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Navigating Socio Economic and Security Challenges: An exploration of Central Bank Digital Currency (CBDC) Implementation in Pakistan

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ABSTRACT

The State Bank of Pakistan has expressed its intention of launching its own CBDC, in the form of digital Pakistani rupee. However, a robust mechanism and plan is required for the execution of such. Keeping in view these preliminary conditions this paper employs a multidisciplinary approach through incorporating insights from economics, finance, and technology to present a comprehensive analysis of the opportunities and challenges associated with CBDC in the hopes of providing the groundwork for implementing an effective CBDC programme. By evaluating the potential benefits in terms of socio-economic development and security enhancement, this paper aims to provide policymakers, financial institutions, and academics with valuable insights into the implications of adopting CBDC as strategic initiative for the economic and financial future of Pakistan. The study begins by providing a comprehensive overview of the global trends in CBDC adoption and the associated benefits, drawing parallels to the specific socio-economic conditions prevalent in the South Asian context, which should be kept in mind when launching the programme to avoid any potential pitfalls.

For the establishment of an effective CBDC project certain core requirement such as privacy, resilience, universal access and security are mandatory. To do so the paper highlights the basics of a CBDC project, starting with the different models of CBDC's that are being implemented, moving forward preliminary preparations such as considering infrastructural foundation, capacity, design features as well as changes that will be required in the regulations to make the introduction and use of CBDC's possible. Furthermore, the paper examines the potential of CBDC to enhance financial inclusion, reduce transaction costs, and foster economic growth. By leveraging technological advancements, CBDC

implementation has the capacity to provide secure and accessible financial services to the unbanked and underbanked populations, thus contributing to poverty alleviation and inclusive economic development.

Additionally, it is also important to highlight the impact of CBDC's socioeconomically, this paper investigates the pivotal role CBDC can play in addressing security challenges unique to the region. By fostering transparency and traceability in financial transactions, CBDC's can contribute to the reduction of illicit financial activities, money laundering, and corruption. It is also evident that the introduction of CBDC's will also require enhancing cybersecurity measures as well as the existing know your customer, anti-money laundering, and privacy laws to ensure the integrity of digital financial systems against emerging threats. To achieve these global practices as well as the recommendations given by international organisations such as FATF need to be taken into consideration.

Key Words: “Central Bank Digital Currency”, “Decentralized Finance”, “Central Bank, Distributed Ledger Technology”, “Know Your Customer”

Review of International Agenda

Over the past four years, the global interest in Central Bank Digital Currencies (CBDCs) has surged significantly. This is illustrated by the fact that only “35 countries in 2020” explored CBDC's; presently, “130 countries, representing 98% of the global GDP, are actively investigating national digital currencies”. Among them, “64 of the countries are already at an advanced stage of study, involved in the development, piloting, or launching of CBDCs”. According to the “Bank of International Settlements (BIS), up to 15 retail and 9 wholesale CBDCs are predicted to be in circulation by 2030”.

To date, only four jurisdictions have successfully implemented CBDC at an industrial level: the “Central Bank of the Bahamas”, the “Eastern Caribbean Central Bank”, the “Central Bank of Nigeria”, and the “Bank of Jamaica”.

A key driver of successful CBDC projects is establishing effective communication channels with financial market participants. For instance, the Nigerian e-naira project achieved technical success with a sustainable 24/7 mode. However, its user base did not surpass that of the initial wave of newcomers, and the number of connected retail customers remained below 1% of the total active bank accounts. These outcomes underscore the need for a new, coordinated policy involving all stakeholders to overcome low adoption levels, taking into account the population's readiness to embrace digital currencies. In Pakistan, where approximately 36% of the population lacks bank accounts and relies on cash, regulatory measures, such as cash-out limits, must be carefully devised to encourage the use of the Pakistani Rupee (DPR) as a CBDC.











Many pilot CBDC projects are already underway globally, with some having specific relevance to Pakistan, for instance, those of the “Central Banks of China”, “Brazil”, “Russia”, and the “European Union”, which have unique experiences in implementing digital currencies. Successful pilot projects show a

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need for coordination between central banks and market participants. The best solution is considered to be the two-tier CBDC architecture, where payment service providers are involved in direct dissemination along with the relevant services of digital currencies. Moreover, one identified vital success factor is the need for step-by-step implementation of “DPR” that includes outreach and engagement of all stakeholders. This paper attempts to present a comprehensive analysis of the probable challenges that might be associated with the introduction of “DPR” as a CBDC in Pakistan based on international experience and best practices.

	CHINA	BRASIL	ECB	RUSSIA
YEAR OF THE PROJECT LAUNCH	2014	2017	2022	2019
UTILIZED PLATFORM	Celo	Drex (in-house developed)	In-house developed platform	In-house developed platform
KEY DESIGN PARAMETERS	Two-tier model: the People's Bank of China is responsible for the issuance, redemption, and management of the wallet ecosystem.	Two-tier model: the Central Bank of Brazil issues digital currency and provides access to the platform through intermediaries.	Two-tier model: in the European Central Bank's two-tier model, intermediaries (payment service providers) are responsible for the distribution of digital euros. Individuals have access to digital euros through the payment service providers application through the Eurosystem application.	Two-tier model: the Central Bank of Russia is the platform operator and is also responsible for the transaction security. It is possible to access the wallet through any financial organization in which the client is serviced.
NUMBER OF PARTICIPANTS	As of June 2023, more than 20.8 million individual wallets and 3.5 million corporate wallets were created; 70.7 million transactions worth approximately 54.5 billion yuan (≈\$5.4 billion) were conducted. In 2023, citizens and visitors of 43 provinces in China can use digital yuan for everyday transactions.	14 financial institutions were selected for the participation in the pilot project (May 2023).	The ECB works with the European Commission, the European Parliament and Eurozone finance ministers for the digital euro project development. The project participants are still unknown at the current stage.	In August 2023, a pilot project in the friends and family format was launched. 13 banks and 30 merchants from 11 cities were participating.
FEATURES OF THE PROJECT	<ol style="list-style-type: none"> Digital yuan is used for tax payments (Hainan province). Civil servants receive their salaries in digital yuan (Changshu). Pilot projects with SIM-based offline wallets is planned. 	<ol style="list-style-type: none"> The digital currency launch into circulation is planned for end of 2024 At the current stage of the pilot project, the Central Bank of Brasil is testing the confidentiality and programmability features of the platform for the DvP scenario. 	<ol style="list-style-type: none"> From July 2022 to February 2023, the ECB conducted test of the digital euro platform. The test assessed how the digital euro can be integrated into the current European payments landscape. There is an ongoing study of offline transactions. Non-resident access is possible. QR code and NFC payments are being investigated. The decision on the implementation of the digital euro is planned for 2023. 	<ol style="list-style-type: none"> Reduced commission for businesses in case of accepting payment for goods and services in digital rubles (0.3% of the payment amount). A law on the digital ruble has been adopted (Federal Law No. 339-FZ of 24.07.2023). Monthly limits on the transfer of non-cash funds into the digital ruble are implemented. Smart contracts are planned for the launch in 2023. Plans for the project's next stages include offline payments.

