

**A STUDY ON CENTRAL BANK DIGITAL CURRENCY: TECHNOLOGICAL,
MONETARY AND ENVIRONMENTAL IMPLICATIONS ON IMPLEMENTATION IN
INDIA**

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ABSTRACT:

Introduction of CBDCs is in the best interest of RBI, considering the potential benefits that digital money carries. This paper discusses about the implications of introducing a centralized digital currency towards technology, the monetary policy and environment of India and its potential benefits. We show that the introduction of CBDCs in India would depend on different factors such as the Platform, Resilience, Design, Type and so on from the perspective of advancement of digitalization in India, and a need for India to move towards achieving environmental sustainability through this project. This paper highlights on the speculative changes on the policies, that can take place by introduction of CBDCs ; gives an overall insight on the plans that RBI has proposed, on phases of introduction of Indian CBDCs in the near future and how central bank digital currency can help India in reducing the cash management cost & carbon footprint in comparison to other payment systems.

Keywords: Comparative Study, Digital Presence, Service Sectors, Social Media Analysis, Website Analysis.

INTRODUCTION

The idea of centralized digital currency is not today's, but from the 80's. CBDCs which can be centrally controlled & widely accessible & safe amongst users. While other global banks are experimenting on the same, India is also motivated towards introducing a centralized digital currency referred to as **₹ (digital Rupee)**. As payment systems are changing at a rapid pace due to technological advancements, India wants to make use of this era of digitalization to bring in something more resilient & robust in convenience of other aspects of payment systems. As announced by Indian finance minister Nirmala Sitharaman, a Digital Rupee via blockchain & hash-tech will be issued during the year 2022-23, currently, the ministry is working on the pilot stage of implementation. Digital rupee is an attractive & innovative method of money, considering the dangers of cryptocurrency as a threat to financial stability, one of the central

bank's motivations to introduce a risk-free central bank digital currency, which provides vast experiences in dealing with money that is in the digitalized form, without any counter risks associated with the private digital currencies. Along with boosting cross border payments, CBDCs also paves a way towards economical sustainability by reducing the operational costs incurred on the physical bank notes. & Join hands in walking India towards digitalized & cashless economy.

Review of Literature

(Ward, Rochemont, 2019) Actuaries have focused more on Working on the new technologies and International development moving towards cashless society and introduction of new methods of payments, understanding the topic of CBDC for finance and investment professionals with the inclusion of central banks role in presenting the idea, the possible switch from fiat money to electronic currency, the legal tender & the implications and challenges in order to create awareness and implement CBDC in India. Technology is advancing with cryptobased blockchain technology which can be taken as potential advantage to increase and attract investment into this area.

(Kumar, 2021) Kuman in his paper has highlighted the transition from paper to papers transactions in the economy. This paper helps us to understand and study the implications in implementing CBDC on the Indian financial system. As other countries are in the verge of implementation, and some have already implemented the digital national currencies into their financial system, this paper highlights an increase in the number of central banks which are coming up with CBDC, which is the currency which is backed by the central government. Eventhough there are many questions regarding the crypto and the digital currency system, the society's trust is on the central banks guardianship in order to regulate the CBDC's in the country.

(Tripathi, 2022) This paper highlights the importance of such concepts to come into picture in this new early age. This paper helps us understand the potential regulation of cryptocurrencies, the social and societal buzz created in the field of digital currencies and technology coming together in the market and their fiscal benefits. The frameworks used in developing the digital currencies such as hash-tech, POW or POS framework, blockchain technology, adoption of ABFT etc. this paper concludes the merits and demerits on the launch of Indian digital currency based on certain indices which are widely unknown.

(Bhowmik, 2022) This article highlights the advantages of central bank digital currency if implemented in India, and also talks about the current payment situation among the digital banking customers and discusses several analytical frameworks developed by different economists who are into the research of central bank digital currency implementation and issuances, their designs and applications which has a positive impact on the country.

(Dash, 2022) As there is a technological shift in every sector of the economy, the concept of smart banking emergence is essential in the form of digital currency. This paper features about the importance and necessity to adopt digital rupee in India, comparing its economical position and cash orientation. This paper also talks about the socioeconomic and technical challenges in the central bank's monetary policies along with generation 5 (5G) network tech potential to blockchain technology and enhancement of digital rupee transactions along with 5G technology.

