



BANK OF THAILAND

The Way Forward

for Retail Central Bank Digital Currency in Thailand



April 2021

Table of Content

Foreword.....	3
Executive Summary.....	4
บทสรุปผู้บริหาร.....	6
1 Introduction.....	8
1.1 Thailand’s Rapidly Changing Financial Landscape.....	8
1.2 Motivation for Retail CBDC Exploration in Thailand.....	11
2 Our Framework Approach.....	13
3 Stakeholder Engagement.....	15
3.1 Design Thinking Workshop.....	15
3.2 Policy Forum.....	15
3.3 Industry Interviews.....	16
4 Cost-Benefit Analysis of Opportunities, Risks and Challenges.....	17
4.1 CBDC Opportunities Analysis.....	18
4.2 CBDC Risks and Challenges Analysis.....	20
4.3 Cost-Benefit Analysis Conclusion.....	21
5 CBDC Design Considerations.....	23
5.1 CBDC Design Principles by Key Stakeholders.....	23
5.2 CBDC Design Considerations.....	24
6 Capacities and Preparation for Retail CBDC Issuance.....	31
6.1 User Accessibility.....	31
6.2 Digital Infrastructure.....	33
6.3 Legal and Regulatory Frameworks.....	34
7 The Way Forward.....	35
Appendix 1 CBDC Projects in Other Countries.....	36
Appendix 2 Cost-Benefit Analysis of All Opportunities, Risks and Challenges.....	37
Appendix 3 Assessment of All CBDC Design Considerations.....	47
Glossary.....	53
Acknowledgements.....	54
References.....	56

Foreword

Technology presents opportunities for addressing long-standing pain points in the financial system, particularly in terms of efficiency, equitable access and inclusion. The Bank of Thailand (BOT) wishes to explore how emerging technologies can be used to better serve stakeholders, while providing the trust and protection of the central bank. In this regard, the BOT has actively conducted hands-on research and development to better understand the technologies available and, more importantly, the implications of employing them in the future financial landscape.

Beginning with Project Inthanon, conducted during 2018-2020 in collaboration with leading financial institutions, the BOT created a proof-of-concept wholesale Central Bank Digital Currency (CBDC) prototype using distributed ledger technology in different use cases, ranging from enabling automated regulatory compliance processes to tackling high fees in cross-border payments. In late 2020, our CBDC work was extended to the corporate level to explore how CBDC can be used for innovative business applications, such as invoice financing and conditional payments.

In the years since we began this journey, we have seen remarkable developments that are transforming the way consumers and businesses transact with one another. The declining usage of cash coupled with the emergence of private digital currencies has awakened central banks to consider retail CBDC issuance in their respective countries. In anticipation that digital currencies will play a greater role in Thailand's future financial landscape, we now expand our attention to a retail CBDC for the general public.

We believe that a retail CBDC would provide a valuable option for citizens to benefit from a digital currency that is accessible, reliable and safe. It would also lay the groundwork for a safe payment infrastructure, building the foundation for interoperability and collaboration with the private sector to drive financial innovation. The new opportunities brought forth by CBDC also come with risks and challenges. As a result, our exploration of retail CBDC must take into account policy implications, design decisions and risk mitigation measures as we move forward.

As a central bank, we cannot pioneer this movement alone. This paper lays out our approach in considering retail CBDC issuance and what lies ahead. We hope it will be a useful reference for fostering further dialogue and public-private collaboration.



Sethaput Suthiwartnarueput

Governor

April 2021

Executive Summary

Since 2018, the Bank of Thailand (BOT) has been continuously engaged in work on Central Bank Digital Currencies (CBDC), beginning with the exploration of wholesale CBDC through Project Inthanon. In the years since, technological developments have begun to transform the way consumers and businesses transact with one another. We have witnessed a global rise in digital currencies issued by private firms wanting to provide faster, cheaper and more efficient means of payments to consumers. While offering improved user experiences, the potential widespread adoption of these privately-issued digital currencies could pose risks not only to users, but also to the stability of the monetary, financial and payment systems.

As such, it is important for the BOT to prepare for a future financial landscape in which digital currencies could play a greater role. A retail CBDC could serve as a trusted and safe means of payment accessible by Thai households and business alike, existing alongside cash and other payment instruments. As a reliable payment infrastructure, it could help safeguard the stability of the Thai financial and monetary system in the new financial landscape.

This preliminary paper intends to lay out our approach to retail CBDC, which has so far involved studies of policy implications, stakeholder engagement and experimentation with private sector partners. The key findings from this paper can be summarized as follows:

- Our key motivation in exploring a retail CBDC rests on the assumption that privately-issued digital currencies could become widely adopted and systemically important in Thailand. If such a scenario occurs, users may be at risk and the nation's financial and monetary stability as well as the integrity and safety of payment systems could be challenged.
- Through a cost-benefit analysis, we assess how retail CBDC issuance could be opportune. We conclude that the most promising benefits of CBDC for Thailand are: 1) to become a digital form of central bank money that is safe, reliable and accessible by the public, and 2) to serve as an open digital payment infrastructure that supports inclusion and financial innovation in the digital era.
- However, the issuance of CBDC would also pose risks. We identify three primary concerns associated with retail CBDC: 1) disintermediation of financial intermediaries, 2) exacerbation of bank runs especially in times of financial crises, and 3) maintenance of high security standards and public trust in the CBDC system. Nevertheless, these concerns can be mitigated through the design of the CBDC itself and other measures.
- We conduct an initial design assessment, based on our cost-benefit analysis. Some preliminary design suggestions are as follows:
 - We hypothesize that a two-tier distribution model is preferable for a Thai Baht retail CBDC, as it preserves the role of financial intermediaries and payment service providers, while utilizing their existing resources.
 - To mitigate bank runs during times of crises, the CBDC could be initially designed as non-interest bearing akin to cash, with specified limits for holding, transacting and conversion.

- We should aim to harness the strengths of both centralized and decentralized technologies. While centralized technology offers advantages in terms of scalability and performance, decentralized technology offers greater resiliency and its cryptographic techniques can help enhance security.
- End-users should bear zero-to-minimal transaction costs when transacting with CBDC, and the CBDC system should be open to private sector programmability to drive financial innovation.
- Lastly, we identify three main capacities which would be crucial for successful CBDC implementation, namely 1) user accessibility, 2) digital infrastructure, and 3) legal and regulatory frameworks. Collaborative preparation efforts with relevant agencies on building capacities across these three areas will be of utmost importance going forward.