BISIH cross-border CBDC projects

	JURA	DUNBAR	MBRIDGE	ICEBREAKER	MARIANA
BISIH CENTERS					
CB					
OUTPUT	Prototype	Prototype	Pilot	PoC	PoC
CBDC TYPE	Wholesale, trading day	Wholesale, O/N w/o interest	Wholesale, Intraday & O/N	Retail	Wholesale
CURRENCIES	EUR, CHF	AUD, MYR, SGD, SAR	HKD, CNY, THB, AED	ILS, NOK, SEK	EUR, SGD, CHF
TRANSACTION TYPE	Real value	Simulated	Real value	Simulated	Simulated
INTEROPERABILITY MODEL	Common platform w subnetworks	Common platform	Common platform	Hub and spoke	Common platform for FX
DISTRIBUTED LEDGER PLATFORM	Corda	Corda, Quorum	mBridge Ledger	Corda, Hyperledger Besu, Ethereum Quorum	Ethereum
OPERATOR	Private	CB	CB	CB	CB
EXTRA USE CASES	PvP, DvP, offshore	PvP, DvP, offshore	PvP	PvPvP	Forex trading, PvP

Source: BIS, "Lessons learnt on CBDCs" report, July 2023

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Comparison of different money types' characteristics

		MONEY ISSUED BY THE CENTRAL BANK		MONEY ON BANK ACCOUNTS	
FORMAT		Cash money	CBDC	Traditional non-cash funds on accounts	Tokenized non-cash money
ISSUER		CB	CB	Account holding bank	Account holding bank
ORGANIZATIONAL AND TECHNICAL CHARACTERISTICS					
MEDIUM		Secure banknote or coin	Digital record or code in the CB's platform	Digital record or code in the bank's database	Digital record or code in the bank's or independent operator's platform
STORAGE		Wallet/safe deposit box	Account	Account	Account
PERSONALIZATION		A bearer type	Personalized	Personalized	Personalized
COMPATIBLE WITH SMART CONTRACTS		—	✓	✓ (depends on platform compatibility)	✓
ECONOMIC CHARACTERISTICS					
MEANS OF PAYMENT	ONLINE	—	✓	✓	✓
	OFFLINE	✓	— (discussion and design are still going on)	—	—
VALUE STABILITY		✓	✓	✓	✓
VALUE MEASURE		✓	✓	✓	✓
MEANS OF SAVING		Non-interest bearing	Non-interest bearing	Can be interest bearing	Can be interest bearing

METHOD NAME	FUNCTIONS AND TASKS
Opening an account of a legal entity on the DT platform	Basic method for opening a digital account on the DT platform
Opening an account of an individual on the DT platform	Basic method for opening a digital account on the DT platform
Conversion of non-cash KZT to the DT at the "bank - CB" level	Method to enable banks to purchase the DTs from the NBK in exchange for non-cash tenge
Conversion of non-cash KZT to the DT at the "legal entity - bank" level	Method to enable legal entities to purchase the DTs from the NBK in exchange for non-cash tenge via banks
Legal entity-to-legal entity payment	Method to conduct payments between legal entities (in particular, merchants and state organizations)
Legal entity-to-individual payment	Method to transfer the DTs from legal entity to individuals (in particular, from state organizations to end users)
Individual-to-individual transfer	Method to transfer the DTs from individual to individual (QR-code and phone/card number)
Payment at merchant	Method to conduct purchase in the DTs by an individual at merchants' point of sales
Conversion of the DT to non-cash KZT to at the "legal entity - bank" level	Method to conduct purchase of non-cash tenge by legal entities from banks in exchange for the DTs
Conversion of the DT to non-cash KZT to at the "individual - bank" level	Method to conduct purchase of non-cash tenge by individuals from banks in exchange for the DTs
Conversion of the DT to non-cash KZT to at the "bank - CB" level	Method to conduct purchase of non-cash tenge by banks from the NBK in exchange for the DTs
Monitoring	Method to monitor the state of platform components (nodes, wallets, etc.) with respect to implemented role model
Receiving balance-related data	Method to obtain information about the balance of nodes and wallets with respect to implemented role model
Receiving notifications	Method to receive notifications with respect to implemented role model

Across the world, multiple countries have recognized the advantages of central bank digital currencies (CBDCs), In particular for retail payments. CBDCs offers a highly liquid, low-risk and universally accessible means of payment, which proves them to be a metamorphic change in the financial realm

In a survey conducted by the “Bank of International Settlements (BIS)”, it is highlighted that “80% of the 86 central banks accept the potential benefit of having fast payment systems and retail CBDC’s”, this dual approach is as a means to provide access to a wider range of financial institutions, providing special benefit to unbanked segments of a country. Particularly, programmability and offline payments appear as special features that traditional fast payment methods do not offer.

In addition, wholesale CBDCs enjoy the advantage of settling cross-border transactions faster, more safely, and on a less expensive basis. The most essential benefits accruing by digital currencies for cross-border payments are as follows:

1. **Process Simplification and Fewer Intermediaries:** The cross-border payment process would be simplified by avoiding too many intermediaries and eliminating specific complex steps.
2. **Improving Overall Efficiency using automation:** Document collection and verification are automated to improve overall efficiency.

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3. Integration Capabilities: Enhance integration capabilities, particularly in the development of CBDC, to ensure seamless integration with existing systems.
4. Technical Compatibility: This technical compatibility will be enhanced for easier interoperability between various financial systems.
5. Information Security: implementation of new mechanisms and standards that will further enhance information security, and sensitive data regarding financial transactions will be secured.
6. Lower Cross-border and Macro-financial Risk: Lower cross-border risks and the overall stabilization of macro-financial systems.

As Pakistan also wants to explore the possibility of “Central Bank Digital Currency” (DPR), knowing such benefits will be very important to make informed decisions. This paper will examine the benefits of retail and wholesale CBDCs, highlighting how these innovative digital currencies can contribute to financial inclusion, efficiency, and safety within the Pakistani economic landscape.

International Review of Retail and Wholesale CBDC Increased Cross Border Payment

The beginning of CBDC projects has been in wholesale CBDC projects. For example, the “Jasper project began in (2016)”, “Ubin in (2016)”, and the “Stella project was launched in (2017)”. These early projects uncovered some potential benefits of wholesale CBDCs regarding cross-border payments.

