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A STUDY ON DESIGN, IMPLEMENTATION AND CHALLENGES OF CENTRAL BANK DIGITAL CURRENCY WITH SPECIAL REFERENCE TO INDIA'S E-RUPEE

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ABSTRACT
With increase in shift from traditional methods to technological methods to digital methods, even banking industry is gradually stepping into usage of advance technologies. At the macro level of economy even Reserve Bank of India is exploring the potential use of technology by introducing Central Bank Digital Currency (CBDC) (e-Rupee). CBDC is considered to be the pivotal evolution in sovereign money, aiming to address inefficiencies in payment systems, financial inclusion and digital economy's growing needs. Being a case study research and using qualitative research methodology, this paper provides an extensive review of the design frameworks and implementation approaches, while analyzing global data and presenting a detailed examination of Reserve Bank of India's digital rupee pilot. Visualizations and tables accompany the findings to support data analysis.
KEY WORDS: *Macro-Economy, Digital Currency, Payment Systems, Financial Inclusion, Banking System*

INTRODUCTION

Money has seen various forms since generations and has evolved to meet the changing needs of the societies. In ancient times, people relied on the barter system, exchanging goods for goods. As the trade expanded, commodity money like grains, salt or metals began to be used for value exchange. This was followed by the introduction of metallic coins, which standardized value and improved trade efficiency. Later, paper currency emerged, making transactions easier and reducing the burden or carrying metals. With industrialization and globalization, banking systems and digital payments transformed financial transactions. Today, money is entering a new phase with cryptocurrencies and Central Bank Digital Currencies (CBDC).

CBDC is a digital representation of a country's fiat currency, issued and backed by the central bank, but existing entirely in electronic form, unlike cash. Unlike cryptocurrencies, it is not decentralized that is, the CBDC is entirely managed by central bank wherein every authority like issuance, supply and validation will be in the hands of central bank itself. CBDC can be classified into two main types: Retail CBDCs: which is accessible to the general public for daily transactions and Wholesale CBDCs: which is restricted only to financial institutions for settlement and interbank payments.

At global level: Over 110 countries are engaged in CBDC exploration, with 69 in advanced stages and 11 have fully operational CBDCs – such as the Sand Dollar (Bahamas), e- Naira (Nigeria), JAM-DEX (Jamaica) and Zig (Zimbabwe). Nearly all major economies, including 19 of G20 nations, have ongoing CBDC research, pilots or development programs – China's digital Yuan is a large-scale pilot and EU is progressing the digital euro. The IMF projects that by 2030, CBDCs could account for up to 15% of global cross-border payments, highlighting a rapidly evolving space driven by digital transformation, financial inclusion efforts and cross-border payment needs.

CBDCs offer several potential benefits like: a. Efficiency: streamlined payment systems, faster settlements and reduced transaction costs. b. Financial Inclusion: Enables central banks to manage money supply and interest rates with greater precision and flexibility. c. Security: Reduced risks of physical cash theft and fraud; improved tracking for anti-money laundering. d. Cross-border payments: easier and cheaper international transfers and settlements. e. Lower costs: reduction in printing, distributing and securing physical cash. f. Tax and compliance: simplifies tax tracking and compliance monitoring.

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Though CBDCs provide multiple benefits, there are certain issues that must addressed. Such as: a) Disintermediation: could reduce the role of commercial banks, risking disruptions in intermediary services and bank stability. b) Privacy concerns: digital transaction records might compromise user privacy and could lead to excessive surveillance. c) Cybersecurity: vulnerable to hacking and system outages, risking widespread financial instability. d) Infrastructure costs: implementation requires significant investments in digital infrastructure. e) Inequality: without careful planning, CBDCs could worsen existing financial inequalities. f) Regulatory complexity: cross- border features and anti-money laundering compliance present additional difficulties. g) Dependency on technology: purely digital systems depend on reliable internet and electricity, raising concerns in rural or low resources areas.

However, overcoming the challenges and by fixing issues CBDCs would be one of the best tools to reshape the global financial landscape, with each country tailoring its approach to address specific economic, technological and regulatory needs.

LITERATURE REVIEW

Several literatures are available which provide the overview and explain the key aspects of the CBDC. Few are as follows;
"Central Bank Digital Currencies: A Review of the current landscape" by Bank for International Settlements (BIS) provides an overview of CBDCs, their potential benefits and challenge.

"Central Bank Digital Currency: A Review of the Literature" by International Monetary Fund (IMF) – reviews the literature on CBDCs, focusing on their design, implementation and potential impact on monetary policy and financial stability.