Based on our analysis, we conclude that it is critical for the BOT to prioritize capacity building and take the necessary preparations for retail CBDC issuance. Even though there is no immediate need to issue a retail CBDC to the general public under current conditions, the issuance of CBDC may be appropriate if privately-issued digital currencies become widely adopted and systematically important in the near future. Thus, in 2021-2022, we intend to focus our efforts on the research and development of a retail CBDC while closely monitoring business adoption, consumer trends and technology advancements.

Our paper is intended to foster further dialogue on the evaluation and design of retail CBDC. As CBDC issuance would entail far-reaching implications to all sectors, we wish to continue our engagement with relevant stakeholders on this matter. The decision of whether to issue a retail CBDC would not rest solely on the central bank. It would require full support from the government, other regulatory agencies and the general public.

We have outlined some questions for collecting feedback throughout this paper. We welcome all insights and ideas from financial institutions, payment service providers, technology companies, academics, regulatory bodies and the general public. Please send us your thoughts via this [feedback form link](#), the QR code below, or via email to DigitalCurrencyTeam@bot.or.th by 15 June 2021 and clearly indicate your name, organization/profession and contact details so that we can contact you for further discussion.



Please scan this QR code to access our feedback form.

บทสรุปผู้บริหาร

ตั้งแต่ปี 2561 ธนาคารแห่งประเทศไทย (สปท.) ได้ดำเนินการศึกษา พัฒนา และทดสอบสกุลเงินดิจิทัลที่ออกโดยธนาคารกลาง (Central Bank Digital Currency: CBDC) มาอย่างต่อเนื่อง โดยเริ่มจากการพัฒนา CBDC ในระดับสถาบันการเงิน (Wholesale CBDC) เพื่อเพิ่มประสิทธิภาพในการชำระระหว่างกลุ่มธนาคารพาณิชย์ ภายใต้ชื่อ “โครงการอินทนนท์” ทั้งนี้ พัฒนาการทางเทคโนโลยีที่เกิดขึ้นอย่างรวดเร็วทำให้เกิดการเปลี่ยนแปลงรูปแบบการทำธุรกิจและธุรกรรมทางการเงิน ดังเห็นได้จากการที่ภาคเอกชนหลายแห่งทั่วโลกมีการออกสกุลเงินดิจิทัลของตนเอง (Private Digital Currency) เพื่อให้บริการชำระที่รวดเร็วขึ้นและด้วยต้นทุนที่ลดลง อย่างไรก็ตาม ปัจจุบัน Private Digital Currency อาจยังไม่มีคุณสมบัติที่เหมาะสมในการเป็นสื่อกลางการชำระ ดังนั้น หากประชาชนนำสกุลเงินดิจิทัลดังกล่าวมาใช้อย่างแพร่หลาย อาจก่อให้เกิดผลกระทบและความเสี่ยงในด้านต่าง ๆ โดยเฉพาะความเสี่ยงต่อผู้ใช้ รวมถึงผลกระทบต่อเสถียรภาพทางการเงิน ระบบการเงินและระบบการชำระเงิน

ด้วยเหตุนี้ สปท. จำเป็นต้องเตรียมความพร้อมเพื่อรองรับการเปลี่ยนแปลงของภูมิทัศน์ทางการเงิน (Financial landscape) สู่โลกอนาคตที่สกุลเงินดิจิทัลจะเข้ามามีบทบาทมากขึ้น ทั้งนี้ การพัฒนาสกุลเงินดิจิทัลที่ออกโดยธนาคารกลางสำหรับภาคประชาชน (Retail CBDC) จะเป็นสื่อกลางการชำระเงินทางเลือกหนึ่งที่สามารถใช้ควบคู่กับเงินสดและช่องทางการชำระเงินอื่น ๆ และสร้างความมั่นใจและความปลอดภัยให้แก่ประชาชน อีกทั้ง สปท. สามารถทำหน้าที่รักษาเสถียรภาพของระบบการเงินได้ภายใต้ภูมิทัศน์ทางการเงินที่เปลี่ยนแปลงไป

รายงานฉบับนี้มีวัตถุประสงค์เพื่อสื่อสารแนวทางการเตรียมความพร้อมของ สปท. ในการพัฒนา Retail CBDC ซึ่งที่ผ่านมา สปท. ได้ศึกษาผลกระทบเชิงนโยบายจากการออกใช้ Retail CBDC พร้อมทั้งรับฟังความคิดเห็นจากผู้เกี่ยวข้องในเบื้องต้น รวมถึงได้ทดสอบระบบต้นแบบร่วมกับภาคเอกชน โดยมีข้อสรุป ดังนี้

- สาเหตุหลักที่ สปท. เริ่มศึกษา Retail CBDC เนื่องจาก Private Digital Currency อาจมีแนวโน้มถูกใช้อย่างแพร่หลาย จนอาจก่อให้เกิดความเสี่ยงต่อผู้ใช้งาน รวมถึงผลกระทบเชิงระบบต่อเสถียรภาพทางการเงิน ระบบการเงิน ตลอดจนความมั่นคงและความปลอดภัยของระบบการชำระเงิน
- ผลการวิเคราะห์ต้นทุนเทียบกับประโยชน์ (Cost-Benefit Analysis) พบว่า การออก Retail CBDC สามารถสร้างประโยชน์ต่อประเทศไทยในหลายด้าน โดยมี 2 ข้อหลัก ได้แก่ 1) ทำให้ประชาชนสามารถเข้าถึงเงินบาทในรูปแบบดิจิทัลที่ออกโดยธนาคารกลางซึ่งมีความเชื่อมั่นและความปลอดภัยสูง และ 2) เป็นโครงสร้างพื้นฐานการชำระเงินดิจิทัลที่เข้าถึงง่ายและสนับสนุนการพัฒนานวัตกรรมทางการเงินในยุคดิจิทัล
- อย่างไรก็ตาม การออก Retail CBDC อาจก่อให้เกิดความเสี่ยงในด้านต่าง ๆ โดยเฉพาะ 1) ผลกระทบต่อบทบาทของธนาคารพาณิชย์ในการทำหน้าที่เป็นตัวกลางทางการเงิน 2) ความเปราะบางของระบบการเงินที่อาจเพิ่มขึ้นจากการไถ่ถอนเงินที่ทำได้อย่างรวดเร็วขึ้นในยามวิกฤติการเงิน และ 3) ความท้าทายในการสร้างและดูแลระบบ Retail CBDC ให้มีความปลอดภัยสูงและสามารถสร้างความเชื่อมั่นให้กับภาคประชาชนได้ โดยความเสี่ยงดังกล่าวสามารถจำกัดได้โดยการออกแบบลักษณะ CBDC หรือใช้มาตรการอื่น ๆ
- จากการประเมินการออกแบบ Retail CBDC เบื้องต้น สรุปได้ ดังนี้
 - การกระจาย Retail CBDC ให้แก่ประชาชน โดยการอาศัยธนาคารพาณิชย์หรือผู้ให้บริการทางการเงินเป็นตัวกลาง (Two-tier distribution) คาดว่าเป็นที่รูปแบบที่เหมาะสมกับบริบทของไทย เนื่องจากยังคงบทบาทตัวกลางทางการเงินของธนาคารพาณิชย์หรือผู้ให้บริการทางการเงินในปัจจุบัน

