
NATIONAL BANK OF KAZAKHSTAN
Decision-making framework
for digital tenge issuance

CONTENT

Abbreviations

BIS – Bank for International Settlements

ECCB – Eastern Caribbean Central Bank

WEF – World Economic Forum

MP - monetary policy

IMF – International Monetary Fund

Model – Decision-making framework for digital tenge issuance

NBK – National Bank of the Republic of Kazakhstan

PSP – payment service provider

CB – Central Bank(s)

CBDC – Central Bank Digital Currency(ies)

DT – digital tenge

DeFi – decentralized finance

DSGE – dynamic stochastic general equilibrium

MVP – minimum viable product

Executive summary

Since 2021, the National Bank of the Republic of Kazakhstan has been exploring the importance of national digital currency issuance in close cooperation with financial market participants, the expert community, and international partners.

Last year, the prototype of the DT platform was developed to test the viability of the DT concept through the experimental confirmation of the technological feasibility. In addition, a primary model was developed to evaluate the impact of the DT on the economy, financial stability, and monetary policy as well as possible approaches to regulation. The results of last year's study are available in the relevant report.

The introduction of the national digital currency can have a significant impact on all participants' business processes in the country, as well as on the payment ecosystem, financial stability, and the economy in general. In addition, despite the high level of central banks' interest in CBDC, only three jurisdictions have officially launched their digital currency. In the light of the foregoing, in 2022 the National Bank continued a comprehensive study of the benefits and costs of the potential DT introduction.

This document provides a decision-making framework for the implementation of digital currency of the central bank of the Republic of Kazakhstan (hereinafter - the Model). During the elaboration of the Model, the tools recommended by international organizations (International Monetary Fund, World Economic Forum) and approaches of foreign regulators were taken into consideration.

The proposed Model is based on the recommendations of international organizations, but also considers the specific features of the Kazakhstan project. The Model explores different issues with the application of various tools designed to evaluate innovative projects.

Interpretation of the results of the Model will be based on a comprehensive assessment of the results of the study. For the purposes of objective analyses, members of the Advisory Board of the DT project are invited to interpret the results. This council includes independent international experts, as well as employees of international financial institutions.

By the end of 2022, a series of research studies are planned to obtain estimates of the Model, including technological assessment, economic modeling, elaboration of regulation and ecosystem development issues.

OVERVIEW OF CBDC PROJECTS

Currently, at least three Central Banks have fully launched the national digital currency as official means of payment, and more than 70 are studying and piloting CBDC [1]. All these projects differ from each other in several parameters, which ultimately exert influence upon the decision-making strategy and intended approaches to implementation. Different CBs have different goals and objectives for the implementation of CBDC, the level of technological development, and the planned implementation period. According to the BIS 2021 survey, CB motivation depends on the **type of digital currency being investigated** (wholesale or retail), **the level of economic development**, and **the stage of digital currency implementation** [2]. In addition to that, Central Banks differ in **the planned implementation period** and **prioritization of various components of the CBDC**. These differences will be discussed in detail below.

Type of digital currency being investigated and economic development level

According to the BIS survey, the main objectives of the advanced economies in the implementation of retail digital currencies are to ensure the efficiency of domestic payment systems, payment safety and stability of the financial system. Meanwhile, developing countries see retail CBDC as an opportunity to increase financial inclusion and introduce new monetary policy implementation mechanisms. However, they are also interested in improving the efficiency of domestic payment systems. Wholesale digital currencies have similar characteristics. In this case, improving cross-border payment systems is at the heart of both developed and developing countries' motivations for issuing wholesale CBDC. More detailed information on the relationship between the type of digital currency being investigated and the CB`s motivation in various jurisdictions can be found in Appendix-1.

Stage of digital currency implementation

The data from BIS survey also shows that the CB focus on different goals at different stages of digital currency implementation. CB primarily focus on providing the necessary level of safety and robustness in projects that have reached the pilot stage, while others give more emphasis on the efficiency of domestic and cross-border payments in projects that are still in the preliminary study stage. Detailed information on the impact of the implementation stage on the goals may be seen in Appendix-1.

Planned implementation period

Another important difference of CBDC projects is the planned and actual timing of the study and implementation of the digital currency. The most obvious examples of this distinction are the approaches of the Swedish and Nigerian CB. Thus, the development of e-Naira, Nigeria's digital currency, began in 2017, and in 2021 it was officially launched as a means of payment [3]. Currently, the total turnover of payments made with the Nigerian digital currency has exceeded 190 million naira [4]. Such a relatively short development period can also be seen in the Bahamas SandDollar project, which went from idea to pilot project and implementation in two years [5].

The first work intended to explore the implementation potential of the e-crown, the Swedish CBDC, also began in 2017. Already in 2020, a pilot project aimed at developing the necessary technical platform was conducted, but work on the e-currency (including research on the feasibility of implementing digital currency) is still ongoing [6]. The official end date of the project, as well as the final implementation decision, has not yet been announced.

A similar situation is observed in the case of the digital currency of the People's Republic of China, which has been under study since 2014, but has not yet been released [7].

Prioritization of various components of the CBDC

Another factor that distinguishes some digital currency projects from others is the focus on different components of the implementation of digital currencies. The above-mentioned e-crown project covers the fundamental research and puts emphasizes ensuring financial stability, as well as testing the performance of various technology platforms [6]. The Nigerian CB, due to the short timeframe of the project, initially focused on the design and deployment of the necessary technological platform, together with the appropriate regulatory framework for further operation [3]. Some CB also study economic aspects. For example, experts from the Bank of Canada, the Netherlands Bank, the Bank of Russia, and the Bank of England conduct numerous studies on CBDC, including micro and macroeconomic investigations [8-11].

The combination of all the above factors demonstrates **the fundamental issue regarding the impossibility of developing a universal tool for making a decision on the feasibility of CBDC implementation**. Confirmation of this can be found in a more detailed consideration of already launched digital currencies in Nigeria, the Bahamas, and the Eastern Caribbean States, the experience of which was used in the development of the Kazakh model of digital currency.

Nigeria

Already mentioned above eNair project, was launched to "provide households and businesses with access to fast, efficient and secure payments, thereby enabling them to benefit through a sustainable, innovative, inclusive and competitive payment system.

The project went from conceptual design to a working service in just four years, but some key features are still being implemented. For example, smart contracts, wholesale transactions via RTGS and offline payments have not yet been implemented [3].

Such an approach can be explained by choosing as the highest priority the early improvement of financial inclusion and the rapid deployment of the public payment system in the COVID-19 pandemic [3].

Bahamas

In October 2020, SandDollar became the world's first digital currency that successfully went beyond a pilot project and achieved an official launch [5]. This CBDC became available for use by all Bahamian citizens upon issuance, but integration with the commercial banking system is going on gradually and continues to this day.

In its statement on the project, the Bahamas CB announced that it would "simultaneously help to develop new rules for digital currency and strengthen consumer protections, especially with regard to data protection standards." [5].

Eastern Caribbean States

Antigua and Barbuda, Dominica, Grenada, Montserrat, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines are members of the Organization of Eastern Caribbean States and have a single currency, which is issued by a single CB (Eastern Caribbean CB, ECCB) in Saint Kitts. As in the case of Nigeria, the project for the implementation of CBDC in Eastern Caribbean countries is considered to be successfully launched.

Launched in March 2021, Dcash was targeted for a 12-month pilot [12]. Based on initial statements of the ECCB, the project would have been considered a success if 4,000 end-users and 35 merchants had been integrated, but circumstances have made adjustments to this plan. The COVID-19 pandemic caused the growth of popularity of online shopping services and naturally led to an increase in the population's interest in Dcash. The 2021 volcanic eruption in St. Vincent and the Grenadines also prompted the ECCB to accelerate a pilot project in the affected area for early recovery by providing access to another payment mechanism. Now the ECCB is focusing on the expansion of cooperation with banks and businesses [13].

Along with examples of CB that have successfully implemented digital currencies nationwide, it is equally important to pay attention to the examples of those countries that have been studying the introduction of digital currencies for a long time but have not yet come to a final solution. The most prominent representatives of this approach are China and Russia (see Appendix-1).

Analysis of the experience of these countries and others that have already launched digital currencies confirms the theses described above about the influence of various factors on the development and implementation of CBDC, and allows us to draw the following conclusions:

- The decision to proceed with a digital currency depends on **the initial goals and objectives set by the CB**, which in turn rest on **the CBDC type** under the investigation, **the level of economic development**, and **the stage of implementation/study**. Equally important factors affecting the decision-making process are **the timing of the study and implementation of digital currencies**, and **the selection of certain components of digital currency implementation** as priority areas.
- The most successful examples of digital currency projects either initially **had fundamental goal**, which was achieved to some extent during experiments and pilot projects, after which attention was paid to other aspects (Sweden), or **were based on simple KPIs** (for example, number of end users), but **during further work these indicators were revised** under the influence of external factors (Eastern Caribbean countries).
- Different motivational factors, a wide variation in the timing of implementation and allocated resources, as well as different approaches and strategies of different CB **make it impossible to establish g a single common model for decision-making**.

THE DECISION-MAKING FRAMEWORK FOR DIGITAL TENGE ISSUANCE

The decision-making Model on the need to implement the national digital currency in the Republic of Kazakhstan was developed on the basis of the international experience review, as well as the IMF, WEF tools and other studies in the field of CBDC.

3.1 Description

The IMF and WEF recommended tools (see Appendix-2) constitute the conceptual framework for starting the study, but they do not determine the scope, the basic criteria to form the design of a CBDC, and do not provide viability assessment parameters for each country (see Appendix-3). Taking aforementioned aspects into account, the decision-making Model on the need to implement the national digital currency not only includes recommendations from international organizations, but also defines its own parameters with respect to the Kazakhstani project`s specifics, and the Model further details the use of various tools for assessing DT implementation viability:

1. The structure of the Model differs from the WEF and IMF instruments;
2. Criteria for determining the design of DT take into account success factors in the implementation of DT in the Republic of Kazakhstan;
3. The Model details the tools for assessing the viability of DT;
4. There is no strict sequence of aspect study, parallel analysis of issues is possible;
5. The model is not static, some parameters may be changed in future;
6. Areas of analysis include a comprehensive assessment of various aspects.

1. Model structure

The structure of the Model differs from the WEF and IMF instruments; it also logically groups all questions and analysis criteria into 3 levels:

- the main parameters that determine the design of DT;

- determination of DT design considering architecture and economic issues;

- assessment of the viability of the selected DT design with the focus on three areas.

2. Criteria for defining design

While the IMF and WEF consider the objectives of CBDC implementation to determine the main criteria for the design in the initial phase, the Model also uses the international principles for CBDC implementation and successful implementation criteria with respect to the local principles of the Republic of Kazakhstan in order to define the design of DT. Unlike the IMF and WEF, ecosystem development issues are considered separately from the CBDC design and management as one of the DT`s successful implementation criteria.

The reason to include the aspect of ecosystem development as a separate section of the Model is relatively narrow consideration of CBDC implementation in the WEF and IMF methodologies. The IMF is focusing on end-user interests as part of the CBDC design issue, while the WEF is focusing more on stakeholder-driven governance from collaborative development to release.

However, neither the first nor the second one fully address the issue of ecosystem development. For example, the experience of Ecuador shows that technology alone does not lead to widespread digital currency adoption [27]. The support and interest of the ecosystem participants are crucial for the success of CBDC development, since one of the reasons for the project suspension was the lack of understanding of the new currency`s possibilities by users, as well as the difference in banking sector`s and Central bank`s interests.

While the IMF and WEF tools describe aspects of the CBDC design without reference to specific conditions, the Model considers all their aspects and selects the main parameters for the design with respect to the business requirements in the Republic of Kazakhstan.

3. CBDC viability assessment tools

The CBDC design`s viability assessment should be done with the use of various tools for analyzing innovative projects: experimental evaluation in the pilot project, economic modeling, a series of discussions with the market, the results of other projects, etc.

Digital currencies are new instruments that have no analogues.

