



# Money in the digital age: Exploring the potential of central bank digital currency with a focus on social adaptation and education

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## ARTICLE INFO

### Keywords:

Central bank digital currency  
Digital transformation  
Financial technology  
Monetary policy  
Social acceptance

## ABSTRACT

This study delves into the benefits and risks of central bank digital currency (CBDC) and examines social adaptation, and education using expert interviews and conference insights. Vital findings stress the need for targeted educational efforts to facilitate CBDC adoption. The research also emphasizes best practices, engaging external experts, and a phased introduction strategy for safe and efficient implementation. Highlighting key stages, it underscores addressing genuine market needs for successful CBDC introduction. Overall, prudent risk management, strategic education, and well-planned phased deployment are crucial for successful CBDC implementation.

## 1. Introduction

The development of digital networks and information technology and the growing proportion of Internet-based retailing have created the demand and technological space for digital transactions, which can radically change payment and financial intermediation systems [1]. Globalization, digital transformation, and especially the emergence of innovative payment solutions from Fintech and BigTech companies are encouraging central banks to consider modernizing payment systems and money [28]. Furthermore, the emergence of Bitcoin in 2009 brought attention to the potential development of digital currencies, leading to the subsequent evolution of digital money along three distinct paths: cryptocurrencies, stablecoins, and central bank digital currency (CBDC) [52]. While the future of digital money remains a topic of ongoing discussion, it is evident that private cryptocurrencies like Bitcoin or Ethereum cannot serve as the primary currencies in the future monetary system. Cryptocurrencies introduce uncertainties regarding their impact on monetary policy effectiveness and fall short in fulfilling the fundamental functions of money. Additionally, challenges arise regarding scalability, particularly in handling large transaction volumes simultaneously, and the necessity of government control over the privilege of currency issuance [53].

The concept of modernizing monetary and payment systems is currently receiving significant attention from numerous central banks. According to a survey conducted by the Bank for International Settlements among central banks, a substantial number of the surveyed institutions have initiated studies to explore the benefits and drawbacks of

central bank digital currency. Furthermore, a significant portion of these central banks have already commenced pilot projects in this area [4]. The level of engagement among central banks during the implementation phase can differ based on various country-specific factors, such as the existing digital infrastructure, the prioritization of different policy objectives, and the accompanying motivations and concerns related to these objectives. [22].

The purpose of this article is to examine the possibilities of introducing retail central bank digital currency, focusing on its potential benefits and risks, as well as issues of social adaptation and education. Drawing from the examination of past payment-related initiatives and CBDC pilot programs, it is evident that the success of CBDC implementation projects heavily relies on societal adaptation. Nevertheless, the current volume of research on adaptation and education remains limited. Hence, this research aims to identify key factors that can facilitate the broad acceptance of central bank digital currency. By addressing this gap, the research offers valuable insights and guidelines for central banks seeking to implement CBDC successfully. To answer the research questions, a total of 14 semi-structured interviews were conducted with central bank, technology and digital central bank money experts. In addition to conducting interviews with experts, this article incorporates an analysis of conference presentations and roundtable discussions. By integrating multiple sources of information, the study enhances its comprehensiveness and validity, contributing to a more holistic understanding of the topic. Based on the examination of prior research, it can be concluded that comprehensive guidelines and best practices concerning the introduction of central bank digital currency

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<https://doi.org/10.1016/j.sfr.2023.100136>

Received 11 June 2023; Received in revised form 1 October 2023; Accepted 30 October 2023

Available online 2 November 2023

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have yet to be clearly outlined. Therefore, the article also outlines best practices for central banks when introducing CBDC and provides a potential implementation project timeline. The use of semi-structured interviews in this qualitative research study provided a robust and flexible approach, allowing for the exploration of participants' experiences and viewpoints in a comprehensive and detailed manner. The resulting data contributed to a deeper understanding of the research topic and provided valuable insights for further analysis and interpretation.

## 2. Literature review

### 2.1. Conceptual definition of central bank digital currency

The implementation of central bank digital currency gives rise to a novel manifestation of central bank currency, wherein a digitalized version of sovereign money emerges as a liability of the central banks [14]. Central bank digital currency seems like a new concept these days, but the underlying ideas go back several decades, when David Chaum formulated his vision for electronic money in 1985. Chaum [20] described a notion of a secure and confidential electronic currency governed by a central entity, similar to the physical cash issued by central banks. His-proposal set the foundation for the comprehension and advancement of CBDCs. According to Stanley [48], the history of the first central bank digital currency dates back to 1993, when the Bank of Finland introduced the Avant smart card - an early form of electronic cash -, even though it was discontinued in the early 2000s.

Given the diverse economic characteristics across countries and their varying needs, numerous definitions and approaches to central bank digital currency exist [38]. Based on this, we cannot find a generally accepted, universal definition of central bank digital currency. However, the Money Flower - a taxonomy of money - developed by Bech and Garratt [13], which identifies retail and wholesale CBDC and distinguishes them from other forms of central bank money such as cash and reserves, can be seen as a summary of previous CBDC definitions and characteristics overview. The most common CBDC definitions used in the literature are summarized in Table 1.

**Table 1**  
Digital central bank money definitions in chronological order.

Author(s)	Definition
Bech and Garratt [13]	CBCC is an electronic form of central bank money that can be exchanged in a decentralised manner known as peer-to-peer, meaning that transactions occur directly between the payer and the payee without the need for a central intermediary.
Bjerg [15]	CBDC is electronic, universally accessible, central bank issued money.
Kumhof and Noone [37]	Electronic central bank money that (i) can be accessed more broadly than reserves, (ii) potentially has much greater functionality for retail transactions than cash, (iii) has a separate operational structure to other forms of central bank money, allowing it to potentially serve a different core purpose, and (iv) can be interest bearing, under realistic assumptions paying a rate that would be different to the rate on reserves
Kiff et al. [34]	Central bank digital currency (CBDC) is a digital representation of sovereign currency that is issued by a jurisdiction's monetary authority and appears on the liability side of the monetary authority's balance sheet.
Agur et al. [1]	Central bank digital currency is new type of fiat money that expands digital access to central bank reserves to the public at large, instead of restricting it to commercial banks.
Board of Governors of the Federal Reserve System [17]	CBDC is defined as a digital liability of the Federal Reserve that is widely available to the general public.

Source: Own collection.

According to Lee et al. [38] as a kind of legal digital currency, CBDC should have the four basic functions of currency: medium of exchange, store of value, unit of account, and means of payment.

As stated by Ozturkcan et al. [43], the implementation of digital central bank money has the potential to disrupt the conventional hierarchical framework of financial services by enabling individuals to possess a CBDC account directly with the central bank. This development could potentially lead to a reduction or even elimination of retail banks' deposit account responsibilities, freeing them to concentrate solely on the provision of innovative financial solutions.

Digital central bank money can be categorized into two primary types: "retail" money that is accessible to the public, and "wholesale" money designed for interbank transactions and settlements. Numerous justifications support the issuance of retail digital central bank money.

- 1 By reducing the use of cash, providing digital legal tender to the public.
- 2 Improving the flexibility of payments by providing a reserve system.
- 3 Promoting the diversity and sovereignty of payment systems.
- 4 Strengthening of monetary policy [5].

Residential CBDC projects appear to be more popular in emerging markets and developing economies, such as the Bahamas, Cambodia, and mainland China, according to Cheng's [23] findings. The primary driving force for implementing these systems in these regions is the desire for greater financial integration and the development of more advanced payment systems. For example, the Sand Dollar was introduced in the Bahamas to improve payment services in the scattered archipelago. Conversely, wholesale CBDC research and experimentation have mostly been conducted in developed economies with established interbank systems and financial trading markets, such as Hong Kong, Singapore, Canada, and Japan. In these regions, payment-related issues such as efficiency, security, and robustness are of greater concern than financial integration.

### 2.2. Potential benefits of introducing central bank digital currency

According to a study by the Bank of England, the needs of future payment systems can be met with central bank digital currency, and with the introduction of CBDC, a more resilient financial system can be created as a whole [12]. Central bank digital currency is frequently mentioned as a safer option than commercial bank accounts and is also regarded as a means to expand access to financial services. This results in people who previously did not have access to banking services being able to utilize them [27].