After these first experiments, most countries turned to research on retail CBDCs to find added value for their users. That said, it is rather tricky to prove how CBDCs would be different where financial infrastructures are already advanced since the existing payment systems are pretty user friendly and accessible. Conversely, wholesale CBDC projects designed for cross-border transactions have revealed significant advantages for digital currencies. A prime example is the collaboration between the “Bank for International Settlements Innovation Hub (BISIH)” and various central banks, which has identified and explored key aspects supporting cross-border and foreign exchange transactions using CBDCs.

Beyond offshore or cross-border payments, completed wholesale CBDC projects have specifically concentrated on use cases involving CBDC transfers either in exchange for other “CBDC (Payment versus Payment, PvP model) or in exchange for tokenized securities (Delivery versus Payment, DvP model)”. While existing systems under the “PvP and DvP” models cater to cross-border transfers, their coverage remains limited, and associated costs are often considered relatively high.

The table below illustrates that these three concluded cross-border CBDC projects share two common features. Firstly, each project established a common

distributed ledger platform, as this approach proved more straightforward and promising than alternatives such as separate national platforms. Secondly, a foundational assumption across the projects was that central banks would make their CBDCs for non-resident financial institutions directly accessible. This direct access facilitates cross-border payments within a single system, eliminating intermediaries like correspondent banks. As Pakistan contemplates the introduction of a Digital Rupee (DPR) and explores the potential of wholesale CBDC, insights from these global projects will be instrumental in shaping a strategic approach towards harnessing the full potential of CBDCs in the country's financial landscape.

International organisations are also investing in the CBDC study. In 2022, a solution for interoperability of CBDC networks was put forward by “SWIFT” utilizing the “BIS-2 model”. To do so a sandbox environment for CBDC was implemented by swift was introduced providing an atmosphere of experimentation and research to 18 banks globally. Numerous technical sessions were held to get useful feedback and provide solutions on the matter. Keeping in view the information, the development of a beta version of “CBDC Connector Gateway” is underway by Swift. After its completion, Swift aims to develop a publicly available product that is offered as an international solution for CBDC transactions by CB.

BIS Innovation Hub rCBDC projects focused on domestic use cases Table 1

	Aurum (HK)	Rosalind (UK)	Polaris (SE)	Selz (HK)	Tourbillon (CH)
Problem statement	How tiered architectures can be used for the distribution of rCBDC (using intermediated CBDC and stablecoins backed by CBDC)	How to use API to distribute and settle rCBDC, to explore interoperability with the broader payment system, and to support innovation	How to implement and operate CBDC platforms that are secure and resilient, offline and online	How to ensure cyber-secure open and accessible rCBDC architecture	How to develop a CBDC that preserves transaction privacy, is resilient to quantum computer attacks and can handle large transaction volumes
Output	Prototype	Prototype	Handbook	Prototype	Prototype
Use cases tested in addition to issuance, redemption and distribution	Transfers payment using e-wallet in mobile phone and QR code	30+ use cases (eg. online, in-store and offline payments, DvP, micropayments parent and child wallet)	Analysis of offline payment considerations, security and resilience framework, cyber threat modelling gaps	Transfers using technical service providers	Withdrawal, PoS payment, payment over the internet, peer to peer payment
Main trade-off identified (to date)	Security vs performance	Privacy vs ecosystem data sharing, API extensibility vs consistency in user experience	Risk managements vs privacy vs user experience	Cyber risk vs distributing responsibility	Cyber security vs scalability
Main lesson learnt (to date)	The intermediated CBDC model, allows for decoupling the wholesale and e-wallet systems which could strengthen cyber resilience	Privacy model for an open API is fundamental and should be decided from the outset	Offline solutions are complex and need to be designed from an early stage, even if not implemented until later	The addition of new types of intermediary can lead to a more robust, distributed and resilient system that eliminates single points of attack	It is challenging to reconcile privacy, scalability and quantum security
Technology used	Hyperledger Fabric	Open API, FAPI, Hyperledger Besu and Fabric	Hardware and software solutions, including tamper-resistant devices	M10 Digital Currency Platform	Blind signature, mixed networks, post-quantum cryptography

Bold font denotes project with a published report. Italic and underline denotes ongoing project. () denotes the BIS/HC Centre leading the respective project.

Integrations with Financial Markets

One of the most noteworthy studies regarding Central Bank Digital Currencies (CBDCs) in recent times is the joint project, "Rosalind," with participation by the “Bank of England” and the “Bank for International Settlements (BIS)”. This pioneering effort pointed toward the possibility of a universal, extensible API in achieving seamless “Central Bank (CB)” and private sector infrastructures interconnection, with a particular focus on further enhancing retail payment functionalities within the CBDC framework.

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The Rosalind Project has proven that an appropriately designed API layer can interface with many different private sector and CB applications. The project has found that many use cases are covered under a single set of simple and standardized API functions. Investigating “33 API functionalities” and more than “30 CBDC retail use cases” revealed the transformative potential of a robust “API infrastructure”.

A well-designed API provides additional value beyond the primary purpose that it serves. Firstly, it would facilitate CBDC retail payments, allowing interoperability with other payment systems that could extend to fast payment systems or global card networks. It also offers the capability of being compatible with various forms of money, including stablecoins and commercial bank money, thus offering a solution able to be used in cases such as online shopping platforms.

Secondly, the API applies universality to different kinds of CB ledgers and third-party applications and systems. This kind of broad interoperability is likely to be critical if, on the one hand, central banks are experimenting with different technologies and designs of ledgers, while, on the other, private sector systems might be based on diverse accounting technologies and systems.

Insights from the Rosalind project will be helpful to Pakistan as it moves forward with introducing the Digital Rupee (DPR) and as we explore options for a potential CBDC. Hence, the Rosalind Project shows the important role an adequately designed API could play in efforts toward CBDC between the private sector and central banks. These findings support the fact that standardization and interoperability are essential for the full potential of CBDCs to be realized in fostering creative solutions in retail payments.

Interoperability with Digital Assets and Decentralised Finance

The international discourse on Central Bank Digital Currencies (CBDCs) is growing by the day, and the “Bank for International Settlements (BIS)” has taken a pioneering step in bringing CBDCs into the DeFi ecosystem. Under the Marianna project, BIS is actively researching how “Automated Market Makers (AMMs)” integration can be carried out with current practices to increase transparency, efficiency, and safety in trading and settlements within the foreign exchange market. It will also enable cross-border payments with the help of the functionalities of AMMs. AMMs which originates from decentralized finance, make it possible to acquire one stablecoin by selling another automatically in a decentralized and automated way through a liquidity pool and an algorithmic protocol that defines the exchange rate. Collaborating institutions include the “Bank of France”, the “Monetary Authority of Singapore”, and the “Swiss National Bank”.

At the same time, spearheading with the tokenization and DeFi protocols space is the “Guardian project” being pioneered by the “Monetary Authority of

Singapore”. The project is using applications in DeFi and looking at converting possibilities of real-world assets into digital tokens without implications for the stability and integrity of the international finance system.