(Eichengreen, Gupta, Marple, 2022) This paper proposes a roadmap and timeline for India's central bank digital currency project in view of the arguments about CBDC issuance in India. The payment system enabling cross border transactions, reduced dependence on dollar dominated global payment system and providing global platform for digital innovation. This article also compares the progress of India among the BRICS countries with other countries comparable with levers of per capita GDP.

(Handa, 2022) This paper highlights the future changes in India with accordance to its futuristic revolution in the change of payment system of the country. This article talks about how global pandemic imposed a need for cashless economy and in the Indian payment system & the hard and fast use of technology in order to make thing remote and smooth. His paper helps us understand about the emerging banking systems taking over or even banking system becoming obsolete as the technology is taking over.

(Ozili, Peterson K, 2022) This paper highlights the motivation and merits behind issuance of central bank digital currencies, which has potential to improve Indian monetary policy. India currently is in the need of such digitalized payments in order to increase financial inclusions. this paper focuses more on how the central bank need to give more attention on the design of the CBDC's, to specify the major goals and objectives behind this transformation in payment system and monetary policy. Possibly, there can be a reinvention of CBDC's in the economy harnessing the features of them in a positive way which can change the current central bank objectives towards money supply.

Research Design

Statement of the problem

Implementation of CBDC's in India is to begin by the end of the year. Environmental sustainability being one of the goals & motivation in implementing this project, to cut down on paper currency & popularize electronic form of currency. The peer-to-peer token technology is being tested in this project to work on blockchain like high-tech with government centralization. If implemented, Digital Rupee has a potential to reduce settlement risk in

transactions and being done on the cost of transactions to the lowest in the world. The question here is, using the technology, how are we going to achieve environmental sustainability through implementation of one such initiative of central bank and the government to have 'Digital Rupee' which can change the way of payment and transaction in the coming years.

Scope of the study

India is in the race of dynamicity, Adapting and trying out new technology and also is ahead of many other countries. Central bank digital currencies (CBDCs) are a digital form of currency issued by the central bank of the country, is one such innovative proposal of Reserve Bank of India and the government to have our own centralized digital currency 'Digital Rupee'. This implementation is going to be a revolutionary step in Indian payment system and has a potential to change the way of doing business in India. Right now, the tender is still in the conceptual stage from 2022-23 onwards, which was proposed by the finance minister of India Nirmala Sitharaman, in the Union Budget of India 2022-23. Rising technology growth in India and rapid change in preferences of customers are quite a challenge.

Objectives of the study

- To Understand how central bank digital currency works in a centralized manner.
- To Study about the various technological & Monetary implications that can come towards the implementation of digital Rupee.
- To Understand the changes this project might bring in the financial system after implementation in India
- To Understand how this project can lead us to attain Sustainable Economy

Methods of Data collection

This Research is carried out being secondary & Exploratory in nature. The data collected and analyzed are from the published sources of data which are available in various resources including government publications, business documents and journals based on the theme of the paper.

Sources of Data collection

On the theme of this paper, the data and information are sourced through some of the government articles, press releases, speeches and other online articles. The researcher aimed at collecting 8 research articles, which will be extensively reviewed for the research.

Limitations of the study

On the topic, there are limited quantitative data for thorough analysis and to understand the impact better, as the concept has still not been implemented in real time. Although, based on the researcher's perspective, this study has potential limitations, as there is no previous research done on this topic and the analysis could be purely speculative as the concept is still in the conceptual stage.

ANALYSIS AND INTERPRETATION

Issuance and Management model Of CBDCs

- **Direct Single tier Model:** Direct model of issuance deals with the central bank directly issuing and managing all the aspects of the CBDCs such as issuance, book keeping, accounts, transaction verification etc.
- **Indirect Two-tier Model:** Indirect model deals with the roles given to the central bank and the other intermediaries (banks and any other service providers) in this model, the central bank issues CBDCs to consumers indirectly by the intermediaries, any claims & concerns regarding CBDCs will be handled by the intermediary as the central bank handles wholesale transactions to intermediaries.
- **Hybrid Model:** In this model, the direct issuance on central bank is combined with a private sector layer. Under this model, the Bank will issue CBDC to other entities, when makes those other entities responsible for all activities related to the same. The commercial intermediaries who are the payment service providers, are to provide retail services to the consumers, but the ledger of the retail transactions is retained by the central bank.