- คาดว่า Retail CBDC จะไม่มีการจ่ายดอกเบี้ยเหมือนเงินสด ขณะที่อาจมีการจำกัดปริมาณการถือครองหรือการไต่ถอน เพื่อป้องกันการไต่ถอนเงินอย่างรวดเร็วโดยเฉพาะในยามวิกฤตฉุกเฉินกระทบต่อเสถียรภาพระบบสถาบันการเงิน
- สำหรับทางเลือกเทคโนโลยีเพื่อรองรับระบบ Retail CBDC ควรใช้ประโยชน์ข้อดีของเทคโนโลยีทั้งแบบรวมศูนย์ (Centralized) และกระจายศูนย์ (Decentralized) โดยข้อดีหลักของเทคโนโลยีแบบ Centralized คือ สามารถประมวลผลธุรกรรมปริมาณมากได้อย่างรวดเร็ว ในขณะที่ เทคโนโลยีแบบ Decentralized สามารถเพิ่มความเสถียรให้กับระบบ Retail CBDC และเทคนิคการเข้ารหัส (Cryptographic techniques) ยังเพิ่มความปลอดภัยให้แก่ระบบอีกด้วย
- สำหรับประชาชนผู้ใช้ Retail CBDC ในการทำธุรกรรมชำระเงิน ไม่ควรมีภาระต้นทุนค่าธรรมเนียม (Zero-to-minimal transaction costs) รวมถึงทุกภาคส่วนควรสามารถเข้าถึงระบบ Retail CBDC เพื่อสร้างสรรคนวัตกรรมและต่อยอดธุรกิจทางการเงินได้
- ท้ายที่สุด หากมีความจำเป็นในการออก Retail CBDC เพื่อใช้จริง จำเป็นต้องเตรียมความพร้อมใน 3 ด้านสำคัญ ได้แก่ 1) ความสามารถในการเข้าถึง CBDC ของภาคประชาชน 2) โครงสร้างพื้นฐานดิจิทัล และ 3) กฎหมายและการกำกับดูแลที่เกี่ยวข้อง ดังนั้น ความร่วมมือระหว่างหน่วยงานและภาคส่วนที่เกี่ยวข้องจึงมีความจำเป็นอย่างยิ่งเพื่อพัฒนาศักยภาพและเตรียมความพร้อมรองรับการออก Retail CBDC ในอนาคต

โดย สปท. เห็นถึงความสำคัญในการพัฒนาศักยภาพและเตรียมพร้อมสำหรับการออก Retail CBDC เพื่อสอดคล้องกับภูมิทัศน์ทางการเงินที่เปลี่ยนแปลงอย่างรวดเร็ว อย่างไรก็ตาม แม้ว่าจะในปัจจุบันอาจยังไม่เห็นถึงความจำเป็นในการออก Retail CBDC ให้แก่สาธารณชนในทันที แต่หากประชาชนมีการนำ Private Digital Currency มาใช้อย่างแพร่หลายอย่างมีนัยสำคัญ การออก Retail CBDC อาจเป็นทางเลือกนโยบายที่เหมาะสม โดยในปี 2564-2565 สปท. จะมุ่งศึกษาและพัฒนา Retail CBDC ควบคู่กับการติดตามพัฒนาการของสกุลเงินดิจิทัลและเทคโนโลยีต่าง ๆ

รายงานฉบับนี้ มีวัตถุประสงค์เพื่อจุดประกายให้เกิดการแลกเปลี่ยนความคิดเห็นและความร่วมมือจากทุกภาคส่วน โดยเฉพาะในประเด็นผลกระทบและการออกแบบ Retail CBDC ที่เหมาะสม ทั้งนี้ การตัดสินใจออก Retail CBDC เพื่อใช้ในภาคประชาชนจริง จะไม่ได้ขึ้นกับ สปท. เพียงองค์กรเดียว หากต้องได้รับการสนับสนุนจากภาครัฐ หน่วยงานกำกับดูแลอื่น ๆ รวมถึงภาคประชาชนและธุรกิจ

สปท. จึงเปิดรับฟังความเห็นโดยเฉพาะประเด็นคำถามในแต่ละบทของรายงานนี้ โดยสามารถส่งความคิดเห็นผ่าน [ลิงค์แบบสอบถาม](#) หรือ QR code ด้านล่าง หรืออีเมล DigitalCurrencyTeam@bot.or.th ภายในวันที่ 15 มิถุนายน 2564 พร้อมระบุ ชื่อ-นามสกุล หน่วยงาน/อาชีพ และรายละเอียดเพื่อให้ทีมงานสามารถติดต่อกลับเพื่อสอบถามข้อมูลเพิ่มเติม



