Council of Arab Central Banks and
Monetary Authorities Governors

Central Bank Digital Currencies:
A Practical Guide for Arab Central Banks

Arab Regional Fintech Working Group

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مجلس محافظي المصارف المركزية ومؤسسات النقد العربية
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The opinions expressed in this policy paper are solely those of the writers and do not necessarily reflect those of the central banks and entities they represent.

List of Abbreviations

AML / CFT	Anti-Money Laundering / Combating the Financing of Terrorism
BIS	Bank for international Settlements
CBDC	Central Bank Digital Currency
CBN	The Central Bank of Nigeria
DvP	Delivery versus payment
ECB	European Central Bank
KYC	Know your Customer
PBoC	People's Bank of China
PoC	Proof of Concept
PvP	Payment vs. Payment
R-CBDC	Retail Central Bank Digital Currency
RLN	Regulated Liability Network
RTGS	Real Time Gross Settlement System
RTP	Real Time Payments
sCBDC	Synthetic Central Bank Digital Currency
W-CBDC	Wholesale Central Bank Digital Currency

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Definitions

Central bank digital currency (CBDC):
A digital form of central bank money that may be accessible to the public (general-purpose or retail CBDC), or to a select set of licensed participants such as financial organizations (wholesale CBDC). CBDC is denominated in the national unit of account. It is issued by and is a direct liability of the central bank. (World Economic Forum, 2021, p.11)

E-money:
Short for "electronic money", e-money is stored value held in digital accounts or physical devices (e.g. a chip card or a hard drive in a personal computer) that is used as a means of payment and a store of value. E-money systems vary across different jurisdictions, but they are often fully backed by fiat currency, denominated in the same currency as central bank or commercial bank money and exchangeable at par value for such money or redeemable in cash. (World Economic Forum, 2021, p.12)

Retail (or general-purpose) CBDC:
CBDC whose access and circulation are open to a wider class of agents—in principle, including all agents in a given jurisdiction and beyond. The latter would be the case where CBDC is made accessible for non-resident individuals and entities. (World Bank Group, 2021, p.12)

Retail CBDC may have direct, indirect (synthetic/two-tier), or hybrid structure. All three architectures allow for either account- or token-based access. (Auer and Böhme, 2020, p.88).

Direct Retail CBDC
In the direct CBDC model, the central bank handles all payments in real time and thus keeps a record of all retail holdings. (Auer and Böhme, 2020, p.89).

Hybrid CBDC
Is an intermediate solution providing for direct claims on the central bank while real-time payments are handled by intermediaries. In this architecture, the central bank retains a copy of all retail CBDC holdings, allowing it to transfer holdings from one payment service provider to another in the event of a technical failure. (Auer and Böhme, 2020, p.88-89).

Synthetic CBDC
Allowing e-money providers to hold central bank Reserves. the central bank would merely offer settlement services to e-money providers, including access to central bank. central banks are the major CBDC operators, responsible for many of the following steps: performing customer due diligence, offering or vetting wallets, developing or selecting the underlying technology, offering a settlement platform, managing customer data, monitoring transactions, and interacting with customer requests, complaints, and questions. All other functions would be the responsibility of private e-money providers under regulation. (Adrian and Mancini-Griffoli, 2019, p.14-15)

نظرة عامة

أدت الوتيرة المتسارعة لرقمنة الخدمات المالية خاصة في أعقاب جائحة كورونا، والابتكار في البنية التحتية المالية، واستخدام تقنية السجلات الموزعة (DLT) جنبًا إلى جنب مع ظهور آليات التمويل اللامركزي (DeFi)، إلى قيام البنوك المركزية في جميع أنحاء العالم بتقييم مُختلف جوانب العملات الرقمية للبنوك المركزية والنقود الإلكترونية؛ من حيث دراسة واختبار مُختلف حالات الاستخدام لمدفوعات الجملة والتجزئة للعملات الرقمية للبنوك المركزية.

أيضاً ظهرمفهوم شبكة الإلتزامات المُنظمة (RLN)، التي تتجاوز مفهوم عملات البنوك المركزية الرقمية إلى إطار أوسع بما في ذلك أموال البنك المركزي على شكل رموز رقمية (tokenized)، وأموال البنوك التجارية، والأموال الإلكترونية، ذلك باستخدام تقنية السجلات الموزعة وجعلها قابلة للاستبدال على الشبكات المالية.

في ذات السياق، تتسارع التجارب العالمية لاختبار جدوى مشروع العملات الرقمية للبنوك المركزية، وتقييم جميع الجوانب ذات الصلة، من التصميم إلى دراسة الآثار المختلفة لهذه العملات على الاستقرار المالي والسياسة النقدية ومكافحة غسل الأموال وتمويل الإرهاب ... إلخ. حيث تُحدد أوضاع وأهداف وأولويات البنك المركزي دوافعه لإصدار وتصميم عملة رقمية.

بهدف توفير نهج شامل عند النظر في تقييم أو إطلاق عملات البنوك المركزية الرقمية، يقدم دليل "عملات البنوك المركزية الرقمية: دليل عملي للبنوك المركزية العربية" نظرة شاملة على مختلف جوانب مبادرات إصدار عملات البنوك المركزية، بما يدعم جهود المصارف المركزية العربية في توجههم نحو تقييم مدى إمكانية إصدار العملات الرقمية، وبما يتناسب مع أهداف البنك المركزي والموارد المُتاحة والآثار المُستهدفة، أخذاً في الإعتبار الظروف الخاصة بكل دولة، والبنية التحتية، وكذلك الأطر القانونية والتنظيمية ذات الصلة.

يستشهد الدليل بأحدث التطورات في الدول العربية من واقع إجابات ١٧ مصرف مركزي عربي على الاستبيان الذي أعده الصندوق، وهي الأردن، الإمارات، البحرين، تونس، الجزائر، السعودية، السودان، العراق، عُمان، فلسطين، قطر، الكويت، لُبنان، ليبيا، مصر، المغرب، واليمن. حيث يتناول الإستبيان دوافع وتحديات الإعداد لإصدار عملات رقمية، وما مدى استعداد المصارف المركزية

العربية والجوانب التشغيلية ذات الصلة، والتحديات القانونية التي تدركها المصارف المركزية العربية في سبيل ذلك، إضافة إلى البدائل الأخرى لتحديث نظم المدفوعات.

حيث أظهرت النتائج اهتماماً متزايداً على مستوى المنطقة العربية بتقييم عملية إصدار البنوك المركزية لعملات رقمية (76% من المصارف المركزية العربية)، وإنما لا يزال النقاش في مرحلة الاستكشاف والدراسة. حيث لم يقرر بعد 11 مصرف مركزي عربي، من ضمن المصارف المركزية العربية المُستجيبة للإستبيان، نوع العملة الرقمية التي يستهدف المصرف المركزي إصدارها، في حين أشارت البنوك المركزية الستة الأخرى إلى العملات الرقمية لمدفوعات الجملة ومُختلف أنواع العملات الرقمية لمدفوعات التجزئة، تحديداً العملات الرقمية المُختلطة للبنوك المركزية (Hybrid)، والتجزئة المباشرة، والعملات الرقمية المُركبة (Synthetic). تعكس هذه الردود الإهتمام بالعملات الرقمية لمدفوعات التجزئة في إطار مساعي تسريع وتيرة الشمول المالي، وتعزيز الاقتصاد غير النقدي والانتقال للخدمات المالية الرقمية، ورفع كفاءة تتبع المعاملات وتحويلات العاملين.

في هذا السياق، يُسلط الدليل الضوء على الدوافع الرئيسة التي تحفز المصارف المركزية على التفاكر حول مشروع العملة الرقمية، ومُختلف المخاطر التي تحيط بإصدار عملات رقمية، والبدائل الأخرى لتحديث نظم المدفوعات، إضافة إلى مفهوم شبكة الإلتزامات المُنظمة (RLN). أيضاً يستعرض الدليل مُختلف مشاريع عملات البنوك المركزية الرقمية لعدة دول حول العالم، والتي تم إنجازها مؤخراً والدروس المستفادة منها، بهدف تسليط الضوء على التصاميم المختلفة لتلك العملات، ومُختلف الخيارات التقنية، والمبادرات المتنوعة لتخفيف المخاطر، والسياسات والقرارات الرئيسة في كل حالة.

كما يتناول مجموعة من السياسات التي يمكن صياغتها عند تصميم العملة الرقمية وفقًا للظروف الخاصة بكل دولة: (1) تستند العديد من التجارب الحالية الخاصة بالعملات الرقمية للبنوك المركزية إلى التصميم ذي المستويين للعملات الرقمية الخاصة بمدفوعات التجزئة، للتخفيف من مخاطر عدم الوساطة المالية إذا لم يتم تضمين البنوك التجارية في نظام العملة الرقمية للبنوك المركزية، (2) إدخال قيود على الأرصدة ومبالغ المعاملات للتحويل إلى الحسابات/ المحافظ بمُختلف السيناريوهات، للسيطرة على حجم العملات الرقمية المتداولة، (3) تفعيل الهوية الرقمية وتكاملها مع أنظمة الدفع، (4) الموازنة بين الحفاظ على خصوصية البيانات الشخصية ومكافحة الأنشطة المالية غير المشروعة، حتى في حالة عملات البنوك المركزية الرقمية مجهولة الهوية، وهي العملات الرقمية القائمة على آليات الترميز، (5) توسيع قاعدة المؤسسات المسموح لها بإلحاق العملاء وضمان تدابير "اعرف

عميلك" الخاصة بهم، (6) التخفيف من مخاطر الإقصاء المالي من خلال تسريع معدل وصول المُستخدم النهائي إلى الخدمات المالية وتوفير حلول مالية متنوعة للمُستخدم النهائي، ولا سيما الشرائح الهشة من أفراد المجتمع، وكذلك (7) تعزيز إطار أمن الفضاء الإلكتروني باعتباره حجر الزاوية في نظام العملات الرقمية للمصارف المركزية.

بناءً على ماتقدم، وأخذاً في الإعتبار عوامل التكلفة والتعقيد، يوضح الدليل مفهوم إجراء التجارب كوسيلة فعّالة لتقييم إصدار عملات البنوك المركزية الرقمية قبل إتخاذ القرار بشأنها. ليس فقط للوصول إلى إختيار مناسب للتصميم، والسمات التقنية، وخيارات التقنيات لهيكل العملة الرقمية، فضلاً عن المخاطر المرتبطة بها؛ بل أيضاً لتحديد التعديلات القانونية والتنظيمية اللازمة، وأفضل طريقة لتفعيلها مع الحفاظ على التكلفة والوقت.

أخيراً، ينتهي الدليل بشجرة قرارات تهدف إلى دعم المصارف المركزية العربية في عملية صنع القرار، مما يسمح لها بالمضي خطوة بخطوة في رحلة تقييم إصدار عملات رقمية، بدءًا من تحديد دوافعها لإطلاق عملة رقمية، والتحديات التي تحاول السلطات التنظيمية معالجتها، ذلك عن طريق المرور بمجموعة من الأسئلة التي تتناول مُختلف جوانب عملات المصارف المركزية الرقمية؛ بهدف اختيار التصميم الأنسب للعملة الرقمية الذي يتوافق وأهدافها وغاياتها والموارد المُتاحة والبنية التحتية في الدولة.

EXECUTIVE SUMMARY

The accelerating pace of financial technology and digitalization particularly amid COVID-١٩, the innovation in financial infrastructure, the use of distributed ledger technology (DLT) along with the emergence of decentralized finance (DeFi) modes, led central banks around the globe to explore various aspects of central bank digital currency (CBDC) and digital money; examine and test diversified use cases for wholesale and retail CBDCs.

Going beyond CBDCs, the notion of Regulated Liability Network (RLN) reframes CBDC in a broader context including tokenized central bank money, commercial bank money, and electronic money, using distributed ledger technology and making them exchangeable on financial networks.

Central bank's conditions, objectives and priorities determine central bank's motivations for issuing and tailoring CBDC. Global experiments are accelerating to test viability of a CBDC project and assess all related aspects, from the design to the examination of the different implications of the said CBDCs on financial stability, monetary policy, combatting ML/CFT …etc.

In this context, the Arab region is not isolated from what is happening around the world. As a matter of fact, Arab central banks are interested in further exploring the introduction of CBDCs, and they are still studying their options concerning the type of such digital currency to adopt (wholesale CBDC or retail CBDC) as revealed by the AMF recent survey; which shows that Arab authorities are considering primarily different types of retail CBDCs whereas wholesale CBDC appears as second option.

Given all the above, in addition to time, cost and complexity concerns surrounding the issuance of CBDCs, it is important for Central Banks to appropriately experiment with all the aspects of CBDCs before reaching a decision.

Tests and trials not only allow for experimenting design, and technical features for the CBDC architecture, or the assessment of the risk related issues, but they also provide a great opportunity to identify the needed legal and regulatory amendments related to CBDCs' issuance and the best way to apply them.

Thus, this paper includes an illustration of a decision tree that aims to support Arab central banks in the decision-making process, allowing them to go step by step into the CBDC journey, from the identification of their drivers for launching CBDCs, and the pain points regulators are trying to solve, going through set of questions addressing various aspects of the CBDCs; with the aim of selecting the CBDC best suited for their goals, objectives, existing resources and infrastructure in the country.

INTRODUCTION

Aiming at providing a holistic approach when considering exploring or introducing CBDCs, the "CBDCs: A practical guide for Arab central banks" provides an overview on various aspects of the CBDC initiatives, and draws a way forward to support central banks in their decision making process when considering a CBDC project.

Drivers for launching CBDC vary globally and across the region according to countries' specific situations. Meanwhile, these motivations are associated with a set of challenges and risks that might hinder the proper adoption of CBDC. Having such risks, various policies and initiatives need to be formulated to remedy any improper impact that can affect preserving financial stability and soundness of the financial system.

CBDC experiments so far can inspire authorities with diverse policies and procedures to mitigate the risks associated with CBDCs initiatives, which all depend on countries' specific conditions. These would include, among others the following set of actions, (i) the consideration of a two tier design for retail CBDC to mitigate potential financial disintermediation, (ii) the introduction of limits on balances and transaction amounts for transfer into accounts/ wallets under various scenarios to control CBDC in circulation, (iii) the adoption of Digital Identity and its integration in payment schemes, (iv) the balance between protecting personal data privacy and combating illicit financial activities using various techniques and technologies, (v) the facilitation and acceleration of the rate of end user access to financial services to mitigate the exclusion risk, and (vi) the strengthening of cyber resilience frameworks to ensure network integrity and public confidence.

This guide benefited from the AMF survey, launched in September 2021, to explore Arab central banks' interest in CBDCs, main drivers and challenges for adopting CBDCs, the level of readiness of Arab central banks and their future plans. It also covers other operational aspects for CBDC introduction, and other available alternatives for payment modernisation that can foster digital payments and digital financial inclusion. The survey was answered by 17 Arab countries, namely Jordan, UAE, Bahrain, Tunisia, Algeria, Saudi Arabia, Sudan, Iraq, Oman, Palestine, Qatar, Kuwait, Lebanon, Libya, Egypt, Morocco, and Yemen.

It provides a detailed description of the experimentation notion, illustrating how authorities can try and assess many options for each aspect of the CBDCs, which would allow a good understanding and analysis of CBDC perspectives leading to a more informed decision on whether to issue a CBDC or not. In addition, testing and trials lead to the identification of a selection of options for various aspects related to CBDC adoption. Furthermore, this can help peer central banks reading each other experiences with the subject matter.

