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Review Article

e₹—The digital currency in India: Challenges and prospects

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ABSTRACT

The Reserve Bank of India (RBI) has recently launched the country's first pilot project for the digital currency known as the digital rupee or e-Rupee (e₹). The launch of the digital rupee represents a significant advancement in the "Digital India" revolution. It will be a fantastic opportunity for India since it might make conducting business easier while enhancing the security and resilience of the overall payments system. Digital currency attempts to rapidly progress monetary policy to disrupt physical money, lower the cost of financial transactions, and reshape how the money will circulate. Although the effects of digital currency cannot be foreseen, it is extremely important to thoroughly research digital currency and its effects on the operational stage. The development of a digital currency infrastructure has some challenges in terms of performance, scalability, and different usage scenarios. The article clarifies what e₹ is. How does it work? What makes it different from cryptocurrencies? What are the major challenges and prospects for it in India?

1. Introduction

The shape and purposes of money have changed over time as a result of how the economy and payment system have developed. The evolution of the concept of money from Commodity to Digital Currency is shown in Fig. 1.

India has made remarkable strides in digital payment innovation. Digital currency is not a new concept. We already make regular payments using digital methods such as Real Time Gross Settlement (RTGS), National Electronic Funds Transfer (NEFT), and Immediate Payment Service (IMPS). They are secure, effective, and accessible 24 × 7. Recently, UPI (Unified Payments Service), a revolutionary payment system, has had a significant impact on the nation's economic system and has become a model for other nations looking to develop a scalable, convenient, and real-time payment system. The objective of all digital payment methods is to offer consumers an alternative mode of paying physical cash [1]. Cryptocurrency is a type of digital currency where transactions are verified and records are kept by a decentralized system employing encryption [2]. The showrunner of cryptocurrency is the blockchain [3] or a distributed ledger that keeps track of transactions and distributes access to the authorized users. There are already thousands of different digital currencies, which are collectively referred to as cryptocurrencies. The most well-known example of a fully decentralized, peer-to-peer cryptocurrency is Bitcoin. The Bitcoin debut in 2009 is still a favorite among investors and miners. It sparked the "revolution" in cryptocurrencies that gave rise to many well-known coins including Ethereum, Litecoin, Tether, XRP, etc. India opposed the use of Bitcoin and other cryptocurrencies for many reasons. One reason is that the government is concerned about the potential for money laundering and financing of illegal activities using these digital assets. The Reserve Bank of India (RBI) does not have any control over the transactions of cryptocurrencies. Another reason is that the use of cryptocurrencies could potentially lead to a decline in demand for traditional fiat currencies, such as the Indian rupee, which could in turn have negative impacts on the country's economy. In addition, there are concerns about the volatility of the prices of cryptocurrencies and the lack of regulatory oversight in the market. People were alerted in April 2018 that cryptocurrencies are not accepted as legal currency in India [4]. In 2019, the finance ministry drafted a bill prohibiting cryptocurrency mining, ownership, sales, issuance, transfers, and use in India. A person might face a hefty fine or up to 10 years in jail if proven guilty of violating the law. The Supreme Court of India, however, removed the restriction in March 2020 [5]. Then the finance ministry declared that cryptocurrencies would be subject to a 30% tax as well as the launch of India's own CBDC, known as the digital rupee, in the Union Budget 2022–2023. The Reserve Bank of India (RBI) launched the country's first pilot project for digital currency e₹ (e-Rupee) on 1st December, 2022 [6].

e-Rupee, a digital version of Indian Rupee would be a central bank digital currency (CBDC) backed by RBI. The introduction of a new CBDC may worry the cryptocurrency world because of the confusion around it. With the intention of cutting away the middleman and designing a system of trust independent of any organization, cryptocurrencies were created. The e-Rupee, which is only the digital equivalent

Abbreviations: CBDC, Central Bank Digital Currency

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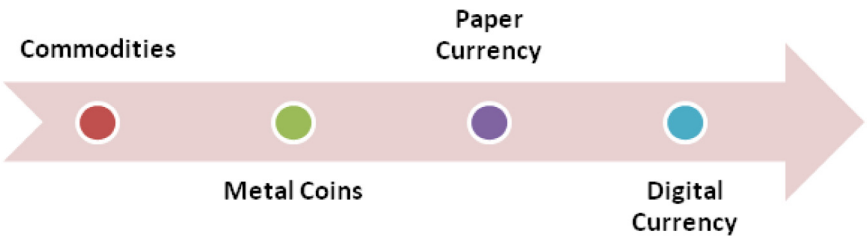

Fig. 1. The evolution of payment system.

of fiat currency, would once again rely on RBI. It is possible that the e-Rupee would be available for use through a digital wallet or banking app. The digital rupee could help to reduce the reliance on cash by providing a secure and convenient alternative for making payments. The success of e-Rupee, will depend on a number of factors, including user adoption, merchant acceptance, regulatory backing, and public confidence. It would probably need to take into account a variety of technological, legal, and regulatory challenges and implement the necessary solutions.