โปรดสแกน QR code เพื่อกรอกแบบสอบถามความคิดเห็นของท่าน

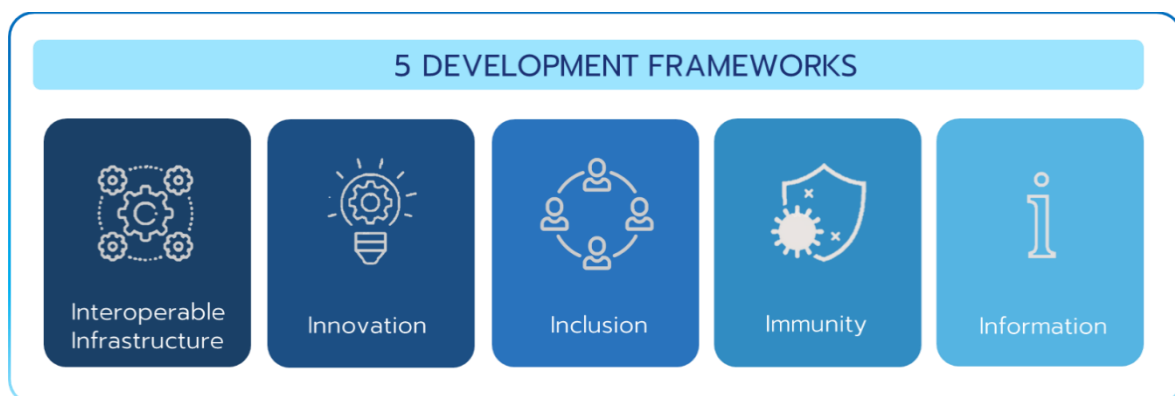
1 | Introduction

1.1 Thailand's Rapidly Changing Financial Landscape

The nature of how payments are made is ever-changing. For many Thais, faster and more efficient payments have become a way of life. From transferring money to friends via PromptPay¹, to donating money to charities via e-Donation services, to scanning QR codes at street vendors to purchase lunch, Thais are making strides towards a digital economy.

The Bank of Thailand (BOT) has quickly adapted to this rapid uptake in digital payments. Our Payments Roadmap No. 4 (2019-2021) is currently underway, emphasizing the development of essential infrastructures and an ecosystem that meets the digital needs of users, while facilitating innovation and supporting competition. The Roadmap promotes usage of digital payments throughout the country, through implementation of various initiatives under five development frameworks (Figure 1): 1) interoperable infrastructure, 2) innovation, 3) inclusion, 4) immunity and 5) information. As of 2020, the average Thai now makes approximately 194 e-payment transactions per year, a 117% increase from 89 transactions in 2018². The volume of transactions per day conducted via PromptPay alone has grown 121% since 2019.

Figure 1: Development frameworks under Thailand's Payments Roadmap No. 4 (2019-2021)



Among the many emerging technologies behind digital adoption, distributed ledger technology (DLT) has been a prominent game changer. It has the capabilities to create trust and enhance the efficiency of payment systems, by eliminating the need for intermediaries to process, validate or authenticate financial transactions. The first significant adoption of DLT was for providing the foundation for Bitcoin and other cryptocurrencies. Due to its openness and decentralized nature, DLT has been quickly adopted by private developers and established institutions alike, creating an exponential rise in many other digital currencies with various functionalities.

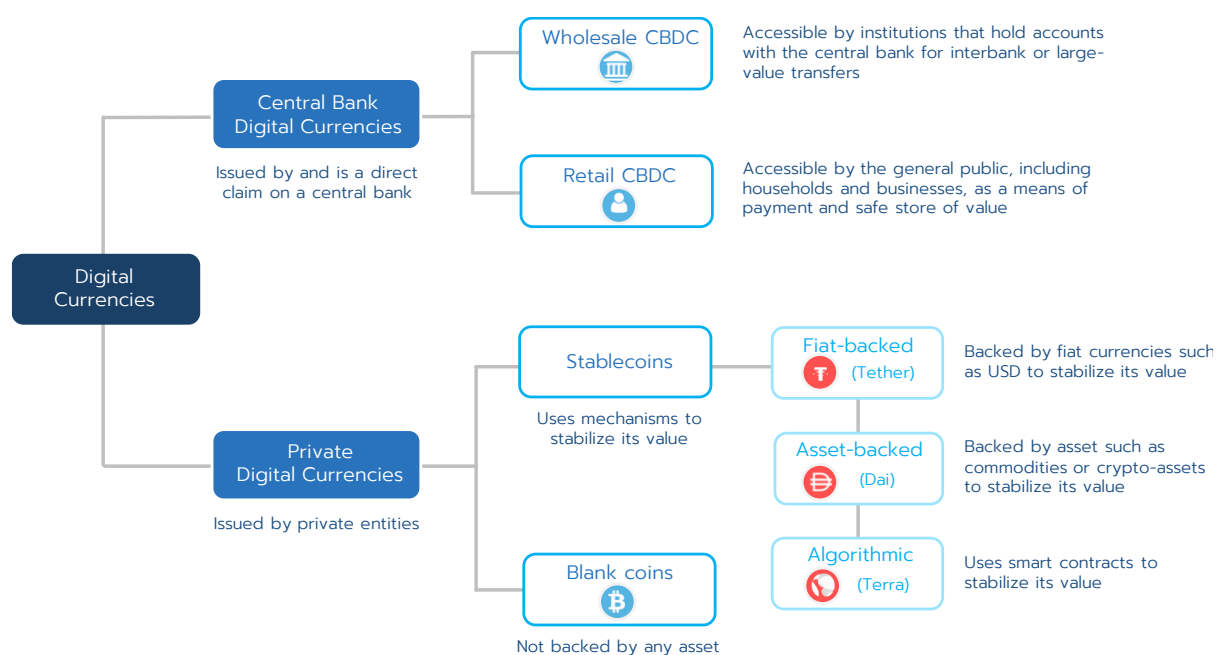
¹ PromptPay is Thailand's national electronic payment scheme which allows users to easily receive and transfer bank funds, using a National Identification number or mobile phone number.

² Bank of Thailand (2020), "Payment Data Indicators November 2020"

Box 1: What is a digital currency?

A digital currency is a digital representation of value. Typically leveraging DLT, digital currencies can be transferred peer-to-peer, stored and traded digitally without the need for intermediaries, and without borders. In addition, the openness and programmability attributes of the technology allow developers to create innovation financial solutions on the currency through the use of smart contracts. The power of DLT is what drives the key distinctions between digital currency and typical e-money, which is an electronic record of money balances issued and managed by a particular company. Digital currencies can be broadly divided into two categories, based on the issuer: central bank digital currencies and private digital currencies.