The guide ends by presenting a decision tree that can support Arab central banks in selecting an optimal CBDC design that matches best for each jurisdiction, taking into consideration country-specific conditions, infrastructure and that is well suited for the central bank objectives, available resources, targeted implications, as well as respective legal and regulatory frameworks.

MOTIVATION FOR ISSUING CBDCs

CBDC is issued by and is a liability of (claim on) the central bank, hence, it does not need to be backed by reserves. CBDC can be offered under different models: wholesale or retail; token, DLT, or account based; interest free or interest bearing; identifying the user or preserving user anonymity (WBG, 2021)[1].

In a world where people and businesses are more and more shifting towards electronic payments, central banks consider issuing CBDC due to their responsibilities to sustain confidence in their currency by sustaining public access to and full usability of central bank money (ECB, 2021).

A central bank's conditions, objectives and priorities determine the central banks motivations for issuing and tailoring CBDC. Main drivers for introducing CBDCs include key pillars, in principle those are related to financial stability and supervision, monetary policy, economic development, as well as operational & environmental issues. All of which will be highlighted in the following section.

1. Drivers related to Financial Stability and Supervision:

a) Ensuring Financial Stability

If appropriately designed and well managed, CBDCs can contribute to ensuring financial stability. However, financial stability can be ensured only in the case where central banks address financial stability risks that CBDCs could generate, and if they introduce the adequate safeguards to counter them. As a matter of fact, CBDCs can provide the central bank with more effective monetary tools, which can lead to increasing confidence in the monetary system, increasing payment efficiency, decreasing transaction costs, reducing risk of systemic manipulation and illicit practices that in turn results in better financial stability.

b) Improving Traceability of Transactions

This driver is valid for non-anonymous CBDCs. In fact, these CBDCs allow the central banks to maintain records of the transactions and trace them all the way. Usually, central banks opt for non- anonymous CBDCs when they are more concerned with meeting and being able to insure and supervise the regulatory

[1] WBG, 2021. Central Bank Digital Currency: A payment Perspective, November 2021. Finance, Competitiveness & Innovation Global Practice, Payment Systems Development Group.

requirements. It is all a question of balancing anonymity and the contribution of the shadow economy in economic growth vs regulatory Requirements.

c) AML/CFT Issues

Some types of CBDCs are anonymous ones, which can incorporate illicit financing risks and can be used to facilitate money laundering and terrorist financing, this is why it is essential for the central bank issuing a CBDCs to enact and implement AML/CFT regulations applicable to CBDCs. Furthermore, it is important to conduct a risk- based approach as a basis for the implementation of these regulations, noting that CBDCs allow the issuing central bank to reduce the related monitoring cost.

While CBDCs, like any payment system, have illicit financing risks, CBDCs are particularly well suited to combat these risks for the following reasons:

1. Having non anonymous CBDC design, whether account based, or token-based that allows more non anonymity levels; will facilitate better AML and sanction screening.
2. And because transactions are executed on a common shared ledger, implementing real time AI-based AML tools is easier.
3. Finally, in the status quo central banks only receive reports of suspicious activity from banks after the fact. With CBDC, the central bank has real time access to transactions and can stop or pause suspicious transactions before they complete.

d) Helping in the fight against corruption and increasing transparency

Non-anonymous CBDCs can play a major role in the fight against corruption and increase transparency since authorities will be able to trace transactions in particular to limit bribery as well as the misuse of public funds and would facilitate the recovery of stolen money or illegal money transfers. In addition to this, CBDCs can enhance tax collection and limit the possibilities of tax fraud and tax evasion.

2. <u>Drivers related to Monetary Policy:</u>

a) Reducing dollarization and shift from the demand for foreign currency in the parallel market to the local CBDC in the formal market

In countries where the trust in the local currency is weak, the demand on the foreign currency in the parallel market tends to be very high. But when these countries succeed in issuing a strong CBDC and in building trust in the local economy by establishing a sound economic governance, people tend to buy it and thus go to formal markets to do so instead of dealing with the black market to buy the foreign currencies, which counterbalances foreign influence on monetary policy.

b) Inclusion of the informal sector and reduction of the negative impact of the cash economy

People tend, in countries where the trust in the banking sector is weak, to withdraw their money from the banks and store the withdrawn cash or new incomes outside the formal sector which escalates the negative impact of the cash economy (speculation, hyperinflation, accentuation of thin economy, loss of opportunity cost, negative impact on lending, impediment of access to finance, limitation of economic growth). But when these countries succeed in issuing strong CBDCs, people will exchange their cash stored outside the formal sector against CBDCs by buying them in the formal sector, thus, moving from a cash to a digital economy and accordingly to a cashless society. Furthermore, CBDCs can enhance market depth by increasing its ability to accept relatively large orders without significantly compromising the value of the market.

c) Preserving central banks' monetary sovereignty while counterbalancing privately issued digital currencies

With the rise of privately issued digital currencies, central banks are concerned that their monetary sovereignty becomes challenged especially if these currencies are largely adopted and used in the economy instead of the official currency which can generate liquidity issues due to the exodus of capitals, and can lead to the deprivation of local economies from financing. Thus, the best way for preserving central banks' monetary sovereignty while counterbalancing privately issued digital currencies is, for them, to issue their own CBDCs and try to make them as appealing for the public as the privately issued digital currencies in order to be able to compete with them.

d) Providing a larger seigniorage income to the issuing central bank

Since seigniorage is the income earned by a Central Bank for issuing money, CBDCs allow central Banks to earn large Seigniorage especially that the cost of producing CBDCs and distributing them is relatively low as compared to their value in the market.

3. Drivers related to Economic Development:

a) Enhancing Financial Inclusion

CBDCs, in particular Retail CBDCs, can foster financial and economic inclusion and can promote an inclusive digital economy especially in emerging markets. Nevertheless, it is important that addressing needs of the un/under-served would constitute the cornerstone of the CBDC design while working on enhancing digital literacy and awareness.

b) Reinforcing Trust in the Local Currency

CBDCs issuance could be undertaken by countries facing economic and financial crisis as an initiative to rebuild trust in the local currency. The CBDC design features are essential so that it would represent a safe and attractive asset to hold and to use as a mean of payment and so that monetary policy implementation measures and responses would be more efficient. As a matter of fact, central banks will need to adopt a new mind-set to safeguarding the national currency, if at a point of time CBDCs become all equally the same and based on a basket of fiat currencies, then the competitive edge will be related to the economic stability and the convenience in portability of the said CBDCs.

c) Improving Remittances for Migrant Workers

CBDCs facilitate local and cross-border payments and enhance their speed, efficiency and affordability by reducing the time and costs of the payments that can be operated by the migrant workers and it is important in this case that the CBDC design would make it accessible to foreign residents through an interoperable infrastructure.

d) Promoting Financial Innovations

CBDCs can foster financial innovation by providing innovative investment and financing tools and schemes including those deriving from open banking and open finance especially if appropriately supported by digital awareness campaigns. Furthermore, CBDCs can insure higher levels of competition in the market.

e) Supporting e-Government initiatives

CBDCs issuance facilitates digital transformation in all economic fields including the public sector and enhances the e-Government initiatives as well as the rule of

law and transparency in the public sector through the digitization of the public payment system which fosters sound public digital governance and resilience and paves the way for further and more efficient public-private partnerships.

4. Operational and environmental drivers

a) Enhancing Payments Efficiency

The issuance of CBDCs leads to enhanced efficiency, flexibility, and convenience in local payments, by allowing faster, smoother and safer real-time payments which would also improve the resilience of the national payment system.

b) Increasing Payments Safety

The safety and the resilience of national payments systems are increased through the use of CBDCs with the possibility of faster settlement, greater interoperability and enhanced money velocity which would encourage transactions, expand economic activity and promote economic growth. CBDCs would also limit liquidity risks by removing the complexity of settlement and clearance due to financial intermediation.

c) Environmental considerations

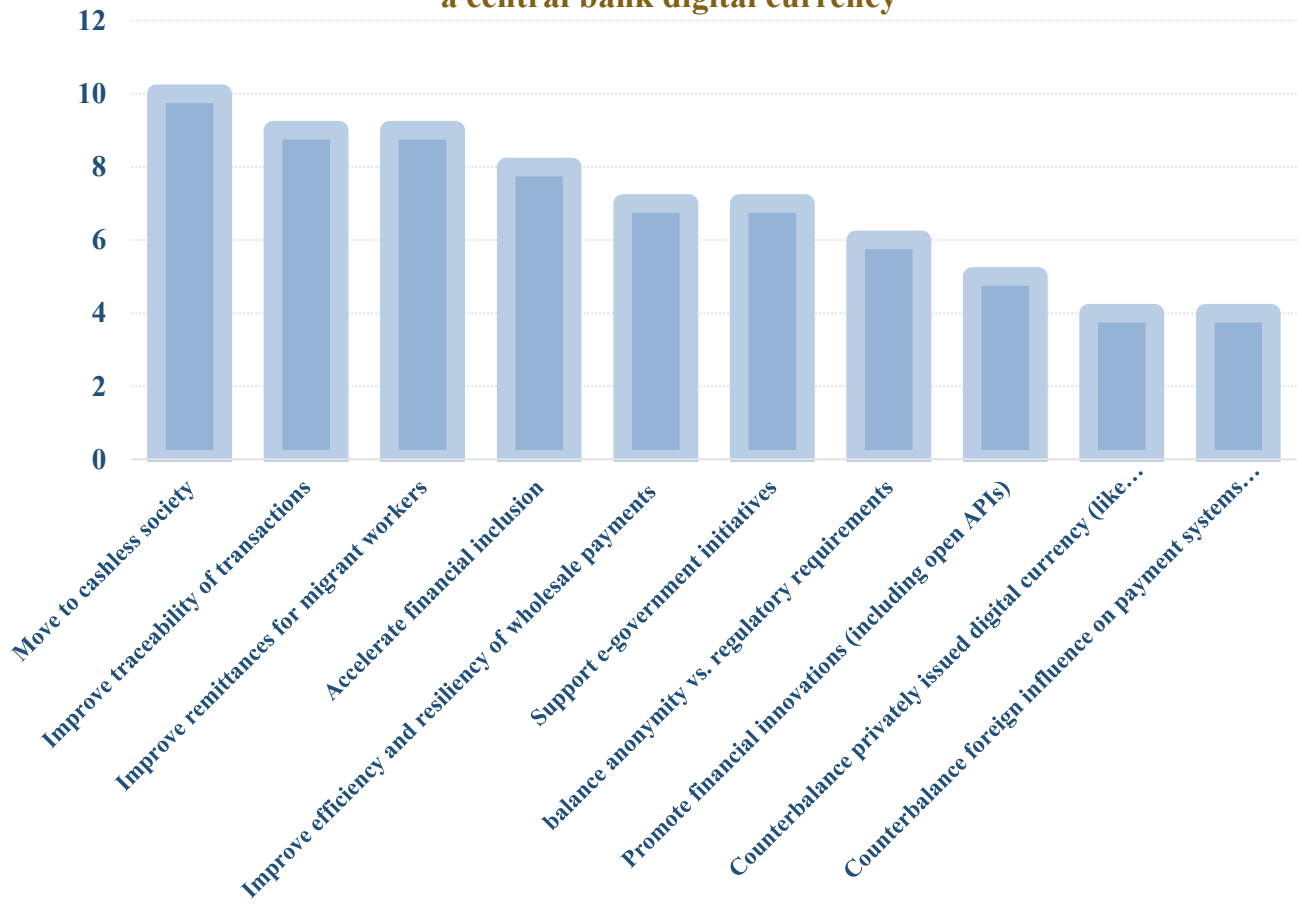
Nowadays, environmental considerations can constitute the basis of CBDCs issuances in the midst of all the emerging climate risks, since central banks try to set the tone at the top through leading by example and being environmentally responsible by prioritizing digital currencies instead of paper-based banknotes.

Those drivers are mainly common to the various CBDC issuances in the market, nevertheless, their weights vary from wholesale to retail CBDCs.

Arab central banks motivation to issue a central bank digital currency

Based on the above and to explore Arab central banks' interest in CBDCs, the Arab Monetary Fund (AMF) conducted a survey in September 2021 covering, among many other pillars, main drivers for adopting CBDCs.

Figure no. (1): Prioritization of drivers to issue a central bank digital currency



The above figure no (1) shows the main drivers that motivate Arab central banks and monetary authorities to engage in a CBDC project, which reflect initially the importance of promoting a cashless economy and of fostering financial inclusion. The first four drivers are: (i) to move to cashless society, (ii) to improve traceability of transactions, (iii) to improve remittances for migrant workers, and (iv) to accelerate financial inclusion. This explains the priority given by Arab countries to explore retail CBDCs. Wholesale payments are marked as a fifth driver followed by promoting e-government and financial innovation initiatives as well as balancing between anonymity and regulatory requirements. Collectively, all these drivers reflect Arab countries' interest in modernising their payment systems. Last, the surveyed countries retained the driver of counterbalancing private digital currencies and counterbalancing foreign influence on payment systems and monetary policy.

Risks Associated with CBDCs

1. Theft and Cyber Attacks:

CBDCs are under the risk of theft and counterfeiting through technical cyber-attacks. One cybersecurity threat to consider is credential theft and loss, since access credentials are needed for accessing and transferring funds. Such cyber-attacks would target the verification and registration system of the central bank in charge of the CBDC. This puts non-tech savvy individuals under risk of being lured by such fraudulent attempts.

Furthermore, given that central banks often have exclusive access and control of their CBDCs algorithms, they may employ a hidden rather than an open blockchain technology. This lack of third party verification puts CBDCs under more risk of cyber-attacks should the central banks ever undergo one. It is also not uncommon for digital currencies to be subject of large cyber-attacks. Cyber-attacks on digital currencies will often leave users with no way of retrieving their funds as they will immobilize users through the loss of user information, suspension of transactions or bankruptcy of the exchange. If a successful cyber-attack was to occur on a CBDC, the central bank associated with it could risk losing public confidence and reputational damage in addition to the evident monetary losses.

Failure of banking services can affect the credibility of the banking system, and the CBDC can transfer this risk to the central bank, destroying the benefits of a strategic structure for sharing the risk among participants in the financial system. Additionally, a central bank does not have the option of temporarily halting transactions or bankruptcy as they cannot pause their systems even when their database is under attack. This is because any suspension of transactions for a longer period of time would disrupt millions of transactions in addition to causing public panic. This is why central banks need to be more stringent and stricter regarding the security and design of their CBDCs.

2. Data Protection and Privacy:

Central banks often struggle with the creation of CBDCs as they need to design a system that ensures a balance between anonymity and the registration of users using their real names. Pure anonymity could pose risk for a CBDC with regards to cyber hackers, money laundering and other illicit acts.

CBDCs are stored in purely digital form which means that they face greater challenges when it comes to protecting personal data. Cash forms are more anonymous because cash does not contain information about the previous owner, whereas digital currencies are determined by the owner's identification code and private key. When private keys and identification codes are exposed, a CBDC user’s personal data information will be exposed which poses risk for two situations: (i) the exposure of the user’s privacy (ii) the loss of a

user's property rights, i.e. a hacker could easily identify and seize ownership of the user's digital money. It is important to note that a potential attack on a CBDC could happen in multiple occurrences: (i) on the central bank's digital verification services center (ii) the customer's digital wallet (iii) the terminal maintained by third parties such as merchants or commercial banks. Therefore, it is recommended that central banks criminalize unauthorized retrieval of personal information of CBDC account owners making such information confidential, e.g. amount of CBDC held, private keys, transaction history, etc. However, the fear is that central bank legislations are not sufficient to protect CBDC users from hackers and cyber-attacks.

