

The Analytical Study On Technology And Electronic Currency: A Research Review

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Abstract

India is actively exploring the integration of digital currency into its monetary system through the introduction of the e-Rupee. This research evaluates the feasibility, benefits, and challenges associated with this transition, aiming to provide a comprehensive understanding of its potential impact. This research review investigates the intersection of technology and electronic currency, emphasizing the advancement, adoption, and economic implications of digital monetary systems. This research review explores the intersection of technology and electronic currency, with a focus on the advancement, adoption, and economic impact of digital monetary systems. The study is guided by three key objectives: firstly, to examine the relationship between technological innovations and the evolution of electronic currencies; second, to assess the current trends in the circulation of the e-Rupee in India; and third, to evaluate the correlation between Bitcoin, as a leading digital currency, and the exchange rates of various national currencies. The study findings explain that stronger digital infrastructure, public awareness, and policy support to ensure broader and more effective integration of electronic currencies and also investigates the evolving role of electronic currencies, with a particular focus on the adoption and circulation of the e-Rupee in India and its correlation with global digital currencies such as Bitcoin. Overall, the digital transformation of money marks a significant shift in global financial architecture. With targeted efforts in technological advancement, policy development, and public engagement, digital currencies like the e-Rupee have the potential to reshape the future of payments, promote financial inclusion, and contribute to a more efficient, secure, and resilient financial system.

Key Words: E-rupee, central bank digital currency (cbdc), rbi, digital currency etc.

Introduction

Digital currencies, particularly Central Bank Digital Currencies (CBDCs), exemplify the ongoing transformation of the global financial ecosystem. As governments explore the digitization of national currencies, CBDCs emerge as a tool to enhance transactional speed and efficiency, reduce costs, and promote financial inclusion by extending access to financial systems for underserved populations. Additionally, digital currencies offer enhanced security, privacy, and control over financial assets, addressing some of the limitations of traditional monetary systems. The advent of smart contracts and decentralized applications (D Apps) further highlights their

innovative potential, driving the shift toward a more decentralized and transparent financial infrastructure. Collectively, these developments not only empower individuals economically but also hold significant potential to reshape the global financial landscape in a more equitable and efficient manner etc.

Relationship between Technology and Electronic Currency:

The emergence and evolution of **electronic currency (e-currency)** are fundamentally driven by **technological advancements** in digital infrastructure, communication systems, and cryptographic security. Technology plays a central role in both enabling and sustaining electronic forms of money—ranging from mobile wallets and online banking to cryptocurrencies and central bank digital currencies (CBDCs).

1. Digital Infrastructure as a Foundation: Modern electronic currencies operate through digital platforms supported by high-speed internet, mobile networks, cloud computing, and data centers. These technologies ensure that electronic money is available anytime and anywhere, making instantaneous transactions across borders possible.

2. Cryptography and Security: The security of electronic currencies is heavily dependent on encryption and cryptographic protocols. In the case of crypto currencies, block chain technology ensures immutability, decentralization, and transparency. For government-issued CBDCs like India's advanced encryption and tokenization techniques protect data and prevent fraud.

3. Payment Systems and APIs: Technological innovations such as UPI (Unified Payments Interface) in India, QR codes, digital wallets, and open banking APIs allow seamless integration of e-currencies into mobile apps and web platforms. These make transactions fast, cost-effective, and user-friendly.

4. Smart Contracts and Automation: Technologies like smart contracts (used in Ethereum and other decentralized platforms) allow programmable money. This enables automated payment execution based on predefined conditions, which can revolutionize supply chains, insurance, and finance.

5. Artificial Intelligence & Data Analytics: AI and big data are being used to monitor transactions, predict fraud, and improve financial accessibility. Central banks also use technology for real-time monetary policy implementation through programmable CBDCs.

6. Financial Inclusion: Technology bridges the gap for the unbanked population by allowing access to digital currency even without traditional banking services via mobile apps or offline-compatible wallets. This is especially crucial in developing countries.

Research Objectives:

1. To examine the relationship between technological advancements and the development and adoption of electronic currencies.
2. To assess the circulation current trends of e-Rupee in India.
3. To evaluate the correlation between Bitcoin (as a representative digital currency) and the exchange rates of various national currencies.

Hypothesis:

- **H0:** There is no significant differences between circulation current trends of e-Rupee in India.
- **H1:** There is a significant difference between circulation current trends of e-Rupee in India
- **H0:** There is no significant correlation between Bitcoin (as a representative digital currency) and the exchange rates of various national currencies.
- **H2:** There is a significant correlation between Bitcoin (as a representative digital currency) and the exchange rates of various national currencies.