Figure 2: Types of Digital Currencies



In Thailand, the cryptocurrency market has grown at a tremendous pace. The trading volumes on domestic cryptocurrency exchanges have increased 17-fold from 143 million US dollars in 2018 to 2,489 million US dollars in 2020. This boom has been due to both speculative investment demand and increased regulatory clarity. Thailand is one of the first countries in the world to regulate digital assets offerings and other related activities, through the Emergency Decree on Digital Asset Businesses of 2018³. The Decree regulates digital asset brokers, dealers, exchanges and ICO portals.

³ Securities and Exchange Commission, Thailand (2018), "Emergency Decree on Digital Asset Businesses B.E. 2561 (2018)"

Yet cryptocurrencies are not well-served as a means of payment as their prices tend to be volatile. This has given rise to stablecoins, a sub-category of cryptocurrencies which utilize underlying assets or algorithms to minimize price volatility. Most recently, some private institutions in Thailand have begun exploring the issuance of Thai Baht-backed stablecoins, which are currently under consideration by the BOT to be regulated under the Payment Systems Act. Our consultation paper on this topic is to be published in the coming months.

The proliferation of digital currencies has attracted the attention of central banks worldwide. Many central banks, including the BOT, are now exploring ways to offer their citizens a safe and reliable digital form of central bank money, in the form of a Central Bank Digital Currency (CBDC). The exploration process often entails testing out the capacities of DLT given each country's different motivations and context. For example, the Monetary Authority of Singapore and the Bank of Canada were among the first central banks to explore DLT for CBDC issuance at the wholesale level with various use cases ranging from interbank settlement to cross-border payments. Meanwhile, Sweden's Riksbank and the People's Bank of China are more keen on exploring retail CBDC as cash usage in their countries has declined significantly (for other CBDC projects, see Appendix 1). In Thailand, the BOT has conducted research and development on DLT with an initial focus on wholesale CBDC under Project Inthanon beginning in 2018 (Box 2). The Project has proved that, overall, DLT can fulfill some payment functionalities at the interbank level. In addition, we found that utilizing DLT at an interbank and cross-border level is suitable as it reinforces trust among banks and central banks in the network. DLT can also easily support wholesale interbank transactions, as they tend to be larger in transaction value but lower in volume.

Nevertheless, a present-day version of wholesale CBDC has long existed in the form of commercial bank deposits with the central bank. These deposits are typically used for maintaining reserve requirements and making large-value payments (also known as current accounts or bank reserves). Individuals, however, do not have direct access to such a digital form of central bank money, only physical banknotes.

Therefore, a retail CBDC would represent a new form of money—a digital alternative to Thai Baht cash that is universally accessible and acceptable as means of payment and store of value. Given the rapid evolution of digital currencies with outreach potential to the wider public, this paper is dedicated to exploring the case for retail CBDC in Thailand, assessing its potential benefits and risks, policy implications, how it might be designed, and which capacities would be necessary for successful implementation.

Box 2: The Bank of Thailand's Work on Wholesale CBDCs

Beginning with the establishment of its internal Digital Currency Team in 2018, the Bank of Thailand has completed three phases of Project Inthanon in which DLT was tested in enhancing payment efficiency, bond tokenization, streamlining workflows and cross-border interbank settlements via a wholesale CBDC. In the third phase of the Project, we partnered with the Hong Kong Monetary Authority to undergo Project Inthanon-LionRock to test the functional benefits of using DLT to eliminate correspondent bank intermediaries in cross-border transactions and settling currencies in a payment-versus-payment manner.

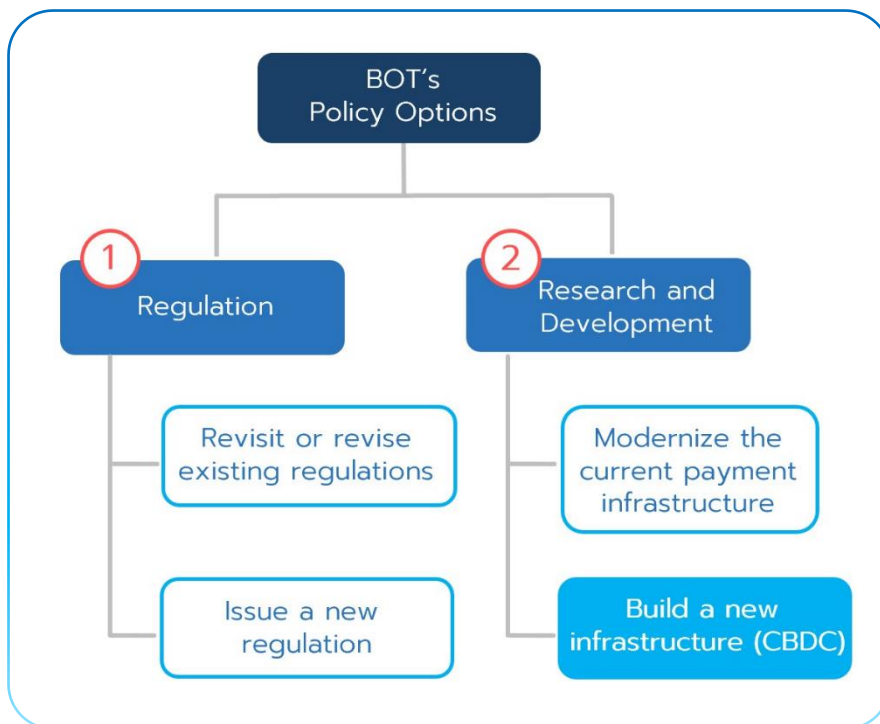
Riding on our experience from Project Inthanon-LionRock, we are currently exploring the capabilities of DLT further in a multi-jurisdictional context with two additional central banks, the Central Bank of the United Arab Emirates and the People's Bank of China. This multi-lateral wholesale CBDC project, supported by the Bank for International Settlements Innovation Hub in Hong Kong, will also explore business use cases in cross-border trade settlement and capital market transactions. The project has been renamed as the Multiple CBDC (m-CBDC) Bridge Project.

1.2 Motivation for Retail CBDC Exploration in Thailand

Currently, digital currencies such as cryptocurrencies are mainly used for speculative purposes, as a store of value rather than a means of payment. Given their current limitations, such as slow transaction processing times and high price volatility, these currencies have yet to reach the same level of usage as cash or established payment methods. **However, technological advancements will offer greater access, flexibility and innovation over time, thus enabling these digital currencies to attract more users and become popular means of payments in the future. This may bring far-reaching implications as well as risks to consumers. If widely adopted domestically, some private digital currencies could displace the Thai Baht, impacting monetary sovereignty and financial stability.** In addition, it could lead to a situation wherein financial services adopt open-sourced, publicly-accessible DLT-based infrastructures that are not subjected to regulatory oversight and assurances. If left unregulated, fragmented adoption or market dominance by a handful of service providers could potentially undermine the integrity and safety of payment systems and end users.