3. Monitoring illegal activities using an AML & CFT framework:

While CBDCs, like any payment system, have illicit financing risks, as noted above CBDCs are particularly well suited to combat these risks.

4. Financial Stability and Financial Inclusion:

Retail direct CBDCs diminish the reliance on intermediaries such as banks and other payment service providers; this may inhibit the role of a bank within the financial system. This addresses a risk to financial stability and monetary policy should a central bank choose to utilize a retail direct CBDC without having the necessary measures to address such risks.

The current method of protecting the public provenance of money and monetary oversight does not require central banks to act as retail banks or technology service providers, but the creation of a retail direct CBDC may challenge those practices. A retail direct CBDC allows central banks and governments operating cash transfers to directly provide subsidies and programmed spending incentives to the general public. In the current system, the government is acting as a lender of last resort to bail out banks and large corporations. Retail direct CBDCs can change the relationship between central banks and individuals. That is why few central banks have piloted a retail direct CBDC. In contrast, indirect or Hybrid CBDC avoid these risks by involving commercial banks in the distribution of the CBDC and the servicing of their customers.

To add to the role of central banks, there are risks inherently associated within the central bank whereby with increased financial innovation, new risks are imposed in which employees of those central banks may not be competent enough to tackle. Regulators may struggle to develop the tools and expertise necessary to address those risks.

There are also risks that develop based on every jurisdiction's design of the CBDC, but factors leading to financial exclusions will always remain. Although retail CBDCs do serve

the wider implication of increasing financial inclusion, the inherent risks of financial exclusion may still exist and play a big role in the adoptability of retail CBDCs amongst individuals. The first factor that must be taken into considerations is access, and especially internet access. Even if a jurisdiction relies on an internet-free design, issues related to financial and technological literacy will still be apparent.

CBDC transactions require access to internet, as well as a smartphone. A good percentage of the world's population does not have access to such. Countries with low technological literacy and smartphone ownership may struggle to adopt a full CBDC based payment eco-system. For CBDCs to realize their potential, governments and Internet service providers need to work together to build an affordable Internet infrastructure. In addition, mobile wallet used for the CBDC must be able to function in low bandwidth areas. Furthermore, governments may need to increase financial literacy as a way to protect consumers.

5. Cross-Border Transactions Risks:

Most central banks are yet to address the key issues relating to cross-border transactions while using CBDCs, but the inherent risks that arise due to the nature of these currencies cannot be undermined. There is a general consensus that non-residents will be allowed to use local CBDCs within the issuing countries' jurisdiction, but a more reluctance to allow the use of those CBDCs abroad. This will generally mean that agreements will have to be made with foreign jurisdictions to allow for cross-border payments, and interoperability will have to be taken into consideration during the development stages.

6. International positions on local CBDCs and Monetary Policy:

Many central banks are adopting digital currencies for different use cases while others are not in favor of adopting CBDCs. Some use cases involve cross-border wholesale remittances while other use cases are limited to residents. There are many risks associated with the international positions on local CBDCs ranging from the risk of "digital dollarization", international spillovers, and the impact on the international role of currencies. If a CBDC is used outside of its jurisdiction successfully, this could lead to a local currency losing its function as a medium of exchange, unit of account, storage of value, and eventually raises financial stability risks. In addition, issuing CBDCs to non-residents can result in an increase in exchange rate volatility and change in capital flow dynamics since CBDC characteristics make them appealing to investors as an alternative financial instrument. Furthermore, this may also expose central banks that issue CBDCs limited to local payments to those risks and strong market pressures.

7. Inoperability of multiple CBDC projects:

Each project will be built on its own system, which may technically mean that those systems are unable to communicate with one another. CBDC project in country A may not correspond to CBDC project in country B, which would delay and deter collaborative projects such as cross-border remittances. Those developing CBDC projects will need to consider a unified approach towards it to allow for easier settlements that could potentially be adopted for multiple use cases in the future. Multiple CBDCs can result in fragmented and truncated data formats, unclear foreign exchange rates and incoming fees, long transaction chains, and complex processing of compliance checks. This could potentially put CBDCs at a disadvantage or no better than the existing system.

8. Vendor risk:

For a CBDC to exist, a technology vendor is often selected to be the provider of the technology housing the digital currency. This introduces an overlooked supply chain operational vulnerabilities and supplier risks. Technology is probably be deemed obsolete (over-time). The technology will not be regulated, but the activity might be leaving many risks trickling down as a result. Systematic risks and incompatibilities could arise without adequate central bank involvement. The same questions have risen with regards to tackling open banking (developing open banking APIs) in different system interoperability which has forced central banks to take a leading approach in unifying the technology governing open banking. CBDCs still represent a technical experiment and such fundamental design mistakes should not be underestimated.

In conclusion, central banks should take into consideration all the risks raised by the issuance of a CBDC, and the various available options to hedge these risks. The implementation of better policies, and upgrades to the cyber security infrastructure greatly reduce the risk of data/credentials theft, and the implementation of better AML/CFT solutions will reduce many of the inherent risks associated with CBDCs. Central banks who take a proactive approach, which includes implementing best practices with all matters related to the launch of CBDC, as well as using a suitable system design for their respective market needs will be much more confident with the mitigation of the associated risks

PAYMENT MODERNIZATION ALTERNATIVES TO CBDC

There have been a number of efforts aiming at payment modernization without reliance on CBDC. Many of these are incremental advances suggested by incumbent players such as SWIFT. Table no. (1) describes some of these attempts.

Alternatives		
Types	**Comments**	**Examples**
Improvements to messaging protocols but continued reliance on correspondent banking for settlement	Payment service providers can use their bank deposits in the receiving country to advance funds to recipients.	Example: SWIFT GPI, Transferwise, Remitly, Revolut, RippleNet.
Coordination of existing RTP systems for interoperability	Synchronize settlement in one instant payment system with settlement in the other and convert real-time messages between the two systems.	Example SWIFT, EBA Clearing and The Clearing House (US) to connect RTP systems in US and Europe using ISO20022.[2] Singapore's PayNow and Thailand's PromptPay linked in April 2021. Subsequent blueprint from BIS and MAS for a gateway to connect RTP systems.[3] [4]
Cryptocurrencies on public DLT	Value fluctuates and is not pegged to a fiat currency. Generally, cryptocurrencies have been used more as a (speculative) store of value rather than a method of payment.	One of the first cryptocurrencies designed primarily for payments was Ripple's XRP.[5] On September 7, 2021, El Salvador became the first

[2] Fxnewsgroup. 2021. EBA Clearing, SWIFT, TCH partner to enhance cross-border payments, October 2021. https://fxnewsgroup.com/forex-news/payments/eba-clearing-swift-tch-partner-to-enhance-cross-border-payments/

[3] Fintech. 2021. BIS and MAS publish blueprint for cross-border payment idea, July 2021. https://fintechmagazine.com/financial-services-finserv/bis-and-mas-publish-blueprint-cross-border-payment-idea

[4] BIS, 2021. Project Dunbar: international settlements using multi-CBDCs, July 2021. https://www.bis.org/press/p210902.htm

[5] Ripple, 2020. The Future of CBDCs- Why All Central Banks Must Take Action. https://ripple.com/

	Designed to be bearer instruments and facilitate anonymous payments; this represents a challenge for anti-money laundering and sanction screening. For this reason, commercial banks are wary of cryptocurrencies. Also represents a threat for currency substitution and can destabilize a country's monetary and banking systems.	jurisdiction to adopt bitcoin as legal tender. [6]
Tokenized assets (fungible and non-fungible)	Tokens represent a fractional interest in property or assets. Fungible (interchangeable) tokens can be used as digital currency.[7] [8] [9] A common example of this is tokenized interests in real property.[10]	In 2018, New York-based wealth management company Elevated Returns closed its first tokenization real estate transaction. The offer was made at The St. Regis Resort in Aspen, Colorado worth $ 18 million on the Ethereum blockchain.[11]

[6] Sergio Gorjón, 2021. The Role of Cryptoassets as Legal Tender: The Example of El Salvador, Banco De Aspana, Analytical Article, Economic Bulletin, April 2021. https://www.bde.es/f/webbde/SES/Secciones/Publicaciones/InformesBoletinesRevistas/ArticulosAnaliticos/21/T4/Files/be2104-art35e.pdf

[7]EY. 2020. Tokenization of Assets, Decentralized Finance (DeFi), Volume 1: Fundraising & StableCoins in Switzerland. https://assets.ey.com/content/dam/ey-sites/ey-com/en_ch/topics/blockchain/ey-tokenization-of-assets-broschure-final.pdf

[8]Deloitte. 2020. The Tokenization of Assets is disrupting the Financial Industry- Are you Ready? November 2020.https://theblockchaintest.com/uploads/resources/Deloitte%20-%20The%20tokenization%20of%20assets%20is%20disrupting%20the%20financial%20industry%20-%20are%20you%20ready%20-%202018%20-%20Nov.pdf

[9] Oerle, Jeroen. 2019. Tokenizing Real Assets, December 2019. https://caia.org/sites/default/files/tokenizing_real_assets.pdf

[10] Hitechnectar, 2021. Use Cases of Tokenization. https://www.hitechnectar.com/blogs/use-cases-tokenization/

[11]Prnewswire, 2020. New Compliant Security Token Issuance Standards. https://www.prnewswire.com/news-releases/elevated-returns-and-securitize-to-tokenize-usd-1b-of-real-estate-on-tezos-will-build-new-compliant-security-token-issuance-standards-300793038.html

However, as noted in the table above, most of these non-CBDC alternatives have significant limitations or flaws. As a result, many central banks continue to undertake proof-of-concepts or pilots with CBDC (See below "Jurisdictions Where Retail CBDC is Being Explored").

Recent developments globally and what we have learnt: Stocktaking of recent projects

Central banks around the world are examining the issuance of CBDCs with different paces, some are exploring the opportunities for issuance, while others are planning to introduce digital currency, many others are already engaged in proof of concepts projects or testing experiments, and few have already moved to the implementation phase such as the Chinese Yuan, the Bahamas Sand Dollar, and e-Naira of the Central Bank of Nigeria.

1. Retail CBDCs

i. China

The People's Bank of China (PBoC) was the first mover in the global CBDC race, it introduced in 2020 a pilot version of digital Yuan (eYuan) named as the Digital Currency Electronic Payment (DCEP) System with expectation to be in widespread use by 2022.

The DCEP is to be a two-tier operating system, preventing financial disintermediation, where the central bank serves as first tier and will be responsible for the issuance, verification and monitoring of the DECP, while commercial banks will act as operating agencies to convert between fiat currency and digital Yuan, and will be responsible for the circulation and establishing the DCEP application ecosystem via direct interaction with the general public.[12]

This implies a centralised management of the DCEP, by which PBoC sustains its control over monetary policy, public trust of the DCEP, while leveraging the resources & IT infrastructure of commercial banks without harming their intermediary level. Currently, four big Chinese commercial banks are involved in the testing phase with announcement from the PBoC to include other commercial institutions at a later stage to operate at the second tier of the system with the objective of enhancing innovation and competition.

The DCEP is to be implemented in a three step process, first adopting the system across governmental services and institutions, second, moving it to the domestic private sector; third, expanding its use beyond China's cross borders[13]. The eYuan is a hybrid system - compatible with token based, account-based, and quasi-account-based system.

China is targeting the local market primarily, so that by adopting the DCEP, the domestic payment system is expected to provide better financial services to the population, to be more efficient, more resilient to cyber-attacks, money laundering, financial crimes as

[12] Xia Mian, 2021. In Search of The Perfect Coin: China's Approach Towards Cryptocurrency and Its Own Central Bank Digital Currency. Banking & Finance Law Review, 2021, pp. 420 – 456.
[13] Mahima Duggal, 2021. The Dawn of the Digital Yuan: China's Central Bank Digital Currency and Its Implications. Institute of Security & Development Policy. Asia Paper, June 2021.

well as tax evasion among others. Moreover, infrastructure has been set to allow each end user to have a DCEP digital wallet installed whether in hardware or software.

Aiming to ensure a fast-track adoption of the system, the PBoC conducted several tests to implement the DECP in several regions across China covering Shenzhen, Suzhou, Chengdu, Xiong'an New Area, Shanghai, and Beijing. This is in addition to trials including main local and international retail giants. Moreover, on the grounds tests involved municipal government trials to disbursements of stimulus package and giveaways to citizens and residents which will support a broad use of the system.[14]

Moreover, **three centres will be established to accommodate the DCEP system adoption**: the registration centre, the verification centre and the big data analysis centre.[15] The Registration Centre registers the ownership of the DCEP, records the corresponding owner's ID. It is responsible for recording the entire process of creating, distributing, inventorying, and destroying of the DCEP. The Verification Centre manages the identity information of DCEP related institutions and users representing a crucial link in the anonymity-controlled design. The Big Data Analysis Centre is also responsible for AML operations, payment behavior analysis, and monitoring and coordination of key parameters.[16]

To enhance governance of the DECP system, China has passed a draft law, followed by a public consultation process in 2020, which sets a legal framework for the DCEP. The draft law provides a legal base for the introduction of DCEP as legal tender and put full control of the PBoC on the digital Yuan.[17]

In an attempt to balance between preserving personal data and combatting illegal activities, PBoC initiated a managed anonymity approach of "Voluntary Anonymity at Front End and Real-Name at Bank End", where front-end users have the choice to remain anonymous, but at the backend PBoC is able to track parties behind transactions and use Regtech solutions and the Big Data Analysis Centre to trace illegal transactions.[18]

Furthermore, a Personal Data Protection (PRC) law is being drafted to close the remaining gaps in the personal data protection provisions currently stipulated in the civil code.

[14] Ibid 13.
[15] Ibid 12.
[16] Ibid 12.
[17] Ibid 13.
[18] Qian, 2020. Systemic Framework, supra note 5.

ii. Nigeria

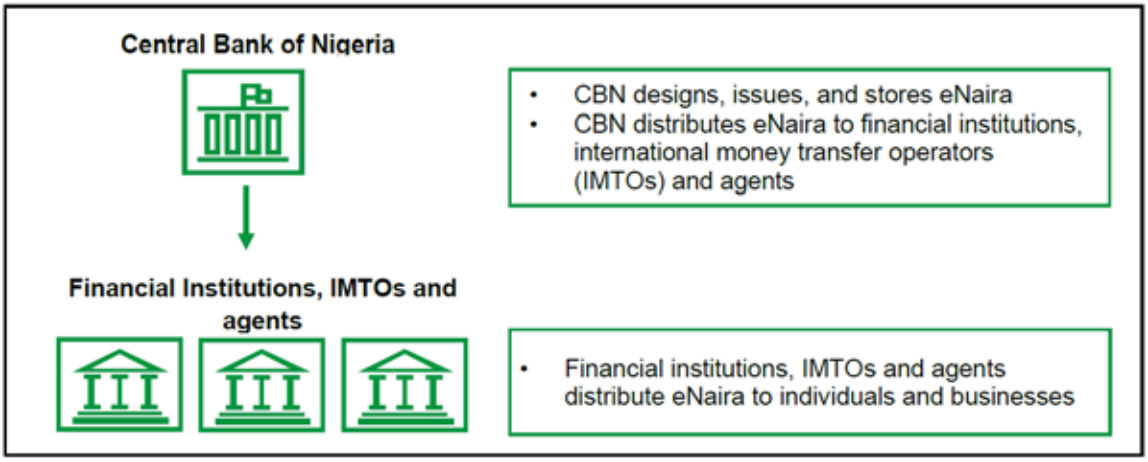
The Central Bank of Nigeria (CBN) launched in October 2021 the e-Naina, which is the digital equivalent of the national currency Naira, as continuation to its CBDC journey that started in 2017.