Traditional methods of analyzing direct benefits and costs that take into account new instruments` additional effects are not suitable for estimating such new means of payment, which have a global scale of use, potential network effects and long-time horizons of various factors` uncertainty. It should also be noted that, according to the classification of methods for evaluating innovative projects, the traditional method of assessing benefits and costs is applicable only to the assessment of economic aspects, while the Model considers both technological and regulatory issues.

In this regard, when evaluating innovations at the research stage, it is possible to make only predictive indicators and reasoning on the benefits and costs. In order to evaluate the results of each DT-related aspects` analysis, various quantitative and qualitative indicators have been developed that help in predicting the benefits and costs and deciding whether to continue the study.

Tool combination

According to the analysis of innovation project evaluation tools, there are numerous possible methods that may be used with respect to the possibilities related to conducting experiments, data availability, etc. As part of the Digital Tenge project, technological experiments, economic studies for the development of models, design sessions, etc. are being implemented. All these areas of work allow the use of various tools: case studies, social value mapping, qualitative comparative analysis, benchmarking, peer review, cost-benefit analysis-modeling, pilot projects, monitoring, adaptive pathways, future-oriented assessment tools, systematic reviews and meta-ratings (see Appendix-3).

Moreover, the complexity of assessing the various factors` causality in the CBDC implementation suggests that the use of experimental assessment methods in the form of pilot projects is the best solution in comparison to the attempts to assess causal relationships (see Appendix-3).

4. Stages of analysis

All aspects are interdependent, but it is possible to consider certain aspects simultaneously. It is logical to study the definition of goals and the design of the architecture design sequentially, then the issues of regulation and the definition of the operational model can be studied simultaneously. That is, in this model there is no strict order in the study of logically separated issues.

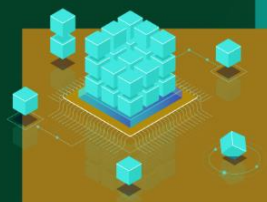
5. Iterative approach

According to the practices of evaluation of innovative projects, as well as the recommendations of the IMF and WEF, it is necessary to follow an adaptive method when studying CBDC, i.e. to have the flexibility to revise previously obtained results as other dependent aspects are studied, which, in turn, is also reflected in the Model (see Appendix-3).

6. Areas of analysis

The model covers the studies aimed to assess technological feasibility, potential economic benefits and costs, the ability to regulate the system, and the potential for ecosystem development.

1 The main parameters that determine the design of DT

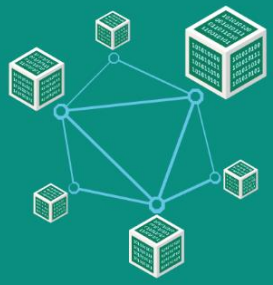


1.1
Goals and objectives of DT implementation

1.2
Criteria for the successful implementation of DT with respect to local principles of Kazakhstan

1.3
International principles for the CBDC implementation

2 DT design



3 Assessment of the viability

Cost-benefit analysis

- Technology
- Economics
- Ecosystem

4 Operational model and regulation

Comprehensive evaluation of results

- NBK
- Advisory board

Recommendations

Roadmap ← YES?

4.2 Analysis and expected results

Below a detailed description of how to work with the Model can be found:

- the main parameters that determine the design of a DT;
- determination of DT design with respect to architecture and economic issues;
- assessment of the viability of the selected DT design.

1. The main parameters that determine the design of a DT

This part of the decision-making Model focuses on considering the goals and objectives as well as the fundamental principles of DT implementation, which then determine the design of the DT.

Goals and objectives of DT implementation

In 2021, two Digital Tenge project`s reports described the main challenges for implementing CBDC in Kazakhstan:

Increased competition in the national financial market

The implementation of DT will ensure the creation of new smart contracts-based payment services by market participants. This will lead to an increase in the payment services market`s supply, thus creating promising opportunities for the domestic fintech market and stimulating a qualitatively and quantitatively increased competition.

Increased proliferation of cashless payments

DT may become one of the key tools for bridging the digital divide between regions via the ability to pay without an Internet connection.

Ensuring continuous functioning of the National Payment System

In the case of critical scenarios in which private organizations will not have the ability to operate sustainably, the digital tenge will ensure continuous and effective operation of the National Payment System.

Increased efficiency of payments with the participation of the state

Enormous potential of CBDC in improving the efficiency of state payments is obvious. In particular, the technology of smart contracts makes it possible to increase the efficiency of the current electronic public procurement system, as well as mechanisms for fiscal stimulation of the economy. One of the possible scenarios for DT use can be a digital social wallet that will ensure quick payments related to the state's social commitments or control of social welfare expenditures` targeting.

Increased financial market`s competitiveness in relation to players from different sectors and countries

Further development of remote biometric identification and smart contracts technology will provide opportunities to create services related to "invisible payments" (in case of transaction participants complying with several terms and conditions).

In addition, the seamless integration of the digital tenge with other digital platforms can assist in the creation of fundamentally new payment and financial products (e.g., transaction calculation in the "delivery versus payment" mode). Access to such infrastructure will allow financial market participants to remain competitive with players from different sectors and countries.

Taking into account the dynamics of the decentralized finance industry`s development (also known as DeFi) and digital assets, as well as the challenges of regulation and interaction between traditional financial infrastructure and DeFi, the possibility of using the DT infrastructure to solve emerging challenges (for example, the emergence of new unregulated players, most of which do not use the practices of operational and cyber risk management, imperfection of decentralized management algorithms, etc.) described in the overview report "Decentralized Finance and Digital Assets: Challenges for Regulation".

It should be noted that, regardless of the technology, the DT design must meet the criteria for the successful implementation of a new payment instrument in the Republic of Kazakhstan, as well as the international principles of the CBDC implementation.

1.2 Criteria for the successful implementation of digital tenge with respect to local principles of the Republic of Kazakhstan

The most important indicator of the need to implement a CBDC is an assessment of the market incentives and dynamics embodied in technology design options and other aspects of a CBDC. In this regard, the DT model pays special attention to this issue, in contrast to the IMF and WEF instruments, as mentioned above. It is critically important not only to study the preferences of end users according to design, but also to analyze the development potential of a holistic ecosystem, including an assessment of network effects.

Active involvement of the market and experts in the development of a decision on the implementation of DT will allow considering the interests of market participants in determining the optimal operational model for DT. In other words, the principles and market mechanisms should contribute to the development of the DT ecosystem:

1. The natural development of market interest in the use of digital currency, as well as the creation of new services and products with DT without the use of exclusively administrative-command methods.
2. Ensuring equal access to the DT system.
3. Customer-oriented approach - protecting the interests of consumers.

Thus, consideration the motivation to use the digital currency system on the example of ecosystem development should be provided for by the design of the DT and later evaluated in the Model as one of the criteria for the successful implementation of the DT.

1.3 International principles for the CBDC implementation

It should also be noted that the DT`s design considers the international principles developed by the G7. These public policy principles for retail CBDCs are a continuation of the basic principles created by the Bank for International Settlements. The G7 principles are divided into two categories:

1) fundamental principles for the CBDC implementation:

- existence of legal and regulatory frameworks;
- data protection;
- coexistence with existing payment systems;
- operational resilience and cybersecurity;
- preventing illegal financial activities;
- international monetary and financial systems` stability;
- eco-friendly use.

2) additional CBDC`s features:

- support for digital economy`s innovation;
- increased financial inclusion;
- public sector payments;
- cross border payments;
- support for international development.

In 2021, the basic design parameters were determined for following design aspects:

1. availability for consumers - retail currency;
2. design of access technology - token;
3. approach to the technological infrastructure`s organization - a combination of centralized and decentralized systems;
4. approach to the implementation of the architecture - hybrid.

In 2022, other design parameters (anonymity, offline payments, wallet management, etc.; these options will be discussed in more detailed way below). will be studied and determined according to the DT technological functionality required to achieve the goals, and the operational model will also be detailed with the respect to the market participants` interests to ensure market mechanisms for further DT proliferation.

2. Definition of DT design

DT implementation`s goals and objectives, implementation success criteria with respect to the local principles of the Republic of Kazakhstan, international principles of the CBDC implementation collectively form business requirements for the DH design.

№	Parameters that determine the design of DT	Description	Impact on DT design and other aspects of DT
1	**DT implementation`s goals and objectives**	– Increased competition in the financial market within the country; – increase in the penetration of non-cash payments; – ensuring the uninterrupted functioning of the National Payment System; – increasing the efficiency of payments with the participation of the state; – increasing the competitiveness of the financial market in relation to players from different sectors of the economy and other countries.	**Technological functionality** – programming; – system flexibility; – implementation of offline payments. **Operational model** – system management; – wallet and account management; – ecosystem expansion; – general process management.
2	**Implementation success criteria with respect to the local principles of the Republic of Kazakhstan**	**Principles aligned with market mechanisms** – the natural development of market interest in the use of digital currency, as well as the creation of new services and products with DT without purely administrative measures – ensuring equal access to the DT system; – customer-oriented approach; – consumer protection.	**Operational model** – system management; – wallet and account management; – ecosystem expansion; – general process management.
3	**International principles of the CBDC implementation**	– fundamental principles of the CBDC implementation; – additional features of the CBDC.	**Technological functionality** **Operational model** **Properties of DT Design –** **Economic Aspects** **Regulation**

In total, DT`s design-related questions can be divided into 2 categories depending on the impact on the technological architecture and the DT`s properties that would achieve the goals and objectives described in the previous section:

- Technological functionality and operational model that affect the DT`s architecture
- Economic aspects (interest and limits) that affect the DT `s properties.

Technological issues are related to

- programming;
- flexibility;
- implementation of offline payments.

Operational model-related questions

- System management - maintaining the main part (core ledger) of the infrastructure
- Wallet and account management - service processing and account management in the main system
- Ecosystem expansion - a wider range of financial services
- Management - processes through which the DT capabilities, system structure, technical characteristics are considered, and related decisions are made.

The main issues that will be considered in the operational model according to the criteria for the success of ecosystem development are listed below:

1) Are there incentives in technology design to develop network effects?
2) Are there incentives for players in the system regulation?
3) Are there barriers for DT accessibility for consumers?
4) Will there be additional costs for merchants to receive the opportunity to provide products and services with DT?

The answers to the operational model-related questions will be formed based on the results of discussions with market participants.

Categories of questions by operational model

	Category	What
	**System management**	*Running of core ledger and infrastructure* *Communication with core infrastructure and its enabling functions*
	**Wallet and account management**	*Processing services and managing accounts in its core system*
	**Broader ecosystem**	*Wider range of financial services, for example, merchant services, payments gateways, and programmable or individualized services*
	**Governance**	*Processes by which decisions over the structure, capabilities, and technical features of a CBDC systems are made*

Economy-related questions

- What properties of DT should be included in the design to ensure financial stability?

The cost-benefit analysis is based on the viability assessment of the selected DT design, conceptual operational and regulatory models.

3. Assessment of DT design`s viability

Decision-making criteria:

1. Technological effect
2. Technological and cyber-risks
3. Economic effects
4. Economic risks
5. Market and consumer readiness

4. Analysis of the conceptual operational and regulatory models

6. Regulatory impact
7. Benefits and costs within the operational model

Cost-benefit analysis

3 Assessment of the viability

- Technology
- Economics
- Ecosystem

Decision-making criteria

01 Technological effects
02 Technological risks and cyber risks
03 Economic effect
04 Economic risks
05 Market and consumer readiness

4 Operational model and regulation

06 Regulatory impact
07 Benefits and costs of the operational model

Comprehensive evaluation of results

NBK

Advisory board

Roadmap ← YES?

Recommendations

1. Technological effect

Description

In the Model, the technological effect is defined as the technological feasibility of the DT technology`s necessary functionality embedded in the design in relation to the goals and objectives of the CBDC implementation. This DT project parameter will be assessed for the following three aspects of the developed design with respect to technological forks (more details can be found in Appendix-2):

- programming (in particular – smart-contracts implementation);
- system`s flexibility (a high level of interoperability combined with the possibility of effective interaction between the DT and other payment systems/financial mechanisms - exchanges, marketplaces, etc.);
- offline payment implementation.