Framework of CBDC's

CBDC'S are a new form of digital currency issued by the central bank. it would be very different from the physical cash or the central bank reserve account, which can be stored both as medium of exchange and store of value.

CBDC's are issued by Reserve bank as a legal tender, which can be exchanged at par with fiat money. as this currency is issued and regulated by the Central bank. It would be the liability of the same, & not the commercial banks, which acts as an intermediate between the two transaction parties.

Some of the properties of CBDC's are listed below.

- CBDC's are Issued by the central bank
- CBDC's are in the form of digital currency
- CBDC's have got a wide range of accessibility
- CBDC's uses peer-to-peer token account technology

Core Features of CBDC's

- CBDC's are safe to store by all the users, i.e., government entities, citizens and enterprises
- CBDC's can be easily converted into liquid cash or money against commercial banks
- CBDC's are considered as legal tender for which the currency holders need not have a bank account
- Cost of issuing CBDC's, transaction and money cost are expected to be lower.

Monetary policy implications of introduction of CBDCs

Central banks across the world are experimenting on central bank digital currencies, few countries have also introduced proof/concepts/ pilots on CBDC as well. Government of India, ministry of finance has set up a committee called The High Level Inter-Ministerial Committee (November 2017) which went through the policy and legal regulatory framework of virtual/digital/cryptocurrencies and has recommended CBDC to be introduced in a digital form of fiat money in India. Currently, RBI is also exploring towards the advantages and disadvantages of introducing central bank digital currency since a while.

Other countries have implemented CBDCs in segments in wholesale and retail. In India, the introduction of specific purpose CBDCs are currently being studied and will be evaluated post-launch. RBI is currently working on implementation of CBDCs in phases to understand the impact and provide enough space for correction, so that the introduction could be done with minimal or no disruption.

Key Issues under this examination are:

- (i) The scope of digital currency, as whether they should be used in the retail payment segment or in the wholesale payment
- (ii) The choice of technology or platform to be used, whether it should be distributed ledger or a centralized ledger.

- (iii) The validation mechanism, should they be account based or token based
- (iv) The distribution mechanism, weather the CBDCs to be directly issued by RBI or through other commercial banks

Conceptually, we are expecting a major change in the art of money supply and the public holdings post he issuance of CBDC's, right now the impact cannot be gauged. Expecting a large demand for central bank digital currency in the country, the banking system should ensure more security and liquidity to offset any technological risk arising in the system.

lately, discussions about negative interest bearing CBDC's are in the field, as due to the shift to cash, negative interest rate would become ineffective. however, when the currency itself carries negative interest rates, there would be a spike in monetary transmission of negative interest rates which would possibly increase demand and would result in success. thus, CBDC would be considered as a novel tool for unconventional monetary policy to encourage moneysupply. According to the BIS CPMI-MC report of 2018, the impact of CBDCs on the monetary policy depends upon the way it is designed and the amount of usage.

The factors that depend on the policy decisions are:

- Renumeration and non-renumeration of CBDCs
- Weather it would be used as widely as the physical currency, or will it be limited only for the whole sale users such as banks (or as central bank reserves)
- Weather the ownership of the digital currency user be identifiable, like bank transaction trails or will it be anonymous like other physical currencies such as cash
 - CBDCs could be used as safer substitute to bank deposits, it earns no interest income unlike physical cash but functions as physical cash. CBDCs are wholly guaranteed by the central bank & there is no risk of loss of money or the face value, and can easily be stored in larger amounts.
 - Any amount of fall in the bank lending would reduce the importance of lending in overall monetary policy transmission. Such issues can be dodged by setting holding limit & transaction limit on CBDCs in the banks.
 - On the other hand, Interest bearing CBDCs can help increase the efficiency of monetary supply. As people might shift from bank deposits to CBDC.s which increases deposit outflow. This technique is possible if there is high insertion of liquidity and should be regularly injected by

- The banking system as there will be deposition competition amongst banks in order to increase their deposit rates, CBDC can help banks in achieving these deposit rates provided they are bearing interests.
- Currently at the pilot stage, the actual impact on monetary policy due to the introduction of CBDCs would be purely speculative, as very limited countries have issued CBDCs and are limited in existence.