Similarly, China has also shown commitment to advancing to payment systems that are based on digital currency to the “World Economic Forum”. One of the most critical moves is initiating the “Universal Digital Payment Network (UDPN)” to facilitate interoperability between regulated stablecoins and CBDCs (digital assets pegged to stable reserve assets like gold or the US dollar). This will be integrated to lower the cost of digital payments and, therefore, increase the use of digital assets by the bank. Developed by “Red Date Technology”, the tech provider of China’s blockchain-based service network, the UDPN offers a giant leap toward enhancing the functionality of payment systems globally.

As Pakistan continues with its endeavors related to CBDC exploration, international initiatives such as these set new milestones for the evolving integration of CBDCs into the DeFi ecosystem. The conceptions and understanding provided through these projects offers invaluable considerations for the policymakers, central banks, and financial institutions heading forward in order to harness the full potential of CBDCs in a rapidly evolving economic landscape.

Alternative Forms of Tokenized Assets and Currencies

A crucial subject of innovation in developing CBDCs is the exploration for tokenized deposits. For instance, projects like the “Bank for International Settlements (BIS)” “Dynamo Project” or the “Digital Euro Association” are actively working on the tokenization of bank deposits, through which the traditional bank deposits are converted into digital assets using “Distributed Ledger Technology (DLT) platforms”. Mastercard has also plunged into this area, with pilot tests on the tokenized bank deposits to be carried out in the “Multi-Token Network in the United Kingdom”.

These representations work as digital surrogates of existing bank liabilities, and they are safely held in licensed depository institutions and recorded in distributed ledgers. This innovation is such that it allows easy integration within the existing banking system, enabling direct fund transfers between accounts. In comparisons to volatile cryptocurrencies, tokenized non-cash money like stablecoins have specific assets backing their value. Further advantages of tokenized non-cash include lower transaction costs, especially for micro-payments, machine-to-machine transactions, and programmable payments.

Discussion on potential international applications of tokenized non-cash in commercial bank accounts is increasing. Specifically, the “Bank of Russia’s” report mentions such advantages as reducing transaction costs, speeding up and simplifying the process, enabling new products and services within the framework of Web 3.0 and the Internet of Things, opportunities for fund control using smart contracts, ensuring the usual user experience while opening new

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possibilities, creating a safe environment for informed users, and providing technological alternatives to surrogates of money. In addition, non-cash money that is tokenized is viewed as one of the things that could bring about improvement in cross-border payments.

Impact of Tokenized non-cash money can be seen on other things beyond just transactional efficiency, it influences the speed of money circulation, as well as the monetary policy transmission mechanism. The token interoperability and smart contracts offered by different issuers advance the positive externality of this innovation. Only optimal conditions for collaborative market platform architectures such as regulated liability networks or a single national platform designed by regulators, including infrastructures using CBDCs based platforms are considered. As a Digital Rupee (DPR) is under consideration in Pakistan, the global learnings have various important considerations for a CBDC strategy, specially tokenized deposits and non-cash money.

Increase in Efficiency and Innovation

Numerous innovative features of CBDC implementation that allow numerous functionalities are being thoroughly analyzed in the dynamic field of “Central Bank Digital Currency” (CBDC) research.

Some of the pioneering use cases developed within the BIS project Rosalind include the reservation of CBDC for purchases with settlement upon physical delivery, real-time social assistance for electricity bills, earning and saving points with offline transactions for charitable purposes, open banking for CBDC accounts and payments, programmable payments for tasks like settlement of payments post work completion, or refund of the cost of tickets in case of a train delay.

With the move toward smart contracts, cross-border payment projects consider the potential applications. Notable instances in this direction include projects like “Ubin” and “InthanonLionRock”, where smart contracts are put to work for “Payment versus Payment (PvP) transactions”, enhancing efficiency and transparency across borders.

The Digital Real initiative in Brazil inspired by Ethereum, will be put in place a native token in a vast ecosystem so that institutions in the financial sector can tokenize deposits and unlock new functionalities. The President of the Central Bank of Brazil highlighted that a license to deposit tokenization in an intermediary, combined with CBDC, provides programmable money and innovative contract features.

Furthermore, Digital Real is envisioned to enable the Brazilian financial system to leverage applications geared towards the “Internet of Things (IoT)”. The Central Bank of Brazil is actively exploring potential collaborations with prominent public blockchains, including “Ethereum”, “Binance Smart Chain”, “Solana”, “Cardano”, “Tron”, and others.

International research outcomes, including those from the mentioned projects, have played a pivotal role in shaping the study of CBDC implementation in the domestic context. These insights have contributed to key aspects such as engagement with market participants, API development, exploration of offline payment methods, and the delicate balance between ensuring user anonymity and meeting Anti-Money Laundering/Combating the Financing of Terrorism (AML/CFT) requirements. This research collectively underscores the transformative potential of CBDCs and their capacity to revolutionize various aspects of financial transactions on a global scale

Pakistan` CBDC Program

The State Bank of Pakistan has published the SBP Vision 2028 (SBP Strategic Plan 2023-2028) highlighting areas of key importance, one such area being technological innovations where it mentions adapting to changing customer preferences. Indicating towards the emergence of a centralized bank digital currency (CBDC). The Bank is however keen on adopting a slow and steady approach, mainly focusing on learning from the approaches and potential pitfalls identified by other central banks. Moreover, the central bank is looking to launch its pilot program in stages involving a select group of participants before expanding further (COINTELEGRAPH, 2022).

There are no sources in the current document.

Tech Aspect of Pakistan` CBDC program

As mentioned in the examples given earlier the two variants of CBDC's are

1. Wholesale CBDC's, these are primarily designed for financial institutions that have reserve deposits in a central bank
2. Retail CBDC's on the other hand are designed for use by the general public. The two types of retail CBDC's are

The account based CBDC where all the users have an account based on a digital identity system. As a result, the transactions are approved on the basis of user identities.

The token-based system is one where the originator and beneficiary use digital signatures and private and public key pairs for the approval of a transaction. This ensures more privacy as this does not require assessing the user's identity however at the same time this also leads to issues in the traceability of fraudulent transactions and money laundering activities. However,

they can be considered as the exact digital alternative for cash (101 Blockchains, 2021).

System Architecture and Technological Considerations

The main goals behind introducing a CBDC system are privacy, resilience, universal access and security which is why it is imperative for central banks considering engaging in the adoption of CBDC's should see which system architecture best caters to their needs. As a result of which three models have emerged:

A one tier or direct CBDC system, where all the activities are managed by the central bank such as payments, on boarding clients, implementing know your customer as well as providing the day-to-day services. In short, the bank operates the retail ledger, as evident this puts a lot of burden on one party and would as a matter of fact require a huge technical infrastructure to cater to demands. A plus side is that it allows central banks to have complete knowledge of retail account balances, allowing claims with ease as the information needed for verification is readily available. However, it is criticised for marginalizing the private sector, moreover, such a system could lead to inefficiency. It is believed that the central bank's main role is to provide monetary and financial stability while innovation should be left to the private sector.

