions. The RTGS experienced moderate growth in 2020-21, followed by a significant jump in 2021-22 (30.53%), reflecting increased adoption for high-value transactions during the pandemic when businesses sought contactless options. RTGS remains a preferred method for large-value transfers. However, its growth is slower compared to retail digital payments, as its scope is narrower and targeted at high-value users. The CAGR is positive and it works out to 21.46% even the skewness value is positive (0.11). It indicates consistent growth in Real-Time Gross Settlement (RTGS) payments, reflecting increased usage in high-value transactions. However, during the study period the volume (in Lakhs) of RTGS varied between 1507 lakhs (2019-20) to 2700 Lakhs (2023-24) with a range of 1193 lakhs and with 5 years annual average volume of 2061 lakhs represents the growth of RTGS transactions over time, though moderate compared to other categories. But moderate variation in transactions with stable growth in RTGS during the study period revealed by the SD of 517 and CV of 25%. Overall, the RTGS has shown stable growth, underlining its importance for high-value transactions.

Retail digital payments exhibited explosive growth in 2021-22 (64.81%) and 2022-23 (58.42%), driven

by government initiatives such as UPI, Bharat QR, and mobile wallets. The growth rate slightly tapered in 2023-24 to 44.39%, but it still represents significant expansion. The sector's high growth rate underscores a massive shift toward digital payments in retail, driven by greater accessibility, digital infrastructure improvements, and changing consumer preferences. However, the declining growth rate suggests the sector is maturing. The CAGR is positive (68.70%) even skewness is positive (0.80) which indicates the extremely high growth, showing a robust shift toward digital payment adoption by individuals and small businesses. During the study period, volume of retail digital payment varied between 341947 lakhs (2019-20) and 1641602 lakhs (2023-24) with a range of 1299655 lakhs and with annual average of 854775 lakhs, it reflects, India's push for digital transactions result in to the exponential growth in retail digital payments. Even in this case, volume of retail digital payment has rapid growth and shifts in transaction volumes as a apparent from the SD of 537661 lakhs and CV of 63%.

The rapid CAGR and high growth rates for retail digital payments and total payments indicate a structural transformation in India's payment ecosystem and Retail digital payments and total payments exhibit high volatility in Growth (High CV), indicating a phase of rapid adoption and scaling.

Table-2: Digital payment and settlement system on the basis Value (Crore)

Year	RTGS	Growth Rate (%)	Retail Digital Payments	Growth Rate (%)	Paper-based Instruments	Growth Rate (%)	Total Payments	Growth Rate (%)
2019-20	131156475	-	31149420	-		-	162305895	-
2020-21	105599849	-19.49	35858640	15.12	562710	#DIV/0!	142021195	-12.50
2021-22	128657516	21.83	45743717	27.57	6650333	1081.84	181051615	27.48
2022-23	149946286	16.55	58738587	28.41	7172904	7.86	215857822	19.22
2023-24	170886670	13.97	71937128	22.47	7212333	0.55	250036167	15.83
CAGR	9.22		32.18		#DIV/0!		15.49	
Min	105599849		31149420		562710		142021195	
Max	170886670		71937128		7212333		250036167	
Range	65286821		40787708		6649623		108014973	
Avg	137249359		48685498		5399570		190254539	
SD	24522006		16751114		3234731		43074491	
CV	18		34		60		23	
Skew	0.21		0.54		-1.96		0.50	

Source: Compiled from the annual report from 2019-20 to 2023-24 of RBI.

The above table provides that the notable fluctuation in the value of RTGS. The value of RTGS Declined sharply in 2020-21 (-19.49%) due to disruptions likely caused by the COVID-19 pandemic. The highest growth rate was in 2021-22 (21.83%), and maintained upward momentum in subsequent years. Peaked in 2023-24 with Rs.17,08,86,670 crore, showing steady adoption and recovery in the economy.it indicates that RTGS remains the backbone for high-value transactions, experiencing consistent growth in both volume and value due to increasing reliance by businesses and institutions The CAGR is positive and it works out to 9.22% even the skewness value is positive (0.21). It indicates that most values are concentrated on the lower side, with significant growth in later years.. However, during the study period the values (in crores) of RTGS varied between Rs.105599849 1 crores (2020-21) and Rs.170886670 crores (2023-24) with a range of Rs. 65286821 crores and with 5 years annual average volume of Rs. 137249359 crores represents the Moderate growth with low variance in value, as RTGS usage is relatively stable for high-value transactions. It also have stable and consistent growth and most values are concentration on the lower side, with significant growth in later year during the study period revealed by the SD of Rs. 24522006 crores and CV of 18%.