Technological considerations of CBDCs

Technology Architecture Options

Technology has helped India to establish large scale client server designs which are already implemented in sectors like banking, retail, healthcare etc.

DLT or non-DLT

Implementation of CBDCs could be based on a conventionally/ centrally controlled database, or a **distributed ledger technology (DLT)**. It is based on the method of data updating.

In conventional databases, resilience is ensured on storage, as it is controlled by one central authority, on the other hand, DLT based systems are usually managed jointly by multiple entities in a decentralized manner. DLT enables lower transactions compared to conventional architectures. Thus, comparing to the number of digital transactions, DLT is not quite feasible technology except for a very small jurisdiction.

Scalability of CBDCs

The system to be able to hold the likely volume of transactions (billions per day) thus the implementation design should be such that it has a scope to be expanded in the future and can be used in large scale deployments without being reworked or redesigned.

Offline Functionality of CBDCs

Traditionally, digital payments rely upon inline interface with many intermediaries such as banks, payment gateways, processors etc. to authorize and process the transactions. These payments would only be possible if there is continuous feed of internet facility. This can also be a challenge in implementing CBDCs in India as the users in India, out of the 1.4 billion population, 852 million people have internet access. This would restrict the use of CBDCs for

many Indians due to lack of internet connectivity. to mitigate this problem and ensure overall use of CBDCs, necessary steps have to be taken and offline access has to be incorporated.

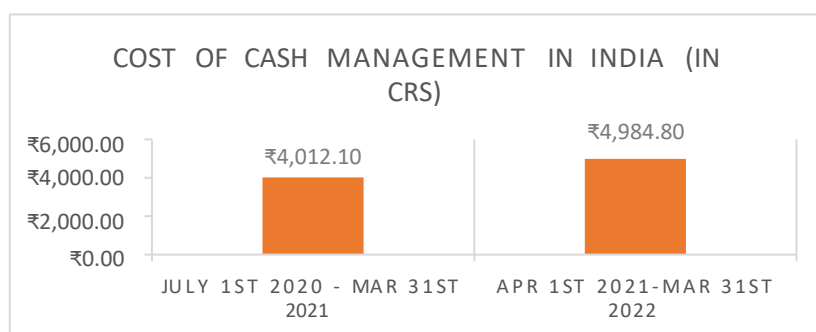
According to the report published by **Bank of Japan (BOJ)** exploring on possibilities of potential of offline usage of digital yen CBDCs through including an IC chip on a SIM card with a feature phone rather than smartphone. The report also suggests that the application would not be user friendly is also experimenting on their PASMO cards which are used for ticket booking & electronic money.

VISA has also proposed **offline payment system (OPS)**. This enables CBDCs to be directly downloaded to a smartphone or tablet. The storage would be secure and hardware embedded in that device, which is similar to wallet but offline. These stored CBDCs can be sent from one device to another directly without the help of any intermediaries or payment processors using Bluetooth or **near field communication (NFC)**. However, there is a risk of double spending in offline transactions. This risk can be mitigated by providing technical solutions and rules such as monetary limit setup.

This system can be more resilient in remote places where there is limited access to electricity and mobile networks. Wallets must be able to verify the authenticity of transactions without communicating to the central server during transactions. There would be a need to find a solution in case of offline transactions, where there would still be a need for network connection and power facilities to sync the wallet balances with the central servers,

Without which, offline CBDCs would not be found as an attractive medium of payment method for a vast number of users.

Environmental implications of CBDCs



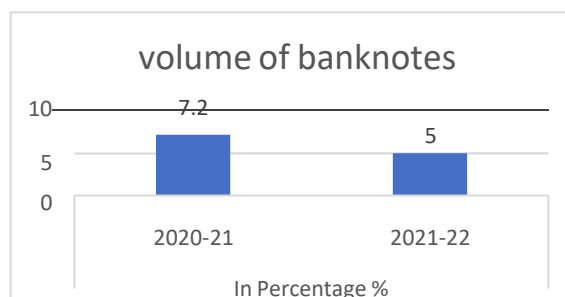
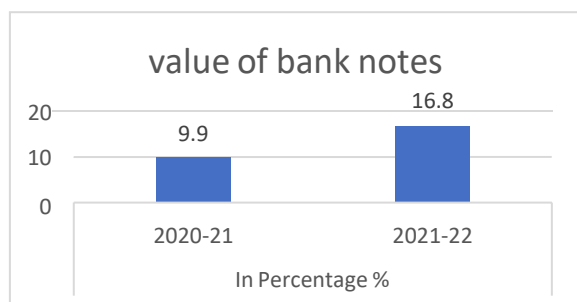
the total expenses incurred on cash management during 2021-22 was ₹4,984.80, against ₹4,012.10, the previous year cost of 2020-21. these costs do not include ESG. the overall cost

of money printing seems to have been increased, and are to be borne by the central bank and its stakeholders.