Research Methodology:

This study is grounded in secondary data sources, with information collected from reliable and authoritative databases. Primary sources of data include the International Financial System, the Centre for Monitoring Indian Economy (CMIE) database, and official publications by the Reserve Bank of India (RBI). In addition, supplementary data was obtained from annual bulletins, peer-reviewed journals, books, research articles, financial newspapers, periodicals, and other relevant **reports and academic studies** related to the research topic. To analyze the collected data, **SPSS Version 21.0** was employed. The study made use of various statistical techniques, including:

- **Descriptive statistics** (mean, standard deviation) to summarize and interpret the data,
- **Correlation analysis** to examine the relationship between digital currencies and national currency exchange rates.

Review of Literature:

Cheah Moore (2017) conducted a study to examine the factors influencing Bitcoin's price volatility, addressing a significant gap in existing literature related to the economic behavior of digital currencies. The research employed modeling and econometric analysis to evaluate the determinants of price fluctuations in the Bitcoin market. The findings revealed that market liquidity, regulatory announcements, and media coverage significantly affect the volatility of Bitcoin prices. This study provides important insights into the complex dynamics of crypto currency markets and highlights the interplay between external factors and digital asset pricing respectively.

Al-Amril (2018) examined the relationship between financial market stress and the volatility of crypto currency **prices**. Their findings revealed dynamic and time-varying correlations, indicating that during periods of heightened financial market stress, the prices of crypto currencies show stronger volatility and greater sensitivity. This suggests that digital currencies are not immune to broader macroeconomic conditions and may behave as non-traditional financial assets during times of uncertainty. Collectively, these studies underscore the multifaceted and evolving nature of digital currency markets and point to the necessity for continued research into their behavior under various economic conditions respectively.

Mashatan (2020) shifted attention toward the consumer perception of crypto currencies as a payment method. The study uncovered mixed attitudes: while users appreciated the traceability and innovation behind crypto currency transactions, they expressed concerns regarding security and privacy. These apprehensions pose challenges to the broader adoption of digital currencies in everyday transactions, highlighting the importance of secure technological design and transparent policies to build consumer trust. Together, these studies reflect the complex interplay between market dynamics, user sentiment, and technological attributes in shaping the trajectory of crypto currency markets.

Kumar (2022) focused on stable coins, which serve as a middle ground between crypto currencies and traditional financial assets. Their study underscored the potential of stable coins to reduce volatility while maintaining digital efficiency, thus making them a more reliable medium of exchange and store of value in both retail and institutional contexts. Together, these studies provide a comprehensive view of the multidimensional nature of digital currencies, encompassing economic behavior, investor sentiment, consumer trust, and innovations in financial instruments such as stable coins.

Rajcaniova, and Kancs (2024) provide a significant contribution to understanding the macroeconomic impact of digital currencies. Their study addresses a critical research gap stemming from the limited analysis of how digital currencies influence economic stability at the national and global levels. Using economic modeling and simulation techniques, the authors investigate the potential consequences of widespread digital currency adoption. The findings highlight how such adoption could lead to substantial shifts in key macroeconomic variables, including the money supply, inflation dynamics, and the effectiveness of monetary policy transmission mechanisms.

Mallick and Mallick (2025) investigated the correlation between crypto currencies and official Indian foreign exchange rates. Their analysis revealed only limited linkages, attributing this to the lack of legal recognition and low public acceptance of crypto currencies within India. As a result, crypto currencies currently exert minimal influence on domestic currency markets. Interestingly, the study also found stronger correlations with emerging market currencies compared to developed ones with the Russian ruble as a notable exception. The authors suggest that the ruble's divergence may reflect unique structural and policy characteristics of the Russian economy.

Data Analysis and Interpretations

1. Illustrates the data on e-Rupee circulation in India:

Table No.1 explains data on the circulation of the E-Rs (Digital Rupee) between 2024–25. The figures, provided in Rs crore, indicate that the total E-Rs circulation from Rs 16.39 crore in 2022–23 to Rs 234.12 crore in 2024–25. This sharp growth highlights the Reserve Bank of India's expanding efforts to digitalize the monetary system and increase public and institutional engagement with the digital rupee. This reflects the increased public trust and participation in the retail digital currency ecosystem. The most substantial growth is observed in higher

denominations such as the Rs. 500 which surged from E-Rs 2.71 crore to Rs.164.36 crore, indicating that larger transactions and possibly business-to-business (B2B) payments are beginning to shift toward digital currency formats. Lower denominations, such as Rs 1 and Rs 2, also witnessed noticeable growth, which may point to the adoption of E-Rs for everyday small-value retail transactions. In contrast, wholesale E-Rs usage saw a drastic decline from Rs. 10.69 crore in 2023–24 to just Rs. 0.08 crore in 2024–25. This inverse trend suggests that while the RBI initially emphasized institutional and interbank testing of the E-Rs in its pilot phase, focus has now shifted towards retail deployment. It also indicates that businesses and banks might be returning to traditional settlement systems or waiting for further technological and regulatory clarity before fully adopting wholesale E-Rs for large-value transfers respectively.