"CBDCs: A review of the Global Landscape" by World Economic Forum provides a global perspective on CBDCs.
"Central Bank Digital Currency in India: Opportunities and Challenges" by Reserve Bank of India discusses the potential benefits and challenges of introducing a CBDC in India, including its impact on monetary policy and financial inclusion.

These literature reviews provide a comprehensive overview of the CBDC concept, its potential benefits, challenges and opportunities for innovation, as well as its implications for monetary policy and financial stability. However, these literatures are very broad and contain technical jargons hence this paper aims at simplifying the concept of CBDC. Hence, this study aims to understand CBDC in simple terms and understand the differences between traditional money and CBDC, operational mechanics and India's digital rupee case study.

OBJECTIVES OF THE STUDY

a. To analyze the implementation and impact of Digital Rupee in India – Case study.
b. To examine the operational mechanics and architecture of CBDC.
c. To understand the key differences between traditional currencies and CBDC, and between UPI-CBDC.

RESEARCH METHODOLOGY

This qualitative research paper employs a case study approach to examine the implementation and impact of CBDC, focusing on the Digital Rupee in India. Data were collected from secondary sources including Reserve Bank of India, International Monetary Fund, World Economic Forum, Bank for International Settlements and few peer-reviewed journals. The collected data were analyzed using thematic analysis, focusing on identifying and exploring key themes and patterns related to CBDC and digital rupee.

LIMITATIONS

The research paper focuses on the qualitative aspects of CBDC and Digital Rupee, and does not involve quantitative analysis or empirical testing. The scope of the paper is limited to exploring the implementation and impact of CBDC and doesn't consider technical aspects of CBDC.

CASE STUDY: ANALYSIS

India's Digital Rupee (e-Rupee):
India's Reserve Bank (RBI) began exploring CBDC in 2021, motivated by: growing digital payment adoption; need for efficient, inclusive and resilient financial infrastructure and to reduce costs/exposure to private digital assets. RBI planned to follow two-phase approach in order to launch and implement CBDC. Phase I was a pilot

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study, where RBI choose 4 cities namely: Mumbai, New Delhi, Bengaluru and Bhubaneshwar particularly for selected users and merchants. In Phase II, RBI is planning to gradually expand and scale up to additional cities, diversify user groups and cross broader transactions. RBI has chosen two technical models for the better implementation they are: a) Hybrid architecture: in which digital rupee is issued by RBI and would be distributed through commercial banks in electronic wallets. b) Both tokens based for retail, anonymous low-transfers and account based for higher value and traceable transactions.

However, there are certain challenges for Indian scenario that has to be addressed, they are:

a. Privacy and transparency trade off.
b. Integration with existing financial and payment infrastructures.
c. Need for robust legal, cybersecurity and compliance framework.

CBDC is similar to Traditional money as they both are issued and monitored by RBI and they also share several fundamental characteristics such as: legal tender[1]; government backing and store of value[2]. But they vary a lot in several aspects such as:

Aspect	Traditional Currency	CBDC
Form and format	Physical form (Coins and banknotes) and digital form through traditional banking system.	Only in physical form as electronic tokens in digital wallets, completely paperless.
Technology infrastructure	Conventional banking system.	Advanced technologies like blockchain.
Privacy and traceability	Cash transactions are highly untraceable; only transactions through bank like cheques, DD can be traced.	All transactions are traceable and can be monitored by Central Banks.
Transaction efficiency	Depends on banking hours and intermediaries.	Enables instant and 24/7 transactions.
Programmability features	No programmable capabilities-money functions as a simple medium of exchange.	Offers programmable money features including automated payments, conditional transfers, expiry dates and smart contract functionality.

Table I: Representing the key differences between CBDC and Traditional currency

India however had a revolution in digital payment landscape with the introduction of Unified Payment Interface (UPI) in the year 2016 by the National Payments Corporation of India (NPCI). With approximately over 500 million unique users as of August 2025, UPI has become a default mode of payments for millions, bridging the digital divide and empowering communities. But this should not be confused with CBDC as both vary in some aspects such as:

Aspect	CBDC	UPI
Definition	Digital form of fiat currency[3] issued and backed by the central bank, considered as legal tender.	Payment platform for instant, real-time transfers between bank accounts using mobile devices; not a currency.
Issuing Authority	Issued and regulated directly by the central bank-RBI	Developed and operated by NPCI; regulated by RBI.
Transaction process	Peer-to-peer transfers of currency tokens via digital wallets, without bank intermediaries.	Transfers funds between bank accounts; involves intermediary banks and UPI-enabled apps.
Underlying Technology	Blockchain or Distributed Ledger Technology; direct regulation and settlement.	Immediate Payment Service (IMPS) infrastructure; mobile and app-based interface.
Role and purpose	Can revolutionize monetary policy, financial inclusion, cross-border transactions and government transfers.	Designed for seamless domestic retail payments, bill splits and day-to-day transactions.