CBDCs helps in reducing overall operational costs which is related to printing, storage, transportation and replacement of notes and the costs along the lines of settlement. Although the overall issuance and establishment, fixed infrastructure cost might be incurred on a higherscale, but on the long-run, the subsequent marginal operating costs will fall low.

The concept of cost-effective cash management using CBDCs gives additional push for introduction of CBDCs in India, which is also perceived to be green money. India is a countryof large-scale transactions, that is where CBDCs helps in cost reduction of many processes associated with movement of physical cash across the country. CBDCs can ensure seamless transactions across the geography as making physical cash available in that spread is achallenge.

India currently moving towards digitalization and cashless economy, the pace of growth of electronic medium payment is high and has not resulted in reduction of physical cash demand.



Source: RBI Annual Report for the year (2021-22)

The percentage of value in banknotes have increased and the volume of the banknotes have been decreased in the current year 2021-22 compared to the previous year 2020-21. The adoption of digital payments across the country is demonstrated by The **Reserve Bank DigitalPayment index (RBIDPI)**.

The consensus mechanism of CBDCs should be appropriately measured while choosing blockchain technology as a design for the ledger infrastructure to maintain all the confidentialinformation recorded within the blockchain network. Different consensus mechanisms have different impact on financial and security aspects, also will affect different energy consumptionlevels. i.e., the centralized existing digital money system will have low energy consumption,

low security advantage, and high performance, where the Nakamoto network (bitcoin) has high energy consumption, high level security and low performance.

CBDCs environmental footprint compared with other payment methods

Cryptocurrency

Cryptocurrency is an energy intensive mechanism with high level of security under a decentralized ecosystem. It can be a challenge for cryptos to operate on a reduced energy level for that of the existing value. The negative side of cryptocurrencies is that the energy consumption is high and there is a negative impact on the environment, that is one concern on the critical side of cryptos.

The energy consumption of cryptocurrencies varies depending on their type and the underlying structure. Ethereum is currently using **Proof-of-work sybil resistance mechanism**. In response to the call of green money and sustainability, the recent adoptions of cryptocurrencies are more eco-friendly mechanisms. However, CBDCs are different when it comes to energy consumption structure, because it is backed by the central bank, and the environmental footprint is higher compared to other existing digital money system than cryptocurrencies

Cash and card network

In efforts to verify climate payment methods, **De Nederlandsche Bank (DNB)** evaluated the environmental impact of debit card payments. It is said that the ecological impact is 1.5 times higher than the debit card payments. It is estimated that the energy consumption of card is comparatively lesser than cash and blockchain assets. The paper lifecycle is hard to trace because of the factors like raw materials used and in different countries. The cards including debit and credit cards consume less energy compared to other payment methods. As seen the numbers are far less than those of cryptocurrencies & Paper money. In comparison to these methods, introducing CBDCs would also help in improving the cost & environmental sustainability of payment systems.

Even though there are certain drawbacks that cannot be directly faced while comparing the ecological sustainability of the future CBDCs with other payment methods, such as cryptos which consume high energy, followed by card and physical cash. We see similar characteristics between card network and CBDCs.

Pilot launch of CBDCs in India

CBDC was launched in India on December 1st 2022, over Closed user groups (CUG), for Merchant participants. e₹-R will be issued as token technology, same as the denominations of paper currency, this digital currency will be distributed through intermediaries i.e., banks. The users can transact this money through a digital wallet offered by the banks which will be stored in mobile phones / smart devices. The transactions will take place in both person to person (P2P) & person to merchant (P2M). Similar to UPI payments, a QR code will be displayed in payment locations.