The structure of our paper is organized as follows. Section 2 provides an overview of digital currencies. Section 3 explains operating procedure of e-Rupee. Section 4 suggests a general architecture of an e-Rupee system based on a private blockchain network. Section 5 analyzes the feasibility of the scheme. Section 6 compares e-Rupee with some other CBDCs. Section 7 discusses the future prospects of e-Rupee. Section 8 highlights the limitations of e-Rupee. Section 9 concludes the paper with some remarks.

2. Digital currencies

Digital currencies are a type of currency that exists solely in digital form, without a physical counterpart like paper money or coins. They are often used for online transactions and can be transferred electronically between parties. Digital currencies continue to gain popularity and are increasingly being adopted by businesses and consumers around the world. Digital currencies can be broadly divided into two categories: Central Bank Digital Currency (CBDC) and Cryptocurrency.

2.1. Central Bank Digital Currency (CBDC)

CBDCs are digital versions of traditional fiat currencies issued and backed by central banks. CBDCs can be used for a variety of purposes, such as facilitating cross-border payments, reducing the costs of cash management, and improving financial inclusion. CBDC can use blockchain technology, but it is not a requirement [7,8]. CBDCs can be implemented using a variety of technological approaches. Blockchain technology is one possible approach for implementing CBDCs, as it provides a distributed and transparent ledger that can be used to track transactions and ensure the integrity of the currency. Some central banks are exploring the use of blockchain technology for CBDCs, such as the Central Bank of the Bahamas which launched the Sand Dollar, a digital version of the Bahamian dollar that uses blockchain technology [9,10]. However, other central banks are exploring alternative approaches for implementing CBDCs, such as using a centralized database or a hybrid solution that combines centralized and decentralized elements. The choice of technological approach will depend on various factors, including the specific goals of the CBDC, the existing financial infrastructure, and the regulatory environment in which it will operate.

2.2. Cryptocurrency

Cryptocurrencies are digital or virtual currencies that use cryptographic techniques to secure transactions and control the creation of new units. Most cryptocurrencies are built on blockchain technology, which is a decentralized, distributed ledger that records transactions in a verifiable and permanent way [11]. A blockchain consists of a series of blocks that contain a set of transactions, and each block is connected to the previous one in a chain-like manner. Blockchain-based currencies are a revolutionary development in the world of finance and technology [12]. Transactions are validated by a network of users, who are rewarded with new units of the cryptocurrency for their efforts. Cryptocurrencies are decentralized, so they are not controlled by any central authority or financial institution, meaning that they are not subject to the same level of regulation as CBDCs or traditional fiat currencies. Public and private key cryptography is used to secure transactions, with public keys being used to receive payments and private keys being used to access and control a user's cryptocurrency holdings. Mining is the process by which new units of a cryptocurrency are created and added to the blockchain, with users solving complex mathematical problems to validate transactions. This process is computationally intensive and requires a significant amount of computational power, which is why some cryptocurrencies require specialized hardware (i.e. high-end GPU-equipped computer) to mine. Everything that is recorded on the blockchain is transparent and unchangeable, meaning that it cannot be altered by any means. Cryptocurrencies use consensus mechanisms to validate transactions and to ensure that the blockchain remains secure and tamper-proof. There are several different consensus mechanisms, including Proof of Work (PoW), Proof of Stake (PoS), and Delegated Proof of Stake (DPoS). Each mechanism has its own advantages and disadvantages, and the choice of mechanism can have a significant impact on the speed, scalability, and security of the network. Cryptocurrency wallets allow users to store, manage, and transfer their cryptocurrency holdings with different levels of security and convenience. Cryptocurrencies are often used as a means of exchange, and they can be bought and sold on online exchanges or traded peer-to-peer. There are many different cryptocurrencies, each with its own unique technical specifications and features. The transaction process of Bitcoin has been shown in Fig. 2 [13]. The key differences between the CBDCs and cryptocurrencies are shown in Table 1.

Table 1
CBDCs vs. Cryptocurrencies.

Digital Currencies	CBDCs	Cryptocurrencies
Issuance:	issued and backed by the central bank	created through a process called "mining"
Regulation:	same level of regulation as traditional fiat currencies	generally less regulated
Decentralization:	may use a private blockchain	operate on a public blockchain in a decentralized network
Use cases:	exchange and store of value	exchange, store of value, as a platform for decentralized applications etc.