Currently, Thailand's payment and financial environment is not yet conducive to the aforementioned scenario. Nevertheless, as we move towards a future financial landscape in which digital currencies play a greater role, it is important for the BOT to stand ready and prepare well in advance for the **changing nature of money**. In addition to closely monitoring and assessing the development of digital currencies, the BOT could strategize two policy options: 1) revising or establishing regulations to supervise digital currencies, or 2) conducting research and development to modernize the payment system's capabilities. For the latter, **the BOT can build the capacity to develop a cash-like retail CBDC to serve as a safe form of public money and payment infrastructure, accessible and trusted by households and businesses.**

Figure 3: The BOT's policy options for addressing digital currencies

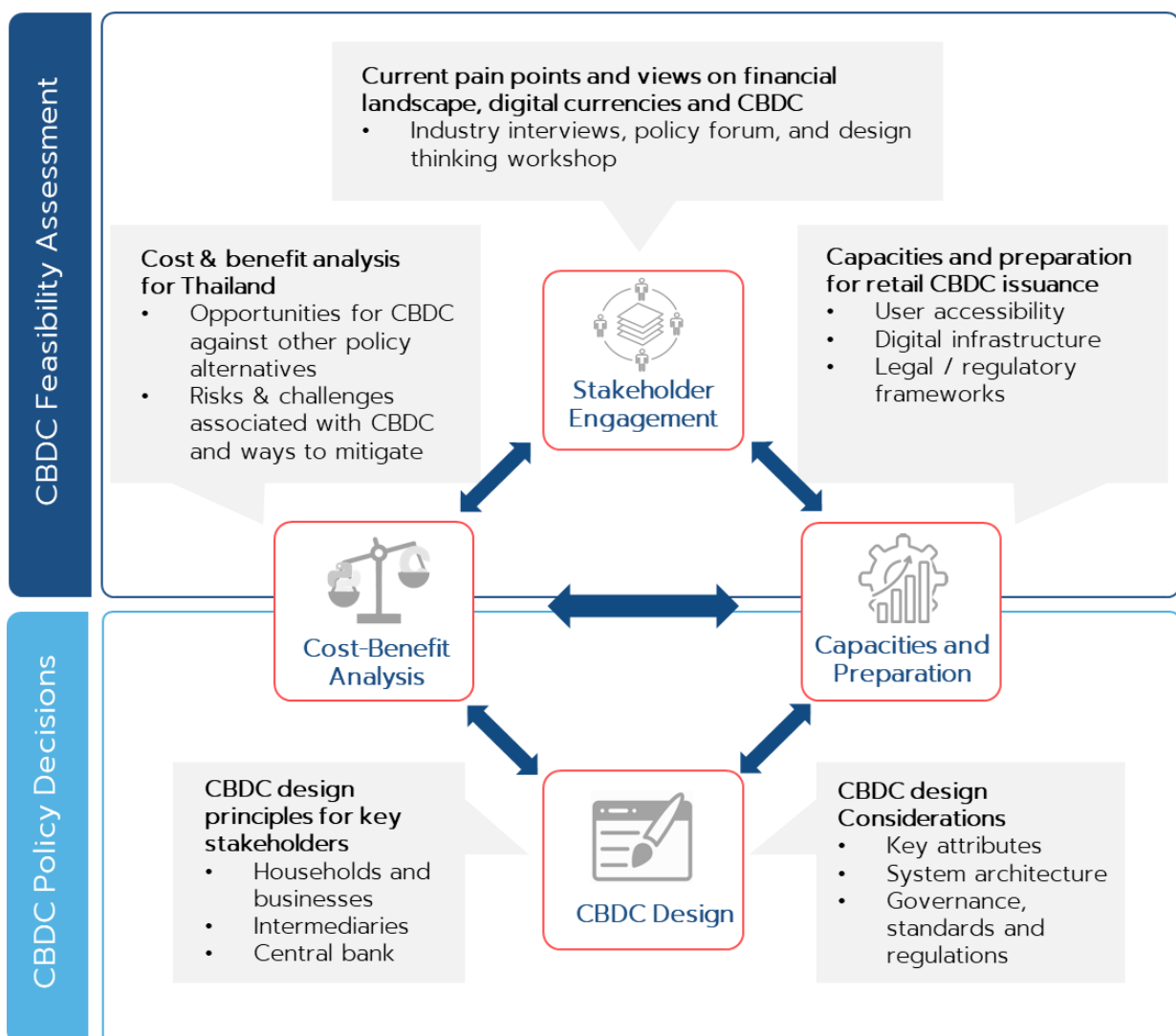


2 | Our Framework Approach

This paper presents our approach to considering retail CBDC issuance. A CBDC is not a one-size-fits-all solution for problems within the financial system; every country should conduct an in-depth study of the motives and implications of introducing a nationwide digital currency.

Given our key motivations in exploring CBDC, this section will explain the framework approach in assessing the feasibility and impact of retail CBDC issuance. We begin our approach by engaging with stakeholders (Section 3), then applying their insights to analyze the opportunities, risks and challenges associated with retail CBDC for Thailand within a cost-benefit analysis model (Section 4). We then integrate our analysis results to propose design aspects for consideration (Section 5). Lastly, we conduct a scan of environmental factors and capacities necessary for CBDC implementation (Section 6). Our framework approach is illustrated in Figure 4.

Figure 4: Analytical framework to assess the feasibility and design considerations for retail CBDC



The central questions discussed and explored in our framework consist of the following:

- What are the opportunities that CBDC offers and to what extent are they applicable in Thailand? How does CBDC's attractiveness as a policy option compare to other alternative policies to address these opportunities?
- What are the risks and challenges of CBDC issuance in Thailand? How can these risks and challenges be mitigated or addressed?
- What goals and requirements for different stakeholders should be factored into the CBDC design considerations? How would they influence the CBDC design, system architecture and operations?
- What factors and capacities would be crucial for successful CBDC implementation at a nationwide scale? What are some necessary preparation requirements going forward?