Table II: Represents the key differences between CBDC and UPI

[1] *Refers to the currency that is legally recognized and accepted as valid form for payments.*
[2] *Asset that maintains its value over time, allowing individuals to save and retrieve wealth in the future like gold, cash, etc.*
[3] *A type of currency that has no intrinsic value but is instead backed by a government's decree or law. Value is derived from trust and confidence people have on the issuing authority.*

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The CBDCs works in three different models: a. Indirect CBDC; b. Direct CBDC and c. Hybrid CBDC.

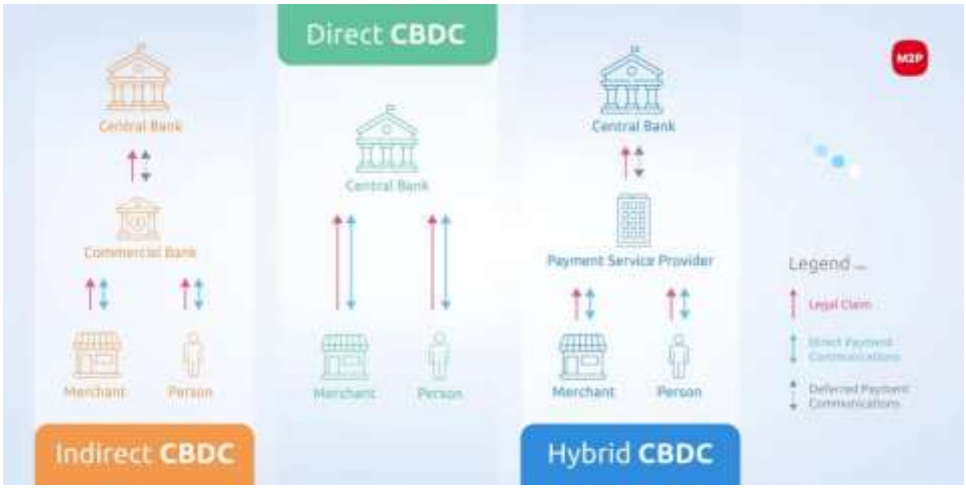

Image I: Representing the working of three models of CBDC. **Source: M2P Blog**

a. **Indirect model:** In this model, the central bank issues digital currency to commercial banks. An individual or merchant would interact with the commercial bank to access and use the CBDC. All transactions like buying something from a store, go through the commercial bank.
b. **Direct CBDC:** This is the simplest model. The central bank directly issues the digital currency to the public. This means you can transact directly with the central bank for all your payments, bypassing commercial banks entirely.
c. **Hybrid CBDC:** this model combines elements of both. The central bank still issues the digital currency, but a payment service provider acts as an intermediary. While the money is a direct claim on the central bank, transactions between an individual and a merchant are handled by this service provider. This offers a balance between direct central bank involvement and the existing payment systems.

CONCLUSION

CBDCs can modernize monetary systems, increase financial access and strengthen sovereign control over payments. The RBI's e-Rupee pilot underscores lessons for global policymakers: a. Careful design balancing privacy, efficiency and security. b. Gradual, flexible implementation tailored to local needs. c. institutional, legal and technological adaptions are perquisites for sustainability. Ongoing collaboration among central banks, private sector and regulators is essential to mitigate risks and maximize benefits as more CBDCs move from concept to reality.

REFERENCES

1. *https://www.investopedia.com/terms/c/central-bank-digital-currency-cbdc.asp*
2. *https://en.wikipedia.org/wiki/Central_bank_digital_currency*
3. *https://coinlaw.io/cbdc-statistics/*
4. *https://www.federalreserve.gov/cbdc-faqs.htm*
5. *https://sdk.finance/central-bank-digital-currency-cbdc-explained-simply-pros-cons-and-real-world-examples/*
6. *https://www.imf.org/en/Topics/digital-payments-and-finance/central-bank-digital-currency/virtual-handbook*
7. *https://www.rbi.org.in/commonperson/english/Scripts/FAQs.aspx?Id=3686*
8. *https://www.bis.org/publ/othp33.pdf*
9. *https://www.sciencedirect.com/science/article/abs/pii/S0304393221000520*
10. *https://www.pwc.in/assets/pdfs/consulting/financial-services/fintech/point-of-view/pov-downloads/central-bank-digital-currency-in-the-indian-context.pdf*
11. *https://m2pfintech.com/blog/central-bank-digital-currency-cbdc-101-a-primer/*