3. How will e₹ work?

e₹ (e-Rupee or digital Rupee) aims to provide a simple, secure, and convenient payment system that can be used by all sections of society,

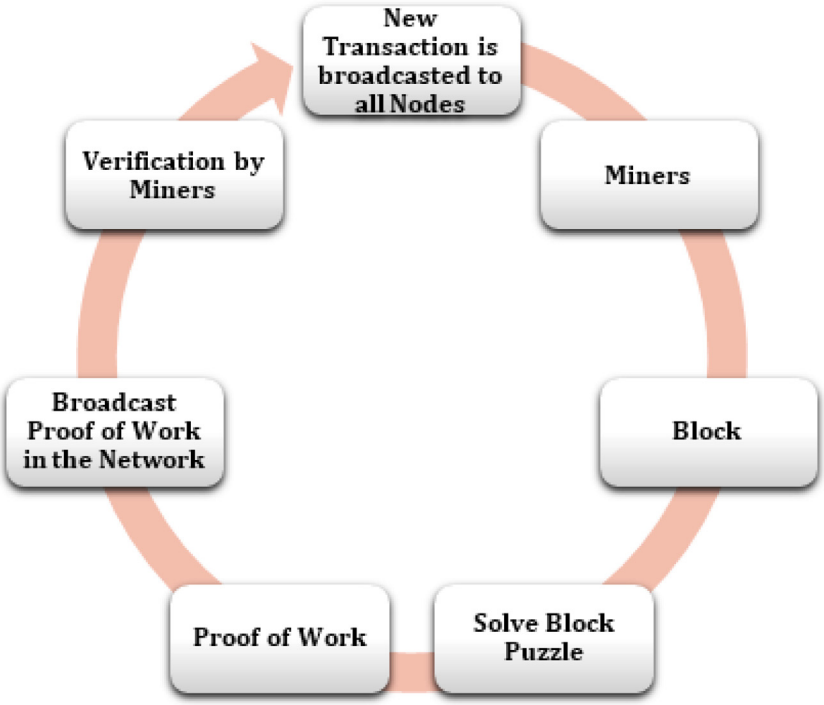

Fig. 2. Bitcoin transaction process.

Table 2
Token-based e₹ vs. Account-based e₹.

Token-based e-Rupee	Account-based e-Rupee
It is represented as a digital token on a blockchain.	It is not represented as a digital token on a blockchain.
It is a unique digital asset and can be transferred from one person to another through transactions.	It is not a standalone digital asset, but rather a balance that is associated with a user's account.
It can be exchanged for other cryptocurrencies or fiat currencies	It can only be used within the system in which it is issued, and it cannot be exchanged for other currencies.

including those who do not have access to traditional banking services. By promoting digital payments, e₹ is expected to help reduce the use of cash in the economy. Many people believe that e₹ is India's own version of cryptocurrency. However, the e-Rupee and cryptocurrency are not exactly the same. Like other CBDCs, the digital Rupee would be a digital version of physical cash and could be used in the same way as physical cash is used. It would be intended to be used as a means of exchange and store of value, similar to traditional fiat currencies. The e-Rupee will be given through the intermediate banks in the same denominations as coins and paper notes. Users have the option of purchasing digital Rupee through the designated banks, the official app, or the website. It is important to note that the digital Rupee is still in its infancy and that its functioning is not yet completely known. There are two different ways in which e-Rupee can be implemented namely Token-based e₹ and Account-based e₹. The differences between these two have been provided in Table 2.

It was made clear by the RBI that both Person to Person (P2P) and Person to Merchant (P2M) transactions are allowed. All transactions may adhere to one of the following models like other CBDCs [14].

(i) Direct Model: In this model, all transactions are processed by a central authority (RBI). The central authority is responsible for issuing e-Rupee, maintaining the ledger of all transactions, and ensuring that the e-Rupee supply is kept in check. It is also called the single tier model (Fig. 3).

(ii) Two Tier Model: It is also known as the indirect model (Fig. 4). In this model, all transactions are processed by both a central authority (RBI) and a network of decentralized nodes. The central authority is responsible for issuing e-Rupee and maintaining the ledger of all transactions, while the decentralized nodes are responsible for verifying and recording transactions on the ledger.

(iii) Hybrid Model: The hybrid model is a type of e-Rupee architecture that combines elements of both the single tier and two-tier models (Fig. 5). In this model, a central authority (RBI) is responsible for issuing e-Rupee and maintaining the ledger of all transactions, while a network of decentralized nodes is responsible for verifying and recording transactions on the ledger. The hybrid model is designed to provide the benefits of both the single tier and two-tier models, while minimizing their respective drawbacks.

The general procedures for generating and distributing a central bank digital currency (CBDC) backed by the Reserve Bank of India (RBI) are depicted in Fig. 6. The technologies used in CBDCs can vary depending on the design and implementation of the specific CBDC, but some common technologies that can be used include:

• Distributed Ledger Technology (DLT): CBDCs can be built on DLT platforms such as blockchain, which allows for decentralized and secure record-keeping of transactions.