Another goal of the introduction of digital central bank money may be to increase the efficiency of payment systems and reduce the costs of cross-border transactions [25]. Regarding the implementation, Csonka et al. [24] highlighted the potential for addressing efficiency concerns associated with the utilization of cash. This encompasses the costs related to cash handling, as well as sustainability considerations pertaining to production, storage, and transportation. Additionally, digital central bank money offers potential advantages in combating issues such as money laundering, tax evasion, terrorist financing, and other illicit activities [47].

As noted by Müller and Kerényi [41], the implementation of CBDC can serve as a partial defense mechanism against the growing dominance of major technology companies in the financial services sector and the realm of cryptocurrencies.

Other authors highlight the potential of introducing CBDC to enhance competition, suggesting that digital central bank money can facilitate the development of innovative financial solutions. The introduction of CBDC can typically foster competition in a country's payment landscape through two main channels: (1) direct competition with existing payment methods, and (2) indirect competition if CBDC is designed as an open platform that allows private payment providers to

enter the market more easily, thus reducing entry barriers for companies seeking to offer new payment services [47].

### 2.3. Risks and challenges related to the introduction of central bank digital currency

Aside from the advantages brought about by the implementation of central bank digital currency, it is also essential to consider potential risks. These risks may pertain to various aspects, such as technological, economic, systematic, ethical, and legal concerns.

According to the findings of Lee et al. [38] unrestricted public access to digital currency may lead to a decline in the demand for commercial banks' deposits and reserves. This could potentially result in banks facing liquidity shortages and, in extreme cases, trigger a bank run, thereby heightening the risk of financial instability. Jun and Yeo [32] also drew attention to this risk, according to which, since CBDC can become a strong substitute for demand deposits, the risk of bank failure increases as the credit supply decreases. All of this is offset by the subsequent increase in the rate of return on term deposits and loans, which reduces the supply of loans and thus the risk of bank failure. As long as the loan interest rate remains below a specific threshold, these factors do not bring about substantial transformations in the banking sector. However, surpassing this threshold raises the risk of bank failures, posing a threat to banking stability. In light of these observations, the authors suggest that central banks contemplating the implementation of an account-based central bank digital currency system for the entire economy should closely monitor loan yields and consider implementing policy measures that incentivize banks to maintain sufficient liquidity reserves.

According to a study by Fülöp et al. [29] an important aspect when considering risks is that, with the introduction of the CBDC, the central bank becomes a deposit-collecting central bank, i.e. it only opens the liability side of its balance sheet to users, or the asset side as well, with which it becomes a lending central bank. The shift to a deposit-collecting central bank can potentially lead to liquidity problems in the banking sector due to deposit outflows. Conversely, if the central bank becomes a lending institution, commercial banks may face market and revenue losses, resulting in stability risks. Additionally, the central bank itself may encounter new types of risks during its operations. Chen and Siklos [21] also discovered that the introduction of digital central bank money has the potential to significantly magnify the international spillover effects of typical macroeconomic shocks.

Kiff et al. [34] indicate that the introduction of CBDC systems can bring about operational risks in several areas, such as IT infrastructure, cyber security, outsourcing, governance, and processes. Additionally, strategic and political risks may emerge from the central bank's overall strategy and policy, while financial risks may arise from financial operations. If one or more of these risks occur, it can result in reputational

risk, which is a combination of all the mentioned risks. The risk categories mentioned are illustrated in the figure below (Fig. 1).

The risks presented emphasize the potential for fintech and cybersecurity advancements to both benefit and exacerbate non-financial risks for central banks if not implemented properly. This underscores the ongoing importance of robust risk management by central banks, especially given the overlapping nature of many of the identified risks. As such, central banks should conduct comprehensive analysis of fintech and cybersecurity issues, incorporating central bank risk management considerations into their approach [33].

### 2.4. Aspects and questions related to the development of CBDC systems

The design of CBDC systems raises several questions that are actively discussed in policy debates surrounding central bank digital currency. The Bank for International Settlements has identified the following key issues: (1) whether central bank digital currency should be recorded on the central bank's balance sheet as an indirect or direct claim; (2) whether the system should be built using distributed ledger technology or traditional central bank architecture; (3) whether access should be based on proof of identity or token technology; (4) whether there should be limits on the amount of CBDC that can be held; and (5) whether access should be extended to foreign citizens [9].

In general, three central principles can be defined for all central banks during the design of CBDC systems:

- **Do no harm:** The central bank must ensure that any newly introduced forms of currency uphold public policy goals and do not hinder the central bank's ability to fulfill its responsibility of maintaining monetary and financial stability.
- **Coexistence:** Various forms of central bank money should harmoniously coexist and complement other privately issued currencies to effectively serve public policy objectives. As long as there remains a substantial demand from the public for physical cash, central banks should continue to ensure its availability and accessibility.
- **Ensuring innovation and efficiency:** In the absence of ongoing innovation and competition aimed at enhancing the efficiency of a particular jurisdiction's payment system, users might be inclined to adopt alternative, less secure payment instruments or currencies, which could potentially result in economic and consumer detriment [8].

#### 2.4.1. Technological requirements

In addition to keeping the central principles in mind, the basic technological requirements must also be treated as a top priority when designing CBDC systems. Blakstad and Allen [16] summarized the high-level technological requirements for digital central bank money

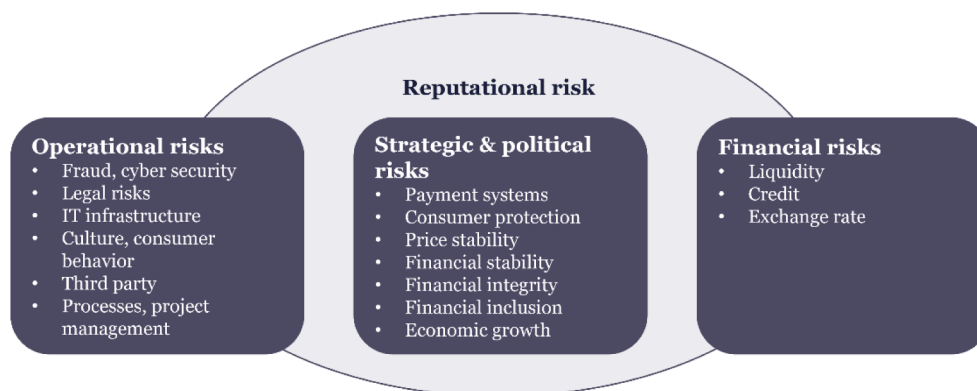


Fig. 1. Potential risks of introducing central bank digital currency systems. Source: Own editing based on Kiff et al. [34]

systems along eight factors, which can be seen in the table below (Table 2).

Real-time and irrevocable completion of transactions are essential aspects of central bank digital currency enabling users to engage in risk-free payments among themselves. CBDC has the potential to be utilized by individuals, businesses, and governments for purchasing goods and services, as well as settling financial obligations. Governments can leverage central bank digital currency as a means of tax collection and direct disbursement of benefits to citizens. Furthermore, there is an expectation that digital central bank money will be programmable, allowing for automated payments to be executed at predetermined intervals [17].

#### 2.4.2. Data protection

Ballaschk and Paulick [6] highlight that data protection is one of the most intricate matters in the discussions surrounding the design of CBDC systems. The authors emphasize that these systems must comply with data protection regulations specific to the jurisdiction in which they operate. Additionally, they must ensure that authorities have access to necessary information for conducting anti-money laundering (AML) or customer identification (Know Your Customer - KYC) procedures. The degree of anonymity in a CBDC system, in terms of data protection, is considered to be more of a political and social issue than a purely technical one, according to the Bank of England [12] report. While complying with anti-money laundering regulations, which prohibit completely anonymous transactions, CBDC systems can still be designed to safeguard users' privacy. These systems can provide users with control over who they share their data with, even if CBDC payments are not entirely anonymous or confidential.