The introduction of eNaira is backed by the **perceived opportunities** that it may bring to the national economy including supporting a resilient payment system with less costs, moving to a cash less economy, and facilitating migrant remittances, which in turn will enhance financial inclusion in the country. This is in addition to the direct disbursement for welfare and potential increase in revenues and tax collection.

The eNaira has the same features as the physical currency, so as to be the official tender of Nigeria, representing a **liability of the CBN and can be exchanged 1:1**[19].

The CBN designed the eNaira based on five key principles to ensure inclusiveness, innovation, efficiency, resilience and representing national identity while addressing the Nigerian payment system[20].

The eNaira **design and architecture** were developed according to general principles and recommendations from international organizations. It is based on key design elements, namely the architecture, infrastructure, access and interlinkage. The Nigerian digital currency is a Hybrid CBDC, having two tiers architecture, where the central bank is responsible for issuing the eNaira while engaging the financial institutions with users in direct distribution of eNaira, payment facilitation, dispute resolutions and other roles that may be defined by the CBN. The below figure no. (2) illustrates the eNaira architecture.



Source: Central Bank of Nigeria.

[19]Central Bank of Nigeria, 2021. Design Paper for the eNaira, October 2021. https://enaira.com/download/eNaira_Design_Paper.pdf
[20] Ibid 19.

Potential risks are perceived to be associated with of e Naira, namely (i) disintermediation of banking system and its impact on financial stability, (ii) exposure to payment system uncertainty, (iii) further financial exclusion, (iv) operational risks including among other considerations: legal considerations, responsibilities of eNaira platform, dispute resolution, robustness of IT infrastructure, governance of the eNaira payment system, third party risks ... etc. (v) cyber security, as well as (vi) reputational risk.

To mitigate such risks, CBN has taken these risks into considerations and took measures in particular those related to the compliance with AML/CFT standards to preserve the integrity of the financial and payment systems. This implies (i) putting limits for daily transactions and balances for the transfer of funds from bank deposits to eNaira wallets. (ii) Using a tiered identity verification system and applying more rigorous controls to relatively less verified users. Currently, only individuals with a bank verification number (BVN) can open a wallet, and wallet owners who meet the highest standards of identity verification cannot hold more than 5 million naira in their eNaira wallets.[21]

iii. Singapore

In an attempt to assess the case for retail CBDC in Singapore and its implications on monetary policy and financial stability, the Monetary Authority of Singapore (MAS) achieved a pilot project to explore the opportunities for issuing a Singapore dollar retail CBDC in partnership with the private sector to serve as a public digital payment option. This was an extension to the previous wholesale CBDC projects in which MAS engaged with the participation of financial institutions only.

A retail CBDC would be a **direct claim on the MAS**, the private sector, on the other hand, handles distribution and customer contact activities, such as compliance and know-your-customer checks. Moreover, Singapore dollar retail CBDC have to be stored in an electronic wallet.

Even though MAS preliminary assessment for a retail CBDC suggest that **macro-financial risks can be managed by a proper regulatory framework**, the MAS concluded that at this stage there is no need to issue a Singapore dollar retail CBDC, however, it is advisable to engage in further exploratory work to promote technical and policy capacities for its potential retail CBDC introduction.

[21] IMF, 2021. Five Observations on Nigeria's Central Bank Digital Currency, November 2021. https://www.imf.org/en/News/Articles/2021/11/15/na111621-five-observations-on-nigerias-central-bank-digital-currency

iv. Digital Euro:

The European Central Bank (ECB) launched a digital Euro experiment in 2020 aiming to explore the opportunity of a digital euro as a CBDC from the perspective of the Eurosystem. In July 2021 the ECB decided to initiate a two year examination phase for the digital euro project starting in October 2021[22].

Such a digital euro becomes a central bank liability provided in digital form for citizens and businesses to use for retail payments. This complements the current cash and central bank deposit wholesale offerings.[23]

The results of the experiments provide inputs for design decisions, possible digital euro use cases, as well as related policies on a possible digital euro without preventing or committing the Eurosystem to initiate a digital euro. Experiment findings are consolidated into four main categories: digital euro ledger, privacy and AML, limits on digital euro in circulation, as well as the end-user access.[24]

The experiments' findings reveal that none of the examined topics have significant technical restrictions, and the design requirements can be met.

Regarding the **digital euro ledger**, experiments tested if it would be limited by the technological choices in terms of performance and flexibility, and many findings have revealed: (i) there are various solutions that can be available for a combined architecture of centralized and decentralized infrastructures, however, it did not take into account throughput or latency considerations, which are requirements for a multi-ledger environment to be considered a viable option. (ii) Payment channel networks can be used to improve scalability and data protection. Nevertheless, a legal clarification of the role of each node in the payment channel network is needed, while exploring the implications of such roles. (iii) Testing the potential expansion of the digital Euro with programmability features demonstrates that different types of automation can be programmed in DLT: whether by adopting different blockchain protocols, which can be either token-based or not; or through comprehensive functionalities, or even through as a restricted set of instructions. (iv) experiment results proved the feasibility of offline payments from a technical point of view but without confirming means of talking full control of the double spending risk.[25]

[22] European Central Bank, 2021. Central Bank Digital Currency: functional scope, pricing and controls, Occasional Paper Series, No. 286, December 2021.
[23] European Central Bank, 2020. Report on Digital Euro, October 2020.
[24] European Central Bank, 2021. Digital euro experimentation scope and key learnings, July 2021.
[25] Ibid 24.

As for the **privacy models and their compatibility with AML/CTF** regulatory requirements, tests illustrated that blockchains can be easily adapted to different privacy levels, either directly or indirectly, which should enhance the privacy options for end users. This implied merging multiple privacy techniques such as, among others, one-time pseudonyms, transaction mixing, payment channel network; so that number of technological solutions have been identified as basis for a payment solution with a very high level of privacy. In addition, investigations highlighted that complete untraceability was probable in offline solutions given that the digital euro exchanged remains offline[26].

Moreover, **limits on digital euro in circulation** has been tested and experiments proved the possibility to introduce limits on balances and transaction amounts regardless of the underlying technology. Findings also identified a possible mean for the automatic transfer of the excess amount to an account/wallet in private money which is linked to the digital euro account/wallet. Further tests are still needed to confirm the feasibility of such limits impact on transaction latency.

Despite the fact that **remuneration** was successfully applied on different types of ledgers, some limitations may restraint employing a remuneration scheme. This can be addressed by holding valuable instruments in custodial wallets that permit remuneration schemes to be applied equivalently to account-based schemes[27].

The **end user access** tests, using several end-user solutions (mobile applications, web apps and cards, point-of-interaction/ point-of-sale integrations), highlighted several opportunities for providing access to digital euro to an extensive diversified pool of users. Embracing the current infrastructures and technologies will enable the digital euro adoption as a means of payment.

When tested state issued electronic identity (e-ID) solutions for user authentication, results confirm that user authentication process can be performed for the same account/wallet provider. In addition, linking an individual's e-ID to holding a digital euro allows for relatively smooth application of limits and tiered remuneration. An e-ID also makes it easier to switch between digital Euro account/ wallet service providers and has the potential to decrease the cost of KYC and AML. At the end, this is depending on countries' level of adoption for government e-IDs, which requires a widespread adoption of an e-ID solution to support digital euro services[28].

[26] Ibid 24.
[27] Ibid 24.
[28] Ibid 24.

2. Wholesale CBDCs

Many countries across the globe have initiated wholesale CBDC projects, mainly POC, most recent of which, as on the date of issuance, are highlighted below.

i. France – The Banque de France[29]

The Banque de France initiated an experimentation program in 2020 jointly with market participants to explore the opportunities of issuing a **wholesale CBDC (W-CBDC)**, as a new form of central bank money (CeBM) on a distributed ledger platform. This includes two experiments on means of employing W-CBDC (i) to settle securities in different configurations and for a variety of assets, and (ii) to achieve cross-border and cross-currency transactions, exploring the diverse potential types of multiple CBDC (mCBDC) arrangements.

The two experiments have been accomplished in early November 2021 deriving significant outcomes, first, a (W-CBDC) can be applied on several types of DLT so as to be an efficient mean of payment, advancing CeBM with new functions and use cases that promote innovation in financial markets. Second, from a technical perspective, DLT technologies offer various tools for central banks to retain control over central bank money (CeBM) by leveraging their capacities to execute programmability features.

As preceding experiences, the experiments' programme raised **open questions and issues of concern that need further observation**. These imply (i) the access to CeBM, particularly in case of increased demand from financial institutions that do not have currently access to CeBM, which may impact the monetary policy and the macroeconomic outlook. Similarly, the technology that could support the issuance and distribution of a W-CBDC need to be deeply assessed.

Furthermore, findings highlight the need for more experiments to assess **interoperability** with existing traditional systems, and W-CBDC cross-border multi-currency use cases. This is in addition to further examination in order to ensure preserving **financial stability and monetary sovereignty** given the dissemination of crypto-assets, including stablecoins, as settlement assets, and the emergent decentralized finance (DeFi) modes.

[29] Banque De France, 2021. Wholesale Central Bank Digital Currency Experiments with The Banque De France: Results & Key Findings, November 2021.

ii. Australia - Project Atom[30]

The Reserve Bank of Australia (RBA) conducted the project Atom, in 2020-2021, jointly with the Commonwealth Bank of Australia (CBA), National Australia Bank (NAB), in addition to private entities. Atom implies a proof-of-concept (POC) for the issuance of a tokenized CBDC, which represents a digital form of money that is a direct claim on the central bank. Whereby wholesale market participants can use the CBDC to fund, process and repay syndicated loans on the Ethereum-based DLT platform.

Atom (POC) explored RBA issuance of a **two-tier wholesale CBDC** to commercial banks, and then banks make it available to eligible wholesale market participants on the platform; which in turn preserves the current role of commercial banks, including customer onboarding and all customers' related activities.

The research project illustrated many of **the potential benefits** of issuing a wholesale CBDC to settle transactions in tokenized assets on DLT platforms. This would include instantaneous delivery-versus-payment (DvP), digitization of syndicated loans on a DLT platform, settlement of the loan and its repayment. This is in addition to the use of smart contract functionality of DLT for execution and settlement of complex multi-stage and multi-party transactions involving conditions and interdependencies.

On the other hand, the POC project triggered **issues and implications** of initiating a wholesale CBDC that need to be explored to tackle if there is a case for a wholesale CBDC and how it could be addressed. This implies the use of existing "off-chain" payment systems, the broader access to the CBDC by non-banking institutions participating in the platform; e.g. the eligibility to access CBDC, its usage, the relationship between commercial banks and their sponsored participants, as well as the prospective repercussions on financial intermediation and financial stability from moving deposits from commercial banks to CBDC. Furthermore, Atom project excludes non-functional requirements such as the scalability of the system, and means of strengthening cyber resilience.

When it comes to the **technology**, the POC findings revealed that an enterprise-grade DLT platform with the pertinent access and security controls can meet many potential requirements for a wholesale CBDC and tokenized assets platform, including the certainty related to transaction, security, and privacy. However, further examination and testing of the technology will be necessary to evaluate its suitability for the production system.

[30] Project Atom: Exploring a Wholesale CBDC for Syndicated Lending, December 2021. https://www.rba.gov.au/payments-and-infrastructure/central-bank-digital-currency/pdf/project-atom-report_2021-12.pdf

iii. Project Jura: Banque De France - Swiss National Bank[31]

Project Jura examined the direct transfer of euro and Swiss franc wCBDCs between French and Swiss commercial banks on a single DLT platform operated by a third party. Tokenized asset and foreign exchange trades were settled using payment versus payment (PvP) and delivery versus payment (DvP) mechanisms. The experimentation was achieved in a near-real setting using real value transactions and meeting applicable regulatory requirements.

Jura explores a new approach including subnetworks and dual-notary signing to issue wCBDC on a third-party platform and to provide non-resident financial institutions with access to wCBDC.

The experiments involved **four types of transaction:** (i) issuance and redemption of EUR and CHF wCBDC; (ii) primary issuance and redemption of tokenized Negotiable European Commercial Papers (NEU CP) on the Digital Asset Registry (DAR)[32] and the mirroring on the SDX test platform; (iii) DvP on the SDX test platform; and (iv) PvP on the SIX Digital Exchange (SDX)[33] test platform.

In Project Jura, EUR and CHF wCBDC and the NEU CP token on the SDX test platform had **no legal force, meaning that the wCBDCs did not represent a direct central bank liability**. While exchanges for the PvP and the DvP were achieved on the SDX test platform, final, real-value settlement occurred in the underlying RTGS systems for the wCBDCs and in the DAR for the NEU CP. All settlements on the SDX test platform and the DAR were governed by the rulebooks.

Issuance and redemption of wCBDC, Commercial banks trigger the issuance and redemption of wCBDC by transferring funds to central banks' technical accounts in the RTGS systems (in case a commercial bank is not a participant in the RTGS system, it relies on a local correspondent bank for the transfer of the RTGS system balances). Upon receipt of funds, a central bank creates an equivalent amount of wCBDC in its issuer node on the SDX test platform and signs and time-stamps them with its notary node.

To redeem wCBDC, a commercial bank transfers it from its node to the central bank issuer node on the SDX test platform. The central bank then destroys the wCBDC, signing and time-stamping this with the central bank notary node. Funds are then transferred from the

[31] Banque de France, Bank for International Settlements, Swiss National Bank. 2021. Project Jura, Cross-border Settlement using wholesale CBDC. December 2021.
[32] Digital Asset Registry (DAR): a new DLT based registry for tokenised commercial papers issued under French law (NEU CP).
[33] SIX Digital Exchange (SDX): a licensed exchange and CSD for tokenised assets.

technical account in the RTGS system to the commercial bank's account or that of its correspondent.

Jurisdictions Where Retail CBDC Is Being Explored (as of January 11, 2022)[34]

It worth noting that retail CBDC is a broadly available general purpose digital payment instrument, denominated in the jurisdiction's unit of account, that is a direct liability of the jurisdiction's monetary authority. The below table no. (2) does not cover wholesale CBDC, which is limited to a set of predefined user groups, typically financial institutions.

Where central banks have launched or piloted (or soon will)
Bahamas (fully launched)
Jamaica (pilot launch imminent)
China (pilot launched)
Nigeria (pilot launched in October 2021)
Eastern Caribbean (pilot launched)
Uruguay (pilot completed)
Where central banks have done proofs of concepts (or soon will)
Bhutan (proof of concept planned)
Korea (proof of concept started)
Japan (proof of concept started)
Sweden (proof of concept underway)
Ukraine (proof of concept done)
Ghana (2021) (update; 2021)
Hungary (2021)
Kazakhstan (2021)
Russia (2021)
Thailand (2021)
Turkey (2021)

[34] CBDC Tracker. https://cbdctracker.org/; https://kiffmeister.blogspot.com/2019/12/countries-where-retail-cbdc-is-being.html.