• Smart Contracts: CBDCs can use smart contracts, which are self-executing contracts with the terms of the agreement directly written into code. This can help automate processes and reduce transaction costs.

• Cryptography: CBDCs can use cryptography to secure transactions and prevent fraud. Techniques such as digital signatures, hashing, and encryption can be used to ensure the authenticity and confidentiality of transactions.

• Application Programming Interfaces (APIs): CBDCs can use APIs to integrate with existing payment systems and infrastructure. This can enable seamless transactions between different payment systems and increase interoperability.

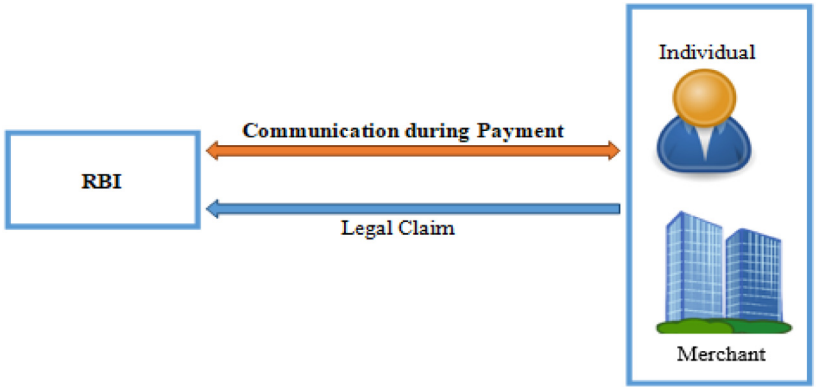

Fig. 3. Direct model.

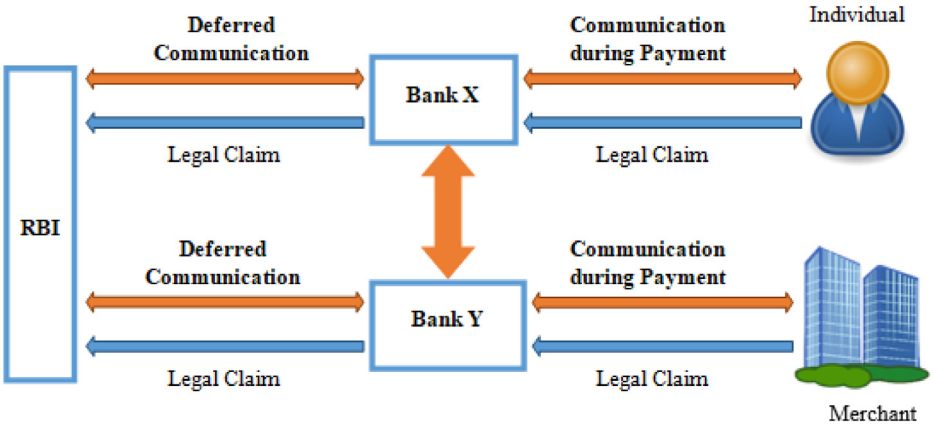

Fig. 4. Two-tier model.

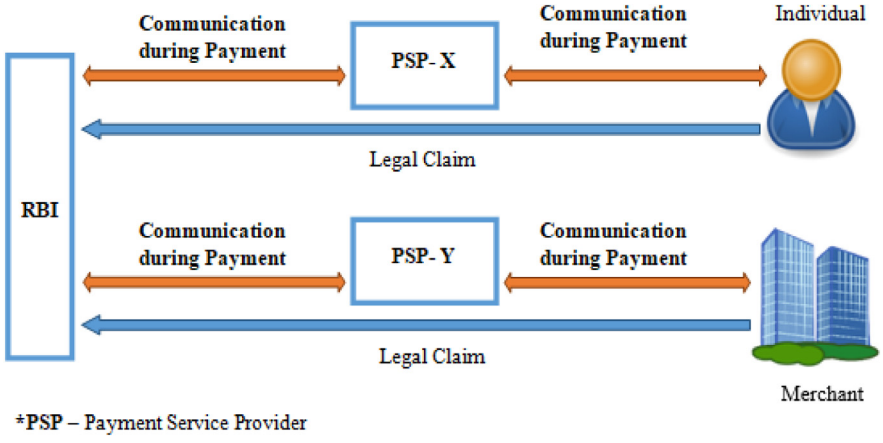

Fig. 5. Hybrid model.

• Mobile Wallets: CBDCs can be stored and transacted using mobile wallets, which can be downloaded as mobile applications. Mobile wallets can provide a user-friendly and accessible interface for CBDC transactions.

• Digital Identity: CBDCs can be linked to digital identity systems, such as biometric identification or national identification systems. This can help ensure that CBDC transactions are secure and authentic.

Overall, the technologies used in CBDCs are designed to provide a secure, reliable, and accessible digital currency that can be used for everyday transactions. By leveraging advanced technologies, CBDCs can offer many advantages over traditional fiat currencies, such as faster transaction speeds, reduced transaction costs, increased security, and greater financial inclusion.