Questions for the criterion evaluation

The data obtained during the MVP should be evaluated by the following criteria:

- Solution availability (What products/technologies exist on the market? Will additional research work be required for their implementation or is it enough to purchase a product/technology that already exists on the market?);|
- Compliance with system requirements for security, throughput and scalability (Is the product/technology secure/powerful/scalable enough to meet all business requirements? How will system use cases be implemented at the level of the baseline MVP?);

Analysis tools and study phases

The main tool for testing the technology`s viability will be a pilot platform that will operate in two modes:

- a pilot project in a limited area with a limited list of merchants and consumers for the platform`s functionality end-to-end testing from the DT issuance to its redemption;
- a closed test environment ("technology sandbox") for research and advanced functionality`s viability assessment.

Due to the alleged participation of real merchants and consumers, it is planned to implement end-to-end testing of the project within the framework of the NBRK's "regulatory sandbox". In the "technological sandbox", various scenarios using smart contracts will be worked out, including the development of an offline payment chain. It is also planned to connect external participants and implement joint scenarios based on the Digital Tenge Hub.

Completion forms - answer options

After that, it will be necessary to rate the selected approaches based on the following description:

Grade "A" ("This aspect is technologically feasible, its implementation will not require additional research and/or resources")

Grade "B" ("This aspect is currently technologically feasible, but its implementation may require some additional analytical and research work and/or an insignificant amount of resources");

Grade "C" ("This aspect is currently technologically feasible, but its implementation may require separate additional research and/or a small amount of resources");

Grade "D" ("This aspect is currently technologically feasible, but its implementation may require a separate fundamental research and/or an average amount of resources");

Grade "F" ("This aspect is currently technologically infeasible due to the lack of necessary

The estimates above correspond to the following three groups of possible outcomes:

Grade "A" - "Technological effects are feasible“

Grade "B", "C", "D" - “Further research is required“

Grade "F" - "Technological effects are not feasible"

It is also worth noting that the final decision will be made not only on the basis of this assessment, but with respect to the provided documents with calculations and explanations (the process of assessing each of the three previously described criteria should end with the creation of a report that will describe the steps for assigning grades in the most detailed way).

2. Technological and cyber-risks

Description

Particular attention should be paid to information security and technological risks. Being essentially a non-functional requirements, these aspects are rightly considered as the most important ones when considering the viability of payment mechanisms. During the MVP works, it is planned to study and implement security mechanisms at the administrative, logical (software) and physical levels with the prioritization of the last two. All required information security policies will also be developed, followed by audits and tests. The combination of all these measures will ensure the necessary level of confidentiality, integrity and availability of the DT system.

Questions for the criterion evaluation

- The presence of certain risks (What risks/vulnerabilities exist in the chosen approach? Will it be needed to conduct additional research to find them?);
- Mitigation possibility (Is it possible to mitigate all identified risks? If so, how exactly?);
- Mitigation cost (How much will mitigation measures cost? How will this affect the key parameters of the service and main functions? What restrictions and on what processes should be imposed?)

Analysis tools and study phases

The main tool for testing the technology`s viability will be a pilot platform that will operate in two modes:

- a pilot project in a limited area with a limited list of merchants and consumers for the platform`s functionality end-to-end testing from the DT issuance to its redemption;

- a closed test environment ("technology sandbox") for research and advanced functionality`s viability assessment.

Completion forms - answer options

After that, it will be necessary to rate the selected approaches based on the following description:

Grade "A" ("Technological risks of this approach are either insignificant, or their mitigation will not require additional research and/or resources");

Grade "B" ("Mitigating this approach`s technological risks may require some additional research work and/or an insignificant amount of resources");

Grade "C" ("Mitigating this approach`s technological risks may require additional considerable research work and/or a small amount of resources");

Grade "D" ("Mitigating this approach`s technological risks may require additional fundamental research work and/or a small amount of resources");

Grade "F" ("Technological risks of this approach cannot be mitigated").

The estimates above correspond to the following three groups of possible outcomes:

Grade "A" - "Technological risks can be mitigated“

Grade "B", "C", "D" - “Further research is required“

Grade "F" - "Technological risks cannot be mitigated".

3. Economic effect

Description

The implementation of DT will potentially bring a whole range of completely new digital opportunities and benefits that will be available to all key stakeholder groups: consumers, financial institutions and government institutions (more details in the final report). However, it is difficult to assess the potential demand for DT and potential benefits by economic agents.

Questions for the criterion evaluation

- What will be the demand for DT?
- How will the implementation of DT affect the well-being of society?

Analysis tools and study phases

As an analysis tools, a survey, a microeconometric study, a DSGE model and conclusions from discussions with experts will be utilized.

A survey is planned to collect data. A microeconometric study is a tool for predicting the potential demand for DT compared to its close alternatives (cash and current accounts) using an econometric model.

The assessment of the potential demand for DT is important to understand the impact of digital currency on banking products and the potential use of digital currency in the country.

Households' preference for attributes is currently being estimated by applying a structural demand model to existing product survey data. Provided that these preferences remain unchanged after the release of the DT, the demand for DT can be predicted based on its attributes (characteristics), DT design (cost of use, ease of use/convenience, security, anonymity, usefulness for budgeting, etc.) and the extent to which households value each attribute. The influence of different design attributes on DT demand should be explored. Thus, to study the demand for digital currency in Kazakhstan, it is necessary, firstly, to study the attitude of households towards DT, secondly, to identify what characteristics of monetary forms are attractive to households, and thirdly, to study the opinion of different population groups on the use of DT. According to methodological approaches to assessing people's behavior in the absence of empirical data, conducting surveys and modeling provide the maximum possible estimated parameters of consumer demand for a new currency.

The results of the micro econometric model will be further used in the DSGE model to assess the households` well-being in the absence and presence of DT with alternative technical characteristics and other varying parameters. The model estimates how the balanced growth trajectory of key macroeconomic variables will change after the potential launch of DT, with all other parameters held constant. The open economy model for Kazakhstan includes the specific characteristics of the domestic economy: the oil sector, fiscal rules, monetary policy.

The results of the analysis will also include conclusions from discussions with experts. The final version of the working paper will be comparable in all respects with the studies of other central banks.

Completion forms - answer options

Based on micro econometric estimates using survey data, this article will empirically answer the following questions:

- What will be demand for DT?
- What attributes (characteristics) of DT design (such as cost of use, ease of use/convenience, security, anonymity, usefulness for budgeting, etc.) will affect demand?
- To what extent will DT affect the demand for cash and current accounts?

The DSGE model also endogenously defines the following issues:

- households` demand for DT through optimal first-order equations;
- change in households` welfare with the implementation of DT.

The analysis of the results will allow classifying the responses into the following categories: **positive / neutral effect**, **unattainable**, **further research is required**.

4. Economic risks

Description

As described in the CBDC` aspects (see Appendix-2), along with the potential benefits, there are economic risks from the implementation of DT: changes in macroeconomic parameters and impact on financial stability.

Questions for the criterion evaluation

- How will macroeconomic variables change in case of varying different DT`s properties?
- What will DT affect monetary polices?
- How will different DT implementation rules affect bank lending and borrowing activities in the economy?

Analysis tools and study phases

The tools for analysis will be the results of a micro econometric model, two DSGE models and conclusions from discussions with experts.

The results of the micro econometric model will be used further in two DSGE models. The first DSGE model will include fiscal rules such as monetary policy and DT. The combination of all these characteristics will help to study how the presence of DT affects the impulse responses of GDP, inflation and other key macroeconomic variables to exogenous shocks (e.g., oil price shock, public spending shock). In addition to this, it will be possible to analyze the optimal monetary policy with DT. The model can also be used to analyze stable values of inflation and interest rates in the economy in the absence and presence of DT. This is extremely important information because understanding how the balanced growth path of key macroeconomic variables will change after the potential launch of DT with all other parameters unchanged is required for further analysis . After carrying out all the above analyses, there will be a clear economic justification for the impact of DT based on the general equilibrium model of the Kazakh economy derived from the first principles of economic theory.

Currently, the number of available sources related to the impact of CBDC on financial stability is growing [30-35]. These studies analyze the effect on financial stability by examining the impact of the CBDC on the activities of commercial banks (lending and borrowing).

The problems of financial stability are associated with the risk of a massive deposit outflow from banks to the CBDC system that will lead to a lack of funds in the banking system. However, most of these studies are either theoretical or partial equilibrium models that are too general. No interest will be charged on the DT to mitigate this risk (more details in the final report).

To assess the impact of DT on financial stability, a second DSGE model for Kazakhstan will be developed, including DT, financial frictions/constraints and banks. The above analysis will provide a clear explanation of the overall impact of DT based on microeconomic general equilibrium models of the Kazakh economy. The analysis above assists in achieving a clear understanding of the overall DT`s impact based on the microeconomic theory of the general equilibrium model of the Kazakh economy.

Completion forms - answer options

The first DSGE model estimates

- how the responses of macroeconomic variables will change in case of exogenous shocks in the presence and absence of DT in the economy;
- macroeconomic variables with different properties of digital currency (fixed or variable volume of DT issuance, etc.);
- how the optimal monetary policy can change or how the monetary policy can be changed in case of the DT implementation.

The second DSGE model will help in studying following aspects:

- how different DT implementation rules may affect bank lending and borrowing activities in the economy. The potential impact of risks on financial stability due to various shocks (e.g., demand and technology shocks) will be investigated.

The analysis of the results of economic risks assessment will allow evaluating responses in the following categories: **economic risks can be mitigated**, **economic risks cannot be mitigated** and **further research is required**.

5. Market and consumer readiness

Description

A critically important driver of the project is the creation of an ecosystem around DT with financial market participants (for more details about the relevance of ecosystem development, see Appendix-2). To this end, it is planned to create a Digital Tenge Hub to connect infrastructure players, international partners, market representatives and consumers to the process of design sessions and develop integrations with the DH platform. This, in turn, will allow assessing the readiness of the market and consumers for the implemetation of DT.

Questions for the criterion evaluation

- Immersion of market participants in the project and involvement in the development of optimal approaches to solve open issues (How well do market participants understand the concept of DT? How interested are they in the further development of DT?)
- What will DT affect monetary polices? Training and certification of market participants to jointly form a list of relevant scenarios for consumers and to develop innovative smart contracts (How will training and certification be organized? What percentage of scenarios can be worked out within the DT Hub?)

Analysis tools and study phases

The main tools for assessing the readiness of the market and consumers will be the analysis of interaction experience within the DT Hub:

- surveys among market participants and consumers on key topics related to the further development and use of DT;
- evaluation of the various start-ups`/joint projects` experience within the DT Hub.

Completion forms - answer options

After that, it will be necessary to give a mark that shows market and consumer readiness based on the following description:

Grade "A" ("The market and consumers are ready and interested in the introduction and further development of DT");

Grade "B" ("The vast majority of market participants and consumers are ready and interested in the introduction and further development of DT");

Grade "C" ("More than half of market participants and consumers are ready and interested in the introduction and further development of DT");

Grade "D" ("Less than half of market participants and consumers are ready and interested in the introduction and further development of DT ");

Grade "F" ("Technological risks of this approach cannot be mitigated. The market and consumers are neither ready nor interested in the introduction and further development of DT").

The estimates above correspond to the following three groups of possible outcomes:

Grade "A" - "High level of readiness"

Grade "B", "C", "D" - "Medium level of readiness"

Grade "F" - "Low level of readiness ".

4. Analysis of the conceptual operational and regulatory models

The pilot project`s results are not sufficient to conduct an analysis of the operational model and regulation, since the pilot project does not address all issues: forecast estimates for future costs are required, etc.

6. Regulatory impact

Description

The feasibility of the CBDC`s potential benefits with a particular design selected in accordance with specific operational model depends on a particular country`s regulation: to what extent current regulations allow the proposed distribution of roles in the CBDS system to be organized, to what extent the use of new mechanisms for managing data privacy is allowed, how the interests of various players will be protected and how the common control is organized (see Appendix-2).