In a two-tier system the central bank only handles the retail transactions whereas clients on boarding and servicing are handled by the private sector. This would reduce the burden on the system, inculcate efficiency as each party will deal in their own specialized fields as well as better security due to the decentralized nature of record keeping.

In a hybrid CBDC model payments are handled by the private sector such as client onboarding and servicing as well as recording and execution of individual transactions, but as an added layer of security and record keeping the central bank also updates its record of retail transactions. This is useful in situations where the retail payment provider fails to honor the transaction the central bank can step in to ensure the continuity of the transaction (CBDC Architecture, cepr).

The IMF in its "Central Bank Digital Currency" Virtual Handbook has identified five areas every country should explore before initiating the task.

1. Countries should clearly identify policy objectives and relevant success measures for their CBDC project
2. Potential risks should be identified and strategies developed for their containment
3. Domestic authorities should carefully assess the extent of their resources and expertise for testing, regulating, overseeing and the ultimate implementation of CBDC's

4. Communication is key in the entire process of implementation, which requires that a plan of engaging with stakeholders is developed at the earliest
5. A reliable legal and regulatory framework should be developed and put into practice from the beginning.

Policy Management and Decision Making

The most common policy objectives considered by central banks before engaging in the launch of CBDCs can be categorized into: make access to payment systems more accessible to all classes and strata of the economy, to increase competition, productivity and adaptability, to make access to central bank money easier and hassle free, to come at par with international trends and protect monetary sovereignty and for a more financially stable future. In this regard a key task of effective policy governance is to design the CBDC a way that increases to the capacity of the central bank to fulfil its purpose. Where each phase will require making integral decisions and to decide when the process can be shifted from one phase to the next. Moreover, the different technology options available to the central bank are certain key criteria that need to be considered at the outset. Below the policy objectives will be further broken down as provided in the IMF handbook.

Infrastructure Foundations

The first and foremost element to consider when developing the CBDC requires an adequate development of technological infrastructure facilities this includes nonstop access to electricity, internet and mobile networks. Since, this is vital to the completion and effective execution of the plan.

Institutional Capacity

For an effective CBDC project a lot of factors are important to measure primarily the human resource available to the central bank along with the technical skills of the staff engaged to kick off such a hightech project. It should also test the knowledge of its staff that will be responsible for carrying out the project and if gaps are identified then they should be filled with effective training in the area. Moreover, if the state decides on engaging any private sector collaborators, then they should be clear on the role these collaborators will play. In short, the central bank should possess the technological expertise and have access to technological vendors to reduce the operational risks involved.

Cybersecurity Considerations

Before implementing a successful CBDC project it is imperative that a robust cybersecurity system is established because a lack of such can compromise the users' funds, central banks reputation, trust in money and the stability of the

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payment system. This is a very risky area and can severely damage the currencies reputation globally leading to major setbacks.

Methodology for Operation and Distribution of CBDCs

As discussed earlier, the selection of an effective CBDC model is one of the main questions that need to be considered. Although the CBDC is issued by the central bank there are many functions that need to be carried out for its effective use. The central bank should therefore be clear on who will perform those, whether they want to execute the entire task themselves or they have agreed to engage with the private sector for the provision of certain services. On the basis of whatever conclusions are reached by the central bank they should adopt any of the models discussed in the above section of technology interface.

Broadly speaking certain design features have to be taken into consideration to meet specific purposes such as:

- Account and Transaction Limits
- Low Connectivity and Offline use
- Cross Border Functionality
- Privacy and Anonymity

Legal Framework, Regulation, and Oversight

The issuance of CBDC is not achievable without a sound and robust regulatory foundation. This would require the introduction of new laws and amendments to previously existing ones as well. This includes updating the AML/CFT regimes along with improving administrative and regulatory aspects concerning CBDC's. The process would entail drafting new laws and policies in relation to the protection of sensitive data, privacy and technological systems that would be used to maintain and record such data.

Additionally, central bank laws are likely to undergo changes to make the issuance and implementation of CBDC's a possibility which includes the following:

A central role of the the central bank laws is "to issue currency" generally, this would require broadening the role of central banks to issue currency in addition to physical bank notes and coins¹

- This naturally implies extending the role to issue token based CBDC's. As in the case of Bank notes and coins the authority to produce, hold, withdraw, distribute and destroy token based CBDCs
- The authority to open and maintain CBDC accounts for users
- The monopoly to issue for the state. Across a large number of countries there are laws that give central banks the sole right to issue currency which

includes bank notes and coins on behalf of the state. The question is, can such a law be extended to digital currency.

- *Cours forcé*. This concept was developed initially for banknotes, mandating that bank notes should be accepted at their face value, free from the requirement to be converted into gold.
- Its status as a legal tender. Which requires that it must be accepted by the laws of the jurisdiction to extinguish any monetary obligations and should be recognized as a valid mode of payment by courts of law.
- Privileges under private law. States have accepted it as a valid mode of payment by favouring it under private law, this would mainly entail facilitating the circulation of the currency in comparison to other means of payment.
- Protection under criminal law. States also grant protection to the officially mandated mode of payment by initiating criminal charges against those who destroy, damage or counterfeit those instruments. (IMF CBDC, Virtual Handbook, 2023).

Socio Economic Impact of CBDC

Political and Geopolitical Implications

One's interest should be further stimulated when they contemplate the political and geopolitical dimensions of CBDCs. Consider, for instance, the concern regarding privacy in the context of remittances. The distinctive characteristic of cash—in the shape of banknotes and coins—is complete anonymity: it can be used to purchase products and services without revealing one's identity. This is not the case when using mobile payment applications or credit cards; whenever you make a purchase using these methods, you leave a digital footprint. The increasing prevalence of digital payment systems has led to the accumulation of transaction data by private providers, who profit from the information they collect. However, central banks are not profit-oriented; thus, CBDCs may seek to impose restrictions on the exploitation of payment data. It is logical for central banks to aggregate data in order to strengthen the integrity of the monetary and financial system. A reduction in the size of a nation's informal economy and an enhancement in the capacity of central banks to combat money laundering and tax evasion could result from stricter oversight of transaction histories. Furthermore, in the context of monetary policy intervention decision-making, central banks could enhance their monitoring of domestic economic conditions and mitigate the prevailing information asymmetry through improved tracking of payment data (Glynn, 2010).