4. Proposed e₹-Architecture

The specific architecture of an e-Rupee system will depend on a variety of factors, including the goals and requirements of the system, the technological capabilities of the system, and the regulatory environment in which the system operates. We propose an overall system architecture that can be split into two parts: a Private Blockchain network that runs the Reserve Bank and all licensed banks, and a Consortium Blockchain that runs the transactions between customers,

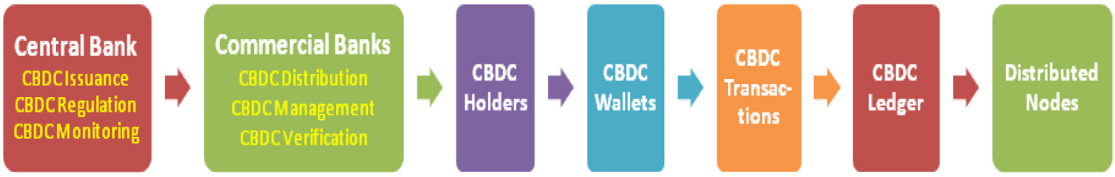

Fig. 6. CBDC process flow diagram.

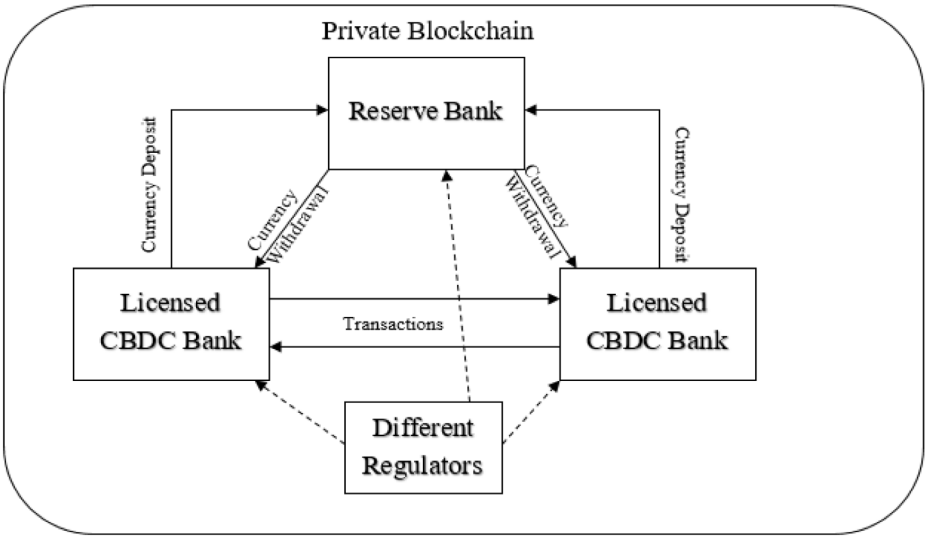

Fig. 7. Private blockchain.

account holders, businesses and licensed banks with or without third-party apps. Private blockchain and consortium blockchain are the two forms of blockchain networks that are intended for private, closed access.

4.1. Private blockchain

While the volume of transactions handled by licensed banks and the reserve bank is expected to be high, a private blockchain network that is more efficient is required. The nodes in a private blockchain are managed by a single company, and transactions can be processed swiftly and effectively. Private blockchain uses a consensus process that can be tuned for speed, as there are fewer nodes to reach consensus with. In the suggested concept, the Regulatory compliance agencies (SEBI, Income Tax Authority, CAB, and Enforcement Directorate) can also be included to a private blockchain for transaction monitoring and auditing. CBDC can be implemented using a private blockchain.

4.2. Consortium blockchain

Consortium Blockchain is a type of blockchain network where multiple organizations or entities come together to form a decentralized network. This type of network is suitable for digital currencies issued by central banks, known as Central Bank Digital Currency (CBDC), because it provides a balance between privacy, security, and scalability. Also, in the Indian economy scenario as there are multiple third party apps, and many licensed banks, creating a consortium blockchain network will provide a secure, privacy-proof network. All the digital applications need to have in-built operation interoperability to perform transactions between CBDC and UPI, NEFT, RTGS or instant money transfer.

The architectures of the private blockchain and consortium blockchain have been shown in Figs. 7 and 8 respectively. Private and consortium blockchain technology offer certain advantages over public blockchain technology, including:

• Privacy: Private and consortium blockchains offer greater privacy than public blockchains, as access to the network is restricted to authorized users. This can be particularly important for organizations that deal with sensitive or confidential data.

• Scalability: Private and consortium blockchains can be more scalable than public blockchains, as they do not require the same level of computational power to maintain the network. This can make them more cost-effective and efficient for certain types of transactions.