Questions for the criterion evaluation

The main questions that are being studied at this stage :

- How will the operational model and oversight be managed ?
- What legislative changes are needed to ensure data privacy?
- What changes are needed to ensure consumer protection (security, fraud)?
- How will the issues of different players` conflicting interests be resolved?
- How will economic risks be managed?
- Can incentives for ecosystem development be regulated?

Analysis tools and study phases

There will be an analysis of legal acts, international studies, discussions on the basis of the **DT Hub** on regulatory issues.

Completion forms - answer options

In 2022, the DH regulatory framework will be developed. Based on the results of the analyzes, the following aspects will be tested:

- definition of DT;
- data security issues;
- roles of participants and the NBK;
- administrative requirements for participants;
- technical requirements of the target platform.

The analysis`s results are regulatory costs assessment with respect to the recommended changes in regulatory legal acts that allow the implementation of DT and related necessary functionality in accordance with the selected operational model.

Such analysis will provide the following answers: **low regulatory costs** or **excessive regulation is required**.

7. Benefits and costs within the operational model

Description

Not all operational benefits are considered in economic analysis, they should be assessed at the micro level of market participants in more detailed way. The implementation of DT requires the study of issues related to infrastructure costs when deploying and maintaining the system for all participants in the system. To begin with, it is necessary to assess the availability of an adequately developed technological infrastructure. The most important strategic issue in the deployment of DT infrastructure is the balance between internal DT capacity and external providers. In the majority of cases, successful infrastructure projects involve interaction with suppliers while building internal experience. This helps to better understand the product, minimize vendor lock-in, and facilitate appropriate distribution of responsibilities within the market.

Questions for the criterion evaluation

- What are the benefits for system participants from the chosen operating model?
- The cost of purchasing/implementing the solution combined with the cost of the necessary infrastructure equipment, related works and support for the selected period (how much will the product/technology + infrastructure equipment + works + support cost separately for the NBRK, banks, fintech and payment organizations?)
- What will the expected evolution of specific hosting qualifications, physical infrastructure management certification, and audit programs look like?
- What will be the approaches to software development, maintenance and management?
- How long will it be possible to maintain the system without increasing costs?
- How much will it cost for market participants to comply with regulatory requirements, technical requirements, etc. (e.g., in terms of cybersecurity)?

Analysis tools and study phases

Answers to the questions related to the operational model will be formed based on the results of discussions with market participants based on the DT Hub and analysis of international studies.

Completion forms - answer options

Based on the results of the work, the analysis of the operational benefits and costs for market participants in deploying and maintaining the new system will be created. Responses can be classified in the following way: **benefits > costs** or **benefits < costs**.

There are five criteria with three answers, two criteria with two answers, thus, according to the results of all works, there can be 972 possible combinations of answers.

Possible answers for each criterion

Technological effect	Technological and cyber-risks	Economic effect	Economic risks
Feasible	Can be mitigated	Positive/neutral	Can be mitigated
Further research is required	Further research is required	Further research is required	Further research is required
Not feasible	Cannot be mitigated	недостижимы	Cannot be mitigated

Market and consumer readiness	Regulatory impact	Benefits and costs within the operational model
High	Low regulatory costs	Benefits > costs
Medium	Excessive regulation is required	Benefits < costs.
Low		

Is the implementation of digital tenge in Kazakhstan worthwhile?

What are the potential benefits for business sector participants?

They were technologically proven as part of prototype development in 2021

Review of CBDC possibilities

What potential risks are highly likely in the case of implementation?

They were covered in white paper 2021,will be updated as part of the DT Hub

Overview of CBDC risks, costs

Goals and objectives of DT implementation

They were addressed as part of the study in 2021

Criteria for the successful implementation of DT

They were addressed as part of the study in 2021, will be updated as part of the DT Hub work

International principles for the CBDC implementation

According to the G7 recommendations

Business requirements for DT design

How should DT be designed to achieve the stated goals while minimizing risks?

Projecting DT design

It was partially addressed within the framework of the study in 2021, will be updated as part of the DT Hub and MVP

Is it realistic to ensure that the platform functioning with the design?

Assessment of DT design`s viability

Technology pilot under MVP, economic modeling and surveys, regulatory impact analysis in 2022

- Technology
- Economics
- Ecosystem

Conceptual operational and regulatory model analysis

3.3 Interpretation of assessment results

Ultimately, the Model should answer the main question - "**is it necessary to implement DT in Kazakhstan?**". This will require the decomposition of the question into two: "**What potential benefits can be obtained by participants in the business turnover?"** and "**What potential risks are likely in case of DT being implemented**?". The answers to them will be a review of the CBDC possibilities and a review of the risks and costs, respectively. In turn, these reviews will help define the goals and objectives of DT implementation, the criteria for successful implementation of DT, and will also allow them to be compared with the international principles of CBDC implementation.

An analysis of all the above aspects of the DT implementation is used to determine the business requirements for the DT design, which are necessary to answer the question: "**How should DT be designed in order to achieve the stated goals, taking into account the minimization of risks?".** Based on these requirements, the DT design will be constructed, which in turn will be assessed for feasibility in the context of technology, economy and ecosystem – in other words, a detailed answer will be provided to the question "**Is it realistic to ensure the functioning of the platform, taking into account the chosen design?**".

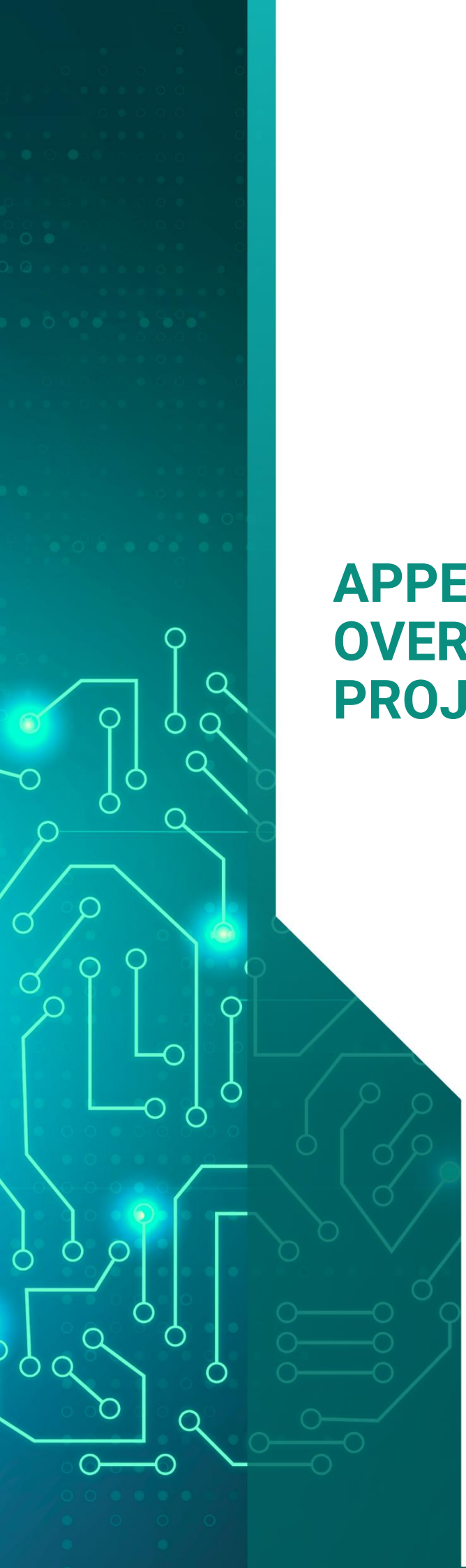
The information related to the selected design`s feasibility will be used later to assess the required regulatory impact. Viability testing will be conducted using an experimental approach within the MVP and technology sandbox. It is worth noting that the assessment will use both the experience of the 2021 project and data obtained directly during the implementation of the MVP.

The information obtained after all the actions above will be aggregated into a single assessment document for the consequent decision-making process. To interpret the assessment, it is planned to create an independent expert group - an advisory council to evaluate the implementation approaches, as well as the results of the project. The group will include international and Kazakhstani experts, which will provide a comprehensive assessment and optimal solutions for the CBDC-related various issues being determined. The recommended decision will be developed based on the position of the advisory board obtained as a result of voting and based on the conclusion of the NBK with reference to the results of the evaluation according to the model.

The main focus of the project evaluation will be on the consideration of **the issue of the cumulative achievement of previously mentioned fundamental DT implementation goals and objectives**. Further ranking of aspects by priority will be performed by the experts themselves with a mandatory explanation of the reasons for assigning a particular priority. The interim results of the evaluation will be published on the official website of the NBRK. Design sessions will be organized at the Digital Tenge Hub site for joint study of issues within the framework of the Model.

In order to successfully and fully study the issues of introducing a national digital currency in Kazakhstan, the Digital Tenge Hub was created, a collaborative platform for the Digital Tenge pilot project, which brings together all interested parties to jointly study all aspects of digital transformation.