Please note that this preliminary assessment is intended as a guideline for deeper analysis and discussion before definite policy decisions can be made with regards to retail CBDC issuance. At the time of writing, we recognize the difficulties in quantifying the impact of CBDC and associated costs as data is limited. Therefore, an analysis of implementation costs and technological feasibility will not be included in this paper. We intend to continuously monitor developments and reassess opportunities, risks and challenges going forward.



3 | Stakeholder Engagement

Retail CBDC issuance would undoubtedly change the financial landscape, having far-reaching implications on many stakeholders. Any decision to introduce retail CBDC would require rigorous public-private cooperation to drive mainstream adoption. With this in mind, we reached out to industry participants and stakeholders to gather their initial thoughts on CBDC.

3.1 Design Thinking Workshop

In July 2020, the BOT organized a design thinking workshop to gather insights on how CBDC could help alleviate pain points in the current payment system. Workshop participants consisted of representatives from financial institutions, corporates, and FinTech startups such as cryptocurrency exchanges and venture builders. The objective was to have industry participants share ideas on whether and how CBDC could be used to alleviate existing pain points and brainstorm what an ideal CBDC architecture would look like.

Views on CBDC and Payment Systems

Corporates shared their thoughts on the shortcomings of the current payment system, such as the limited operating hours, high transaction costs and lack of standardized messaging formats as well as verification of end-recipient account details. Meanwhile, startups and small businesses voiced their difficulties in accessing financial services, high transaction costs particularly for cross-border payments, and rigid regulatory frameworks which hinder financial innovation.

For a CBDC to successfully alleviate these pain points and improve payment experiences for intermediaries and customers alike, participants envision the system to offer lower costs, operate 24/7, support real-time payments, have standardized formats and the ability to verify sender and recipient details. For it to foster innovation, the CBDC infrastructure should also allow for open APIs and interoperability to encourage greater participation and competition from FinTechs.

3.2 Policy Forum

In August 2020, the BOT's Puey Ungphakorn Institute for Economic Research held a policy forum to discuss the economic implications of CBDC. Participants of the forum included academics from top universities and economists from the banking industry.

Views on CBDC and Monetary Policy and Financial Stability

Participants emphasized that the benefits of retail CBDC should first be weighed against all negative impacts, before any decision on CBDC issuance can be made. The benefits of retail CBDC could increase efficiency and reduce costs in the financial system. In addition, as central bank money, retail CBDC could protect monetary sovereignty and become a more direct monetary tool. In terms of risks, participants voiced concerns that CBDC could make central banks more powerful and extensive,

leading to a reduction in the role of banks. While the introduction of CBDC could encourage banks to develop new business models, it may initially be met with resistance. This will be particularly concerning if the CBDC is designed to be interest-bearing and a viable substitute for bank deposits. In addition, CBDC could bring about unintended consequences such as increasing economic inequality. CBDC could create a reverse financial inclusion barrier if low-income households are not able to access the CBDC due to technology restrictions.

3.3 Industry Interviews

During the last quarter of 2020, the BOT's Digital Currency Team interviewed top management and experts from regulatory bodies, financial institutions, payment service providers and technology companies. The objective was to understand the implications of the adoption of digital assets. Interviewees were given three scenarios and asked which aligned best with their intermediate to long-term outlook on Thailand's future financial landscape, and how CBDCs would fit into that scenario (Figure 5).

Views on CBDCs and the Future Financial Landscape

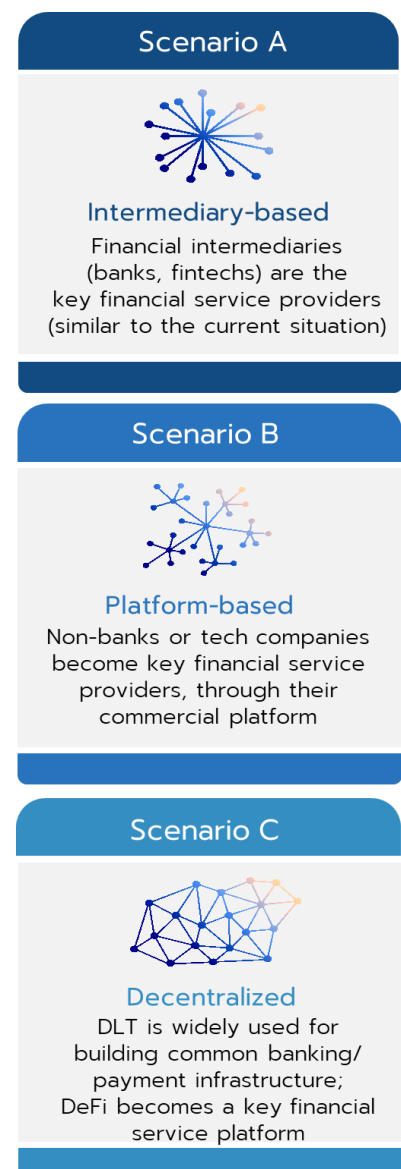
The majority of viewpoints on CBDCs from the interviewees can be concluded as cautiously positive. Many interviewees believe that banks will remain the main provider of financial services (Scenario A). In this scenario, industry experts see CBDC as having potential to serve as a trusted digital infrastructure co-existing alongside cash and bank deposits, and to improve cross-border payments.

A smaller yet sizeable portion of interviewees envision the future financial landscape as being more diverse and inclusive of technology-driven non-banks (Scenario B). They believe that banking services will be provided by non-banks who can benefit from extensive network effects, scale their technology at very low costs and leverage data insights to offer more consumer-centric services. Interviewees think a highly-interoperable CBDC could become the medium in many of these banking services.

Last but not least, very few interviewees anticipate that Thailand's financial landscape will be quick to adopt decentralized finance (DeFi) in the immediate term (Scenario C).

All the feedback has been incorporated into our analysis in Section 4 to the best extent possible.