• Governance: Private and consortium blockchains offer greater control over the network, as they are governed by a single entity or a group of entities working together. This can make it easier to implement changes and updates to the network, and can also provide greater accountability.

• Flexibility: Private and consortium blockchains can be customized to meet the specific needs of the organization or consortium using them. This can make them more flexible than public blockchains, which may not be able to accommodate certain types of transactions or use cases.

• Compliance: Private and consortium blockchains can be designed to comply with specific regulatory requirements, which can be important for organizations operating in heavily regulated industries such as finance or healthcare.

5. Feasibility analysis

The Reserve Bank of India (RBI) is exploring the possibility of launching a digital version of the Indian Rupee. However, we can still discuss the theoretical and implementation feasibility of digital currencies in India based on available information and general trends.

5.1. Theoretical feasibility

Theoretically, a digital currency in India could provide several benefits, including:

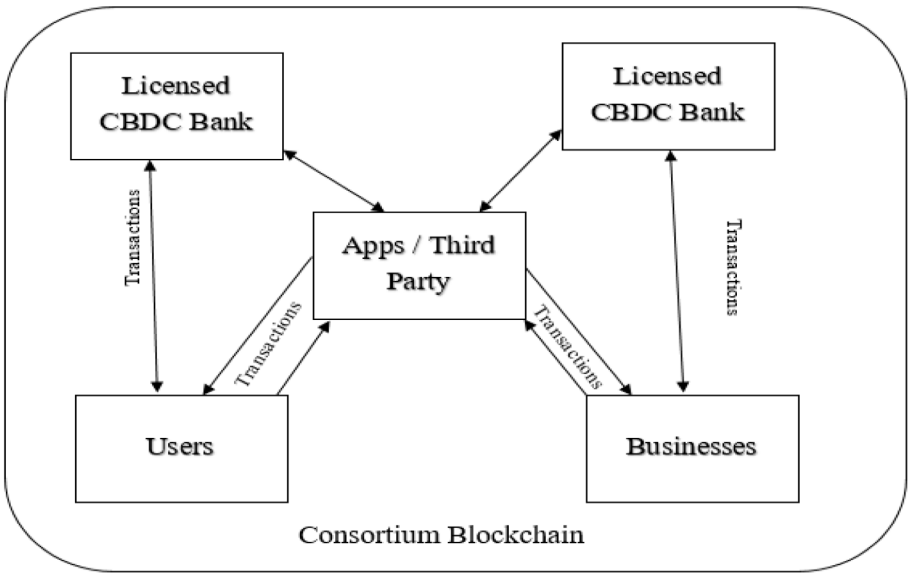

Fig. 8. Consortium blockchain.

- Increased Financial Inclusion: India is a country with a large population of unbanked individuals who do not have access to traditional financial services. A digital currency could provide these individuals with a low-cost and accessible means of transacting value, enabling greater financial inclusion.
- Reduced Transaction Costs: Digital currencies can potentially reduce transaction costs by eliminating the need for intermediaries such as banks and payment processors, which could lead to greater efficiency and lower costs for consumers and businesses.
- Improved Transparency: Digital currencies have the potential to increase transparency in financial transactions, making it easier to track money flows and prevent fraudulent activities such as money laundering.

5.2. Implementation feasibility

The implementation of a digital Rupee system in India will require a significant and reliable technical infrastructure and regulatory support that can handle large volumes of transactions and ensure the stability of the digital currency. Here are some of the key factors that would impact the implementation feasibility:

- Technical Infrastructure: Implementing a digital currency requires robust technical infrastructure that can support the transactional volume and speed required for a large-scale digital currency system. This would require significant investment in hardware and software, as well as cybersecurity measures to ensure the security and integrity of the system.
- Regulatory Framework: Digital currencies operate in a legal and regulatory environment that must be supportive and well-defined. India has a complex regulatory environment for financial services, and any digital currency project would need to operate within this framework while also addressing issues such as data privacy and security.
- Public Acceptance: The success of any digital currency project depends on the acceptance and adoption by the public. India is a country with a diverse population and varying levels of technological literacy, and any digital currency project would need to address these factors to ensure widespread adoption.

In summary, the theoretical benefits of a digital currency in India are clear, but the implementation feasibility will depend on a range of factors, including technical infrastructure, regulatory framework, and public acceptance. It remains to be seen whether the RBI will proceed with a digital currency project, but it is clear that any such project would require significant investment, planning, and regulatory support.