Link to Digital Tenge Hub registration page

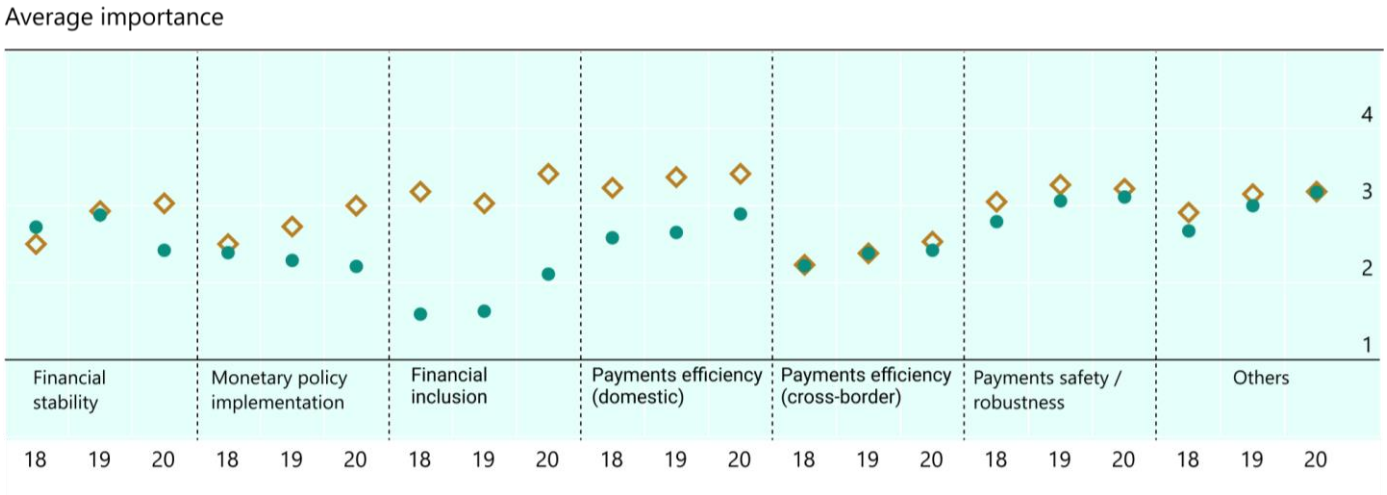


APPENDIX 1
OVERVIEW OF CBDC PROJECTS

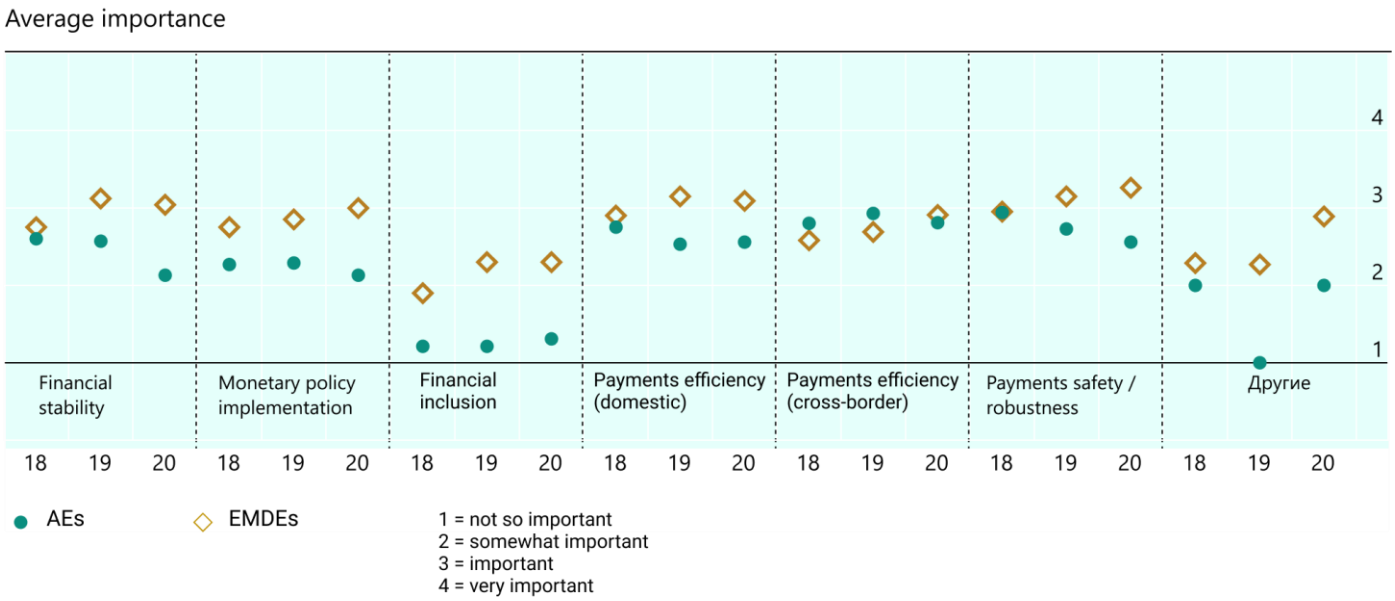
Currently, at least three CB have fully launched the national digital currency as official means of payment, and more than 70 are studying and piloting CBDC [1]. All of these projects differ from each other in a number of parameters, which ultimately exert influence upon the decision-making strategy and intended approaches to implementation. In particular, different CBs have different goals and objectives for the implementation of CBDC, the level of technological development, and the planned implementation period. These differences will be discussed in detail below.

One of the most important differences lies in the goals and objectives of the different CBDC. According to the BIS 2021 survey, CB motivation depends on the type of digital currency being investigated (wholesale or retail), the level of economic development, and the stage of digital currency implementation [2].

Motivations for issuing a retail CBDC [2]

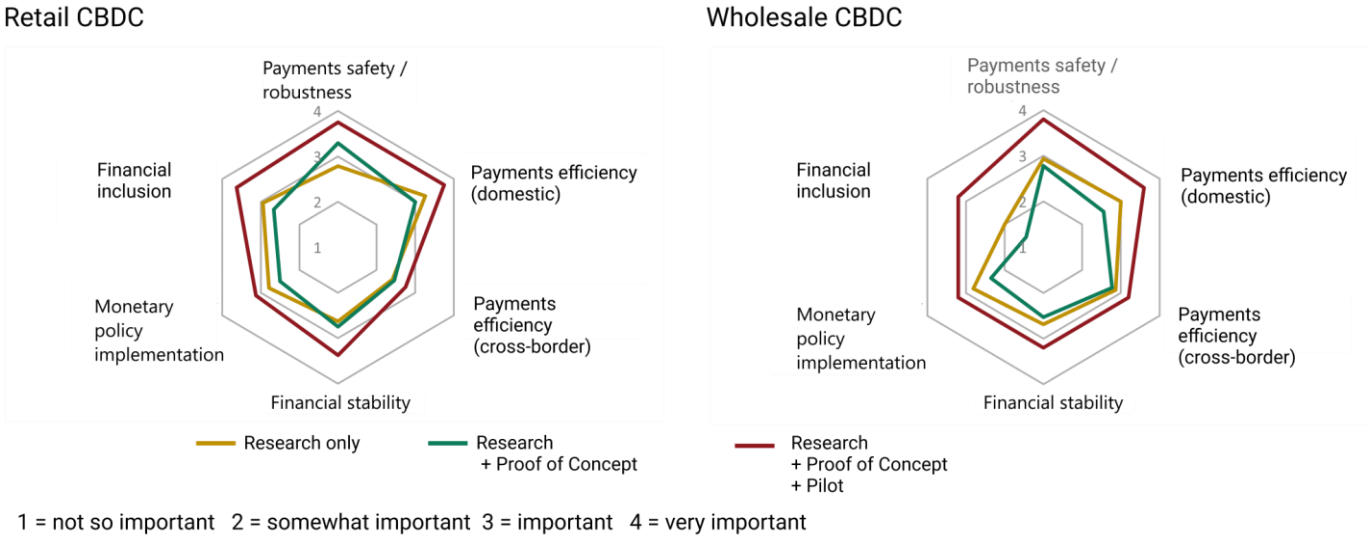


Motivations for issuing a wholesale CBDC [2]



As depicted in the graphs, the main objectives of the advanced economies in the implementation of retail digital currencies are to ensure the efficiency of domestic payment systems, payment safety, and stability of the financial system. Meanwhile, developing countries see retail CBDC as an opportunity to increase financial inclusion and introduce new monetary policy implementation mechanisms. However, they are also interested in improving the efficiency of domestic payment systems. Wholesale digital currencies have similar characteristics. In this case, improving cross-border payment systems is at the heart of both developed and developing countries' motivations for issuing wholesale CBDC.

Main motivations of CBDC work by stage [2]



The diagram above shows that the CB focus on different goals at different stages of digital currency implementation. In particular, CB primarily focus on providing the necessary level of safety and robustness in projects that have reached the pilot stage, while others give more emphasis on the efficiency of domestic and cross-border payments in projects that are still in the preliminary study stage.

Another important difference of CBDC projects is the planned and actual timing of the study and implementation of the digital currency. The most obvious examples of this distinction are the approaches of the Swedish and Nigerian CB. Thus, the development of e-Naira, Nigeria's digital currency, began in 2017, and in 2021 it was officially launched as a means of payment [3]. Currently, the total turnover of payments made with the Nigerian digital currency has exceeded 190 million naira [4]. Such a relatively short development period can also be seen in the Bahamas SandDollar project, which went from idea to pilot project and implementation in two years [5].

China

The first information about the study of the digital yuan dates back to 2014, but the beginning of the development of e-CNY as a means of payment is commonly referred to as 2017. That's when the Digital Currency Research Institute was opened [7, 14]. In any case, it can be argued that the People's Bank of China has been studying the implementation of CBDC for a long period.

The following four aspects are considered as the main motivations for the implementation of digital yuan: providing digital money to the public, supporting fair competition along with efficient and secure payment services, improving the efficiency of cross-border payments, and positively affecting financial inclusion [14].

To test the ability of CBDC to achieve the above-mentioned goals and test individual scenarios, a pilot project was launched in four regions in 2020. However, as early as 2021, the geography of research expanded to ten regions, with the digital yuan gradually becoming more available nationwide over time.

This in turn affects the volume of funds and their circulation: the total turnover in the People's Bank of China's CBDC system in 2021 reached 35 billion yuan. At the moment, the integration of banking services with the e-CNY system is going on, as well as the development and testing of various off-line payment options (in particular, using specially designed devices for the storage of CBDC and subsequent payment) [14].

However, the People's Bank of China has not announced a planned date for the final launch of the digital yuan. On the contrary, officials state that "there is no set timeframe for the final launch".

Russia

The issue of implementing a digital ruble began to be discussed at the end of 2020, but the first studies of the digital currency were conducted by the CB of Russia back in 2019 [15, 16]. The main goals of the introduction of CBDC are considered to be to increase the stability of the financial system, develop competition among financial institutions, subsequently reduce the cost of payment services and transfers, and stimulate innovation for the development of the digital economy [15]. Along with this, the need for the establishment of a secure payment system and the implementation of offline payments are also mentioned.

The prototype was developed in December 2021, and the digital ruble is currently undergoing closed experiments in cooperation with 12 Russian banks to test the possibility of online transfers of funds using CBDC through mobile banking applications [18]. The next stage aims to test transactions for the payment of goods and services, payments for public services, and the implementation of smart contracts. As a more distant prospect, the implementation of offline payments, interaction with other digital platforms, and allowing non-resident clients to use the digital ruble are considered. As in the case of e-CNY, the project of the digital ruble has no stated timeline for implementation, only the research and experiments are known for now.

It is worth noting that during the development of the Model, the experiences of other countries that are either in the final stages of implementation of CBDC (Cambodia, Jamaica, Arab countries) or have a significant amount of relevant information obtained in the process of research work (Sweden, EU, Thailand) were taken into account.

APPENDIX 2
CBDC ASPECTS FOR INVESTIGATION

The above-mentioned review of international experience demonstrates that there is currently no universal tool that fully addresses the issue of the feasibility of implementing digital currencies. Each CB is developing its methodological approaches to the study of digital currency, moreover, CB of different countries prioritize different aspects of the introduction of digital currencies at different stages of the study.

The need for such an approach is also stressed by international organizations such as the WEF and the IMF. They offer their tools in terms of algorithms for structuring issues, but experts also recognize that there is no universal approach due to the different tasks and stages of the study of digital currencies by different CB [19, 20]. In addition, they note that the mechanisms developed under these instruments are not exhaustive and are intended to complement existing sources in the area of digital currency analysis. Because of the broad scope of digital currency investigation, the tools proposed by the WEF and IMF are worth examining in more detail.

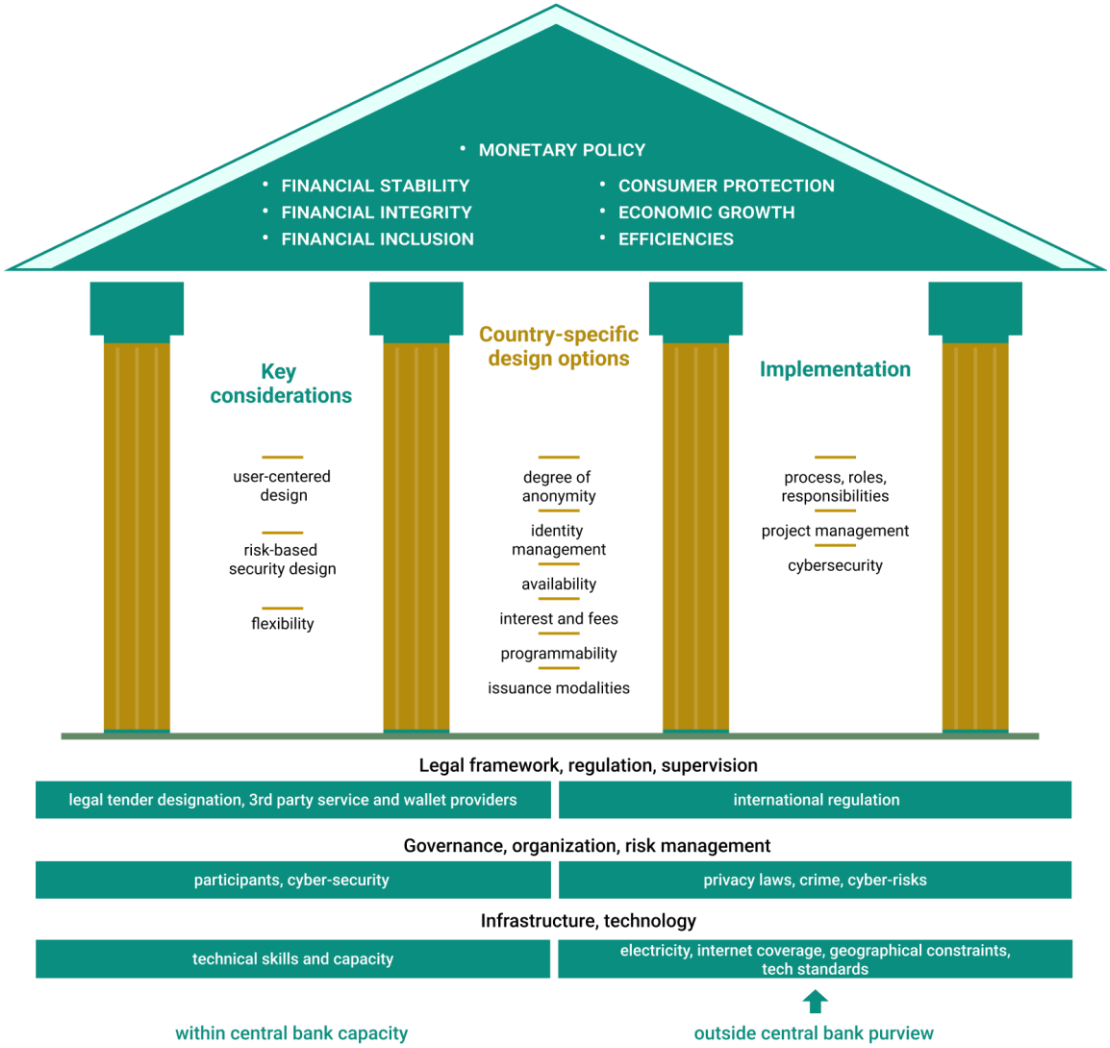
A Survey of Research on Retail Central Bank Digital Currency, which was released in 2020 as part of the IMF Working Papers for further discussion, is one of the first attempts to offer policymakers a defined framework for making decisions about CBDC.