The value of retail digital payments also rose sharply from Rs.31,149420 crores to Rs.71,937128 crores and Highest annual growth rate observed in 2022-23 (+28.41%), reflecting widespread adoption of digital payment methods post-pandemic. The growth remained consistently high, reflecting an increase in both transaction frequency and average transaction size. The exponential growth in retail digital payments signifies a robust move towards a cashless economy, supported by innovations like UPI, mobile wallets, and digital

banking services. However, the data highlights a significant shift towards digital payments, with retail digital payments growing at an impressive CAGR of 32.12%, surpassing RTGS and paper-based instruments. During the study period, volume of retail digital payment varied between Rs. 31149420 crore (2019-20) and Rs. 71937128 crores (2023-24) with a range of Rs. 40787708 crores and with annual average of Rs. 48685498 crores with SD of 537661 lakhs and CV of 63%, the high mean and large SD reflecting rapid adoption and consistent growth and moderate CV reflects rapid growth but with some variability over the study period.

Table-3: Digital Payment mode on the base of Volume(in Lakhs)

Year	Mobile Payments	Growth Rate (%)	Internet Payments	Growth Rate (%)	ATMs	Growth Rate (%)	Micro ATMs	Growth Rate (%)	PoS	Growth Rate (%)
2020-21	252365	-	32483	-	60906	-	9460	-	395	-
2021-22	506842	100.84	40727	25.38	65240	7.12	11126	17.61	91	-76.90
2022-23	805338	58.89	42631	4.68	69469	6.48	12375	11.23	28	-69.58
2023-24	1252599	55.54	45035	5.64	66441	-4.36	11755	-5.01	15	-45.26
CAGR	70.58		11.51		2.94		7.51		-66	
Min	252365		32483		60906		9460		15	
Max	1252599		45035		69469		12375		395	
Range	1000234		12552		8563		2915		379	
Avg	704286		40219		65514		11179		132	
SD	429758		5450		3550		1254		178	
CV	61		14		5		11		135	
Skew	0.55		-1.39		-0.52		-1.07		1.80	

Source: Compiled from the annual report from 2019-20 to 2023-24 of RBI.

The table presents data on digital payment modes based on volume (in lakhs) from 2020-21 to 2023-24 across five categories: Mobile Payments, Internet Payments, ATMs, Micro ATMs, and PoS (Point of Sale). Here's a detailed analysis based on the given metrics:

The above table shows that volume of mode of digital payment through mobile phones increased from 252365 lakhs in 2020-21 to 1252599 lakhs in 2023-24 which indicates wider adoption of mobile phones for digital payments. The payment through mobile phone showed the highest growth rate (GAGR:70.58%) and significant annual increases. Especially 100.84% in 2021-22. The mode of payment through mobile varied between 252365 lakhs(2020-21) and 1252599 lakhs(2023-24) with a range of 1,000,234 lakhs and with 4 years annual average of 704,286 lakhs, indicating significant variability in transaction volumes over the years and it has dominant role in digital payments. The SD volume of mobile payment is 429,758 lakhs with CV of 61% shows that the moderate variability relative to its mean. Overall, Mobile payments have shown remarkable growth, becoming the most significant digital payment mode due to technological advancements, smartphone penetration, and user convenience.

The modest growth in the internet payments has CAGR of 11.51%, even the annual growth rates remained relatively low. And it has peaking at 25.18% in 2021-22. The internet payment varied between 32483 lakhs and 45035 lakhs with a range of 12552 lakhs and average of 40219 lakhs, indicating the stable performance in transaction volumes. The SD volume of internet payment is 5,450 lakhs with lowest CV of 14% shows that more stability in the internet payment system and also it has negative skewness (-1.39) showing a concentration of higher values with some lower outliers. Overall, Internet payments have grown steadily, reflecting consistent adoption by businesses and consumers for online transactions.