#### 2.4.3. Technology background

Lima and Salinas [39] emphasize the importance of considering the main attributes and goals of the CBDC system before deciding on its technological infrastructure. It is crucial to ensure that the technological choice does not restrict the implementation of the desired system defined by the central bank. Various options exist for the technological background of CBDC systems, including those based on distributed ledger technology, traditional infrastructures, or even a hybrid approach combining both approaches.

The manner in which data is updated is one of the key distinctions between traditional and distributed ledger technologies. Traditional databases typically achieve flexibility by storing data on multiple physical nodes that are controlled by a single authoritative entity at the top of the hierarchy. In contrast, distributed ledger systems enable the ledger to be managed in a decentralized manner by multiple entities. This means that any update to the ledger must be synchronized across all nodes that are controlled by these entities [2].

As Zhang and Huang [54] highlight, the characteristics of auditability and immutability make blockchain technology well-suited for fulfilling the needs of central bank digital currency systems. In their study on the technological underpinnings of CBDC systems, Zhang and

**Table 2**  
Technological requirements related to central bank digital currency systems.

Requirement	Description
Resilience	High operational availability (24/7/365)
Security	Security against cyber attacks
Scalability	The possibility of thousands of transactions per second
Transaction Processing	Near-instant, real-time settlement finality
Confidentiality	Private, but not anonymous
Interoperability	Compatible with existing systems and other CBDCs
Innovation	Enabling the development of innovative functions and services
Future proof	Ability to update and repair without affecting service

Source: Own editing based on Blakstad and Allen [16].

Huang [54] discovered that private blockchain technology appears to be the most suitable option compared to its public counterpart. However, despite its potential, blockchain technology currently faces several challenges. The performance of existing blockchain systems still lags behind traditional centralized systems, and scalability is crucial to accommodate the growing volume of transactions. Furthermore, interoperability issues may arise in cross-border transactions if different CBDC systems rely on distinct blockchains with varying encryption algorithms, digital signature schemes, transaction structures, and block sizes.

#### 2.4.4. Method of granting access

In the case of CBDC systems, an additional question arises as to whether an account- or token-based system should be introduced [36]. The primary distinction between the two types lies in the manner of identification and the process of monetary transactions. In the token-based system, the token owner possesses a claim against the central bank, and the token itself is not associated with a specific account [18]. The system's status is represented by a collection of distinct tokens that possess unique values and are owned by individuals. To initiate a money transfer, the recipient must provide evidence of ownership of the token intended for transfer. This is accomplished by signing the payment order using the recipient's exclusive private key [7]. However, most proposals related to CBDC systems are account-based [19]. In an account-based system, such as commercial bank money, the system's status is maintained as a roster of accounts, with each account being connected to a distinct identity and balance. To initiate a payment within such systems, the recipient must demonstrate either their identity or their knowledge of the account details necessary for the transaction [7]. However, in contrast to many privately issued cryptocurrencies, both the account-based and token-based systems of CBDC may necessitate user identification, not only for payment transactions but also to adhere to anti-money laundering and anti-terrorist financing regulations [2].

#### 2.4.5. Considerations related to CBDC design

From a monetary policy perspective, the consideration of interest rates and the possible implementation of quantitative limits holds significant importance. By offering interest payments, digital central bank money can function as an alternative to bank deposits, thereby serving as a valuable instrument in the central banks' monetary policy toolkit. This can contribute to enhancing the effectiveness of central bank decisions and improving overall decision-making efficiency [35]. If the interest rate offered by CBDC proves to be an appealing alternative in comparison to the prevailing interest rate environment, it cannot only attract retail customers but also establish the lower boundary of the money market interest corridor for institutional investors [31]. Nevertheless, the provision of interest payments may lead to a potential outflow of commercial bank deposits towards CBDC systems, thereby potentially impacting financial stability and the liquidity of commercial banks. This raises the question of whether it is truly essential to offer interest payments for CBDC. In relation to this, it can be observed that recent drafts of CBDC often advocate for the implementation of non-interest-bearing central bank digital currency [1]. Moreover, in the scenario of digital central bank money that has already been introduced, like the Bahamian sand dollar, they have chosen to implement non-interest-bearing CBDC. In addition, they have imposed restrictions on the holding and transaction amounts of CBDC [36]. On the subject of quantitative limits, they can be either general or defined along multiple dimensions, including transaction size, monthly transaction limit, account balance limit etc. [26].

#### 2.5. Potential operating models of central bank digital currency systems

When it comes to the functioning of CBDC systems, three main models can be identified: direct, hybrid, and indirect. In the direct

model, CBDC represents a direct claim to the central bank, which also manages real-time payments and maintains records of household holdings. In the hybrid CBDC architecture, claims are still made against the central bank, but intermediaries such as commercial banks or payment service providers handle real-time payments. For central banks concerned about data protection and security issues, the mediated CBDC architecture can be a potential solution, where the central bank only maintains records of wholesale balances, rather than individual residential data. Some authors argue that the hybrid or indirect concept may be more advantageous for central banks compared to the direct CBDC model, as it allows them to focus on essential tasks while leaving the operational aspects to competing intermediaries. From a technical perspective, various infrastructures can be employed to distribute responsibilities based on the desired level of flexibility. However, central banks must carefully consider the technological requirements of their operational architecture [3]. However, according to Fáykiss and Szombati [26] in the case of the indirect model, it is argued that since the system does not establish a direct claim against the central bank, some experts do not even categorize this solution as a true CBDC.

The presented operational models indicate that the implementation of central bank digital currency systems may require the establishment of intricate ecosystems that involve various types of actors in the system's operation.

Participants in the CBDC system play a crucial role as intermediaries connecting the central bank with end users. These intermediaries can vary depending on the regulatory landscape and may include banks, payment service providers, mobile service providers, fintech companies, and bigtech companies, among others. Intermediaries are responsible for various payment services, encompassing pre-transaction processes such as customer onboarding and channel provision, transaction-related activities like customer service, and post-transaction tasks like consulting and invoicing [10].

As stated by Fáykiss and Szombati [26], the collaborative effort of multiple entities may be required when designing and implementing residential CBDC systems. In this context, the central bank would assume the role of system creator and be responsible for establishing the primary regulations. Operators would be entrusted with operating the physical infrastructure and maintaining the technical requirements, while payment providers, potentially including commercial banks, depending on the specific implementation model, would handle customer registration and manage customer interactions. Additionally, banks may assume the responsibility of facilitating the conversion between digital central bank money and money issued by commercial banks to ensure their compatibility.

## 2.6. Social acceptance of central bank digital currency

The embrace of central bank digital currency is influenced by various factors, including culture, demographics, functionality concerns, and attitudes towards money usage. Consequently, it is imperative for central banks to give paramount importance to these aspects during CBDC implementation. This entails crafting adaptation strategies that effectively tackle consumer apprehensions.

According to a Bank for International Settlements [11] report, while CBDC adoption strategies should be customized to each region's economic structure, regulation and payment landscape, it is essential to learn from both successful and unsuccessful payment initiatives. Past studies suggest that CBDC adoption can be more successful if it addresses unmet user needs, creates network effects - where consumers and merchants mutually support its use -, and leverages existing accessible technology and infrastructure.

Sarmiento's [45] research on Uruguay's e-Peso pilot emphasized that CBDC design should consider financial inclusion and cultural aspects, not just technological factors. This includes a comprehensive evaluation of the payment ecosystem and a thorough understanding of the cultural implications of gradual but inevitable change. Therefore,

research on CBDC should not only focus on technical matters but also encompass unique aspects such as economic organization, historical factors, and the social aspects of money.

Haque and Shoaib [30], analyzing the e-Rupee pilot program by the Reserve Bank of India, also determined that the effective introduction of CBDC hinges on social acceptance. A critical factor within this is the technological literacy of society, a facet that CBDC initiatives should address for a successful rollout. This involves providing suitable education, ensuring high-level security, reliability, and ease of use for prospective users.

Through the application of text mining to Facebook data spanning from 2012 to 2022, Ngo et al. [42] determined that government performance, inflation rate, economic inequality, and technological literacy exert a substantial influence on the public's perception of central bank digital currency.