In particular, the authors stipulate the need for an Agile approach to the implementation of digital currencies (iterative development along with the possibility of reassessing the goals of implementation at different stages), they also consider the advantages and disadvantages of different CBDC distribution and elaborate possible problems with the development of the necessary legal and regulatory framework for the operation of digital currencies.

The IMF considers the following aspects of CBDC, which are logically divided into 5 main levels [19]:

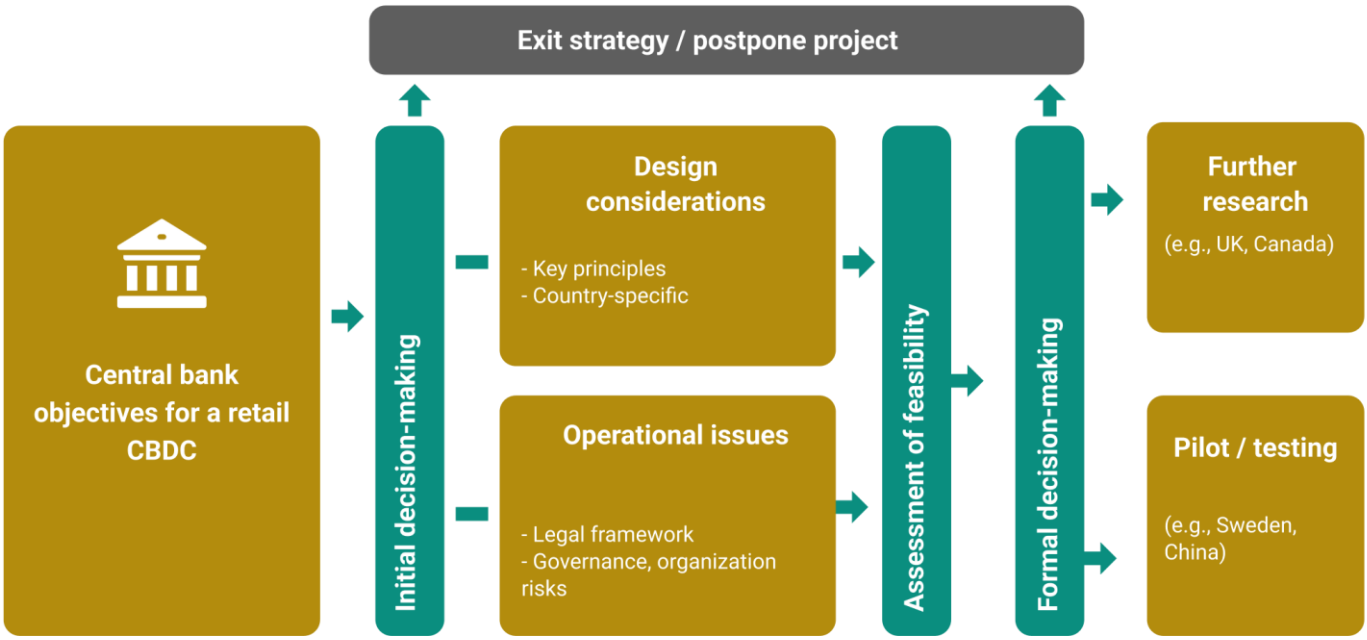
1. CB objectives
2. Design considerations
3. Legal framework, regulation, supervision
4. Governance, organization, risk management
5. Infrastructure, technology

IMF Toolkit for CBDC policy makers: aspects of the study



The CBDC Policy-Maker Toolkit of WEF is developed within the Centre for the Fourth Industrial Revolution's. The main goals of this paper are to provide an overview of the technology, demonstrate possible challenges and trade-offs, and provide a suggested set of actions for policymakers interested in exploring the implementation of CBDC. In contrast to the previous paper, this document is more of a set of defined rules and guidelines rather than an academic publication aimed at elaboration of the issue in depth. In both cases, however, the issues addressed and the conclusions drawn are compatible .

Central Bank Digital Currency Policy-Maker Toolkit: study stages



Key questions

- What is/are the objectives of issuing CBDC? Have all other options been considered? Interaction with existing objectives?
- Is the legal/regulatory/supervisory framework supportive? Is the relevant infrastructure available?
- Are all risks (e.g., macroeconomic, monetary policy implementation, financial stability, cyber security) identified and addressed?
- Are key stakeholders involved? Are proper project management principles and practices being followed?

WEF Toolkit considers issues step by step in five phases [20]:

Phase 1. Preliminary analysis: determination of CBDC goals and objectives in the context of alternative solutions with respect to interested parties; description of the initial project management.

Phase 2. Definition of CBDC forms considering digital payments landscape and hybrid forms of CBDC.

Phase 3. Risk estimation with respect to operational issues, financial availability, protection of data and economic aspects.

Phase 4. CBCB design: technological platforms creation, development of required infrastructure, life cycle governance issues including regulation with the help of normative legal acts.

Phase 5. Implementation strategy: further management and development of infrastructure enhancement.

Central Bank Digital Currency Policy-Maker Toolkit: Aspects and Study Stages

The structure of the Model includes all the analytical aspects of the WEF and IMF instruments and logically group them into three main blocks:

- the main parameters that determine the CBDC design;
- definition of CBDC design;
- selected CBDC design`s viability assessment.

1. The main parameters that determine the CBDC design

As noted by BIS, WEF, and IMF, many CBs begin to study digital currencies by defining goals and potential benefits. WEF describes all the different but related interrelated political goals for CBDC, as well as the technology requirements for achieving each goal [20]:

1. Providing access to the CB`s money
2. Financial inclusion
3. Payment system`s efficiency (internal or cross-border)
4. Payment system`s security and stability
5. Reduction of currency substitution risks
6. Improving payments` efficiency and banks` competitiveness
7. Conducting effective monetary policy
8. Fiscal households` transactions

It should also be noted that the implementation of the CBDC itself does not lead to the achievement of political goals. For this purpose, it is necessary to change the normative-legal base and policy for complex task performance.

2. Defining CBDC design

The goals create the foundation for understanding how CBDC can be technically designed. Moreover, each CB develops unique technological solutions that meet the nation`s goals, conditions, and legal limitations. In addition, the design is influenced by a number of issues related to technological opportunities and economic risks, as well as the choice of the operational model of interaction with market participants.

The questions that directly depend on technological potential include programmability, the flexibility of system reconfiguration to perform new tasks, offline payments, etc. In the research conducted by the Oliver Wyman Forum and Amazon Web Services (AWS) it is stated that the basic technological solutions for forming desired attributes (such as the confidentiality of the data) are affected by system configuration [21].

Also, a number of economic issues contribute to the definition of currencies` characteristics: for example, interest calculation. Moreover, the operating model of the digital currency system should be built concerning the private sector`s available roles in the provision of new CBDC-based products and services. Differences in jurisdictions also have their influence on the design configuration: for example, the implementation of smart contracts may be limited due to the existing legal framework.

Nowadays, there is an ongoing discussion related to the choice between distributed ledger technologies and traditional centralized systems. **Various combinations of these two options can satisfy a wide range of numerous political needs of CB**. Furthermore, the choice of architecture and design (for example, the participants` roles and information flow) is more sensitive to political decisions and requires clarification at the early stages of the design process. The creation of technical solutions that are simultaneously sufficiently flexible to meet unclear or changing political goals and thus provide a sufficiently optimized result requires thorough processing. It is necessary to provide a degree of flexibility in architectural design to ensure the possibility of conducting experiments and the implementation of an iterative approach in the future.

Other important questions for consideration are technological developments, which should be taken into account as early as possible and concerning the goals and objectives of the Central Bank.

Conducted analysis of sources and materials dedicated to the CBDC design and implementation indicates a number of technological trade-offs that must be taken into account. The list below describes such compromises [22]:

1. New functional capabilities vs Inclusion

The addition of new features may require users to use expensive equipment (for example, smartphones with specific characteristics or hardware). The most prominent example of such a situation may be observed in the approaches to offline payments. Some designs use custom devices that are resistant to hacking and physical impact. However, the cost of such devices can be extremely high, which in turn limits the circle of people who have access to offline payments.

2. Security vs Accessibility

The required level of payment system`s security may be achieved via various identification (know-your-customer) and verification mechanisms (password, SMS access, etc.). However, the implementation of such measures inevitably affects the availability of services. For example, if it is required to confirm a transaction using an SMS code, the access to the system for users located in the area of poor GSM coverage is limited.

3. Accessibility vs Conflicts

As in the case of the first compromise, offline payments are the best illustration of such a problem. Currently, it is not possible to create an absolutely secure offline payment mechanism, and the measures aimed at reducing risks (for example, limiting the maximum amount of money that can be utilized in offline payments, the need to verify identity for a transaction, etc.) reduce the number of scenarios for using such payments.

4. Recoverability vs Anonymity

This trade-off can be most clearly seen in the example of one of the most popular cryptocurrencies using blockchain technology - bitcoin. Users can access their funds by using a password known only to the account holder. The absence of a supervisory or controlling body is essential for complete anonymity (only the user has access to the account, and only the user knows which account belongs to him/her). However, in case of loss of access (for example, if the user has not used the account for a long time and forgot the password), the account with all the funds becomes unavailable to the user forever. The presence of some higher authority (for example, the NBK) allows you to restore access to the account, but it creates the risk of the unauthorized dissemination of information about the user (for example, as a result of a hacker attack).

5. Widespread Free Usage vs. Controllability

The introduction of control measures inevitably leads to a decrease in the speed of transactions and additional delays. On the other hand, the lack of control can lead to extremely negative consequences, such as funds stealing due to hacker attack and the subsequent financial entire system destabilization.

6. Personal Data Protection of vs Legality

Tracking illegal practices (such as money laundering) and subsequent prevention requires the ability to track transaction flows and identify users involved in such practices. However, this in turn creates the risk of personal data being leaked.

7. Financial Inclusion vs Data Monopolies

Expanding the range of financial services available to the average user causes the dissemination of personal data (for example, phone number, account ID for transfers through other systems, or access to the exchange). However, this in turn may create conflicts with the right of companies and users not to share such information and may also lead to the situation of data monopoly created and exploited by some companies.

8. Coexistence with other systems vs. Low integration complexity

The coexistence of various payment systems leads to the need to build intermediate solutions to ensure the ability to transfer funds from one system to another. But the very existence of such intermediate solutions contradicts the idea of service integration.

9. Decentralization vs Accountability

Decentralization can create sustainable systems with a high level of recoverability. However, in the case of using a decentralized approach, the issues of management, responsibility, and protection of the interests of users do not have a clear solution.