Where central banks are in advanced stages of research and development	
Canada (update)	Mauritius (update)
Euro Area	United Kingdom
Norway	United States
Where central banks are still in the exploratory stages (with year of last update)	
Australia (2021)	Brazil (2021) (update, 2021)
Kuwait (2019)	Bahrain (2021)
Chile (2021)	Haiti (Bitkòb) (2021)
Singapore (2021)	Philippines (2020)
Madagascar (2021)	Hong Kong SAR (2021)
Malaysia (2021)	South Africa (2021)
Czech Republic (2021)	Iceland (2018)
Morocco (2019) (update; 2021)	Switzerland (2019)
Denmark (2017)	India (2021)
New Zealand (2021)	Taiwan (2020)
Eswatini (2020)	Egypt (2018)
Pakistan (2021)	Indonesia (2020)(update; 2021)
Georgia (2021) (update; 2021)	Trinidad and Tobago (2021)
Peru (2019) (update; 2021)	Tunisia (2018)
Kenya (2020)	Curaçao en Sint Maarten (2018)
	Zimbabwe (2021)
Where central banks have explored or are exploring issuing retail CBDC	
United Arab Emirates (2021)	Mexico (2021)
Lebanon (2020)	Honduras (2021)
Palestine (2021)	Rwanda (2021)
Viet Nam (2021)	Tanzania (2021)
Guatemala (2021)	Laos (2021)
Macau (2021)	Iran (2018)
Where central banks have launched and discontinued	
Ecuador (2014-2018)	
Finland (1992-2006)	

Sources: Central banks or various news sources per hyperlinks above, the Bank for International Settlements CBDC database and CBDCTracker.org.

Tokenizing Central Bank Money

Historically, the main focus of CBDCs was on tokenizing central bank money, and in the case of synthetic CBDC, commercial bank money. The table no. (3) below shows types of fiat currency tokenization.

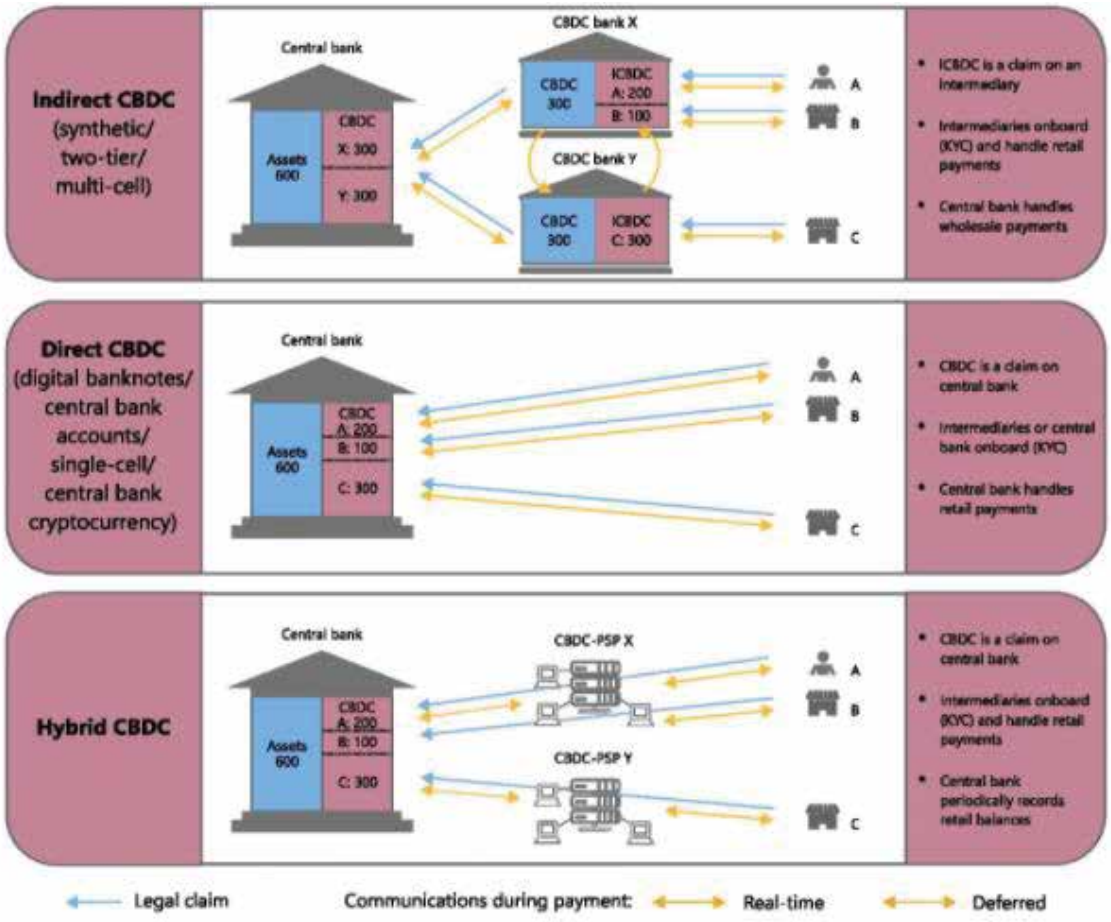
Token based fiat currencies[35]	
Types	**Comments**
Central bank digital currencies (CBDC): issued by the central bank as legal tender.	Can be issued by central banks directly to consumers and businesses (direct CBDC), or distributed through commercial banks (indirect CBDC).
Synthetic central bank digital currencies: issued by commercial banks or e-money institutions. Although there is no legal tender, they are fully covered by central bank reserves. Also, there is an obligation to exchange for fiat currency at any time.	Introduced by Tobias Adrian and Tommaso Mancini-Griffoli from the International Monetary Fund.[36] Synthetic CBDC arrangement outsource diverse tasks to private sector e-money institutions, which are "all sources of substantial costs and risks". The ECB, in this case, would only be responsible for managing some tasks, therefore, saving resources.[37]

[35]Gross, Jonas. 2020. Programmable Money and Programmable Payments, September 2020. https://jonasgross.medium.com/programmable-money-and-programmable-payments-c0f06bbcd569 (accessed October 2021).

[36] Adrian, T. (2019). Stablecoins, Central Bank Digital Currencies, and Cross-Border Payments: A New Look at the International Monetary System. Remarks by Tobias Adrian at the IMF-Swiss National Bank Conference, https://www.imf.org/en/News/Articles/2019/05/13/sp051419-stablecoins-central-bank-digital-currencies-and-cross-border-payments (Accessed: 03.04.2020).

[37]Gross, Jonas. 2020. Synthetic central bank digital currency (sCBDC) - Public private CBDC collaboration, July 2020. https://jonasgross.medium.com/synthetic-central-bank-digital-currency-scbdc-public-private-cbdc-collaboration-46a3f4eb9808

These CBDCs are represented in the familiar diagram, figure no. (3), from the Bank for International Settlements:



Source: BIS, 2021.

However, there are additional ways to tokenize fiat currencies as described in the table below no. (4). These are normally not thought of as part of a CBDC.

Additional Modes[38]	Description
DLT-based commercial bank money: issued by regulated financial institutions, e.g. commercial banks. It is not a fiat currency, i.e. no legal tender, and is only partially backed by central bank reserves, i.e. fractional reserves. There is an obligation to exchange for fiat currency at any time.	Example" JPM Onyx (previously JPM Coin)[39]

[38] Sandner, Philipp. 2020. Programmable Money and Programmable Payments, September 2020. Frankfurt School Blockchain Center. https://philippsandner.medium.com/?p=8038ed8fa714

[39] J.P.Morgan, ONYX Index. https://www.jpmorgan.com/onyx/index

DLT-based e-money: issued by e-money institutions, i.e. there is no legal tender. It is fully backed by e-money on accounts. There is an obligation to exchange for fiat currency at any time.	In application of the new MiCA regulation proposed by the European Commission, these would be so-called E-Money tokens (EMTs).[40]
Fiat-pegged stablecoins: issued by regulated (e.g., commercial banks, payment service providers) or non-regulated financial institutions (e.g., companies that do not have all of the necessary licenses in all required countries).	Stablecoins are only "fiat derivatives." They replicate the price of a fiat currency, however, they are neither legal tender nor there is an obligation to exchange them for legal tender, like the case of commercial bank money. Therefore, they involve counterparty, exchange rates and liquidity risks (Sandner, 2020). According to the MiCA regulation proposed by the European Commission, these would be so-called asset-references tokens (ARTs).[41]

Later in this paper, we will revisit this topic to consider whether including these alternatives might be convenient.

[40] European Commission. EU E-Money Directives. https://ec.europa.eu/info/business-economy-euro/banking-and-finance/consumer-finance-and-payments/payment-services/e-money_en

[41] Ibid 38.

CBDC PROJECTS HAVE BEEN COSTLY AND HAVE TAKEN MONTHS OR EVEN YEARS TO BE ACCOMPLISHED

CBDC projects have three common characteristics:

- They are technically complex and challenging to build.
- They take a long time.
- As a result, they are costly.

As Evidence of this complexity, lengthiness and costliness can be found by reviewing the chronology of two well-known CBDC projects: the Bahama's Sand Dollar and Swedish e-krona.

1. One of the earliest and most closely watched CBDC efforts was the **Sand Dollar Project of the Central Bank of the Bahamas**.[42]

January 2016	John Rolle joins the Central Bank of the Bahamas from the IMF to champion a CBDC.[43]
August 2018	Central Bank of the Bahamas issues Expression of Interest for a technology solution provider. More than 30 entities submit a bid.[44]
March 2019	NZIA Limited selected as the preferred solution provider
November 2019	National Payments Council approves Sand Dollar approach
December 27, 2019	Island of Exuma pilot launched
February 28, 2020	Expansion to the island of Abaco
October 2020	Expansion to a nationwide pilot available to general public
February 2021	Request for public comments on proposed legislation for the regulation and use of Sand Dollar CBDC
April 2021	Request for public comments on Project Sand Dollar on the following pillars: "project communications management, communication strategy, public relations, event design and execution, social media strategy and management, community outreach, brand strategy, and brand activation"

[42] Sanddollar. 2021. Digital Bahamian Dollar, the Bahamian Payments Systems Modernisation Initiative (PSMI). https://www.sanddollar.bs/history

[43] Bloomberg. 2021. Why Bahamas Sand Dollar Led the Way. https://www.bloomberg.com/news/articles/2021-05-20/the-bahamas-central-banker-explains-why-its-sand-dollar-led-the-way

[44] Cemla. 2020. Implementing a CBDC: Lessons Learnt and Key Insights Policy Report, October 2020. Central Bank Digital Currencies Working Group (CBDC WG). https://www.cemla.org/fintech/docs/2020-Implementing-CBDC.pdf

It is worth noting the significant time required to plan, pilot and launch the Sand Dollar CBDC. The Central Bank of the Bahamas had to finance this work entirely on its own.

2. Another visible CBDC project is **the Riksbank e-krona project in Sweden**.[45]

March 2017	Riksbank starts the analysis on e-krona project[46]
June 2019	Riksbank issues a proposal solicitation for technical solution provider
December 2019	Riksbank selects Accenture to design and test a prototype.[47]
February 2020	E-krona pilot begins
April 2021	Riksbank issues report on e-krona pilot phase one.[48] Riksbank will continue testing the technical solution and investigating required legal requirements to issue e-krona. The Agreement with Accenture is extended another year and work begins to study integration with commercial banks, development of offline functionality, key and token storage, development of customer support, improvement of performance and scalability and acceptance at physical retail.[49]
June 2021	Riksbank extends e-krona pilot with integrations to Handelsbanken[50]

The cost of the Riksbank CBDC phase one pilot has been estimated at more than USD 5 million.

Even a very modest CBDC pilot may require significant investment. The National Bank of Ukraine undertook a simple test to issue e-hryvnia in 2018. Developing the platform took from February to August in collaboration with Attic Lab LLC the responsible for creating the system's core, UAPAY LLC acting as settlement agent and Finance Company OMP 2013 LLC

[45]Sveriges Riskbank. 2020. E-Krona Pilot, December 2020. ksbank.se/en-gb/payments--cash/e-krona/

[46]Aitken, Roger. 2017. Cashless Society: Is This What An 'E-krona' In Sweden Could Look Like?. https://www.forbes.com/sites/rogeraitken/2017/09/26/cashless-society-is-this-what-an-e-krona-in-sweden-could-look-like/

[47]CoinDesk. 2019. Accenture Picked to Build Sweden's E-Krona Digital Currency Pilot, December 2019. https://www.coindesk.com/policy/2019/12/13/accenture-picked-to-build-swedens-e-krona-digital-currency-pilot/

[48]Sveriges Riskbank. 2021. E-krona pilot- Phase 1, April 2021. https://www.riksbank.se/globalassets/media/rapporter/e-krona/2021/e-krona-pilot-phase-1.pdf

[49] Ibid 48.

[50]Reuters. 2021. Sweden's Handelsbanken to help test central bank digital currency, May 2021. https://www.reuters.com/article/cenbanks-digital-sweden/swedens-handelsbanken-to-help-test-central-bank-digital-currency-idUSL5N2NF1TB

acting as distribution agent. Deloitte and Touche advised on the pilot.[51] The pilot itself was run in September and October; only 5,443 e-hryvnia were issued. Statistical analysis of the test was concluded in December 2018.[52] Four years later, in January 2021, the National Bank of Ukraine announced the start of a second CBDC pilot with technology partner Stellar.[53]

As described above, China launched its CBDC pilot in April 2020. The People's Bank of China started work on the development of the Digital Currency/Electronic Payment or DC/EP in 2014, more than six years earlier.[54] While the cost of the pilot has not been made public, the size, scale and duration of planning, implementation and testing would suggest that this pilot may have been the most costly yet.

Of particular interest to countries in the Arab region is the recent request for proposal from Saudi Payments, a division of the Saudi Arabia Monetary Authority. The RFP was released in November 2021 and will be performed in 2022. This project builds on the SAMA and Central Bank of the UAE of Project Aber in 2019 and 2020. Applicants are asked to provide cost estimates and SAMA will pay all expenses of the winning bid. In addition to the CBDC, the proposal also includes the implementation of a lending platform based on smart contracts enabled by blockchain[55]. The new RFP explicitly asks for new value propositions and use cases beyond CBDC, including smart contracts and digital assets.

Taken together, the foregoing case studies provide strong evidence that CBDC pilots can be complex, take a long time, and are very costly.

MOST OF THE CBDC EXPERIMENTS HAVE BEEN UNDERTAKEN WITHOUT LEGAL AUTHORIZATION

Some accounts mistakenly report that CBDCs begin with legal reforms to authorize the CBDC. This is untrue.

That is because these CBDC experiments did not issue new legal tender and do not include plans for moving to issuance. This is the case of the e-krona project in Sweden and the e-peso project in Uruguay. In addition, the Sand Dollar project in the Bahamas, which launched in

[51] National Bank of Ukraine. 2019. Analytical Report on the E-hryvnia Pilot Project, 2019. https://bank.gov.ua/admin_uploads/article/Analytical%20Report%20on%20E-hryvnia.pdf?v=4

[52] Ibid 51.