6. Comparison of e₹ and other CBDCs

CBDCs are designed to provide a secure, efficient, and reliable means of transacting digital currency, and to complement or replace physical cash in the economy. Several countries were exploring the possibility of launching central bank digital currencies (CBDCs). The People's Bank of China is one of the furthest along in developing a CBDC, known as the Digital Currency Electronic Payment (DCEP) [15,16]. The Central Bank of the Bahamas has already launched a CBDC in 2020 known as the Sand Dollar [9]. The Riksbank, Sweden's central bank, is exploring the potential launch of an e-krona [17], which is expected to be an account-based system, with users storing their e-krona in a digital wallet. It will be interesting to see how these systems continue to evolve and differ from one another. However, it is difficult to compare the specifics of different CBDCs, as each country will have its own unique set of circumstances, needs, and objectives. Table 3 provides some of the basic differences among e-Rupee and these three CBDCs.

7. Prospects of e₹

Digital Rupee could offer several potential advantages over physical currencies in India, especially in terms of increasing efficiency, promoting financial inclusion, and improving security and transparency in the payment system. e-Rupee is probably simpler, faster, and less expensive and will offer every transaction advantage available with other types of digital currency. It is essentially identical to banknotes. The digital Rupee has the potential to bring significant benefits to the Indian economy and society by reducing the reliance on cash, and modernizing the financial system. The following arguments support the notion that the digital Rupee is the currency of the future:

7.1. Centralized

The Indian government has expressed an interest in promoting the use of digital currencies, and has taken steps to support the development and adoption of e-Rupee. This could help to increase trust in e-Rupee and encourage its use. The government will recognize

Table 3
Comparison among different CBDCs.

CBDC	e-Rupee	Sand Dollar	E-Krona	DCEP
Launch Date	Pilot project launched on 1st December, 2022	October, 2020	Still in the development and testing phase, with no official launch dates yet.	Trial began in April, 2020
Technology	Centralized blockchain based system that follows a hybrid model.	Centralized blockchain based system that works on a two-tier model.	Centralized blockchain based system, two-tier architecture.	Centralized, permissioned blockchain based system, two-tier architecture.
Payment Mechanism	Prepaid digital currency	Digital version of fiat currency	Digital version of fiat currency	Prepaid digital currency
Accessibility	Available to anyone with a smartphone	Available only to residents of the Bahamas	Expected to be accessible only to Swedish residents	Available to anyone with a smartphone
Interoperability	Not interoperable with other digital currencies	Designed to be interoperable with other digital currencies	Expected to be interoperable with other blockchain-based currencies	Not interoperable with other digital currencies
Offline Capabilities	Expected to have an offline feature	Require internet connectivity	Require internet connectivity	Has offline payment feature
Privacy	Still evaluating privacy issues	Uses a privacy-enhancing technology called zero-knowledge proofs	Still evaluating privacy issues	The Chinese government has indicated that DCEP transactions will be traceable, which has raised some privacy concerns
Geographic Coverage	Not known	Within the Bahamas	Limited to Sweden	Intended to be used both domestically and internationally
Status	Still in the testing phase	Fully operational	Still in the testing phase	Rolled out in major cities including Shanghai, Chengdu and Beijing

the digital Rupee as entirely legal tender. The digital Rupee will not be completely decentralized like other cryptocurrencies; instead, the Reserve Bank of India (RBI) will control it. The RBI/Government has access to every transaction taking place on authorized networks.

7.2. Secure

A digital Rupee can potentially offer greater security compared to traditional physical money by leveraging advanced cryptographic protocols, multi-factor authentication, decentralized ledger technology, and reduced susceptibility to physical theft. It may also be integrated with Aadhaar, a biometric identification system used in India, which will enable users to receive payments directly into their bank accounts without the need for physical documents or signatures. In contrast to real currency, a digital currency's lifespan will be infinite because it cannot be physically damaged or lost. A digital currency leaves a digital trail that can be traced and audited more easily compared to physical cash. This can help prevent and detect fraud, money laundering, and other illicit activities. Therefore, the digital Rupee is expected to have a robust security system that includes the use of cryptography and a consensus mechanism that prevents double-spending and other fraudulent activities.

7.3. Ease of use

Digital currency can be used anytime and anywhere, without the need for physical cash or a physical bank. This can make transactions more convenient and efficient, especially for people who live in remote or rural areas. We do not necessarily need a bank account to use e₹. We may still purchase digital Rupees from the bank in the form of tokens. In general, it would be similar to a cash withdrawal from our bank account; but, instead of giving us cash, banks would credit our electronic wallets, allowing us to use it just like regular currency. The transactions via e₹ will provide real-time account settlements.

7.4. Global acceptance

Money transfers across borders and currency exchanges are time-consuming and costly. The fast cross-border money transfer is expected to improve bank cash management and operations with the introduction of the digital Rupee. NRIs who hold digital Rupee can utilize it for international financial transactions without regard to location. It will support the expansion of Indian economic endeavors.