The digital payment through ATMs and Micro ATMs shows moderate growth rate with a CGAR of 2.94% and 7.51% respectively, indicating both modes of payments have slight decline in 2023-24(-4.36% and -5.01%). The mode of payment through ATMS varied between 60906 lakhs (2020-21) and 69469 lakhs (2023-24) with a range of 8563 lakhs, whereas, through Micro ATMs varied between 9460 lakhs (2020-21 and 12375 lakhs (2022-23) with a range of 2915 lakhs indicating that the relatively smaller volume of fluctuations during the study period. ATMs and Micro ATMs have lower averages (65,514 lakhs and 11,179 lakhs, respectively), indicating less reliance on cash withdrawals and moderate SDs (3,550 lakhs and 1,254 lakhs) with CVs (5% and 11%, respectively), and signifying low relative variability. It also shows negative skew (ATMs—0.52 and -

1.07), indicating a balanced distribution with a slight concentration on higher values of payments. Overall, the slow growth and eventual decline indicate a shift toward cashless payment methods. Whereas, PoS has declined trend consistently with a negative CAGR (-66%) and a steep fall in growth rates across the years. The PoS shows smallest range (379 lakhs) and lowest average (132 lakhs) with positive skew(1.8) reflecting its decline in usage and concentration of smaller values during the study period. SD of 178 lakhs with CV of 135 highlighting extreme variability and inconsistency in the digital payment. Overall, PoS transactions have drastically reduced, likely due to the growing preference for mobile and online payments.

Table-4: Digital Payment mode on the base of Value(Crore)

Year	Mobile Payments	Growth Rate (%)	Internet Payments	Growth Rate (%)	ATMs	Growth Rate (%)	Micro ATMs	Growth Rate (%)	PoS	Growth Rate (%)
2020-21	9089832	-	41534334	-	2889826	-	225420	-	1532	-
2021-22	14961371	64.59	83159996	100.22	3111946	7.69	299776	32.99	728	-52.48
2022-23	22031628	47.26	91539296	10.08	3305008	6.20	333966	11.41	278	-61.81
2023-24	30687088	39.29	102117736	11.56	3259388	-1.38	314003	-5.98	148	-46.76
CAGR	50.01		34.97		4.09		11.68		-54	
Min	9089832		41534334		2889826		225420		148	
Max	30687088		102117736		3305008		333966		1532	
Range	21597256		60583402		415182		108546		1384	
Avg	19192480		79587841		3141542		293291		672	
SD	9312224		26528369		186945		47371		625	
CV	49		33		6		16		93	
Skew	0.36		-1.50		-1.02		-1.48		1.18	

Source: Compiled from the annual from 2019-20 to 2023-24 of RBI.

The above table presents an analysis of mobile payment modes (in crores) for the years 2020-21 to 2023-24. The mobile payments show rapid growth, averaging a 50.01% annual increase. This highlights the increasing preference for mobile payment platforms due to their convenience, accessibility, and widespread adoption of smartphones. The growth rate decreased from 64.59 % (2020-21) to 39.29 % (2023-24) which shows a slight slowdown as adoption begins to saturate in some regions or maturity in the market. A wide range (Rs. 21597256 crore) with annual average (Rs.19192480 crore), in transaction value reflects significant year-to-year changes, driven by an expanding user base and increasing trust in mobile payment apps and its dominance as a primary digital payment mode during the year. The mobile payment has recorded the SD of Rs.9312224 crores and CV of 49%, indicates that growth has been consistent despite market fluctuations.

The digital payment through internet option have seen steady growth, driven by the adoption of e-commerce, UPI, and net banking, which is revealed by CAGR (34.97%). The growth rate declined from 100.22% (2021-22) to 11.56% (2023-24) but the growth marks to 100.22% (2021-22) a massive increase, likely due to digital transformation during and after the pandemic. And growth slows significantly to 10.08 % (2022-23) as the market matures and stabilizes and it also slightly rebound with 11.56% (2023-24) growth, indicating consistent adoption of internet payment system. Extremely wide range of Rs.60583402 crore with annual average of Rs. 79587841 crore reflects the massive adoption during 2021-22 compared to the prior period and high average value underscores the importance of internet payments in large-scale digital transactions. Relatively low variability compared to the mean, showcasing the stability of internet payments after initial surges revealed by SD of Rs. 26528369 crore and CV of 33% during the study period.

The growth rate of ATMs is fluctuating slightly, from 7.69% (2021-22) to 6.20% (2022-23), then again rebounds to 11.56% (2023-24) possibly reflecting adjustments in cash withdrawals patterns, whereas, in the case of Micro ATMs the growth rate fluctuating, with the highest at 32.99% (2021-22) and negative growth in 2023-24 (-5.98%). indicates that initially strong push due to government or financial institutions effort later on stagnation reliance on this mode of payment. The CAGR has 4.09% of ATMs, on other hand, 11.68% of Micro ATMs shows that the limited growth payment through ATMs, whereas, moderate growth payment through Micro ATMs indicates gradual adoption, likely driven by rural financial inclusion initiatives. The small range of Rs.415182 crores payment through ATMs and the moderate range of Rs.108546 crores through Micro ATMs,

shows that smaller range indicates the stability in ATMs usages over the year, whereas, moderate range indicates variability in adoption, driven by external factors like policies or rural connectivity. The consistent average usage of Rs.3141542 crores through AMTs shows that while ATMs are declining in importance, they are still essential for certain demographics (e.g., rural areas). On other hand, Micro ATMs has an average transaction values (of Rs.293291 crores) are low, reflecting their niche use in rural and underserved areas.