Although the aforementioned statements are accurate, central banks would also have the capability to obtain and amass data that was previously inaccessible, thus gaining a more comprehensive understanding of users and the capacity for payment transfers. It would permit location surveillance and the

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accumulation of sensitive personal information, in addition to spending habits. In the event that CBDCs are misapplied, they may promote an unparalleled concentration of information within a public institution—whether that institution be the central bank or the government itself, contingent on the nature of its affiliation with the government. The objective is to evaluate potential risks associated with an increase in public visibility within a financial system, which could disrupt the equilibrium of power between governments and citizens, rather than to forecast an Orwellian scenario (Krylov et al., 2018).

Complete anonymity within the framework of CBDC is undesirable, as it may facilitate unauthorised transactions and compromise adherence to regulations pertaining to Anti-Money Laundering (AML) and Know Your Customer (KYC), which are designed to deter financial offences and fraud. Similar to how complete absence of anonymity would result in avoidable peril. Technically, CBDCs could and ought to be structured in a way that governs state oversight while affording users a measure of confidentiality and anonymity. However, the optimal degree of anonymity in a CBDC system, with regard to efficiency and security, is a matter of policy rather than technology. With intention, the underlying infrastructure is determined. Where the boundaries between anonymity and security reside and how to guarantee that those boundaries are respected is therefore the central issue. The European Central Bank (ECB), for instance, has recognized that the payments ecosystem must discover a solution to a matter that affects every citizen: how to enable a degree of privacy in electronic payments while maintaining full compliance with AML/CFT [Combating the Financing of Terrorism] regulations.

The ECB suggests that as a technical remedy, be created for low-value transactions, while standard AML checks are applied to high-value transactions. Monthly vouchers with quantity and time restrictions would be issued to users, irrespective of their account balances. One voucher would be redeemed for each unit of CBDC, and these vouchers would not be transferable to other consumers. A critical inquiry that may arise in this situation, apart from a series of technical aspects requiring enhancement, pertains to the standards by which the ECB would establish the boundaries of anonymity vouchers that are available to users. Once more, this would involve a political as opposed to a technical decision.

Privacy concerns regarding CBDC systems arise due to the restrictions imposed by their domestic market. Foreign governments may have the ability to collect data directly from retail and corporate customers who utilize a CBDC located in another country. This can occur in various scenarios, including initiatives involving cross-border interbank settlements, migrant remittances, tourists, or business travelers. When individuals utilize domestic CBDCs that have distinct confidentiality of client information policies and safeguards, foreign-user data may become susceptible.

[13] An additional perspective can be observed in the increasing apprehensions held by governments and central banks regarding the potential continued decline of currency usage in favor of digital payment systems. As stated earlier, the massive trend of digital transactions may grant private providers a new position of authority in our economy, posing a potential threat to the function of central banks in regulating and issuing currency. When the aforementioned private providers are large technology companies that benefit from strong network effects—that is, when their digital currencies could potentially reach a global scale—these concerns become especially pertinent. In essence, their endeavors could be enhanced by two critical factors that have a substantial impact on money circulation. First, the issuer’s credibility ("Towards “Central Bank Digital Currency”—A Systematic Literature Review." (2020))

.Consumers must have confidence that their digital tokens can be converted into fiat currency at any time, and that the currency’s value is stable and supported by reserves. Furthermore, the level of approval.

Motivating users to embrace a digital currency backed by a corporation with a well-established connection to a substantial consumer base and widespread brand recognition could serve to alleviate concerns regarding the perceived risks associated with its governance. Simultaneously, this alliance could bolster an ecosystem of services and products that are accessible via the digital currency, capitalising on the synergistic effects of the network. These attributes may facilitate the dissemination of knowledge and acceptance, thereby diminishing the typical obstacles to entry associated with conventional currencies.

The potential ramifications of this transition on the existing financial system could be profoundly disruptive. Former Bank of England governor Mark Carney has recognized that the instant these initiatives are introduced, they have the potential to acquire systemic significance. This explains the prompt response from central banks and international regulators towards Facebook’s stable coin project. Concerning the development of globally privately held digital currencies, the Financial Stability Board (FSB) has highlighted a number of issues, including consumer protection, data concentration, the potential impact on monetary policy and financial stability, money laundering and criminal financing, and fair competition. The rapid scalability of global stablecoins might possibly exceed the capabilities of money (currency and bank deposits), thus increasing the reliance of central banks and states on private providers. There is concern that worldwide stablecoins may compromise the independence of national currency. Subsequently, CBDCs might serve as a counterbalance, thereby fortifying the position of central banks and, by extension, the state, within an economy that is increasingly reliant on digital technologies. The primary objective is to provide the general public with a state-backed method of payment while simultaneously safeguarding the stability and robustness of the monetary system (Wang, 2019).

Strategic geopolitical considerations also factor into the formation of domestic CBDCs. The notion that the first mover will likely affect global

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standards in technology confers a competitive edge over rivals around the globe. The digital renminbi trials conducted by China are a source of concern for both the European Union and the United States.

Potentially, China could serve as a paradigm for other nations to emulate. Furthermore, the implementation of a digital iteration may serve as a strategic complement to China's overarching endeavor to promote the internationalisation of the renminbi. It is important to consider that trade across borders and transnational investments necessitate the use of a national currency for mediation in the absence of a global currency (Goldman, 2022).

Furthermore, certain national currencies are utilised disproportionately for this objective. This decision is influenced by both economic and political factors. Economic factors include stability, security, trade, and financial ties with the chosen currency. Political factors include strategic, diplomatic, and military ties. Unsurprisingly, the US dollar serves as the preeminent global currency, providing a potent proxy instrument for the United States to bolster its global influence. To put it simply, since the vast majority of international transactions are conducted in dollars, any nation or private company would have a difficult time conducting international business if the United States, for whatever reason, prohibited dollar transactions. This is one reason why financial sanctions imposed by the United States are so effective.

In addition, the majority of international banking transfers are currently facilitated by Swift, an international system for financial messaging and cross-border payments and the Society for Worldwide Interbank Financial Telecommunication, which Beijing has historically accused of assisting the United States in enhancing the efficacy of its financial secondary sanctions, thereby granting the latter an extraterritorial reach. China could potentially bypass the Swift system and reduce its susceptibility to US sanctions by utilising CBDC, contingent upon a sufficient number of countries accepting international payments denominated in digital renminbi. As an illustration, the Chinese central bank has initiated a venture facilitating cross-border transactions among China, Hong Kong, Thailand, and the United Arab Emirates—in order to accomplish this objective. 84% of Chinese corporations and 61% of foreign corporations believed that the Digital Currency Electronic Payment (DC/EP), the national digital currency of China, would facilitate the internationalisation of the renminbi (Goldman, 2022).

Economic Macro-Environmental Effects of CBDC

In regard to bank deposit funding, CBDCs may intensify competition. The withdrawal of deposits from banks towards the CBDC may result in a reduction of deposit financing accessible to banks, as the CBDC provides a secure repository for value and facilitates efficient transactions. In what ways the CBDC can be considered a viable replacement for deposits will determine the extent of

this effect. Transfers from deposits to CBDCs will also be restricted by limits on individual holdings (IMF).