Table No.1
Circulation of E-Rupee in India

SI.NO	Denomination	2023–24 (From 01 Dec 2024)	2024–25
1	Rs.0.50 Paise	0.01	0.09
2	Rs.1 Note	0.04	0.37
3	Rs. 2 Note	0.06	0.54
4	Rs. 5 Note	0.12	1.37
5	Rs.10 Note	0.15	2.14
6	Rs. 20 Note	0.23	3.94
7	Rs. 50 Note	0.39	8.49
8	Rs. 100 Note	0.83	20.73
9	Rs.200 Note	1.16	32.01
10	Rs.500 Note	2.71	164.36
11	Rs.2000 Note	--	-
	Total e-Rs Retail	5.7	234.04
	E- Rs-Wholesale	10.69	0.08
	Total e-Rs	16.39	234.12

Source: Reserve Bank of India.

This inverse trend suggests that while the RBI initially emphasized institutional and interbank testing of the E-Rs in its pilot phase, focus has now shifted towards retail deployment. It also indicates that businesses and banks might be returning to traditional settlement systems or waiting for further technological and regulatory clarity before fully adopting wholesale e₹ for large-value transfers. The dramatic rise in E-Rs circulation, especially in the retail segment, demonstrates growing acceptance among the public and merchants. This growth is likely

influenced by the government's digital push, increased smartphone penetration, and the success of platforms like UPI that have familiarized citizens with digital payments. However, the drop in wholesale usage suggests the need for policy adjustments or further infrastructure development to support large-scale commercial use. Moving forward, sustained public awareness, regulatory clarity, and technological refinement will be key to establishing E-Rs as a mainstream component of India's monetary ecosystem.