The growth rate of PoS negative from -52.48%(2021-22) to -61.81%(2022-23 with CAGR of -46.76% drastic declined which indicates diminishing importance of PoS devices, possibly replaced by mobile and internet payments. The narrow range (Rs.1384 crores) of PoS with low average value(Rs.672 crores) reflects consistently low transaction volumes and very low usage of PoS compared to other categories. The SD of Rs.625 creores with 93% CV indicates significantly year to year fluctuation and instability and inconsistency in PoS mode of payment during the study period.

Table-5: Digital Payment System Infrastructures (Lakh)

Years	Number of Cards	Number of PPIs	Number of ATMs	Number of Micro ATMs	Number of PoS Terminals	Bharat QR	UPI QR
2020-21	9603	21953	2	4	47	36	925
2021-22	9913	15554	3	9	61	50	1727
2022-23	10466	16185	3	16	78	54	2564
2023-24	10667	16744	3	18	89	63	3435
CAGR	3.57	-8.63	2.58	63.17	23.56	20.52	54.84
Min	9603	15554	2	4	47	36	925
Max	10667	21953	3	18	89	63	3435
Range	1065	6399	0	14	42	27	2510
Avg	10162	17609	3	12	69	50	2163
SD	491	2936	0	6	18	11	1080
CV	5	17	4	54	27	22	50
Skew	-0.19	1.84	-1.40	-0.50	-0.14	-0.67	0.08

Source: Compiled from the annual report _2019-20 to 2023-24 of RBI.

The above table provides the a detailed view of digital payment systems infrastructures(lakhs) from 2020-21 to 2023-24, the annual growth rate for each parameter over the four years were indicated by CAGR such as 3.57% growth in cards, 1.63% in PPIs growth showing relative low expansion, 2.58% growth of ATMs, 63.17% growth of Micro ATMs which indicates rapid adoption, 23.56% growth of PoS terminals reflecting increasing merchant acceptance, 20.52% growth of Bharat QR indicating growing adoption of QR-based payments and 54.84% growth of UPI QR representing a massive surge in digital payment adoption during the study period. The number of cards varied between 9603 lakhs and 10667 lakhs with range of 1065 lakhs, number of Micro ATMS varied between 4 lakhs and 18 lakhs with range of 14 lakhs, the number UPI QR varied between 925 lakhs and 3435 lakhs with range of 2510 lakhs indicates the significant variations can be observed for UPI QR and Micro ATMs. Among the digital payment infrastructure the highest average number of PPI usages with negative CAGR.. The SD of UPI QR is 1080 lakhs(CV:50) and Micro ATMs SD is 6 lakhs(CB: 4) indicates highest and minimum deviation due to exponential growth.

FINDINGS OF THE STUDY:

➤ **Based on digital payment and settlement:**

1. The volume of RTGS Transactions has shown steady growth, with a CAGR of 21.46% and a positive skewness of 0.11. RTGS remains essential for high-value transfers.
2. The value of RTGS showed lower growth (CAGR of 9.22%), reflecting stability in high-value business transactions and remains a cornerstone of high-value transactions.