[53] CoinDesk. 2021. Ukraine Government Picks Stellar Development Foundation to Help Build National Digital Currency, January 2021. https://www.coindesk.com/business/2021/01/04/ukraine-government-picks-stellar-development-foundation-to-help-build-national-digital-currency/

[54] PWC. 2021. PwC CBDC Global Index, First Edition, April 2021. https://www.pwc.com/gx/en/industries/financial-services/assets/pwc-cbdc-global-index-1st-edition-april-2021.pdf

[55] Saudi Payments Request for Proposal (October 31, 2021)

December 2019, only published proposed authorizing legislation for public comment in February 2021.[56]

The significant majority of central banks participating in CBDC experiments do not have clear legal authority to launch a production program.[57]

[56]The Central Bank of The Bahamas. 2021. CONSULTATION PAPER: Proposed Legislation for the Regulation of the provision and use of Central Bank issued Electronic Bahamian Dollars, February 2021. https://www.centralbankbahamas.com/viewPDF/documents/2021-02-15-11-24-12-Central-Bank-Electronic-Bahamian-Dollars-Regulations-2021.pdf

[57] BIS. 2021. Ready, steady, go? – Results of the third BIS survey on central bank digital currency, BIS Papers No 114, Monetary and Economic Department, January 2021. https://www.bis.org/publ/bppdf/bispap114.pdf

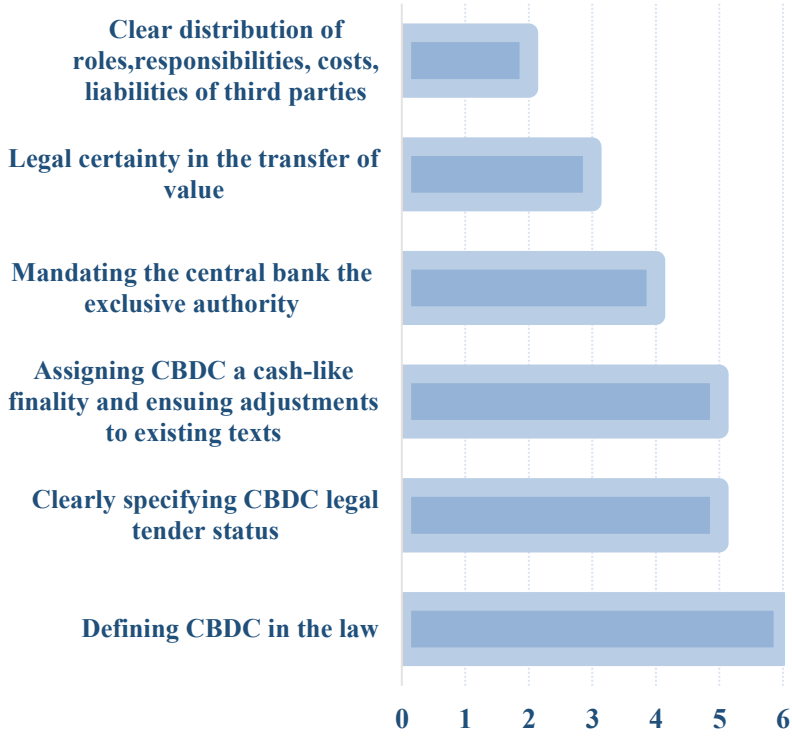
Insights from the Arab region:

As previously mentioned, the AMF conducted a recent survey addressing diverse aspects of CBDCs initiatives, including the main drivers, challenges, the level of readiness of Arab central banks and their future plans. In addition to this, the survey covers other operational aspects for CBDC issuance, and if any other alternative rather than the CBDCs that can foster digital payments and digital financial inclusion.

The survey revealed that 76% of the Arab central banks are considering the introduction of CBDC with different paces and levels of readiness, of which 59 % of the respondent authorities are still exploring the issuance of CBDCs, while 18% are already engaged in CBDC projects. It is against this very strong showed interest that we analyze within the rest of the survey.

Figure no. (4): Barriers impeding the issuance of CBDC

Figure no. (5): Legal Challenges



The above figures (4) and (5) show the challenges pointed out by the Arab central banks and monetary authorities. The set of barriers that impede the introduction of CBDC are reported, and include mainly: (i) the current legal and regulatory framework, (ii) governance aspects, (iii) the ability to verify parties timely and securely. These are followed by a couple of technical aspects as listed: cyber resilience, managing the cloud, as well as various technological aspects of the CBDC issuance (including, among others, requirements, immaturity, interoperability, shared infrastructure). At the end, there are some barriers that are related to the governance

scheme of the public/private component in the supply chain of CBDC, lack of human skills, and anonymity concerns.

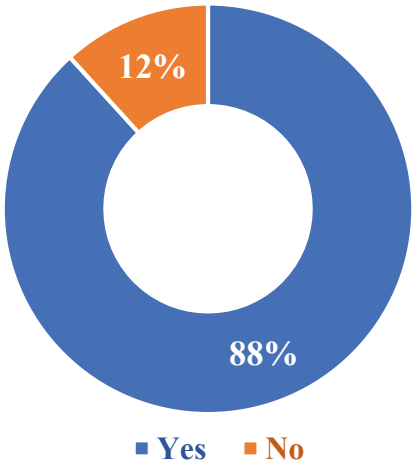
Moreover, Figure no. (5) highlights the legal barriers that authorities perceive to hinder the initiation of CBDCs, where the most important ones respectively are: defining CBDCs in law, clearly specifying CBDC legal tender status, assigning CBDC as cash finality and ensuring adjustments to existing texts, as well as mandating the central bank the exclusive authority. These are followed by the legal certainty in transfer of value and the clear distribution of roles, responsibilities, costs and liabilities of third parties.

As noted in the preceding section, most jurisdictions that have undertaken CBDC experiments have done so without previously implementing legal authorizations. It may be possible that the availability of a low cost, ready-to-use experimental platform in the Arab Region would encourage central banks in the region to set aside legal considerations and move forward with their experimentation. Once an optimal CBDC has been identified by the central bank and the benefits and risks have been quantified, it will be easier for the country's law-makers to adopt the necessary legal changes to fully authorize the CBDC.

- **Engagement in other modernization projects**

Most of respondents (88%) are considering another payment modernization alternative such as APIs or instant payments, while 12% are not. Many of the Arab central banks are either considering or already developing instant and real time payment projects, or running modernization projects to deliver instant payment platforms. For instance, SAMA has recently issued the instant payment project (SARIE), while the central bank of Egypt has already issued the regulation of Instant Payments.

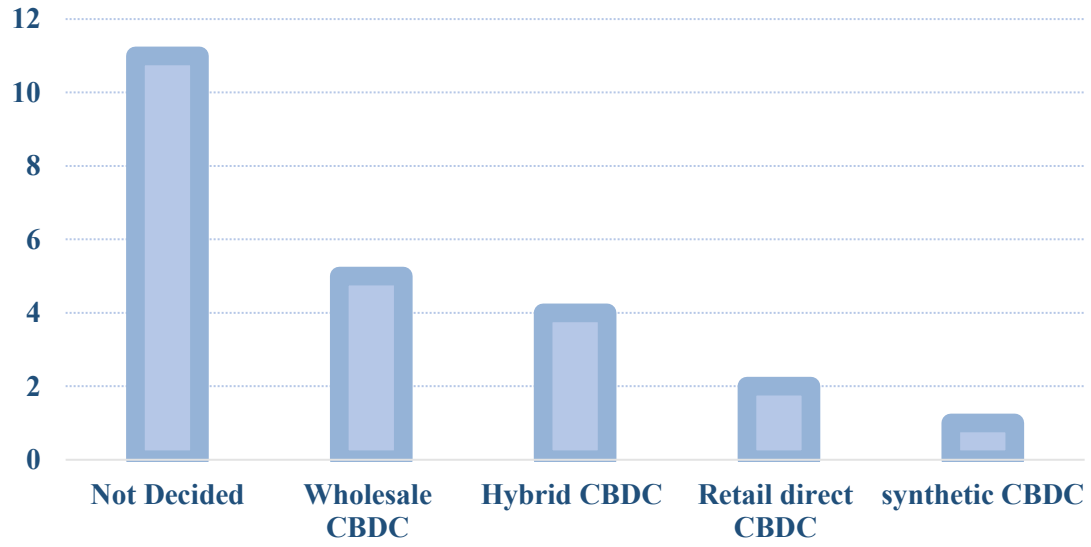
Figure no. (6): Engagement in other payment modernization alternatives



- **General Pattern of common interest without clear decision yet**

Many Arab central banks are exploring the viability of introducing fiat money/ wholesale or retail CBDCs, taking into consideration the local attributes and the structure of the economy; in addition to the feasibility of the issuance from all aspects such as legal, technical, operational, and financial stability. The below figure no. (7) shows that there is a common interest across the region to explore CBDCs without a clear decision taken yet (11 Arab central banks). However, the remaining six Arab central banks listed more than one type of prospective CBDC, which are wholesale and the three retail CBDCs, namely hybrid, direct retail and synthetic reflect the attention given to retail CBDCs within the region, which is related closely to the motivations that authorities have reported.

Figure no. (7): Types of CBDCs that may be considered



- **Engagement in proof of concept and next steps for initiating CBDCs**

As noted above, the survey revealed that 76% of the Arab central banks are considering the introduction of CBDC with different paces and levels of readiness, of which 59% of the respondent authorities are still exploring the issuance of CBDCs, and 18% are already engaged in CBDC projects.

When asked about the next steps to initiate CBDC projects, the majority of respondent authorities (62%) reported that they that may prepare for proof of concept, which is not connected to the core banking system, while 33% may prepare for a phased pilot that could be connected to the core banking system with limitation; and only 5% of respondents may adopt a production system that is connected to the banking system.

Figure no. (8): Exploring Issuance of CBDC

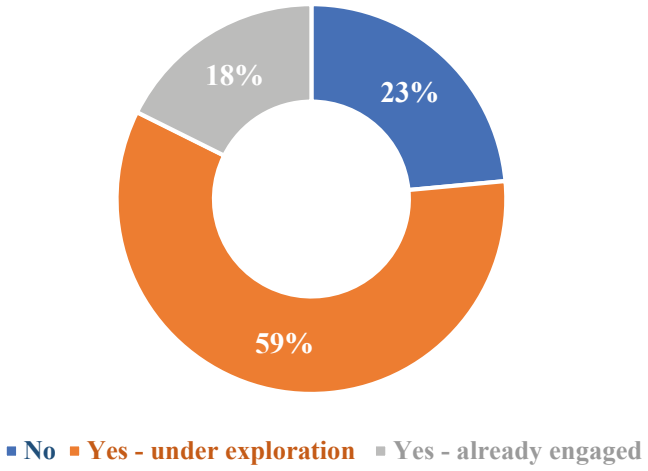
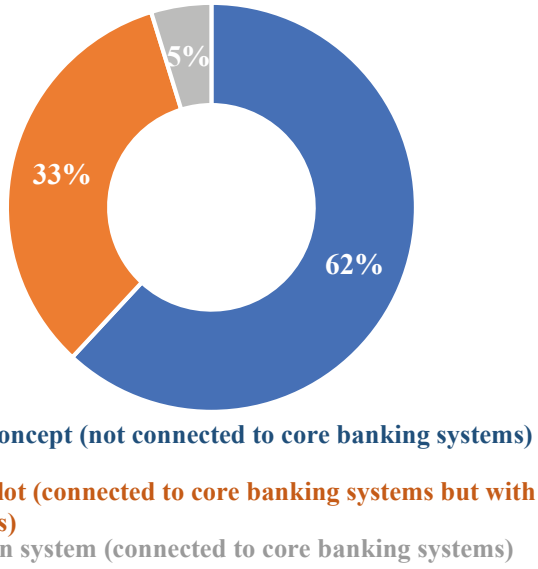


Figure no. (9): Next steps for initiating CBDC



To support further examination for introducing CBDC, many of the Arab central banks took various initiatives such as (i) establishing dedicated committees from relevant departments at the central bank to assess a prospective introduction of CBDC, (ii) exploring use cases for applying a CBDC, and assessing different approaches to implement and operationalize it. (iii) arranging for experimentation to explore all aspects of a CBDC project and the related implications. Furthermore, a limited number of Arab central banks are currently preparing for a pilot phase for testing.

- **Operational considerations:**

The survey tackled various operational aspects such as (i) the prospective type of technology that might be used, (ii) the existence of Digital ID programs and their integration with the CBDC system, (iii) Operation & Sponsorship of the CBDC system.

Figure no. (10): Considered Technology

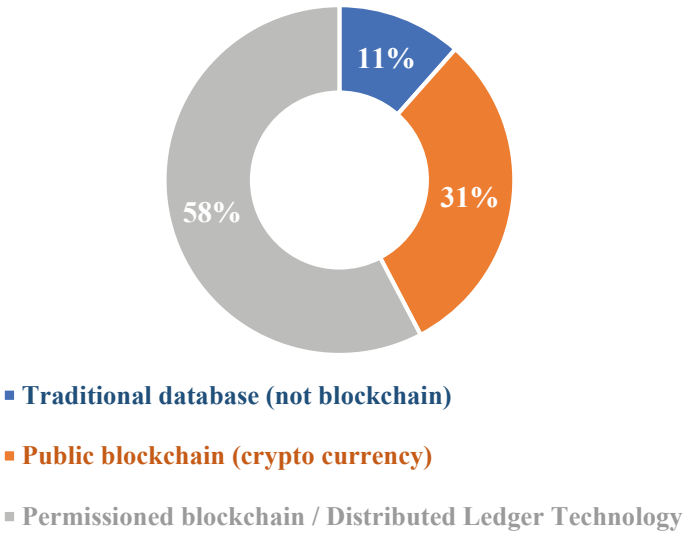
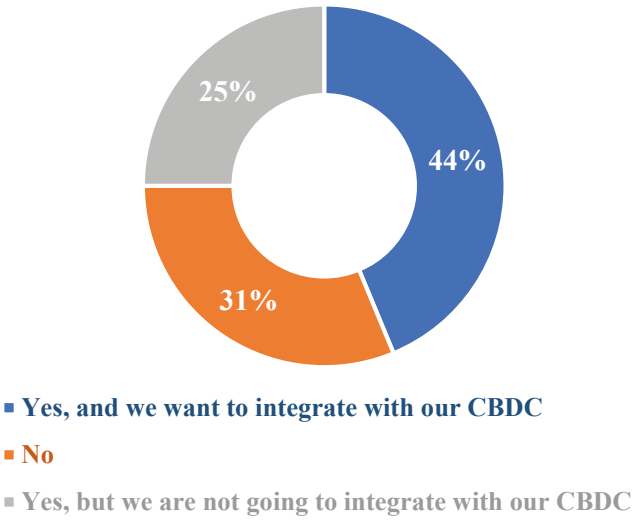


Figure no. (11): Existance of digital ID and if integrated with the CBDC



- The majority of respondent central banks (58%) are considering the permissioned blockchain/ DLT as a technology for applying the CBDCs, while 31% are considering modernizing their payment systems using traditional data base, and the least percentage (11%) goes for employing the public blockchain.
- As for the adoption of the digital identity and its use with the CBDC system, 69% of respondents have an ID program, among them 44% with the intention to integrate it with the CBDC.
- Regarding the settlement systems currently available in the region, all respondent authorities employ Real Time Growth Settlement System (RTGS) with different preferences of integration with the CBDC system, where 59% may integrate it.
  Meanwhile, more than half of respondents (53%) deploy a Real time Payment (RTP) system, of which 29% don't plan to integrate it with the CBDC system.