Tan [49] investigated the uptake of CBDC within households and businesses. His findings suggest that households are inclined to adopt CBDC if it's affordable, serves as an appealing savings option, lowers remittance costs, enhances government payment efficiency, and is acknowledged by merchants as a valuable payment method. On the other hand, businesses are more likely to embrace CBDC if transaction fees are minimal, tax breaks or subsidies apply to CBDC transactions, and a significant portion of their revenue comes from households who prefer using CBDC for payments.

Luu et al. [40] explored the impact of national culture on the adoption of digital central bank money, drawing upon Hofstede's cultural dimensions. Their findings indicate that national cultural values exert a significant influence on the acceptance of digital central bank money, albeit with variations observed across specific cultural dimensions. Notably, the study identified that in countries characterized by higher levels of power distance, masculinity, and long-term orientation, the adoption of CBDC is more likely. Conversely, countries with a tendency to avoid uncertainty exhibit lower levels of support for the introduction of digital central bank money.

In their study, Wu et al. [51] established a positive correlation between financial knowledge, perceived value (such as regarding digital currencies as valuable and high-quality), openness to innovation, perceived comfort (for example, ease of use, flexibility, and convenience), and the intention to use. These findings can be utilized to enhance customer perceptions of digital money and devise effective strategies to promote the intention to use digital currencies.

The study conducted by Tronnier et al. [50] on the social acceptance of central bank digital currency highlights the need for central banks to prioritize the protection of users' data, as this has a negative impact on individuals' willingness to use such currencies. The authors suggest that central banks should take steps to alleviate these concerns and promote user trust, which could involve implementing strategies to enhance the credibility and reputation of both the central bank and the CBDC. To achieve this, it is crucial for central banks to provide potential users with information about their research related to the CBDC and its progress, as this will increase the currency's reliability and credibility. Clear communication about the flow of data in CBDC transactions, including the type and frequency of data, as well as the conditions of data transmission, is also necessary to ensure competent management of user data.

## 2.7. Identification of research gaps

The introduction of central bank digital currency can wield considerable influence over both financial systems and society. Nevertheless, given the early stage of this development, numerous research gaps are apparent in this field. Based on the analysis of prior research, it is evident that research related to CBDC predominantly addresses the motivations, advantages, and potential risks linked to implementing CBDC systems. Additionally, such research outlines ongoing projects, provides comprehensive discussions on system-specific elements and operational models of CBDCs, and delves into regulatory considerations.

Furthermore, one of the most important issues in this field is the exploration of the long-term economic effects and monetary political aspects of the introduction of the CBDC, which necessitates further research considering region-specific factors.

Based on the examination of the factors related to the introduction of CBDC, previous research underscores that the success of CBDC implementation projects is significantly influenced by cultural factors and societal adaptation, with financial and technological literacy being pivotal elements. Likewise, ensuring consumer trust by guaranteeing strong system security is of paramount importance. During the implementation of CBDC, meticulous consideration of these factors is essential, necessitating a comprehensive analysis and comprehension of user needs and preferences. Nonetheless, the current scarcity of studies addressing social adaptation and education emphasizes the need for further research in this domain.

Furthermore, it can be stated that there is insufficient research offering detailed guidance and optimal procedures concerning the introduction of central banks and associated actors. Consequently, more research encompassing interdisciplinary perspectives is vital to bridge these gaps and achieve a holistic understanding of the multifaceted implications of CBDC implementation.

### 3. Research methodology

The research aimed to uncover the potential drivers behind the adoption of central bank digital currency, as well as the potential drawbacks and risks associated with its implementation. Additionally, the research delved into the realms of social acceptance and education, with the objective of pinpointing factors and measures conducive to fostering social acceptance. This is particularly notable as the existing body of research on this matter remains relatively limited, with some studies offering only moderate exploration of the subject. Alongside this, the best practices that the interviewees would recommend for central banks to consider during the implementation of CBDC, as well as their vision for a potential CBDC implementation project were also examined.

Regarding the research process, Robson [44] defined diverse strategies for researchers to enhance the validity and reliability of their study. In accordance with Robson's recommendations, to ensure research robustness a triangulation methodology was employed, encompassing data collection through diverse sources, such as expert interviews and analysis of conference presentations and roundtable discussions, in addition to the literature analysis.

During the research, semi-structured in-depth interviews were conducted, wherein the interviewer primarily employed open-ended questions. The researcher's main task is to reveal the participants' point of view in relation to the investigated questions, based on the reconstruction of the interviewees' experiences [46]. The formulation of research questions was guided by the analysis of the existing literature, taking into account discerned research gaps. The research questions were designed to encompass a comprehensive spectrum of central bank digital currency, facilitating flexibility in response dynamics. The validity of research questions was affirmed through pilot interviews with participants, resulting in the formulation of supplementary questions to comprehensively address specific aspects of the topic. The research questions covered the following topics: drivers for the introduction of central bank digital currency, risks and challenges, importance of social acceptance and education, identification of best practices, main aspects of the introduction of central bank digital currency systems and the potential structure of CBDC projects. In relation to the formulation of the interview questions, open-ended questions were incorporated to mitigate any potential bias of the interviewee's perspective. Furthermore, by employing semi-structured interviews, the study aimed to capture the complexity and intricacies of participants' views, contributing to the depth and validity of the research findings.

In the process of selecting interview participants, a deliberate effort was made to ensure a diverse range of perspectives by including experts

from various fields. During the research, the participants were guaranteed complete anonymity. The interviews were usually conducted for 45–60 min, and in all cases, they were recorded and transcribed verbatim ensuring accurate representation of participants' responses and non-verbal cues. In total, 14 interviews were conducted the list of which and a brief description of the interviewees can be seen in the table below. It is important to note that the views expressed by the interviewees concerning the introduction of central bank digital currency are solely their own and do not necessarily represent the views of their respective organizations. The conducted interviews were analyzed using NVivo, a qualitative data analysis software. NVivo provides a systematic and rigorous approach to analyze and interpret the rich data obtained from the interviews, ensuring a comprehensive exploration of the research topic. Furthermore, following Robson's [44] guidance to enhance analytical rigor and validity, the research results underwent a review and verification process by the interviewees, allowing for their valuable feedback on the analysis. This iterative process allowed for refinement and adjustment of the analysis, ensuring that the findings were grounded in the participants' perspectives. Throughout the research process, comprehensive documentation was maintained, including detailed audio recordings of research-related discussions, textual transcripts of interviews, and supplementary notes from both interviews and conference presentations. The list of interviewees is shown in Table 3.

In addition to conducting interviews with experts, this scientific article incorporates an analysis of conference presentations and roundtable discussions. These additional sources of information provide a broader perspective on the topic of central bank digital currency (CBDC) and contribute to a comprehensive understanding of the subject matter. The conferences featured a diverse array of speakers, including central bank executives, experts in fintech and blockchain technologies, professionals from the Bank for International Settlements (BIS) and from the International Monetary Fund (IMF), leaders and researchers from academic institutions and research centers specializing in digital currency initiatives, as well as consultants specializing in digitalization. The conferences whose presentations and roundtable discussions were analyzed are summarized in Table 4.

During the selection of CBDC conferences, it was important to consider a broad base of experts, ensuring a diverse range of perspectives on central bank digital currencies. These conferences were carefully chosen to cover a comprehensive spectrum of CBDC-related topics, including technological advancements, economic implications, regulatory considerations, international cooperation, and the crucial aspects of social acceptance and education. By including these topics in the selection criteria, the conferences aimed to provide a well-rounded exploration of CBDCs, encompassing not only their technical and financial dimensions but also their societal impact and the need for informed public discourse.

By integrating interviews with experts, conference presentations and roundtable discussions, this article ensures a comprehensive and well-rounded analysis of the topic of CBDCs. This multidimensional approach enhances the validity and richness of the research, providing a holistic understanding of the potential opportunities and challenges associated with central bank digital currencies.