Graph No.1
Circulation of E-Rupee in India

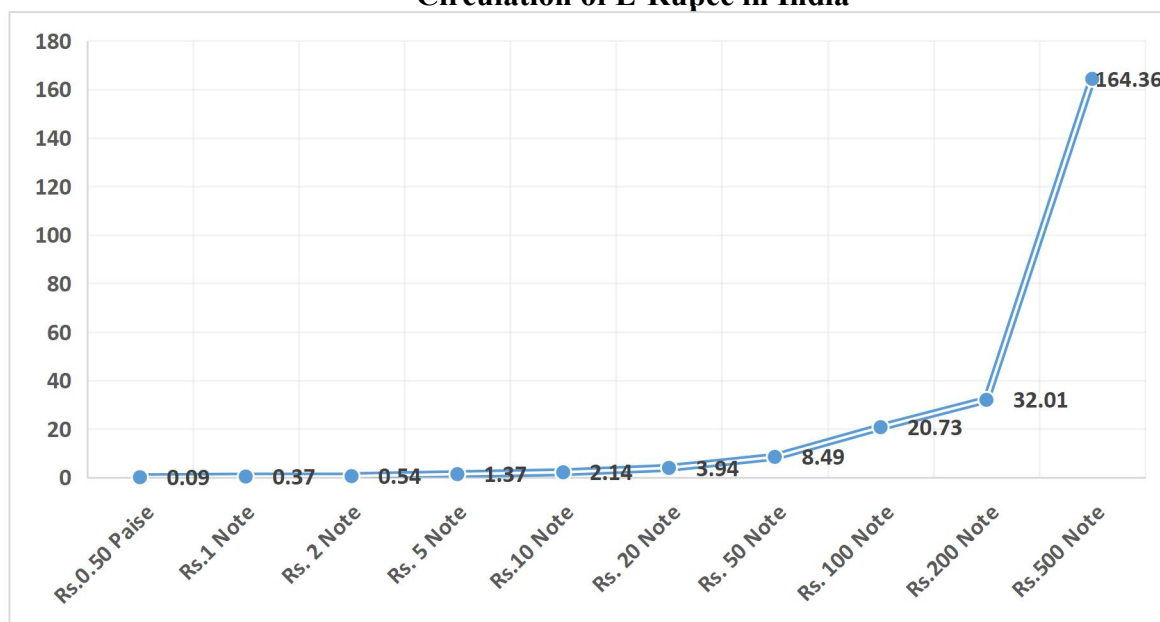


Table No.1 (a) explains the descriptive statistics, the highest mean circulation of e-Rupees (Digital Rupee) is significantly higher at 23.4040, with a very high standard deviation of 50.64650. This reveals wide variability in digital currency circulation across the sample. The standard error of 16.01583 indicates a large sampling error, possibly due to uneven adoption across different denominations or regions. Lastly the much higher mean and variability for e-Rupees compared to traditional notes suggests that digital currency is expanding rapidly but unevenly. While physical note circulation remains stable and limited, the e-Rupee shows potential for scale, albeit with fluctuating adoption patterns.

Table No.1 (a)
Descriptive Statistics
Circulation of E-Rupee in India

One-Sample Statistics				
Variables	N	Mean	Std. Deviation	Std. Error Mean
Circulation of Notes	10	.5700	.84174	.26618
Circulation of E-Rupees	10	23.4040	50.64650	16.01583

Sources: Secondary Data

Table No1 (b) The one-sample t-test was conducted to determine whether the mean circulation of traditional notes and e-Rupees in India. The one sample test p values results that the sig(2-tailed) values shows that less than 0.05. Therefore null hypothesis is accepted and alternative hypothesis is accepted. Despite the highly significant p-value, the wide confidence interval that includes **zero** suggests a high degree of variability in e-Rupee circulation data. This indicates that while the adoption of e-Rupee is growing, **its** distribution is inconsistent, possibly due to differences in regional rollouts, public awareness, or technological infrastructure.

Table No.1 (b)
Results of One Sample
Circulation of E-Rupee in India

One-Sample Test						
Variables	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Circulation of Notes	2.141	9	.001	.57000	-.0321	1.1721
Circulation of E-Rupees	1.461	9	.000	23.40400	-12.8263	59.6343

Sources: Secondary Data

2. Digital Currency Exchange Rates Correlation Between Various National Currencies:

Table No.2 explains the digital currency exchange rates correlation between various national currencies. The analysis reveals a diverse impact of Bitcoin price movements on various national currencies. Argentina shows a strong positive correlation, suggesting that its currency depreciates significantly when Bitcoin appreciates. This implies that Bitcoin may be viewed as a hedge against economic instability in Argentina. Countries such as Turkey, India, and Japan exhibit moderate to weak positive correlations, indicating that while their currencies also weaken as Bitcoin rises, the relationship is less pronounced. This may reflect growing but cautious adoption of crypto currencies in these regions respectively.

Table No.2
Digital Currency Exchange Rates of Various National Currencies

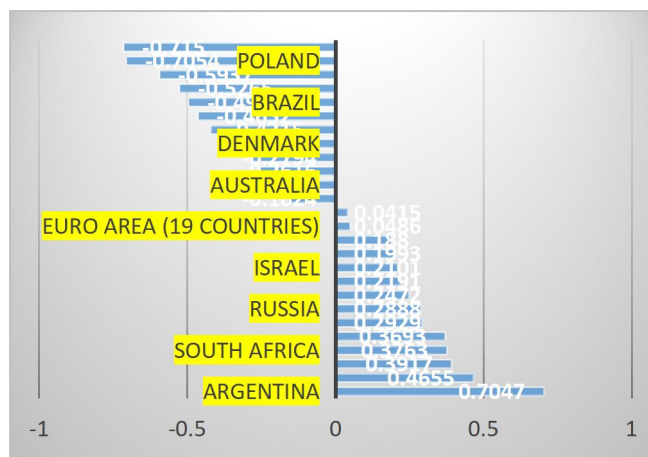
Country	Correlation Coefficient	Correlation Strength
Argentina	0.7047	Strong Positive
Türkiye	0.4655	Moderate Positive
India	0.3917	Moderate Positive
South Africa	0.3763	Moderate Positive
Japan	0.3693	Moderate Positive
China	0.2929	Weak Positive
Russia	0.2888	Weak Positive
Czechia	0.2472	Weak Positive
Korea	0.2191	Weak Positive

Israel	0.2101	Weak Positive
Chile	0.1993	Weak Positive
Indonesia	0.188	Weak Positive
Euro area (19 countries)	0.0486	Weak Positive
New Zealand	0.0415	Weak Positive
Colombia	-0.1624	Weak Negative
Australia	-0.2599	Weak Negative
Canada	-0.2616	Weak Negative
Sweden	-0.2794	Weak Negative
Denmark	-0.3069	Moderate Negative
United Kingdom	-0.4215	Moderate Negative
Mexico	-0.4632	Moderate Negative
Brazil	-0.4955	Moderate Negative
Hungary	-0.5265	Moderate Negative
Switzerland	-0.5937	Moderate Negative
Poland	-0.7054	Strong Negative
Costa Rica	-0.715	Strong Negative