Figure no. (12): Having RTGS System and integration with the CBDC

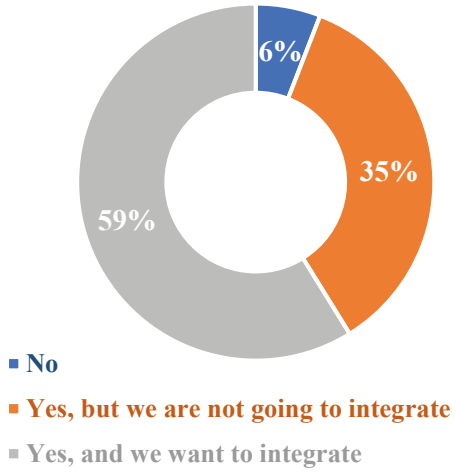
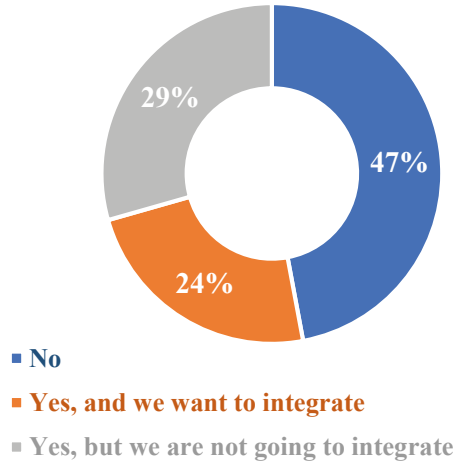


Figure no. (13): Having RTP System and integration with the CBDC



- When Arab central banks and monetary authorities were asked about the sponsorship and operation of the CBDC, 100% reacted that the central bank will sponsor the CBDC initiative while 88% perceived that the central bank will operate the CBDC system; while the two remaining respondent authorities (12%) selected that bank association or the consortium designated by the central bank, or a technology provider designated by the central bank can operate it.
- Moreover, it seems that most of central banks within the region (65%) did not yet get into a dialogue with commercial banks regarding the introduction of CBDC.

○ Criteria for selecting solution providers & system integrators

Although the survey respondents reported that they did not select yet neither the CBDC system provider nor the integrator, Arab authorities gave priorities to some key criteria

when selecting the CBDC's system provider and integrator as illustrated in the figures no. (14 and 15) below:

Figure no. (14): Criteria for selecting system providers

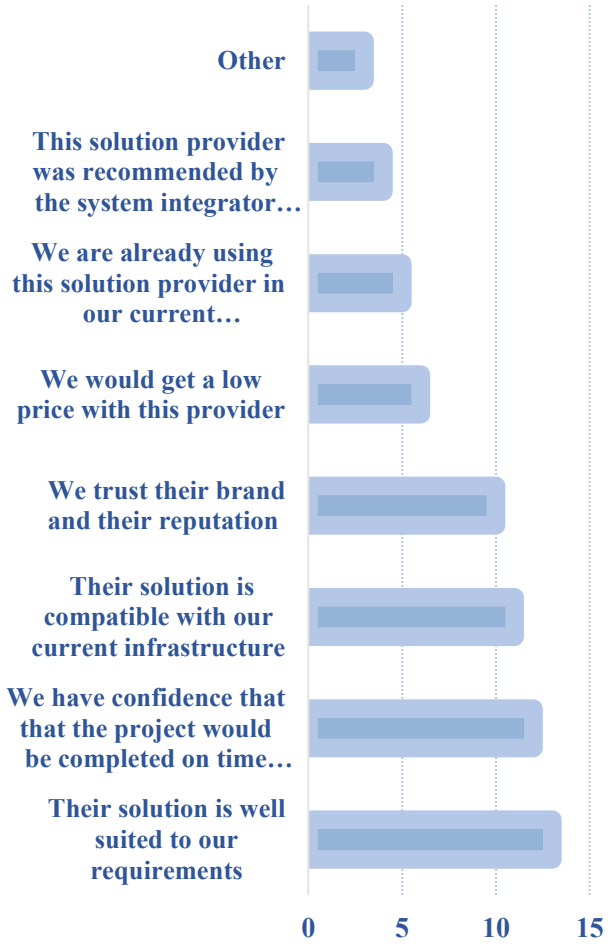
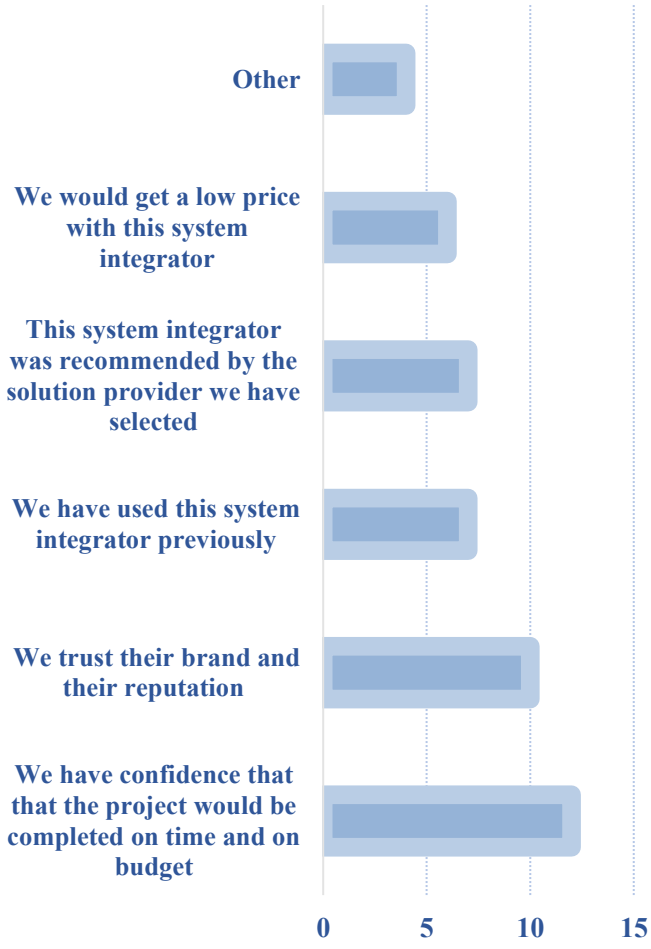


Figure no. (15): Criteria for selecting system integrators



The survey responses indicate that authorities are keen to select system providers who primarily can (i) deliver solutions that suit their requirements, (ii) complete projects on time and within the budget, (iii) provide solutions that are compatible with the current infrastructure. This is in addition to the trust in their brand and reputation.

Regarding the system integrators, responses showed that the criteria of selection focus mainly on (i) time and budget, (ii) trust in system integrator's brand and reputation, (iii) if it has been employed before by the central bank; and then, if the integrator was recommended by the selected solution provider.

THE WAY FORWARD

POLICIES TO MITIGATE RISKS

As many alternatives may exist for the CBDC design, each with their specific opportunities and challenges; many concerns should be addressed to ensure a robust adoption of the CBDC. Some of these remedies are listed below in a generic manner, bearing in mind that the consequences of a CBDC will depend on a number of factors, including but not limited to, the CBDC features, country specific conditions ... etc.

Many CBDCs pilots and experiments are based on **the two tier design for retail CBDC, to mitigate the risk of financial disintermediation** that might occur if commercial banks are not included in the CBDC. In general, the two tiers design implies that the central bank is responsible for the CBDC issuance while banks are engaged with users mainly in direct distribution, payment facilitation, checks of identity and AML/CFT compliance. The two tiers design for retail CBDC involves alternatives that the central bank can choose from to manage users accounts, i.e. whether to manage banks and financial institutions pool of accounts, where the latter can manage their own users' accounts without sharing these details with the central bank; alternatively, the central bank could manage banks' and financial institutions' accounts, and they would manage the users' accounts and periodically inform the central bank of user balance information.

To **control CBDC in circulation**, it may be appropriate to introduce limits on balances and transaction amounts for transfer into accounts/ wallets under various scenarios, which should be examined according to the CBDC design and the specific country circumstances.

The adoption of Digital Identity and its integration with payment schemes enables user verification, authentication, and even facilitates the transfer to wallet accounts/ services while enhancing KYC and AML/CFT checks, which would require a broad coverage of digital identity. This might be coupled with a tiered identity verification system to support all CBDC activities.

Strengthening the cyber security framework is a corner stone in a CBDC system to ensure a stronger protection from cyberattacks, aiming to prevent not only monetary and personal information losses, or suspension of transactions; but also, to maintain the public confidence. This means that the design of the CBDC system has to be secure and robust to sustain sound functioning across the nation.

Balancing between preserving personal data privacy and combating illicit financial activities. Even with anonymous CBDC, namely token based CBDC, transactions can still be tracked. Accordingly, even token-based solutions are not truly anonymous and, in some sense, can provide better protection than cash against risks of money laundering and terrorism financing.

Enhancing the privacy options for end users while ensuring compliance with AML/CFT measures would imply implementing multiple privacy techniques through the DLT platform

and the technological solutions for payment. This would also be coupled with amendments in the legal and regulatory frameworks for personal data protection and AML/ CFT in addition to the use of Regtech/Suptech solutions to trace illegal financial activities and to enhance financial institutions' compliance.

The exclusion risk that can be faced by different categories of the un/underserved people can be mitigated by various majors aiming to **facilitate and accelerate the rate of end user access to financial services at affordable cost of onboarding and transactions,** in particular vulnerable segments including low income people and those in rural areas.

To increase access for unbanked, the central bank might need to broaden the entities allowed to onboard customers and ensure their KYC measures, while supporting banks to do it for those who are not their current clients. Furthermore, enabling convertibility between banknotes and CBDC when paying basic needs to be considered.[58]

This is in addition to the adoption of diverse end-user solutions such as, among others, mobile and web applications, cards, integration of points of sale and points of interaction. This also requires enhancing the financial infrastructure to embrace innovative solutions, platforms and applications while having a wide range of end users connected to digital wallets safely and securely.

All the above-mentioned initiatives and more can be identified in accordance with specific countries' CBDC drivers, design, and architecture, which all can be recognized through experiments. Testing plays a major role in reaching appropriate selection of design and technology options while mitigating the associated risks. Moreover, experimentations would support central banks and monetary authorities to derive pertinent measures to curb perceived issues of concern, and to ensure deep insights on how to conduct the required legal and regulatory amendments.

[58] WBG, 2021. Central Bank Digital Currency: A payment Perspective, November 2021. Finance, Competitiveness & Innovation Global Practice, Payment Systems Development Group.

THE CASE FOR CBDC EXPERIMENTATION

To avoid a poorly designed CBDC, the decision to engage in a CBDC initiative should be based on a deep understanding of its benefits and costs relatively to other alternatives, the associated risks, various design aspects and the related requirements, which all need extensive exploration, which can be done through experimentation first. This will generate an expectation as well about the necessary resources for initiating a CBDC project, in addition to the coordination and the governance of roles and responsibilities with all relevant stakeholders during the design and implementation of the CBDC.

As mentioned above and in light of the AMF survey of Arab central banks and monetary authorities, there appears to be strong interest from many central banks in the Arab region to begin experimenting with CBDCs. 76% of the banks surveyed are considering a proof of concept or phased pilot.

However, as noted earlier, building a CBDC prototype entails significant challenges: cost, engineering resources and time. Projects like the Sand Dollar Project in the Bahamas and e-krona project in Sweden have taken years to complete and costed tens of millions of dollars. Few central banks in the Arab region have these resources or time.

One possible solution to address this would be for the Arab Monetary Fund to create a regional experimentation resource where all member central banks could undertake a CBDC pilot in a quick and affordable manner.

The experimentation resource would ideally have the following characteristics:

Ready Solution: It should be easily configurable to eliminate the need for custom builds. The lab would include command line interface, web interface, mobile app, and APIs. The lab would be hosted in an environment like Amazon Web Services, Google Cloud or Microsoft Azure.

Partitioned: It should be able to be used concurrently by multiple central banks. Each central bank would have their own cloud based CBDC environment, managed by a common operator and operated out of a UAE data center. Each central bank can build an instance based on their goals and preferences, without affecting the ability of another central bank to design something different.

Suitable for Experiments: Most central banks are interested in experimenting first, without the need to implement lengthy legal changes to authorize a full production CBDC.

Configurable and Flexible: Different central banks have different priorities for adopting a CBDC and accordingly have expressed an interest in different types of CBDC: wholesale, retail direct, indirect and hybrid. Any experimental sandbox offered by the AMF must have the flexibility to enable all of these different types of CBDC. Central banks should also be able evaluate different types of CBDC side-by-side.

Easy commercial bank integration. As noted in the AMF survey, few of the central banks have identified a commercial bank to join them in a CBDC pilot. Reluctance on the part of commercial banks is understandable: experimenting could be costly, resource intensive and put the bank's core payment infrastructure at risk. Yet without bank participation, it is not possible to test an indirect or hybrid CBDC. To overcome this, the lab should have APIs which can be integrated to bank infrastructure in an easy and secure fashion.

Path to full production. Almost all of the proof of concept CBDC programs that have been undertaken in Europe and Asia have been run only as experiments, without any path to scaling the pilots to a production system. This accounts, in part, for the lack of projects that have extended beyond initial testing. An ideal experiment platform must be production-ready and offer an easy upgrade path for a central bank to cost effectively transform an initial experiment into a full production CBDC.

Initial tests which could be performed by central banks on their prototype CBDC would include:

Table no. (4): Initial Tests on CBDC Prototypes

Tests	Description
Create & Destroy	
Issue CBDC Destroy CBDC	Create CBDC and distribute to individuals and businesses. Take CBDC out of circulation ("destroy")
Basic payments	
Pay P2P/C2B with CBDC (online) Pay P2P/C2B with CBDC (offline) Request a payment with CBDC	Basic payment operations (send/receive/request) from a payer's and a payee's perspective.
Privacy	
Configure privacy settings	Privacy settings configured by the payment services user
Payments and privacy	Re-run payment test using different privacy settings.
Transaction visibility	
User interface and notifications	Look at available transaction information from the perspective of different personas

Regulator dashboard Commercial bank dashboard	in the ecosystem.
Programmable money	
Payments using contracts	Conditional (if/then) payments programmed using contracts.
Performance	
Throughput Latency Scalability	Test sustained high volume of transactions and measure transaction latency. Increase volume and increase resources to measure scalability.
Resilience	
Component failure(s) System recovery	Test the resilience of the overall system if a certain component/s fail.
Security	
Prevention of double spending and Byzantine Consensus Authentication and public key cryptography Authorization and role-based access control Memory safety and use of RUST Content trust and use of security-focused dev tools and signing solutions Infrastructure testing on cloud (e.g. AWS)	Test various security aspects.