The proportion of wholesale funding held by banks may rise if CBDCs occur. Banks may opt to provide wholesale financing in lieu of deposits in the event that there is a flow of funds away from CBDCs. Bank profits might be diminished by CBDCs. Profits will decline to the extent that increased costs cannot be fully transferred to higher lending rates, should banks increase deposit interest rates in order to contend with CBDCs or if funding costs escalate due to a transition to wholesale funding (World Bank Group).

Financial inclusion might be enhanced by CBDCs. CBDCs allow for the expansion of access to financial services for the unbanked and the improvement of financial inclusion, despite not being a panacea (Lannquist and Tan 2023). In particular, when banks implement a two-tier distribution system for CBDCs, they have the potential to function as an initial gateway to a digital financial account, facilitating access to credit and the establishment of bank accounts (Tan 2023b). How effectively a CBDC eliminates obstacles to financial inclusion in a particular nation will determine the extent to which its effects are felt.

CBDCs may have the potential to aid in de-dollarization or combat Promoting the adoption of the domestic currency as a more appealing method of payment in dollarized or euroized economies might be the result of implementing a CBDC. A CBDC can specifically shield the local currency from being supplanted in the face of the proliferation of alternative digital currencies denominated in foreign currencies (such as stablecoins). A CBDC would not, however, deal with the underlying factors that influence currency substitution, for instance the credibility of a country's central bank and its monetary policy configuration.

Security Aspect of CBDC

CBDC's are considered to be resistant to illegal activities such as money laundering and terrorist financing. Primarily, because they are designed with characteristics that combat these threats such as giving each user a verified and authenticated unique identity. That combined with a robust digital identity verification and an automated customer due diligence procedure act as a deterrent for bad actors. Owing to the traceability of all transactions it has a higher degree of transparency as compared to the conventional currency.

At the time of designing a "Central Bank Digital Currency" certain technological designs decisions can be imposed to curb any possible threats. This includes imposing restrictions on transaction size or restricting the number of transactions per user. These steps can be taken to control large scale illicit transactional activity. The design features can also be used to enforce compliance with financial legislation. Increasing cooperation between financial institutions by using interoperable record keeping technologies. CBDCs strive to ensure transparent transactions in order to prevent illicit activity, while also making

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steps to strike a balance between the necessity of transparency and the rights and freedoms of individual privacy. An essential obstacle in the design of CBDCs is to ensure the provision of sufficient information for supervision while maintaining privacy without making any compromises. According to an article in the World Economic Forum:

“While the scalability of those solutions remains challenging, blockchain has emerged as the most promising disruptive technology in the fight against corruption... It possesses important features that can help anchor integrity in bureaucracies, by securing identity, tracking funds, registering assets, and procuring contracts.”

Surveillance under CBDCs is premised on the use of algorithmic surveillance technologies. In this regard, ongoing surveillance allows for the capturing of signals of suspicious activity that point to money laundering and terrorist financing or whatever illicit activity. Advanced algorithms ensure that surveillance is effective while efficiently handling large volumes of transactions expeditiously. Most CBDC systems have advanced transaction monitoring with advanced data analytics tools. These tools would analyze the patterns of transactions, detect anomalies, and raise alerts to any potential suspicious activities. Analytics may be based on various factors: transaction size and frequency, geographical origin, and other relevant attributes.

(Allen S and others, ‘Design Choices for “Central Bank Digital Currency”: Policy and Technical Considerations’xiv)

In a financial sense, interoperability in record-keeping pertains to how different systems and institutions can send data back and forth with one another during any sort of transaction. Maintaining this feature is vital to tracking the flow of funds between multiple man-made systems, something traditional banking has faced problems with. Not only is it crucial for detecting and preventing financial crimes, but this additional transparency will support compliance with the relevant national and international regulatory standards. One of the challenges in deploying more sophisticated transaction-monitoring technology is finding a medium between security and privacy. CBDCs aim to achieve this balance by maintaining the surveillance of transactions for possible illicit activities while protecting individual privacy, and conforming to relevant data protection regulation. The “right to be forgotten” as covered under the EU General Data Protection Regulation (GDPR) regulations could also apply by preventing certain specific information from being placed on a blockchain.

Enhanced transaction monitoring in CBDCs also plays a role in promoting financial inclusion. Through the delivery of a controlled and supervised digital currency structure, CBDCs might make empowering banking along with financial solutions more widely distributed to underbanked or unbanked populations who may not own access that has regular bank facilities. Financial crimes are always changing and as a result of this, the tactics used by criminals

are always moving along with them. The adaptive nature of enhanced transaction monitoring systems in CBDCs enables them to evolve with risks and threats as well. (Fanti G and Pocher N, 'Privacy in Cross-Border Digital Currency')xv.

A CBDC system by means of blockchain technology makes it an auditable and irreversible record, which in turn helps to locate any sort of suspicious activity quickly. Blockchain records transactions in such a way that once recorded, it cannot be altered or deleted. Especially true if you are providing digital technology on which every transaction needs to have a reliable, and immutable record of transactions, which is important for auditing and recognising fraudulent activities. Blockchain technology grants transparency in transactions histories. The identities of individual users can be shielded, but the transactions on their own will forever remain viewable in a blockchain transaction log, permitting for identifiable tracing of fund movements. It makes the system more immune to manipulation and fraud.

Money Laundering, Terrorism, Corruption

Central Bank Digital Currencies (CBDC's) are required to adhere to certain regulatory and Anti Money Laundering frameworks. On which guidelines, recommendations and standards are provided by authorities. An organization of utmost importance in this regard is the Financial Action Task Force (FATF), that plays a vital role in establishing guidelines and policies aimed at countering money laundering and terrorism financing.

The 40 recommendations of the FATF formulate an international standard for combating financial crimes, stressing customer due diligence and a risk-based approach to AML/CFT efforts. Although the FATF is not a regulating body, the guidelines have a significant impact on member countries because they advise implementing these recommendations so as not to be blacklisted, which may severely affect their economy. This only underscores the point that the implementation of CBDC systems addresses the issue of the concern for privacy within a legal framework, the anonymizing of data, and possibly delegating administration ledger. These are all aimed at balancing needs for security in adaptation to evolving tactics in financial crimes that maintain transaction integrity as well as ensuring privacy rights.

Implementing the CBDC will bring a unique set of opportunities and challenges for AML/CFT. Therefore, adapting these FATF recommendations to the standards regulating the behavior of the various regulatory bodies would mean implementing these standards on specifically CBDCs. This means considering specific factors of digital currencies like digital identification checks, transaction traceability, and cross-border digital transactions. In this respect, the elaboration and implementation of a regulatory framework about CBDCs by FATF standards are the prerogative of each country. This shall include legislation and rules relating to the issue, supply, and usage of CBDCs, which would guarantee that such digital cash is not put to illegal use. The national supervisory

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authorities also enforce that credit institutions participating in the CBDC systems take the proper steps to implement AML/CFT measures.