In contrast, Poland and Costa Rica show strong negative correlations, meaning their currencies tend to strengthen against the USD as Bitcoin's value increases. This could be due to alternative economic strategies, capital flow dynamics, or lower dependency on speculative crypto investments. Other countries such as the United Kingdom and Brazil show moderate negative correlations, hinting at an inverse relationship, where rising Bitcoin prices might align with strengthening local currencies, though not as strongly as in Poland or Costa Rica. Meanwhile, Australia, Canada, and similar economies reflect weak negative correlations, suggesting minimal influence of Bitcoin on their fiat currencies etc.

Graph No.2

Digital Currency Exchange Rates of Various National Currencies



Findings:

1. The wallet-to-wallet transactions replacing intermediaries, the E-Rs offers opportunities to reduce transaction costs and enhance real-time payments.
2. The sharp increase in 2023–24 reflects the transition from pilot testing to broader implementation, especially in the retail sector.
3. No digital currency was issued in the Rs. 2000 denomination, likely aligning with India's broader effort to limit high-denomination circulation.
4. Small denominations like Rs.1, Rs.2, Rs.5, and Rs.10 showed gradual but consistent growth, suggesting expanding use in micro-payments and retail commerce.
5. The e-Rupee will be exchangeable at par with existing currencies, accepted as payment, and provide a secure storage option for wealth. However, achieving widespread adoption as the general public and traditional financial institutions may initially be hesitant to accept this new mode of payment etc.
6. Australia, Canada, and similar economies reflect weak negative correlations, suggesting minimal influence of Bitcoin on their fiat currencies. This could be due to stronger financial regulation, greater market diversification, or mature monetary systems that dilute the effect of crypto currency fluctuations etc.

Suggestions:

1. **Strengthen Digital Infrastructure:** To support the widespread and consistent adoption of e-Rupee across India, there is a need to invest in robust digital infrastructure, especially in semi-urban and rural areas. Reliable internet connectivity, mobile access, and secure digital platforms are essential for seamless e-currency transactions.
2. **Enhance Public Awareness and Financial Literacy:** A significant factor behind the inconsistent adoption of digital currencies is the lack of awareness and trust among users. Targeted educational campaigns should be initiated to improve understanding of the e-Rupee's benefits, usage, and security features, especially among less tech-savvy populations.
3. **Policy and Regulatory Support:** Policymakers should focus on creating a clear, supportive regulatory environment that promotes innovation while ensuring consumer protection.

Regulatory clarity will encourage fintech firms, merchants, and financial institutions to integrate and accept digital currencies with greater confidence.

4. Encourage Private-Public Collaboration:

Collaboration between government bodies, central banks, fintech startups, and private sector players can accelerate digital currency innovations. These partnerships can help deliver customized solutions tailored to different economic and social segments.

5. Address Security and Privacy Concerns: Security and privacy remain key concerns for users of digital currencies. The system must incorporate robust cybersecurity measures and transparent data protection policies to build public trust and safeguard transactions.

Conclusion

The dynamic and evolving nature of digital currency adoption, particularly in the Indian context with the introduction of the e-Rupee. While the circulation of e-Rupees demonstrates considerable potential for growth, the significant variability and inconsistent uptake indicate that further investment in digital infrastructure, financial literacy, and supportive policy frameworks is essential to ensure more uniform and inclusive adoption across regions. The relationship between technology and electronic currency is both mutually reinforcing and transformative. Technological advancements such as block chain, artificial intelligence, and 5G have been instrumental in enabling the creation, secure distribution, and usage of digital money. Simultaneously, the adoption of electronic currencies like CBDCs fuels innovation within the broader financial technology ecosystem, driving new use cases, enhanced transparency, and real-time transaction capabilities. Furthermore, the varying degrees of correlation between Bitcoin and national currency exchange rates underscore the complex and context-dependent interactions between crypto currency markets and traditional financial systems. These correlations suggest that while in some economies, Bitcoin may serve as a hedge against instability, in others, its influence remains limited or inversely related, depending on local economic dynamics and regulatory environments. Overall, this spectrum of correlation strengths underscores the complex and context-dependent relationship between Bitcoin and traditional financial markets, emphasizing how crypto currency trends can mirror or impact national economic conditions and investor behavior globally.

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