10. Scalability vs Operational Sustainability

The ability to program certain functions of the CBDC creates incredible opportunities for expanding the range of services. But at the same time, new products and services will have new vulnerabilities which in turn may negatively affect operational stability.

11. Privacy vs Efficiency

Ensuring confidentiality requires certain protection measures (for example, encrypting messages, adding measures to verify the authenticity of the information, etc.). However, any of these measures will negatively affect a number of system parameters (in particular, response speed, latency in response to requests, and system expandability).

12. Interoperability vs Standardization

Interoperability may be defined as the ability of a system to work effectively with other services. Unfortunately, due to a large number of different approaches and technologies used, interoperability cannot coexist with standardization. Therefore, it is necessary either to build a system that can interact with others or introduce a single standard for the entire service market.

3. Assessing the viability of the selected CBDC design

After determining the CBDC design, it is needed to assess the technological feasibility, economic risks, regulation, and the development potential of the ecosystem.

Technological feasibility

System requirements for the CBDC platform

The work done by WEF states that there are crucial technical requirements for the deployment of any CBDC platform intended for future public use regardless of political goals and related technological configurations [20]:

- High level of cyber security, technical stability, and resilience
- Rational technical management

Fault tolerance, system throughput, interoperability (the ability to effectively interact with other systems), scalability, and security are the most important components of the analysis of any information system.

It is assumed that the best cybersecurity practices such as those published by the US National Institute of Standards and Technology (NIST) or the "STRIDE" model will be applied for the implementation of the CBDC [23]. Rational technical management also considers the regulation of the CBDC network and infrastructure, data placement, law enforcement privileges, etc. The safe and secure storage of information is also critical to the CBDC. For example, users should not lose access to their funds if their mobile phone or any other physical storage device is lost, stolen, or damaged. Additional technical aspects of governance should include compatibility with the existing legal framework and the ability to audit transactions and update software to ensure compatibility with possible changes in legislation.

CBDC infrastructure deployment

The release of the CBDC requires the study of issues related to infrastructure costs related to the system deployment and maintenance. The consideration of this aspect of the Model requires finding the answer to this question: **how long will it be possible to maintain the system without increasing costs?**

To begin with, the assessment of the availability of an adequately developed technological infrastructure should be done. Maintaining the CBDC system requires ensuring a high level of availability and sustainability of the common infrastructure that includes the power grid, mobile network, and Internet coverage.

The most important strategic issue in the deployment of the CBDC infrastructure is to determine the balance between the internal potential of the Central Bank and external providers. As a rule, successful infrastructure projects involve interaction with suppliers while building internal experience. This helps to better understand the product, minimize vendor lock-in and facilitate appropriate allocation of responsibilities.

Economic risks

There is no common opinion about the potential impact of the CBDC on the flow of bank deposits depending on the design of the CBCB, but all experts agree on increased competition in the financial market. Numerous economists believe that in the case of zero interest rate on the CBDC, the flow of funds from current accounts to the CBDC system is insignificant. However, several researchers see the positive effects of the CBDC even in the presence of interest rates.

Studies by CPMI-MC, Fernandez-Villaverde, Keister, and Sanches et al. indicate that the CBDC will structurally reduce the number of deposit funds available to commercial banks because the CBDC will have equal conditions with deposits in terms of liquidity and convenience [24]. Moreover, the CBDC will be predominantly regarded as an asset. Chiu, Kumhof, Noone, and others are convinced of the opposite: the existence of the CBDC in the deposit market as an alternative would incentivize banks to match the CBDC`s interest rate to maintain their deposits. As a result, this will contribute to the growth of savings. Andolfatto believes that interest rates for the CBDC will improve the availability of financial services in systems where the banking sector is less competitive while reducing the demand for cash.

Some studies point to the potential for increased competition created by the CBDC to increase the overall depositor base, which in turn expands lending and reduces borrowing costs. Andolfatto argues that higher deposit rates can increase the deposit base and lower borrowing rates, thereby expanding bank lending [24].

According to the latest BIS studies, the proposed measures to eliminate the risks of the flow of funds to CBDC systems are grouped into two categories: quantitative and price-related ones.

Design options for the CBDC			
Quantitative Measures/Restrictions	Maximum storage limit	Differentiated limits	Transaction limits
Price indicators/ interest rate	No interest rate/negative interest rate		Multilayer interest rate
Anti-crisis measures	Corridor/limits for conversion		Bank support

CBDC regulation

The feasibility of the CBDC`s potential benefits with a particular design selected following a specific operating model depends on a particular country`s regulation: to what extent do current regulations allow the proposed distribution of roles in the CBDS system to be organized, and to what extent the use of new mechanisms for managing data privacy is allowed, how the interests of various players will be protected and how the common control is organized.

It is important to ensure the regulatory framework`s integrity for the functioning of DT, including addressing the questions related to its definition and the obligations of participants in the payment turnover arising from this mandate. In addition, the regulatory paradigm should also reflect the design elements of the national digital currency, including, for example, limits on conversion to digital currency, business continuity processes, etc. The CBDC system should be flexible to meet future user needs and interface with new and existing systems and mechanisms while achieving political goals and system sustainability. Therefore, when distributing roles in the system, the Central Bank should be able to change the system either through its activities or with the help of supervisory powers. In any digital currency system, the central bank will play an important role and should be able to allocate resources accordingly. The distribution of functions must be carefully managed to ensure sustainability and public confidence in the CBDC as a public good.

The IMF suggests that it will be critical to determine whether the CBDC mechanism can be characterized as a payment system, and if so, to determine whether it is systemically important. A digital currency can be characterized as a payment system if the arrangement on CBDC is "a set of tools, procedures and rules for the transfer of funds between participants, including participants and the organization managing this arrangement" [23]. Determining systemic importance will also be critical given its potential role in the financial system. Key criteria may be the same as for private payment systems, including the number and value of transactions processed, number and type of participants, markets served, interconnectedness, and any available alternatives.

However, given the high expectations of the public, it is likely that the CBDC mechanism will be recognized as systemically important, regardless of its current and potential size. Thus, if the CBDC mechanism is to be identified as a systemically important payment system, then it should be subject to stricter regulation, oversight and control.

Developing a global and innovation-friendly regulatory and policy framework for digital currencies is a challenging task. The WEF has identified three key challenges faced by CBDC policymakers [19]:

- the conflict between rapidly changing technologies and the reactive rulemaking process;
- lack of coordination among decision-makers in the financial services sector;
- отсутствие консенсуса в вопросе, для чего предназначены цифровые валюты, особенно в сравнении с уже существующими альтернативами. . lack of consensus on what the digital currencies' goals and objectives especially when compared to existing alternatives.

These issues are addressed during the research phase after the design of the architecture (including the operating model) has been determined.

Ecosystem development

The most important indicator of the need to implement a CBDC is an assessment of the market incentives and dynamics embodied in technology design options and other aspects of a CBDC. In this regard, the DT model pays special attention to this issue, in contrast to the IMF and WEF instruments, as mentioned above. It is critically important not only to study the preferences of end-users according to design but also to analyze the development potential of a holistic ecosystem, including an assessment of network effects.

Numerous CB are working with financial institutions and other stakeholders to consider the role of the private sector in providing CBDC products and services. The choice of policy and technology will determine what functions different entities can perform, how information is exchanged, and how service providers gain access to the digital currency system. As a result, different technical solutions will lead to different competition dynamics and different network effects due to the availability of certain data [20, 23].

Thus, when evaluating CBDC design options, the private sector should be seen as a critical player in analyzing what incentives and business models will create conditions for innovation and competition in financial services, while providing the best opportunity to keep the system running, sustainable, and evolving.

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The BIS also notes that an integral part of the adoption and use of a general-purpose CBDC in a given jurisdiction will be understanding and meeting the current and future needs of users in a rapidly changing payment landscape. There are factors that determine user acceptance of digital payment services. For example, the BIS highlights three factors for the CBDC:

- covering the users` needs with the unique advantages of Central Bank money (settlements` finality, liquidity, reliability);
- network effects (consumers will only use the CBDC if merchants are willing to accept it);
- the absence of the need to purchase new devices (if the CBDC relies on off-the-shelf technology, then it will be easier for users to set up an account, service, application, or device for storing the CBDC [25]).

For this reason, it is necessary to assess the level of market readiness to accept a new currency based on indicative measures, assumptions, and discussions. Consideration of ecosystem development is key in the early stages of a project. For example, when defining scenarios for a pilot, engaging market participants is critical to understanding end-user needs as well as assessing players' readiness to connect to the new system.

Potential CBDC implementation risks and methods to eliminate them

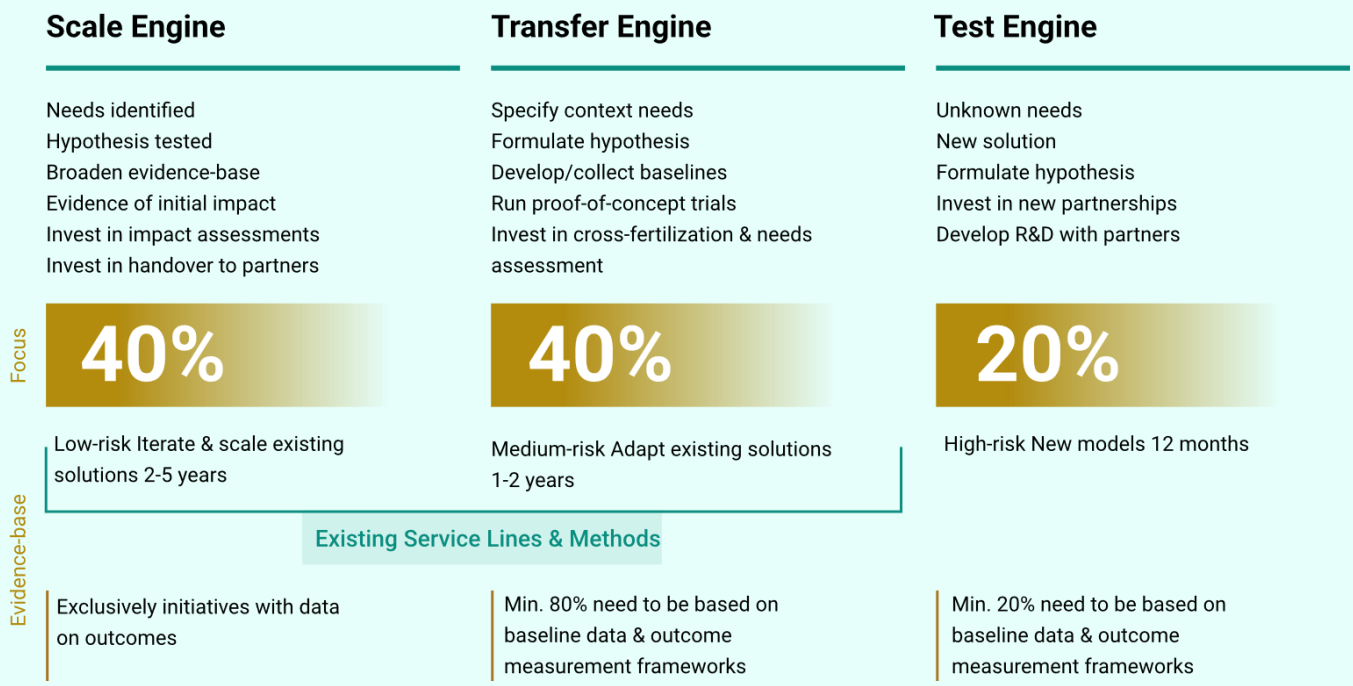
Successful CBDC implementation requires a sustained focus on critical elements of implementation and a set of measures to manage risks, as well as methods to address them. Potential implementation risks may include:

CBDC implementation risks	Methods to eliminate them
Technological risks of implementation, including cybersecurity risks, issues of embedding in banking applications, and implementation of AML and CFT checks.	▪ Stage-by-stage implementation of the DT platform with detailed elaboration and testing of security and scalability aspects. ▪ Active involvement of external participants in the development of technological aspects at an early stage.
Organizational risks can include a lack of competencies and resources for implementation.	▪ Attracting external expertise and resources to support the implementation of initiatives. ▪ Involvement of employees from the industry with specific knowledge of the segment and retraining of personnel.
Economic risks – the CBDC introduction can lead to the outflow of liquidity and affect the characteristics of the volume, velocity, and multiplication of monetary aggregates.	▪ Creation of additional tools for banks to replace money on their balance sheets in an orderly manner. ▪ Adjustment of the operation through refinancing and readiness to absorb excess liquidity in the market, if the velocity of money circulation increases excessively. ▪ Consideration of the use of limits as an additional tool for regulating the volume of conversion of funds to DT.
Proliferation risks, including insufficient demand from consumers and financial players, low level of financial literacy in terms of using CBDC.	▪ Conducting activities to improve financial literacy of the population and businesses with regard to the use of DT. ▪ Active involvement of financial market participants in the early stages of development and piloting of DT.
Global risks associated with the strengthening of the role of CBDC of other countries in cross-border settlements, the use of which in the Republic of Kazakhstan could lead to increased dependence on other currencies.	▪ Implementation of pilot projects on the use of DT in cross-border settlements. ▪ Cooperation and collaboration with international organizations and CB of other countries.