## 4. Research results

### 4.1. Potential drivers for introducing central bank digital currency

As previously established in the literature review, the introduction of central bank digital currency can be driven by various motivational factors. The interviews conducted further confirmed the factors identified in the literature, while also shedding light on additional elements not previously discussed that are associated with the introduction of CBDC.

During the interviews, a consensus emerged among participants

**Table 3**  
List of interviewees.

Interview ID	Title	Short description of the interviewee
1	Journalist, professional editor	Editor of a professional portal dealing with crypto assets.
2	Independent central bank digital currency consultant	He has been dealing with central bank digital currency for more than 2,5 years, regularly publishes analyses, industry news, and contributes to the construction of a CBDC competence center. He works together with many central banks, fintech companies and public organizations.
3	CEO	CEO of a company developing innovative blockchain-based insurance products.
4	Senior Economic Analyst – Central Bank	Economic analyst with more than 10 years of central banking experience. His-main field is currently the investigation of the monetary policy aspects of digital central bank money.
5	Technology advisor	Technology consultant of a leading consulting company. He regularly participates in domestic and international research focused on digital central bank money, the primary focus of which is the examination of the technological background of CBDC.
6	Manager – Technology consulting	Manager of a leading consulting company in the field of technology consulting. He has more than 10 years of experience in the field of technology consulting, and is actively involved in Web3, Metaverse, and general IT consulting. He regularly participates in blockchain and crypto asset focused projects.
7	Digital transformation advisor	He has almost 15 years of experience in IT, and worked on many large corporate IT projects as a project manager and then as a development manager. He is currently working on digitalization projects primarily among financial companies and commercial banks.
8	Partner, senior consultant	He has a 15-year professional background in commercial banking, after which he started working as an external consultant for banks. He is the founder of a consulting company dealing with digital transformation and innovation, whose clients include the largest financial institutions. In addition, he actively participates in the development of the strategic and regulatory background of financial technologies.
9	Central bank legal expert	Legal expert specializing in central banking and digital currencies. With a deep understanding of the legal implications surrounding CBDCs, she has advised central banks on the development of legal frameworks, privacy concerns, and compliance issues related to digital currencies.
10	Fintech advisor	A seasoned fintech professional with over 15 years of experience in the financial technology industry. As the Head of Digital Payments at a fintech company, he has been at the forefront of developing innovative digital payment solutions. He has a comprehensive understanding of the technical and operational aspects of

**Table 3 (continued)**

Interview ID	Title	Short description of the interviewee
11	CEO, Co-founder	digital currencies and their integration within existing financial systems. CEO & Co-founder of a blockchain-based development company in the financial industry. The interviewee's company has developed innovative solutions for secure and efficient digital transactions. His-expertise lies in understanding the technical intricacies of blockchain systems, and she has a wealth of experience in building scalable and secure platforms for financial applications.
12	Central bank expert – Digital technologies	Central bank expert specializing in digital technologies and their impact on monetary policy. With a strong background in economics and a deep understanding of emerging digital trends. He has advised central banks on harnessing digital technologies to enhance financial inclusion, improve payment systems, and strengthen monetary policy transmission mechanisms.
13	Head of Digital Transformation – Retail bank	Highly experienced retail bank expert with a strong focus on digital transformation within the financial industry. With over 20 years of experience in retail banking, he has witnessed and actively participated in the evolving landscape of banking services and customer expectations. His-expertise extends to areas such as digital payment solutions, omni-channel banking experiences, customer relationship management, and data-driven decision-making.
14	Researcher	Researcher specializing in the financial sector and digital transformation. Her extensive knowledge spans various areas, including fintech, blockchain technology, digital currencies, and the adoption of digital platforms in banking and investment.

regarding the flexible and programmable nature of CBDC, which presents numerous untapped opportunities for market participants. Introducing CBDC offers a significant advantage by providing central banks with a more effective tool for implementing monetary policy. As cash usage decreases, central banks face challenges in influencing monetary processes, suggesting the potential need for CBDC implementation. CBDC can be leveraged to manage the money supply and directly and effectively impact interest rates. Furthermore, participants emphasized the potential reduction in cash usage, which currently imposes substantial costs on the national economy.

The introduction of central bank digital currency has the potential to accelerate overall money circulation, thereby enhancing accessibility to money, particularly for individuals currently excluded from traditional banking services. This inclusivity can contribute to economic growth and stability. With the implementation of CBDC, the central bank would also gain access to additional information on money usage, allowing for closer interaction with individual users. Furthermore, it was emphasized that the promotion of cashless payment methods aids in combating the underground economy while reducing the risks associated with criminal activities and corruption. Encouragement for CBDC implementation can stem from expanding coverage to underserved regions, facilitating cash flows, and involving new consumer segments that are currently underserved or have limited access to commercial banking services. For instance, targeting younger generations to increase their participation in

**Table 4**

Description of the analyzed conferences.

Conference	Date	Conference information	Organizer information
Financial Stability Conference: New Challenges and Focuses	26–27 May 2022	The event was attended by many experts from four continents. The discussions focused on recent challenges to the financial system, including risks posed by COVID-19 or the Russia-Ukraine crisis, and on issues related to the future of the financial system, such as climate risk management or digitalisation, affecting financial intermediation in various ways.	The conference was organised by the Hungarian National Bank and the Official Monetary Financial Institutions Forum.
Financial IT Conference	31 May 2022	The conference delved into various themes, including digital business challenges such as international and digital competition among banks, global banking trends embracing ESG, AI, and cloud technologies, open banking and its extensions, the Instant Payment System, innovative technologies, and the adoption of CBDC and BNPL in the payment market. Additionally, the conference provided insights into the technologies employed by banks to enhance efficiency, along with their data-driven operations and the utilization of distributed systems.	The conference was organized by Portfolio, which is a recognized Hungarian online business portal.
FinTech Show	12 October 2022	At Hungary's largest fintech forum, the most current questions and challenges of the digital transformation of the financial sector were examined with international and domestic speakers. A prominent topic at the conference was the discussion of aspects of central bank digital currency.	The conference was organized by the FinTechZone online portal, which presents 21st century digital financial solutions.

**Table 4 (continued)**

Conference	Date	Conference information	Organizer information
DC <sup>3</sup> Conference – From Cryptocurrencies to Central Bank Digital Currencies (CBDCs)	24–27 January 2023	Conference participants shared insights on the latest trends, policy and regulatory framework and innovative applications of central bank digital currency, cryptocurrency, stablecoins and DeFi. The participants also discussed emerging technologies driving the innovations behind digital currencies and areas where technical standards are needed.	The DC <sup>3</sup> Conference was organised as part of the activities of the Digital Currency Global Initiative which is a joint collaboration between the International Telecommunication Union (ITU) and the Future of Digital Currency Initiative at Stanford University.
New Age of Central Banking in Emerging Markets Conference	17 March 2023	The focus of the international conference was the fight against inflation and the discussion of various aspects of central bank digital currency.	The conference was jointly organized by the Corvinus University of Budapest, the Bank for International Settlements and the London School of Economics and Political Science with the support of the Hungarian National Bank.

financial services can foster greater financial awareness.

Making cross-border transactions more efficient was highlighted as an additional advantage. Currently, these transactions tend to be slower, more costly, and involve multiple intermediaries. However, the implementation of CBDC allows for direct, instantaneous, and cost-effective cross-border payments. The adoption of digital central bank money eliminates the need for currency conversions, lowers transaction fees, and facilitates smoother and more efficient international trade. Furthermore, CBDC can contribute to improved transparency while mitigating the risks of fraud and corruption in cross-border transactions. Nevertheless, there are several challenges to be addressed in cross-border payments, including the interoperability between different CBDC systems, adherence to international regulations, and the development of robust security measures.

The introduction of digital central bank money can promote competition in the financial sector, leading to the development of more affordable and user-friendly solutions that benefit consumers. In cases where the banking system lacks sufficient competition or operates as an oligopoly, it can result in high fees on deposit accounts and limited access to banking services. Moreover, low deposit interest rates can hinder effective monetary transmission. In such situations, the introduction of central bank digital currency, where the central bank competes in the deposit market, can serve as a solution to stimulate competition. However, increased competition also presents challenges in terms of regulation, security, anti-money laundering measures, and consumer protection, which must be addressed to ensure that central bank digital currency brings tangible benefits to the financial sector.