3. The volume of retail digital payments saw explosive growth, with a CAGR of 68.70%, and a positive skewness of 0.80. The high variability (SD: 537,661 lakhs, CV: 63%) reflects rapid adoption.
 4. The transaction value through Retail Digital Payments grew rapidly (CAGR of 32.12%), showing a clear consumer and business preference for faster, more convenient payment methods like UPI and mobile banking.
- **Based on mode of digital payment**
1. The mobile payments have become the most significant in the volume of digital payment mode, with a CAGR of 70.58% and a dominant share of digital payment transactions.
 2. The volume of internet Payments showed steady growth (CAGR: 11.51%) with low variability (CV: 14%). Adoption was driven by e-commerce and UPI.
 3. The value of transaction through Mobile and Internet Payments show robust growth with high CAGR values of 50.01% and 34.97%, respectively. This indicates that consumers are increasingly adopting these modes for transactions
 4. The volumes of ATMs and Micro ATMs are the modest growth, with ATMs growing at 2.94% and Micro ATMs at 7.51%. Both experienced declining usage in 2023-24, indicating a shift to cashless methods.
 5. It is find out that the there is a stable usage of ATM and Micro ATM because they show limited growth with lower variability, suggesting they remain a consistent but less preferred mode of transactions
 6. The volume of PoS transactions declined consistently (CAGR: -66%), reflecting the preference for mobile and online payments.
 7. The value of PoS transactions has severe negative CAGR (-46.76%) and high variability (CV = 93%) indicate that PoS usage is rapidly declining, potentially due to increasing reliance on other digital methods like mobile and internet payments.
- **Based on digital payment infrastructure:**
1. The rapid adoption of digital Infrastructure such as UPI QR (CAGR: 54.84%) and Micro ATMs (CAGR: 63.17%) highlights the success of government initiatives in enhancing payment accessibility.
 2. It is find out that the Micro ATMs and PoS Terminals' growth signifies infrastructural support for digital payments.
 3. It is also underlines the rapid expansion and variability in digital payment systems, particularly UPI QR, while traditional methods like cards and ATMs grow at a slower pace.
 4. The high growth areas in Micro ATMs, PoS Terminals, Bharat QR, and especially UPI QR demonstrate high CAGR, reflecting digital payment adoption trends.
 5. The steady growth areas in number of Cards and ATMs exhibit consistent but moderate growth.
 6. The significant growth in adoption of UPI QR and Bharat QR systems highlights India's increasing preference for cashless transactions.

III. SUGGESTIONS:

- To promote RTGS for mid-value transactions to increase adoption further and enhance RTGS accessibility for SMEs to integrate them into high-value transaction systems.
- Promote financial inclusion by expanding access to digital payment systems, particularly in rural and underserved areas.
- Enhance security measures to protect digital payment transactions from cyber threats and fraud.
- Simplify regulations and reduce complexity to facilitate the growth of digital payments.
- Encourage innovation in digital payments, including the development of new payment technologies and services especially. Encourage innovation in mobile and internet payment systems to sustain growth and address variability.
- Address cyber security concerns to build trust among new users.
- Strengthen digital payment ecosystems, such as UPI, to maintain growth momentum
- Promote education and awareness about internet payment systems for consistent adoption
- Strategically reduce reliance on declining modes like ATMs and PoS by integrating them with digital platforms for seamless transactions.
- Monitor ATM and Micro ATM Trends: These may serve niche segments, so strategies should focus on maintaining their relevance for rural or specific demographics.
- Expand UPI QR and Micro ATMs to remote areas to boost financial inclusion.

- Enhance interoperability among payment modes to improve user convenience.
- Invest in improving digital payment infrastructure, including mobile and internet payments, to support the growing demand for digital transactions
- Invest in improving PoS infrastructure or integrating them with mobile/internet solutions to curb the declining trend
- Invest in enhancing mobile payment infrastructure, especially in rural areas.
- Enhance RTGS: Improve RTGS infrastructure to support seamless large-value transactions.

IV. CONCLUSION:

The study highlights the significant growth of digital payments in India, driven by the increasing adoption of mobile and internet payments. reflecting changing consumer behavior and the push for digital adoption. Policymakers and businesses should focus on promoting stable and growing channels like mobile and internet payments while addressing the decline in PoS systems and the need to improve digital payment infrastructure, promote financial inclusion, enhance security measures, simplify regulations, and encourage innovation. By addressing these challenges and opportunities, India can accelerate its transition to a digital economy and achieve greater financial inclusion and economic growth.

The RTGS remains crucial for high-value transactions, reflecting stability and consistent growth. The exponential growth in retail digital payments underscores India's transition to a cashless economy by Retail Digital Payments system. The rapid adoption of mobile and internet payments demonstrates user preference for convenience and accessibility and innovations like UPI QR and Micro ATMs have driven financial inclusion and digital adoption.

Total payments consistently exhibit high growth, underscoring the increasing penetration of formal financial services in the economy. The study highlights the dynamic shift in India's payment system, with growth in digital transactions reshaping the landscape and it confirms India's strong transition toward digital payments while reducing dependence on traditional, paper-based systems. Overall, the Indian digital payment landscape is experiencing structural transformation, driven by technological advancements, government initiatives, and changing consumer behaviors. Future growth will depend on addressing security concerns, ensuring equitable access, and fostering innovation to sustain momentum.

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