Ensuring AML in CBDC operations involves various activities, including customer due diligence, monitoring of transactions, and reporting suspicious activities. These measures are designed to prevent, detect, and report potential money laundering or terrorist financing activities. Effective CBDC, AML/CFT compliance, therefore, requires close collaboration between regulatory bodies and financial institutions to ensure that the guidelines and recommendations are effectively implemented for the CBDC system to be secure and compliant.

Such considerations of AML/CFT measures in implementation have to be harmonized with privacy and data protection laws. Regulatory bodies ensure that such AML/CFT measures within CBDC systems comply with individual rights to privacy, hence balancing security and privacy. It also ensures compliance with AML/CFT regulations and enforces them through regular audits, inspections, and enforcement of these regulations. whenever necessary, imposing of sanctions against those organizations that do not follow these regulations.

One of the crucial roles is the stakeholder's role in incorporating AML compliance in the context of CBDC. This involves a different, but at the same time, combination of the roles and responsibilities of central banks, financial institutions, and technology providers to cater to the various risks involved in transactions carried out on the platform of CBDC. Central banks, as issuers of CBDCs, focus mainly on the design and enforcement of AML regulation in the virtual currency ecosystem. They ought to develop CBDCs intrinsically for the deterrence of money laundering and financing terrorism by setting transaction limits, ensuring traceability, and, most importantly, robust identity verification processes. Central banks also retain the right of oversight and control over the compliance of other participants in the system of CBDC.

Banks and other financial institutions are crucial in AML compliance as they facilitate the transactions through CBDCs. They operate under the guidelines provided by the central bank and other regulatory bodies in AML. It usually involves customer due diligence, monitoring transactions for any suspicious activities, and reporting potentially illegal activities to relevant authorities. Staff awareness of AML procedures and compliance is another area for which financial institutions should ensure that staff members are well acquainted. Companies offering the technological infrastructure for CBDCs have some significant responsibilities as they need to design systems supporting compliance with AML regulations. This would encompass the development of robust and secure platforms that can detect and prevent any kind of fraud and developing identity-verification tools and making sure such a system can support monitoring and reporting requirements as put forth by regulatory bodies. Pavlidis G, 'Financial Action Task Force and the Fight against Money Laundering and the Financing of Terrorism: Quo Vadimusxvii).

Stakeholders would also have to work together across different systems and institutions to ensure that the interoperability of these systems and institutions is possible so that it can implement its mission correctly and report suspicious activities across the financial system. They should be looking ahead and responding to new threats as they become manifest in the economic landscape. It also involves continuous research and development with an adaptation of AML strategies and tools to mitigate emerging approaches used in money laundering and terrorist financing. The cross-boundary applicability of CBDCs requires the cooperation of the central banks and bodies that regulate the financial institutions within their respective jurisdictions.

Utilizing technology, with the help of Artificial Intelligence (AI) and Machine Learning (ML) in the CBDC platforms, brings about massive improvements in AML. These advanced technologies enhance the capability to detect risks, monitor real-time transactions, and identify suspicious activities. AI and ML algorithms are quite helpful in picking up complex patterns in data that might indicate money laundering activities. With the ability to scan vast volumes of transaction records, these algorithms are able to recognize anomalies that deviate from normal behavior in terms of transaction size, frequency, or patterning within history, which is characteristic of criminal activities (Deep Learning and Explainable Artificial Intelligence Techniques Applied for Detecting Money Laundering^{xviii})

AI and ML are excellent technologies for the dynamic scoring of transactions and entities in terms of risk. This technique continuously measures the potential risk for updated transactions by new emerging patterns of behavior. Hence, financial institutions can focus more on the investigative resources concentrated on the highest risk activities for inquiry. All this ensures that AI and ML can process and analyze transactions simultaneously. This is an improvement over anything that manual or batch processing can provide. This real-time capability thus allows for immediate action on suspicious activity that are flagged as they occur. ('Distributed Ledger Technologies between Anonymity and Transparency: AML/CFT Regulation of Cryptocurrency Ecosystems in the EU')^{xix}.

One of the main drawbacks of conventional legacy AML systems is that there is a high rate of false positives, which unnecessarily burden financial

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institutions with investigations. AI and ML algorithms further increase the precision of the transaction monitoring systems by reducing false positives in numbers, allowing financial institutions to give genuine suspected activities more attention. ML algorithms can learn and adapt over time. They become more intelligent in finding suspicious activity with the exposure of data and feedback from past flagged transactions investigations thereby ensuring that these AML systems also continually evolve to keep up with suspicious activity. AI and ML can be used for analyzing transaction data across multiple institutions and platforms in a secure, privacy-preserving manner. Such cross-institutional analysis might reveal complex money laundering flows across different financial systems. AI and ML can help central banks and financial institutions remain compliant with international AML norms through automatic adaptive capability toward any change in regulation and upgrading compliance processes accordingly. (Pocher N and Veneris A, 'Privacy and Transparency in Cbdc: A Regulation-by-Design Aml/Cft Scheme' (2021)).xx

Conclusion

In conclusion, the development and implementation of central bank digital currencies (CBDCs) represent a marked advance toward the internationalization of financial systems. undefined emphasized by the investigation of new characteristics and the careful analysis of multiple dimensions of policies and technology

The quest to simultaneously attain privacy, financial health and security in the development of CBDCs has led to the exploration of privacy-preserving technologies, including blind signatures, and the extensive trade-off analysis carried out through initiatives such as the Tourbillon project, conducted by the Bank for International Settlements (BIS). Similarly, the projects such as the Digital Real, Rosalind, Ubin, and Inthanon-LionRock are evidence of the numerous advantages and uses that CBDCs facilitate. They include enabling of

programmable payments, and enhancing of accessible financial integration, the promotion of its inclusion, and the improvement of transparency and effectiveness of international purchases.

Countries like Pakistan are therefore treading carefully in the shift towards the adoption of CBDCs focusing on such factors as regulations, institutions, security, and technology.

Necessary critical steps towards successful CBDC implementations include identifying relevant operational models, assessing design features, and developing robust legal and regulatory frameworks.

Moreover, there is a need to evaluate the social and economic implications that may arise from the issuance of CBDCs since they may encourage availability of financial services, enhance the intensity and effectiveness of payments systems, protect currency sovereignty, and can play their part in the stabilization and expansion of the economy.

Given that the research on CBDCs is still ongoing at the global level, it is important for stakeholders such as central banks, policymakers, IT specialists, and other related stakeholders, combine efforts to optimize taking full advantage of this emerging technology. Such attempts should also include the clarification of concerns about privacy, security, and regulatory compliance.

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