The implementation of central bank digital currency is motivated by various factors, including the consideration of externalities associated with bank failures. This highlights the potential for a systemic wave of bankruptcies, wherein banks could fail due to a severe shock, resulting in significant economic effects both internally and externally. Such a scenario can lead to the collapse of financial intermediation and a



reduction in the overall money supply, as banks play a fundamental role in money creation and financial account management. To address these circumstances, a proposed solution can be to transfer the authority to create money from commercial banks to another entity, such as the central bank. This suggests that the central bank would issue money, with CBDC being a likely option for such issuance. This shift in money creation rights aims to mitigate the risks associated with bank failures and ensure the continuity of financial intermediation and the stability of the monetary system.

Another aspect during the introduction may be fairness, the aim of which is to ensure that goods are relatively fairly distributed between economic actors and society. The seniority - that is, the profit from money issuance - currently falls on commercial banks and private actors due to their significant involvement in the process. The aspect of fairness can prevail if the income from the mentioned actors is redistributed through the state to the larger part of the society by reducing the income from commercial banking money issuance. This requires the central bank to increase the money supply compared to the current situation.

The implementation of CBDC can serve as a strong incentive for central banks to closely monitor global market players, ensuring they do not lag behind in terms of financial innovations. In response to the growing presence of crypto-assets, some interviewees suggest that the introduction of CBDC can serve as a strategic move by central banks, offering a safer and more trustworthy alternative. It is worth highlighting the concept of digital dollarization, where the widespread adoption of various private currencies (such as crypto-assets and stablecoins) or even a CBDC issued by a foreign central bank in another country can diminish the central bank's control over economic processes, hindering its primary objective of maintaining price stability.

#### 4.2. Risks and challenges

In addition to the motivations, possible risks and challenges related to the introduction of CBDC were revealed during the interviews.

One significant challenge that may arise during the identification of risks is the ill-considered preparation of the CBDC system, the selection of inappropriate use cases, and the timing of the introduction. Therefore, it is crucial to carefully consider and plan the timing of introducing digital central bank money to maximize benefits for the economy and society while minimizing risks.

According to the interviewees, central banks may encounter challenges in finding effective motivational strategies to encourage potential users to adopt CBDC. Additionally, it is essential for central banks to ensure that users understand the rationale and potential use cases behind the introduction of the system. Failure to support the launch of CBDC with comprehensive educational campaigns can significantly impede social adaptation and subsequently hinder the success of CBDC initiatives. Furthermore, the limited influence on the behavior of the private sector should be highlighted as a potential risk. This indicates that predicting the demand for digital central bank money, as well as its potential impact on factors such as bank runs and disintermediation, remains challenging. Consequently, it becomes difficult to generate accurate estimates and forecasts related to the CBDC system.

The introduction of CBDC presents an additional challenge in terms of customer management, as the central bank must establish and operate a new payment system, requiring the acquisition of new competences and resources. For instance, if the system is implemented through a direct model, the central bank needs to develop customer relationship management mechanisms, such as establishing a customer service, which can be complex. Interviewees also pointed out that a lack of proper definition of the targeted customer segments and system limits can pose additional risks for users. For instance, if customers with substantial savings and deposits withdraw their funds en masse from commercial banks, it could jeopardize the banks' liquidity. This highlights the significant risk that the introduction of central bank digital currency poses to banks' liquidity and revenues, as their liquidity position heavily

relies on deposit flows and payment transaction management.

Moreover, the implementation of central bank digital currency brings forth various data protection and security challenges that necessitate careful consideration during the system's design and operation. To ensure a secure and efficient operation, it is crucial to establish robust protection and control mechanisms. The planning of the CBDC system should also encompass the management of offline events and transactions, as well as the assessment of exposure to third-party entities and the identification of potential risks.

The introduction of an interest-bearing CBDC can enhance the effectiveness of monetary policy transmission through interest rates. However, an inadequately calibrated interest rate can pose a significant threat to the banking system, potentially leading to disintermediation as some deposits shift towards CBDC. These risks, however, can also manifest in the case of a non-interest-bearing CBDC. Low interest rates may prompt customers to transfer their deposits to the safer CBDC, protected by commercial bank deposit insurance, further exacerbating disintermediation. As a consequence, banks' financing costs in the banking sector would rise, increasing their reliance on overnight central bank and interbank loans, potentially leading to higher prices for their products. Consequently, it becomes apparent that establishing an appropriate interest rate policy and meeting user expectations are crucial for all parties involved.

Another risk that may arise is the limited information available to the central bank when it begins lending to commercial banks through the issuance of CBDC to compensate for lost deposits. In this scenario, the central bank would be responsible for determining the types of loans that commercial banks can offer. However, the central bank may have limited information about the credit requirements of commercial bank customers. This situation creates a potential challenge as commercial banks may be better equipped to assess and decide on loans, which is not compatible with this type of central bank refinancing system. The central bank's decision-making is hindered by insufficient information about potential borrowers, which can give rise to further complications.

The introduction of digital central bank money can also lead to other non-traditional government failures, such as the risk of central banks financing commercial banks in large amounts, which can result in losses for the central bank if the loans are not repaid. In such a scenario, the government would have to reimburse the loss, which can compromise the independence of the central bank.

Through the examination of potential risks, it becomes evident that the implementation of CBDC can bring about a substantial transformation in the financial system. Thus, it is of utmost importance to approach its introduction with careful consideration and in a gradual manner. Central banks must be prepared to address extreme scenarios and anticipate potential risks. Improper implementation of CBDC could pose significant reputational risks for central banks. By meticulously planning and phasing in the introduction of digital central bank money, stakeholders can adequately prepare for the new system, mitigate risks, and capitalize on opportunities. This detailed approach will enable the economy and society to maximize the benefits offered by the introduction of CBDC.

#### 4.3. Factors and measures contributing to the social acceptance of central bank digital currency

The evaluation of challenges and risks associated with the introduction of CBDC has revealed that the success of such an introduction is heavily reliant on social adaptation and education. However, the currently available literature deals with these factors only to a limited extent. Consequently, this research aims to identify the primary factors involved in the social adaptation of the CBDC.

The acceptance of CBDC systems can be influenced by various factors, highlighting the significant role of educational initiatives in facilitating adaptation during the introduction phase. The interviews revealed distinct factors that impact adaptation as well as supportive

activities, which were summarized in the following table (Table 5).

To facilitate acceptance, the interviewees emphasized various design factors of CBDC systems. These factors included ensuring robust security measures, safeguarding personal data, enabling private transaction handling, ensuring transparency, obtaining legal recognition as a payment method, promoting broad usability, facilitating simple and user-friendly interfaces, offering mobile phone payment options, enabling fee-free usage, and providing offline availability. Additionally, from the retailer's perspective, the ease of connecting to the acceptance network was also highlighted as a crucial consideration.

As previously stated, enhancing the customer experience and developing user-friendly interfaces play a pivotal role in fostering social acceptance. By creating interfaces that are easy to use and navigate, there is a greater likelihood of increasing user engagement and generating a compelling appeal for commercial actors to adopt the technology.

An essential consideration during the implementation of central bank digital currency is its seamless integration with users' existing device environments, both on the residential and commercial sides, without significant deviations from previously employed solutions. The design of the currency should prioritize ease of integration and transparency to encourage uptake. Respondents' feedback suggests that users expect central bank digital currency to offer a user experience that is consistent with their current electronic payment practices, as electronic payments have become commonplace.

In addition to the factors previously presented, the level of trust in the government can be a decisive factor in the adoption of digital central bank money. In societies with high political polarization, there is usually increased resistance to the introduction of CBDC.

The adoption and broad dissemination of CBDC can also be impacted by a phenomenon called path dependence, which implies that if the intended users already have an account with a commercial bank, they may be less inclined to open a CBDC account with the central bank. All of this can potentially limit the demand for CBDC, which can be stimulated by offering favorable pricing, limits, and interest rates - although this could also pose risks due to the potential shock it could have on the banking system.