APPENDIX 3
INNOVATION PROJECT EVALUATION

According to the classification of innovative projects, digital currencies belong to the category of projects in which 20% of the analysis is based on existing methods of results evaluation, while 80% require the development of new approaches. The decision-making model integrates a combination of different tools suitable for such innovative projects along with other new evaluation indicators for Kazakhstan.

Classifications of innovative projects



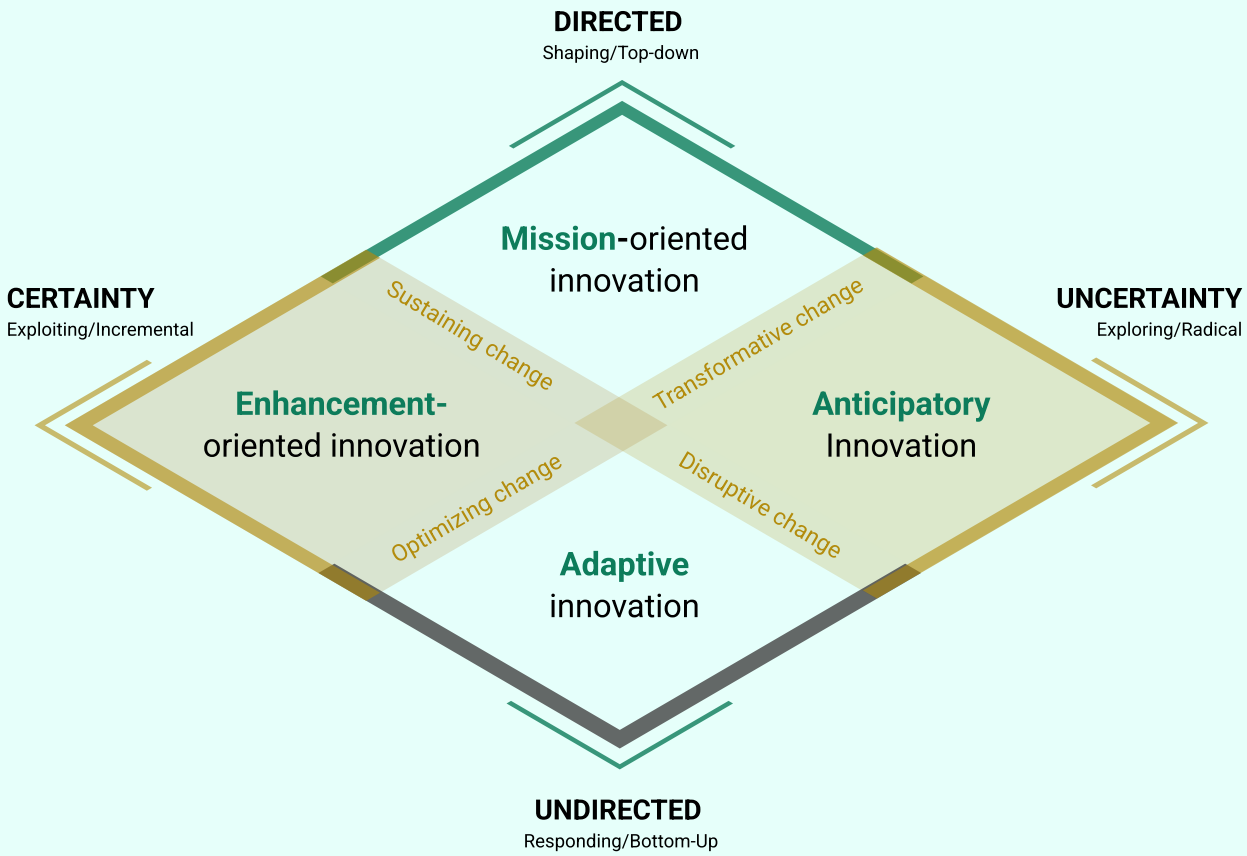
The desire to comply with 'professional' and rational standards

The desire to comply with 'professional' and rational standards – as a good in itself – may actually turn into a threat of moral inversion as evaluators often fail to question seemingly rational practices and assume that instrumental practices are neutral and legitimate. For example, in the field of innovation policy there has been an underlying faith in the existence of 'rational design' and coherence of policies, which may be fundamentally flawed. The Observatory of Public Sector Innovation has proposed a public sector innovation facet model based on two core characteristics – directionality and uncertainty [26]. Public sector innovation will occur in contexts with different levels of uncertainty, and those different contexts will require different strategies, working methods, and types of dissemination and diffusion.

Based on these two factors, four facets emerge:

1. Enhancement-oriented innovation focuses on upgrading practices, achieving efficiencies and better results, and building on existing structures, rather than challenging the status quo. Innovation evaluation here will be concentrated on efficiency and effectiveness and more traditional measurement approaches can be applied.
2. Mission-oriented innovation involves a clear outcome or overarching objective for which innovation is leveraged. There is a clear direction, even if the specifics of how it will be achieved may be uncertain. This type of innovation can range from the incremental to the more radical, but will often fit within, rather than subverting, existing paradigms. Evaluation of mission-oriented innovation has to take a cross-boundary and systemic perspective and cannot rely on linear input-output tools.
3. Adaptive innovation - innovation's purpose may be the discovery process itself, driven by new knowledge or the changing external environment. When the environment changes, perhaps because of the introduction of innovation by others (e.g. new technology, business model, or new practices), it can be necessary to respond in kind with innovation that helps adapt to the change or put forward something just because it has become possible. Evaluation of adaptive innovation is very difficult to conduct, as economic discovery is an uncharted process. This type of innovation is better evaluated through its enabling factors and activities rather than innovations themselves.
4. Anticipatory innovation involves exploration and engagement with emergent issues that might shape future priorities and future commitments. It has the potential to subvert existing paradigms. Very new ideas generally do not cohabit well with existing reporting structures, processes, and workflows. This type of innovative activity is the most uncertain and future-oriented (option theory) base evaluation methods and approaches should be applied. This may also mean that feedback from the current system has to be to a degree ignored to assure the ambidextrous stance of evaluations.

Types of innovation based on two characteristics - direction and uncertainty



The specific features of each aspect allow us to classify the СИВС projects as adaptive innovations, where the CBDC is a tool for adapting to new challenges. Therefore for these projects, new evaluation approaches should be applied.

Tools, methods, and approaches for assessing innovation (as well as highlighted in color that are used in the Model)

Evaluation of performance and outcomes

Impact assessment
Outcome mapping
Outcome harvesting
Contribution analysis
Case studies
Scorecards
Public value mapping
Qualitative comparative analysis
Benchmarking
Expert reviews

Economic evaluation
Cost-benefit analysis
Break even analysis
Social Return on Investment (SROI)
Actuarial valuations

Experimental design
Randomised control trials (RCTs)
Prototypes, pilots
Quasi-experimental methods
Interrupted time series designs
Regression discontinuity design

Audits

Logic modelling

Theory-based approaches

Collaborative and user-centric evaluation

- Joint and participatory evaluation
- Most significant change

In project reflection

- **Monitoring**
- Learning agendas
- Rapid experimentation
- **Adaptive pathway**

Automitised/Digitalised evaluation tools

- Big data and text mining
- Data dashboards and interactive data visualization
- Citizen experts and P2P production of evidence

Future-oriented evaluation tools

- **Risk analysis**
- **Strategic evaluation**
- **Foresight evaluation**
- **Horizon scanning**

Systems-based approaches to evaluation

Systematic reviews and meta-evaluations

Triangulation and mixed methods approaches

Evaluating innovation in a changing context

Evaluating innovations should be an ongoing process, as goals and approaches are subject to change, and practices based on regular retrospect may be more useful for educating innovators than predetermined criteria. From an evolutionary perspective, all actors (not just policymakers and innovators) learn from past experiences, and changes in behavior that occur over time as a result of learning can complicate attempts to assess causal relationships [28].

Primarily, these are specifically connected to the uncertainty and risk connected to the innovation process and the possibility of failure. Here it is fundamental to understand that risk does not equal uncertainty – the latter can be mitigated, but it cannot be assessed and calculated in the same manner as risk. Consequently, effects become apparent only when new methods and approaches are applied. Thus, continuous evaluations are needed, so, that projects in the public sector do not become 'too big to fail' as to avoid wasting time and resources on dead-end projects.

However, these judgments are difficult, because it may take time for an innovative practice to perform and have the impact required. This means that evaluation needs to happen at all stages of the innovation lifecycle for feedback and learning to occur in a timely manner. In this regard, the research phase of the CBDC projects should provide for step-by-step iterative learning [29].

Uncertainty in time - results in the future

The full potential of the CBDC can be evaluated in the future, at the research stage, the uncertainty of the time frame makes it difficult to apply standard methods, i.e. an iterative approach in re-evaluating the results is required. The interventions evaluated as the evaluation process itself are subject to continuous change and uncertain effects, thus, static evaluations in a very dynamic and uncertain situation do not work. Ongoing change, especially when dealing with innovation, needs to be taken into account in evaluations in an adaptive way. Instruments may vary so much across time and space that attempts at the rational meta-evaluation of 'what works' are rendered meaningless for all but the simplest of interventions [27]. Manchester 'Compendium' review of evidence on innovation policies found no clear evidence that any class of innovation policy instrument studied works consistently from place to place or time to time [27]. Uyarra and Ramlogan (2016) found wide differences in policy outcomes resulting from variation not just in objectives and implementation, but also due to context-specific institutional configurations and policy path dependencies [27].

The complexity of assessing people's preferences in economic analysis

In the case of the CBDC projects, it is difficult in the research phase to determine the potential demand for innovative services and products identified by people's preferences.

A richer empirical understanding of actual ‘policy histories’ is needed than is generally seen in innovation research or evaluation research. The understanding agency requires a ‘narrative approach’ that follows the actors and studies processes in real-time, without the treatment of a sequence of events as inevitable [27].

Defining the type of innovation

Despite an increasing number of studies on innovation, studies have generally treated innovative activity as a homogeneous phenomenon. Nevertheless, past research has argued that distinguishing different types or dimensions of innovation is necessary for understanding organizations’ innovative behaviour, because they have different characteristics and organisational responses [27]. For example, there is a sub-stream of ‘complex innovations’ that are difficult to intuitively understand and dynamically develop in non-linear ways, which gives them unique properties that distinguish them from other types of innovation. Others have applied the radical or incremental innovation dichotomy [27].

The pilot's results are better than trying to assess causality

In complex situations causal attribution can be very problematic and misleading. Furthermore, complexity science shows that situations under evaluation are always non-linear and comprising of feedback loops. Yet, an evaluator’s concern is with more directly observable social and public impacts and with monitoring the direct effects of research on such impacts. Thus, often evaluation scope remains too limited and may lead to sub-optimization: e.g., the improvement of a sub-system at the expense of the organization as a whole. In such cases, experimental evaluations - pilot projects or prototypes - provide all possible and most complete indicative indicators of causality [28].

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