Moreover, it would be ideal if the lab had programmable payment and programmable money functionality which central banks could experiment with.[59]

[59] Gross, Jonas. 2020. Programmable Money and Programmable Payments, September 2020. https://jonasgross.medium.com/programmable-money-and-programmable-payments-c0f06bbcd569

FUNCTIONAL DESIGN FRAMEWORK – OPTIONS OF IMPLEMENTATION

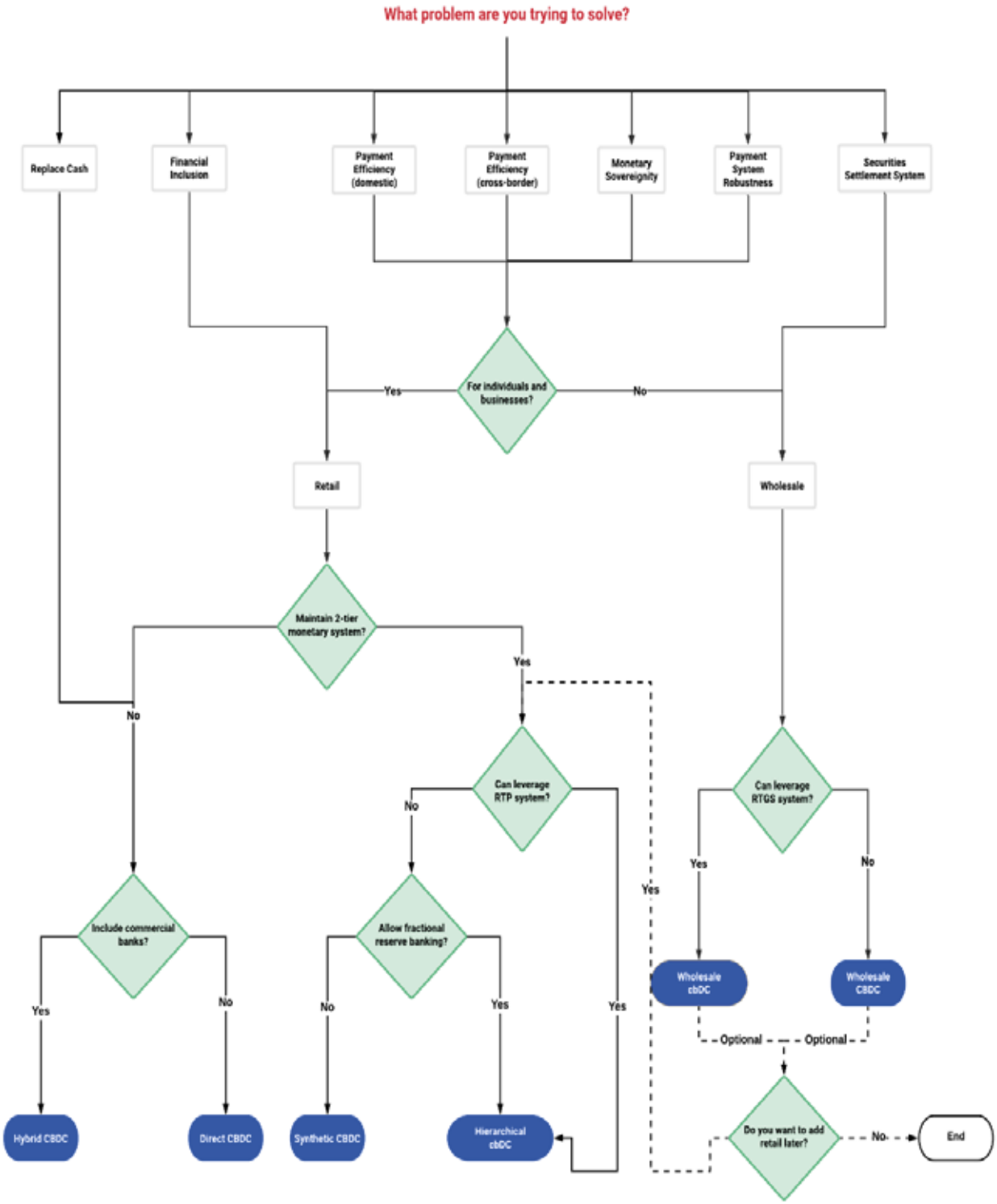
Within an experimentation, what type of CBDC might a central bank wish to test? The diagram below provides an approach to selecting a CBDC or payment modernization type. By starting with the type of problem the central bank is trying to solve, and then answering a series of questions regarding the inclusion of individuals, the preservation of the two-tier monetary system, the participation of commercial banks and the availability of an existing RTP system a final payment scheme is suggested.

One of the key takeaways from the foregoing exercise is that no one form of CBDC is inherently superior to another. Each form has its own advantages and disadvantages. The key is to select the CBDC best suited for the goals and objectives of the central bank and the existing resources and infrastructure in the country.

In some cases, the central bank may have alternative objectives and may wish to test different CBDCs before selecting a CBDC to launch at scale. The Experiment Lab allows a central bank to test different designs side-by-side.

The Experiment Lab also allows for the tokenization of more than just central bank money. Why is this important?

Figure no. (16): Decision Tree for Options of Implementation



Source: M10 Networks, Inc.

Beyond CBDC – the Regulated Network of Liabilities – reframe CBDC in a broader context.

Historically, CBDCs' main focus is primarily on the tokenization of central bank money. But as we noted earlier, commercial bank money, e-money, and regulated stablecoins can also be tokenized on a shared ledger. A network of these regulated liabilities or "Regulated Liabilities Network" or "RLN" has been the subject of much discussion in recent months. Some experts believe that RLNs may replace CBDCs as a design goal of central banks.

The first case for an RLN was introduced in June 2021 paper entitled "The Regulated Internet of Value"[60] (the "Citi paper"), authored by Tony McLaughlin. As described by McLaughlin, "Regulated liabilities would include central bank money, commercial bank money, and electronic money, tokenized using distributed ledger technology and exchangeable on financial networks" (McLaughlin, 2021).

The Citi paper discusses the nature of regulated liabilities and sets forth desirable traits:

- "Regulated liabilities are denominated in national currency units and proceed from the sovereign right of nation-states to decide what counts as money within their territories.
- The end-user has an unambiguous claim on a regulated institution, enforceable through the legal system.
- The claim is redeemable at par value on demand in national currency units.
- Institutions are regulated to ensure that they are able to meet those claims, e.g. capital rules for banks and collateral rules for E-money institutions.
- The liabilities are fungible between regulated institutions, i.e. a dollar is a dollar irrespective of the regulated institution holding the liability.
- Regulated liabilities are in favor of verified legal persons, they are not bearer instruments which helps to combat financial crime.
- Regulated liabilities are on one side of the balance sheet of institutions — on the other side of the balance sheet are assets deployed in an economy to stimulate economic growth."[61]

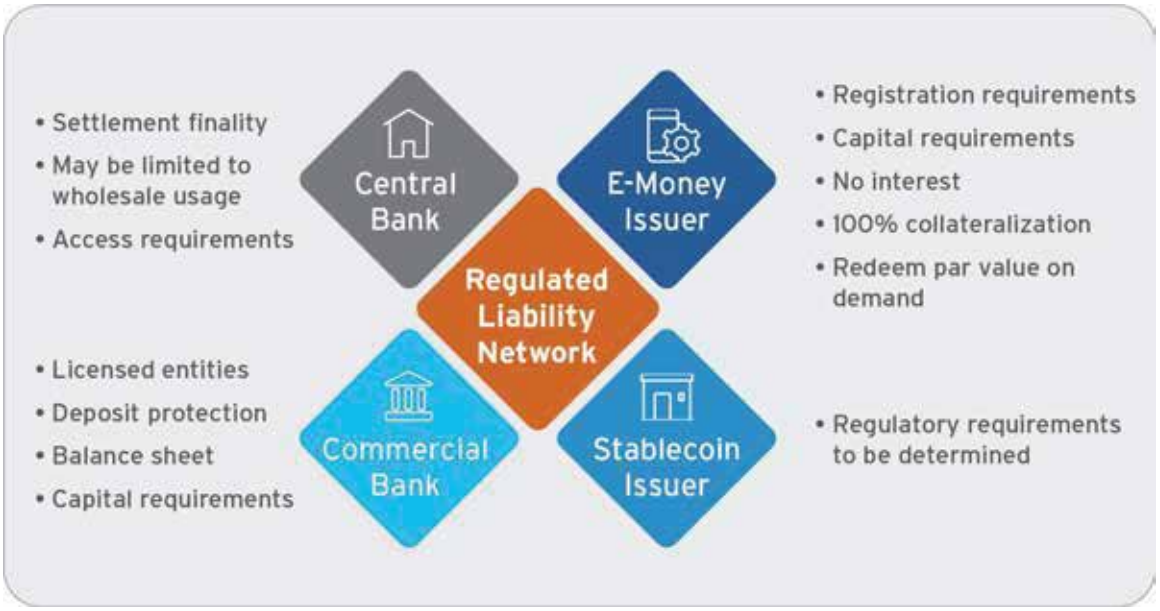
The Citi paper examines how a network would hold liabilities across various regulated entities and concludes:

- A token in a central bank wallet is a liability of the central bank.

[60] McLaughlin, Tony. 2021. The Regulated Internet of Value, June 2021, Citigroup Inc., Treasury and Trade Solutions. https://www.citibank.com/tts/insights/articles/article191.html Citigroup Inc.

[61] McLaughlin, Tony. 2021. The Regulated Internet of Value, June 2021, Citigroup Inc., Treasury and Trade Solutions. https://www.citibank.com/tts/insights/articles/article191.html Citigroup Inc.

- A token in a commercial bank wallet is a liability of the commercial bank.
- A token in an E-money wallet is a liability of the E-money issuer.

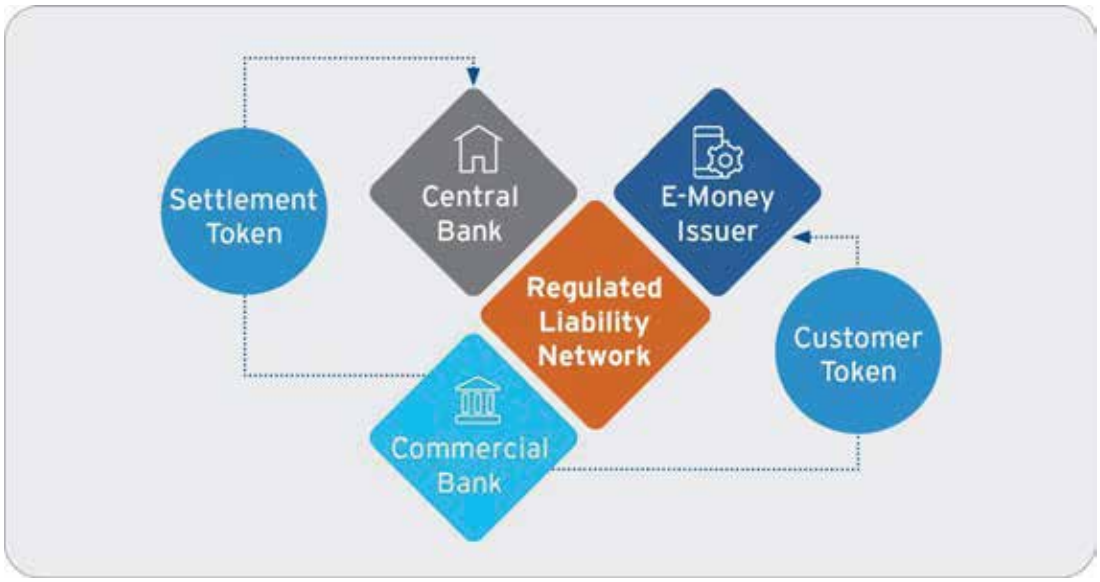


Source: Citibank, 2021.

Moreover, McLaughlin reported in the paper that "the legal meaning of the token is given by its location of the wallet in which it resides. When a token is in a wallet controlled by an institution, then it is on the balance sheet of that institution as a liability in favor of the token holder."[62]

Payments on the RLN are conducted through the transfer of tokens. These are done through entries on a ledger, and not by using bearer instruments.

[62] Ibid.61, p 3



Source: Citibank, 2021.

To achieve a global system, a constellation of interoperable RLNs is envisioned. Each network is "founded on national currencies and supervised by local regulators."[63]

Source: Citibank, 2021.

[63] Ibid 61, p 5.

Finally, the Citi paper calls for a pivot beyond CBDC, making the argument that CBDCs are too limited and that a broader RLN paradigm that tokenizes all regulated liabilities can deliver benefits beyond CBDC.

In a subsequent white paper entitled "Implementing a Regulated Liabilities Network,"[64] intended as a companion to the Citi Paper, M10 Networks outlines **how** an RLN could be built. The paper begins by introducing the concept of a shared hierarchical ledger, which enables both central bank money and commercial bank money to be tokenized. Transactions can settle instantly because banks on the system are transacting using tokenized central bank balances on shared ledgers. The platform supports multiple regulated liabilities. There is one ledger per liability, and banks can have positions on multiple ledgers. The ability for a bank to debit a position on one ledger and credit the balance on a different ledger enables cross-border payments.

Other blockchain providers have also endorsed the idea of an RLN.[65] It has been amplified at recent international conferences and events. [66] [67]

The Citi paper sets up RLN as an alternative to CBDC, or perhaps a more universal solution that includes a CBDC as a component of the larger network. While a hierarchical tokenizing platform can be used for CBDC from the start, an RLN that addresses payment modernization may be a better starting approach. CBDC can easily be added at a later point in time.

Starting with the RLN for payment modernization has a number of benefits:

- **Faster time to market.** The private sector innovates faster than governmental entities. Commercial banks will spend on infrastructure with positive ROI more easily than a central bank which depends on a governmental (and perhaps political) budgeting process.

[64] M10 Network, Inc. "Implementing a Regulated Liabilities Network. July 2021. https://www.dropbox.com/s/24sulnfgrdp0xtt/Implementing%C2%A0a%C2%A0Regulated%20Liabilities%20Network.pdf?dl=0

[65] SETL, 2021. Realizing The Internet of Value - A Multi-Asset Approach to Tokenisation, June 2021, SETL.io. https://setldevelopmentltd.box.com/shared/static/65lw5rki7baxz97fsr0zf58gyu4w1cxb.pdf

[66] Fraser, Jane.2021. Sibos with message of change, Disruption Banking- Citibank, October 2021. https://disruptionbanking.com/2021/10/13/citis-jane-fraser-addresses-sibos-with-message-of-change/

[67] Fintech Futures, 2021. Panel "Sibos 2021: Banks must work together to make the most of CBDCs", October 2021.https://www.fintechfutures.com/2021/10/sibos-2021-banks-must-work-together-to-make-the-most-of-cbdcs-says-panel/

- **The commercial RLN can be implemented without the need for legal changes.** If a CBDC is later desired, the infrastructure is in place (M0 and M1), and the central bank can request the legal changes necessary to enable it to issue central bank digital money on M0.

- **An RLN preserves the two-tier monetary system.** Some types of CBDC, specifically a retail direct CBDC, have the central bank issuing digital currency directly to businesses and consumers, thereby competing with (and potentially marginalizing) the commercial banks. By starting with payment modernization, it is more likely any eventual CBDC will be a hybrid or synthetic CBDC in which the commercial banks continue to maintain their role vis-a-vis businesses and customers.

Conclusion

Drivers for launching CBDC vary globally and across the region according to countries' specific situations. Meanwhile, these motivations are associated with a set of challenges and risks that might hinder a proper adoption of CBDC. Having such risks, various policies and initiatives need to be formulated to address any improper impact that can affect preserving financial stability and soundness of the financial system.

The recent survey by the AMF clearly evidences strong central bank interest in digital currencies. The experimentation provides an accelerated and cost-effective path to allow interested central banks to gain experience and insights without having to take years and allocate large budget to build their own CBDC proof of concept. Moreover, most Arab central banks showed interest in experimenting first, without the need to implement lengthy legal changes to authorize a full production CBDC.

CBDC experiments so far can inspire authorities with diverse policies and procedures to mitigate the risks associated with CBDCs initiatives, which all depend on countries' specific conditions. Test and trials can turn the interest into knowledge and provide authorities with the necessary tools for a path forward based on deep analysis of cost and benefits and in relation to other alternatives.

Furthermore, since an Experiment Lab is capable of tokenizing a variety of regulated liabilities, it can be used by a central bank interested in building a CBDC and/or an RLN.

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