In addition to identifying factors that influence adaptation, the research also revealed activities that can support the widespread acceptance of digital central bank money. In terms of social adaptation, it is important to understand the specific problems and concerns of different target groups with regards to the use of digital central bank money, such as data protection concerns. This understanding can be obtained through comprehensive research and reflected in educational campaigns. Many people consider education to be key to the success of

**Table 5**  
Factors and activities influencing the adaptation of central bank digital currency.

Factors influencing adaptation	Activities supporting adaptation
<ul style="list-style-type: none"> <li>• Security</li> <li>• Protection of personal data, handling of transactions privately</li> <li>• Transparency</li> <li>• Acceptance as legal tender</li> <li>• Wide range of usability</li> <li>• Easy to use, user-friendly interface</li> <li>• Provision of mobile phone payment option</li> <li>• Use without additional fees</li> <li>• Offline availability</li> <li>• Easy connection to the network</li> <li>• Easy integration into existing device environment</li> <li>• Level of trust in government</li> <li>• Path dependency</li> </ul>	<ul style="list-style-type: none"> <li>• Understanding the concerns and problems of target groups</li> <li>• Development of complex educational programs - focusing on the fundamental issues of digital banking</li> <li>• Assessment and management of generational differences</li> <li>• Clarification of misunderstandings related to blockchain technology, presentation of technological background</li> </ul>

the introduction of CBDC since building trust is necessary for its wide-spread use.

During discussions on educational issues related to central bank digital currency, it was found that effective adaptation and understanding of the new system require governments and decision-makers to begin by addressing fundamental questions during their educational activities. For instance, these may include the importance of reducing cash usage, the potential benefits of digital banking, and the current available solutions. Subsequently, an introduction to the central bank-operated environment and a presentation of the differences can be provided.

The age of users is a crucial factor to consider when assessing adoption rates. Typically, in the case of new technologies, older age groups are more likely to reject them. While the older age group may be receptive to central bank digital currency as a secure tool, they tend to be more risk-averse, and digital tools are less prevalent in their routine. Respondents noted that this pattern may also emerge with central bank digital currency. The reason for this is not necessarily security concerns but rather the older age group's higher reliance on cash. These findings underscore the importance of evaluating and managing generational differences in CBDC implementation projects.

When considering the implementation of CBDC, it is crucial to highlight that blockchain technology is commonly associated with crypto-assets. Therefore, potential users may exhibit significant resistance, especially due to recent market events like the FTX scandal. If the CBDC system incorporates blockchain technology, it becomes essential to educate future customers about its purpose, key features, and overall functioning of blockchain. Prioritizing awareness of these aspects should be a focal point in educational initiatives to facilitate social adaptation and garner acceptance.

According to the opinion of the interviewees, however, blockchain technology can also be associated with an early adopter group, who are fundamentally more open to new technological solutions and innovations, so it may be worth focusing on them during marketing activities related to introducing CBDC systems.

#### 4.4. Best practice recommendations related to the introduction of CBDC systems

During the research, all interviewees positively evaluated the openness of central banks towards new digital solutions, but some best practices were also formulated in connection with the introduction of central bank digital currency (Fig. 2).

The interviewees reached a consensus that successful implementation of CBDC projects requires central banks to collaborate not only with other central banks, but also with reputable external experts, market players, suppliers, and potential users to gain a comprehensive understanding of all aspects of the projects. They emphasized the importance of engaging in discussions with the Bank for International Settlements (BIS), which is involved in numerous CBDC projects. Quantitative modeling of the impact on households, businesses, public finances, and the banking system, feasibility studies, and monitoring of ongoing CBDC pilot and live projects are important aspects of such consultations. Cybersecurity and fraud prevention, system-related business processes, participating actors, procedures, IT systems, and the development of CBDC regulations are also essential topics to cover. Based on these discussions, the most critical use cases can be identified and prioritized. When introducing CBDC systems, a crucial aspect is the implementation in phases, wherein central banks identify use cases that address real and pressing market issues. Along with identifying market problems, estimating the anticipated demand becomes essential. To facilitate smoother adaptation, it may be beneficial to create incentives for both corporate and residential users.

Regarding the developments, it is also necessary to review what innovations have been implemented in the market in the recent period - mainly related to blockchain-based solutions - and to evaluate which

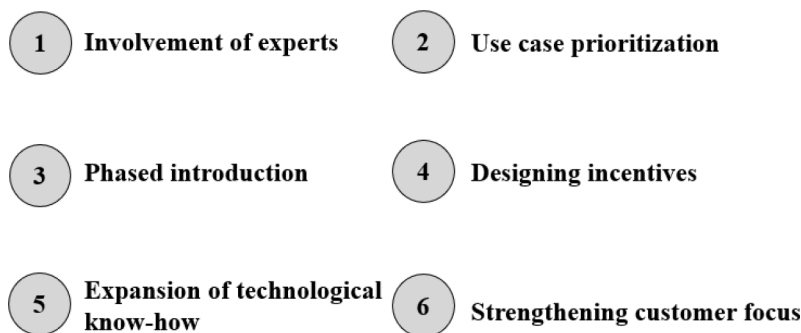


Fig. 2. Best practice recommendations related to the introduction of CBDC systems.

ones have proven to be functional from a technological point of view and which ones have not. In connection with this, the need to expand technological know-how was highlighted, especially in the case of distributed ledger, blockchain-based solutions, as well as the importance of a broad analysis and understanding of the interaction between the technological framework and economic feasibility. Central banks should consider how the latest technologies, including artificial intelligence-based developments, can be utilized for tracking cash flows and making economic forecasts.

Other central elements of the design of CBDC systems - which also require the involvement of external partners - are design, user experience, customer onboarding, and service-type approach, in which areas central banks have less experience due to their operation, since they do not serve retail customers directly. In relation to all of this, it is important that central banks do not strive to create completely new solutions, but rely on previous solutions and payment systems to create a simple and convenient user experience for broad usability.

In general, successful planning and implementation of CBDC projects hinge on collaborating with external partners to gain a diverse range of knowledge and establish a foundation for as many aspects of CBDC systems as possible.

4.5. Potential project milestones of CBDC projects

A further objective of the research was to determine the main steps of a possible CBDC implementation project, in connection with which four main stages emerged based on the interviews: (1) Research, exploration, (2) System design and testing, (3) Gradual introduction, (4) Scaling (Fig. 3). It is crucial to emphasize that during the discussion of each

stage, the interviewees outlined approximate durations. These durations are heavily influenced by a country’s economic standing, digital development, social factors, the development of its banking system, and the level of digital maturity of the central bank. Regarding the detailed content and length of each section, the article aims to provide a general approach. The duration of the different stages can therefore differ significantly in the individual countries depending on the mentioned factors.

- 1 Research, exploration:** The first potential stage of CBDC projects is research and exploration. Apart from assessing the technological and economic aspects of CBDC, it is imperative to concentrate on comprehending the requirements of consumers. Identifying the market failures and issues that a central bank digital currency system can address is crucial when examining the market. During this stage, it is especially vital to select and engage with experts and external partners who will work closely with the central bank throughout all phases. These partners may include commercial banks, chambers of commerce (representing merchants), blockchain developers, IT developers, payment system developers, and consultants. Additionally, this phase involves preparing a feasibility study of the CBDC system and developing a timeline for its implementation.
- 2 System design and testing:** During this phase, the system specification is formulated, which includes defining the system functions, identifying the key performance indicators (KPIs) related to the system’s operation, and determining the technological framework of the CBDC system. As the solution is being developed, continuous testing is necessary to evaluate its performance across various use cases. It is crucial to involve external experts and market participants