Introduction to CBDCs in India will be a phase wise implementation, based on the learning of this pilot, future designs and architectures of CBDCs will be tested further. The reserve bank of India has identified 8 banks as participators. For the pilot phase 4 banks have been selected, viz., SBI, ICICI Bank, YES bank & IDFC First bank in 4 cities across the country viz, Mumbai, Delhi, Bengaluru & Bhubaneswar, which will be later put out to Ahmedabad, Gangtok, Guwahati, Hyderabad, Indore, Kochi, Lucknow, Patna & Shimla. Bank of Baroda, HDFC bank, Kotak Mahindra bank, Union bank of India will be added subsequently as and when more banks and locations are needed.

FINDINGS

- The High Level Inter-Ministerial Committee (under ministry of finance) recommends CBDC to be introduced in a digital form of fiat money in India.
- Interest bearing CBDCs can help Indian economy by increasing the efficiency of monetary supply as people find CBDCs reliable than bank deposits.
- CBDCs can be an effective tool to unconventionally encourage money supply
- challenge in implementing CBDCs in India as the users in India, out of the 1.4 billion population, 852 million people have internet access. This can be more resilient in remote places and where there is no connectivity, offline functionality can also be tested
- CBDCs helps in reducing overall operational costs which is related to printing, storage, transportation and replacement of notes and the costs along the lines of settlements
- the total expenses incurred on cash management during 2021-22 was ₹4,984.80, against ₹4,012.10, the previous year cost of 2020-21, which can be reduced by introducing CBDCs in the economy
- CBDCs gives additional push for introduction of CBDCs in India, which is also perceived to be green money. India is a country of large-scale transactions, that is where

CBDCs helps in cost reduction of many processes associated with movement of physical cash across the country.

- Digitalization in India has an impact on the value of bank notes which has been increased from 9.9% in the year 2020-21 to 16.8% in the year 2021-22. parallelly the volume of bank notes has been fallen down from 7.2% in the year 2020-21 to 5% in theyear 2021-22.
- Comparatively, blockchain technology consumes high-energy with low performance from that of the central digital currency model
- CBDCs are much energy conservative and helps in ecological fingerprinting. Comparing to the other payment methods such as cryptos, digital money, cash and cardsettlements.
- 4 commercial banks have been chosen for the pilot phase of implementation as of December 1st 2022, SBI, ICICI Bank, YES bank & IDFC First bank in 4 cities across the country viz, Mumbai, Delhi, Bengaluru & Bhubaneshwar.

SUGGESTIONS

- At the current scenario, introduction of CBDCs could be a challenge, at the pilot stage, government may incur prototype cost, test run & evaluation cost etc. for which the budgethas to be prepared for the following year.
- Government of India on hands with reserve bank of India should help in raising awarenessabout the central bank digital currency and how it is different from other digital payments such as cryptocurrencies amongst users.
- Central bank should start building a prototype and start testing and evaluation of CBDCs and its technological platforms in India
- Central bank should ensure robust means in Backing up CBDCs, setting up concrete policies such as financial, technological etc.
- Central bank should focus on mitigation of operational risk in the banking sector for efficient usage of CBDCs
- Central bank should consider implementation of CBDCs in the near future, engaging on the technological and ecological advantage.
- Central bank should Inject financial motivation by providing quality interest rates on interest bearing CBDCs to attract deposits

CONCLUSION

- Introduction of CBDCs can change the paradigm of the payment and money supply system of India, there are many central banks experimenting on CBDCs across the countries, which are in conceptual, developmental & pilot stages. The central bank needs to understand the intended benefits which flows along the introduction of a centralized digital currency in the country, considering the needs or steps to be taken in aspects like technology, platform, design & development which suits the requirements of the economy CBDCs also carry potential & significant benefits such as reduction on paper money, higher resilience in transactions, lower transaction costs & reduced operational risk. CBDCs are safer, efficient & trusted as it is regulated as a legal tender payment option, backed up by the central bank. RBI while moving forward in the direction of CBDCs, has to take necessary steps as it would have a big impact on the payment systems in India. Going forward, CBDCs could be introduced with careful understanding and with novel approach considering the stakeholders notice, technological and any other challenges associated with CBDCs should be attended in importance as well. Currently, India is moving towards pilot stage of introducing CBDCs and making necessary arrangements for the same, starting with the use of pilot CBDCs in secondary market transactions & in government securities in a closed user group, which might happen around 2022-2023.the further updates regarding the introduction of CBDCs in India will happen afterthe pilot launch on December 1st 2022.

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