7.5. Positive impact on economy

India has a higher cash inclination than the Nordic nations, including the UK and Australia, at 17% (the ratio of cash withdrawn to GDP) [18]. e-Rupee could help people become less reliant on cash. Naturally, it will reduce the expenses associated with managing, printing, and distributing physical currency. Furthermore, the use of a digital Rupee can also help to reduce the number of illicit transactions and the use of black money, which can increase tax revenue and reduce corruption. Finally, the implementation of a digital Rupee can provide the government with more data and information on spending patterns, which can be used to improve the effectiveness of economic policies and generate more revenue. Overall, the adoption of a digital Rupee can have a significant positive impact on the Indian economy and generate fiscal revenue in the long run.

The development of digital currency is the overarching trend in the modern age of electronic payment [19]. The CBDC is currently being studied by an increasing number of nations due to its numerous advantages [20]. India has also seen a significant increase in the use of digital payment options in recent years, and this trend is expected to continue. This could create demand for e-Rupee as an alternative digital payment option.

8. Challenges

Digital currencies, including e-Rupee, are still a relatively new and complex technology, and there may be regulatory challenges that need to be addressed in order for e-Rupee to be successful. India has not yet developed clear guidelines on the usage of digital currencies, and there have been recommendations to prohibit them outright. The adoption of a digital currency requires adequate digital infrastructure, education, and regulations to ensure its safety, reliability, and usability [21]. It is important to carefully consider the potential risks and challenges associated with a digital currency such as:

8.1. Digital illiteracy

In terms of digital literacy, India ranked 73rd in a list of 120 countries in 2021 [22]. The main reason is that there are many rural areas in India where high speed internet facilities are still not available. Therefore, people of those areas face the problems to avail the facilities of digital revolution. India must solve this issue in order to succeed in its objective to promote digital money.

8.2. Scalability issue

India has a vast population and a digital economy that is expanding rapidly. One major challenge is scalability, as networks can struggle to process large volumes of transactions simultaneously. This issue can be addressed through technological advancements and network upgrades. The architecture must be scalable and capable of handling enormous amounts of transactions and user accounts.

8.3. Privacy and security concern

The RBI keeps a central record of every transaction. Authorities may use centralized data for additional purposes. India is a nation with a high incidence of cyber attacks and a high level of cyber security risk. The introduction of digital currency may result in an increase in cyber attacks and the potential of digital thefts. Therefore, the cyber security threats will always be the major concern. The design must include powerful security features, such as multifactor authentication, encryption, and real-time monitoring and alerting.

8.4. Competition from other payment options

In terms of usability, support system, inventive mechanism and low transaction fees, e-Rupee will face competition from other digital payment options, such as bank-based digital payment systems and existing cryptocurrencies. India has a diversified population that speaks numerous languages. The architecture should handle different languages and provide an intuitive user experience for individuals who may not be skilled in English. India is a price-sensitive market, and excessive transaction fees are likely to dissuade users. To encourage acceptance and usage, the architecture should offer cheap transaction fees. India has a large number of unbanked and underbanked individuals, and incentive mechanisms could be utilized to promote the use of digital currencies. The architecture should include such methods as referral or transaction rewards.

9. Conclusion

India is a largely cash-based society, with a high percentage of transactions being conducted using physical currency. This can be problematic for a number of reasons, including the cost and time required for printing and distributing physical currency, the risk of counterfeiting, and the difficulty of tracking and taxing transactions. The RBI's e₹ – initiative essentially aims to replace traditional currency notes in wallets and may be used to send and receive payments via QR codes or through the respective parties' digital Rupee wallets. It could make it easier for people to make electronic payments and transactions, which could increase financial inclusion and lead to economic growth. e-Rupee will be exchangeable at par with current currencies, accepted as payment, and a secure place to keep wealth. However, there is a challenge of adoption, as the new mode of payment may not be readily accepted by the general public or traditional financial institutions. In order for e-Rupee to be successful, it will need to be accepted by merchants as a form of payment. If merchants are not willing to accept e-Rupee, it will be difficult for it to gain widespread adoption. Education and awareness campaigns may be necessary to overcome these challenges and promote adoption. The architecture should integrate with prominent payment gateways in India, such as digital wallets and UPI, to ease the exchange of digital currency for fiat cash. The government should come up with clear guidelines to boost up confidence among people. It would be important to ensure that the general public is educated about the use and risks of a digital currency, and that the necessary infrastructure is in place to support its use. Security of money would always remain the key obstacles. Efforts must be made to enhance the security of the network through cryptographic protocols and other measures. It is true that there are certain difficulties in employing digital currencies in India. Though many issues may be fixed in a short time, few require a long-term strategy. With the widespread use of digital currencies, India has a great chance to lead the world. e-Rupee could act as a catalyst for innovation, promoting rivalry and payment efficiency. Hopefully, this initiative will open up more discussion on the best course of action.

CRediT authorship contribution statement

Md. Asraful Haque: Equally contributed to the study conception and design and material preparation. **Mohd Shoaib:** Equally contributed to the study conception and design and material preparation.

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Declaration of competing interest

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