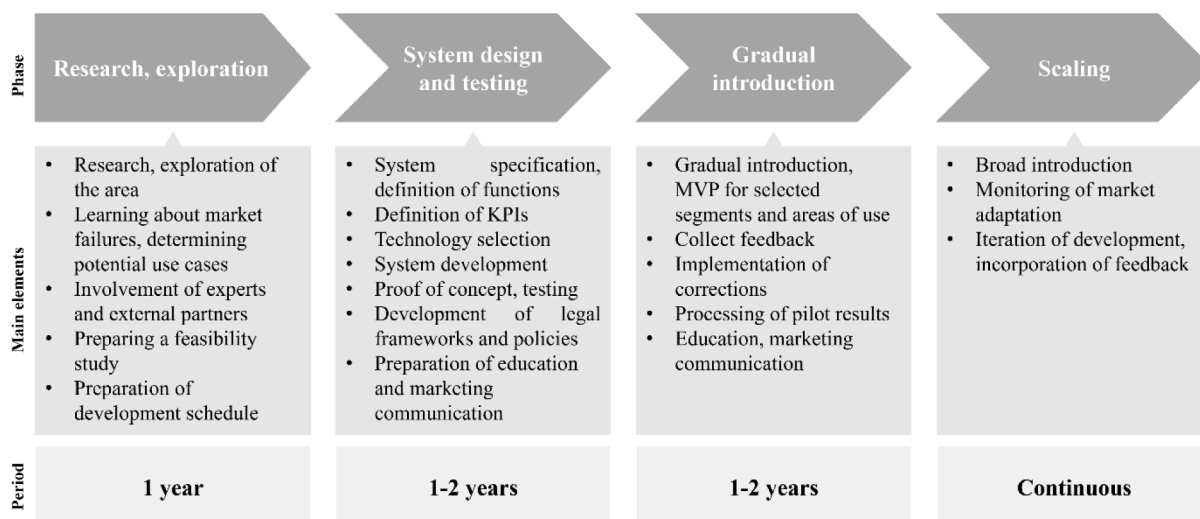


Fig. 3. The main steps of central bank digital currency implementation projects.

in all stages of the process. Alongside system development, creating a regulatory environment and preparing educational and marketing communication strategies are equally important activities. According to the interviewees, starting education as soon as possible is essential to prepare future system users and ensure a successful launch.

- 3 **Gradual introduction:** During the third stage, an important aspect is that the introduction does not immediately cover the entire later user base with full functionality, but MVPs (minimum viable products) should be introduced in smaller selected segments and areas. During the gradual introduction, it is necessary to continuously collect market feedback in order to carry out the necessary improvements and further development tasks. Intensive education and marketing communication are among the central elements of all these stages.
- 4 **Scaling:** Gradual introduction is followed by scaling, during which the CBDC system is widely introduced. Of course, the continuous monitoring of market acceptance, the iteration of development, and the incorporation of feedback into the system are also important factors in this phase.

## 5. Summary

In the digital economy, it is essential to use new financial technologies that enable faster, cheaper and safer execution of financial transactions. In parallel with the spread of new, innovative solutions in the field of financial services, more and more central banks are now dealing with the idea of modernizing payment systems and money, as well as the potential introduction of central bank digital currency and examining its main aspects.

The potential benefits of introducing digital central bank money include factors such as meeting the needs of future payment systems, increasing the efficiency of payment systems, developing the financial services market, creating a more resilient financial system, reducing the costs of cross-border transactions, and reducing the efficiency problems of the cash payment system. In addition to all this, the possibility of reducing money laundering, tax evasion, terrorist financing and other prohibited transactions should be highlighted.

However, in addition to the advantages, it is necessary to take into account the possible risks (e.g. operational, strategic, political, financial risks), since an inappropriate introduction can significantly endanger financial stability. It is therefore important that central banks carefully consider these factors and take appropriate measures to minimize and manage risks.

In this research, the main aspects of the introduction of digital central bank money were examined using in-depth interviews. In addition to supporting and expanding the benefits and risks discussed in the literature, however, aspects emerged that were only moderately presented in previous research.

Based on the research, it became apparent that the introduction and acceptance of central bank digital currency does not only involve technological transformation, but also requires social and cultural changes. Education and awareness are key to the adoption and success of CBDC, to ensure that potential users understand the benefits and risks of the technology and the ways in which central bank digital currency can be used. Education and detailed information can promote social acceptance and adaptation, and contribute to people's safe and efficient use of CBDC. As a result of all this, central banks need to pay special attention to these activities.

During the interviews, best practices were formulated for central banks in relation to the introduction of CBDC, among which the importance of involving external experts (e.g. technology consultants, developers, commercial banks, etc.) should be highlighted, who can help in exploring and evaluating all aspects of the implementation process. This can ensure that the introduction of central bank digital currency is safe and efficient.

Another goal of the research was to determine the main steps of a possible CBDC introduction project, during which it was established that it is of the utmost importance for the introduction of central bank digital currency that it reflects a real market problem, and that the introduction takes place in stages. Based on the interviews, the potential stages of the introduction are as follows: (1) Research, exploration, (2) System design and testing, (3) Gradual introduction, (4) Scaling.

Overall, the introduction of central bank digital currency can have a significant impact on the financial system. However, careful consideration and management of risks and challenges related to the introduction of CBDC, cooperation with external experts, definition and prioritization of use cases, phased introduction of the system and carefully planned education play a key role in terms of success and the realization of potential benefits.

## 6. Limitations and future research directions

One limitation of the present research is the relatively low number of experts actively involved in the field of central bank digital currency (CBDC). As CBDC is a relatively new and emerging topic, there is a scarcity of experts who specialize in this area. The limited number of experts may restrict the availability of diverse perspectives and in-depth insights, potentially impacting the comprehensiveness of the research findings. Another limitation is that the majority of CBDC projects are still in the research or pilot phase, and only a few countries have fully implemented CBDC systems. As a result, the field of investigation is limited to theoretical frameworks, conceptual designs, and small-scale experiments. The lack of fully operational CBDC systems may restrict the ability to draw concrete conclusions and assess the real-world implications of CBDCs. Due to the early stage of CBDC development, there is a scarcity of empirical data related to its impact on various aspects, such as monetary policy, financial stability, and economic performance. The absence of comprehensive empirical studies can limit the depth of analysis and hinder the ability to draw robust conclusions.

As numerous digital central bank money projects are still in the research or pilot phase, it is crucial to closely monitor these initiatives to gain valuable insights and learn lessons for their successful implementation. Future research should focus on assessing the progress of these projects towards full-scale deployment, examining the technological, regulatory, and adoption challenges they face, and identifying best practices and key success factors.

Furthermore, employing quantitative methods can enhance the understanding of CBDC-related issues. Conducting rigorous quantitative analyses can provide empirical evidence on the macroeconomic implications of widespread CBDC adoption, such as its effects on monetary policy, financial stability, and economic growth. These analyses can offer valuable insights into the potential benefits, risks, and trade-offs associated with CBDC implementation.

Another area worth exploring in future research is the analysis of educational and social adaptation support programs implemented by central banks. Understanding the effectiveness of these programs and their impact on promoting financial literacy, inclusion, and user acceptance is crucial. Detailed investigations can shed light on the design, implementation, and outcomes of such programs, enabling policymakers to refine and enhance their strategies for a smooth and inclusive transition to CBDC.

In this study, the principal milestones, and their durations in connection with CBDC implementation projects were identified. Nonetheless, it is worth noting that both the content and duration of these milestones may vary considerably across different countries. Hence, this necessitates further research that delves into a more in-depth examination of each stage, considering country-specific contexts. Additionally, exploring the factors that can influence the implementation milestones of CBDC systems is an important avenue for future research.

Finally, research efforts should focus on identifying and addressing security and privacy concerns associated with CBDCs. Examining

potential risks and developing robust security measures, privacy frameworks, and data protection mechanisms are critical to ensuring user trust and safeguarding the integrity of digital payment systems.

By pursuing these research directions, scholars and policymakers can deepen their understanding of CBDCs and contribute to informed decision-making and effective implementation strategies.

### Declaration of Competing Interest

I have no conflict of interest to declare.

### Data availability

The data that has been used is confidential.

### Acknowledgements

Supported by the ÚNKP-22-4 New National Excellence Program of the Ministry for Culture and Innovation from the source of the National Research, Development and Innovation Fund.

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