Figure 5: Scenarios presented to the interviewees



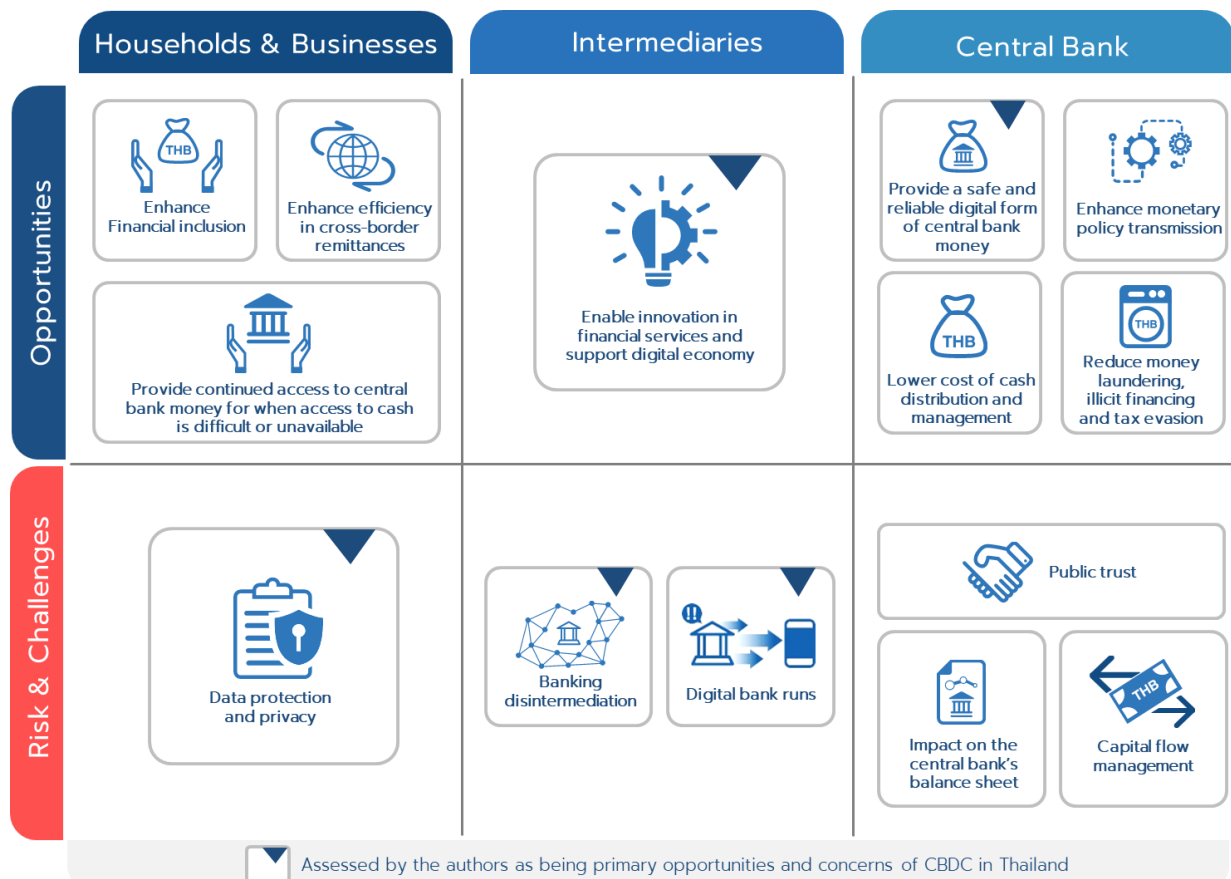
4 | Cost-Benefit Analysis of Opportunities, Risks and Challenges

The introduction of CBDC presents different opportunities as well as risks to different stakeholders. Thorough consideration of alternative policy options and risk mitigation options is required before any decision on whether to issue CBDC can be made. In this regard, a stylized cost-benefit analysis can provide empirical evidence and help provide guidance on whether the introduction of retail CBDC would be a desirable option for Thailand.

In this section, we elaborate on the primary opportunities we assess as having the highest benefits for key stakeholders in Thailand. The opportunities are analyzed against the availability of alternative options that could offer similar benefits (Section 4.1). The analysis is conducted in a similar manner for risks and challenges to identify primary concerns. We then assess these risks and challenges against the availability of mitigation options (Section 4.2). A summary of our analysis is presented in Section 4.3.

Other opportunities, risks and challenges we have taken into consideration are presented in Figure 6, categorized by stakeholder groups. A thorough assessment of each is included in Appendix 2.

Figure 6: Opportunities, risks and challenges of retail CBDC for different stakeholder groups



4.1 CBDC Opportunities Analysis

Retail CBDC offers various benefits, ranging from enhancing financial inclusion to reducing fraud and money laundering. In this section, we assess which CBDC opportunities offer the most promising benefits for Thailand. We conclude that given the Thai context, CBDC could serve as an open public digital payment infrastructure that is highly secure and accessible as well as support financial innovation. We then evaluate alternative options that could deliver similar benefits in order to assess the attractiveness of retail CBDC issuance. Other secondary benefits are outlined in Table 2 of Appendix 2.

a) Provide a safe and reliable digital form of central bank money

If any forms of private digital currencies become widely adopted, the effectiveness of monetary policy and stability of the financial system could be undermined. Due to its openness and borderless nature, these currencies may be used to circumvent Thailand's foreign exchange regulations, and as a result, users could face high credit, liquidity, foreign exchange risks or price volatility from holding these digital currencies. Moreover, users' security could be compromised if these digital currencies are left unregulated.

If such a scenario occurs, CBDC could become a tool to help safeguard monetary and financial stability, as well as be a safer and publicly-accessible alternative to other forms of digital currencies.

Thus, by design, CBDC should possess the integrity and transparency of central bank money, while also having competitive payment features relative to other digital currencies.

Alternative policy options:

- Revise existing regulations or develop new guidelines to regulate private digital currencies with high potential to replace the use of Thai Baht. However, one should bear in mind that any regulatory or surveillance efforts are typically slow relative to the pace of technological development.
- Improve the existing payment and digital infrastructure by developing programs to enhance innovation and competition within the payment sector. Adopt new standards to modernize the system and improve its capabilities to better support new forms of financial services and effectively offer attractive value propositions.

b) Enhance innovation and competition in financial services, and support the digital economy

As the financial landscape progresses towards digitization and decentralization, the BOT needs to ensure that the payment infrastructure is up to pace with technological developments. Retail CBDC could serve as an open digital infrastructure for entities to build value-added services, thus opening more avenues for inclusion and innovation in the financial service sector.

One potential innovative feature of CBDC is that it is programmable, meaning that specific conditions can be programmed into the CBDC, allowing transfers and payments to be automatically executed. If the CBDC is an open and interoperable platform, this programmability feature will allow for third-party developers such as FinTech providers to deploy value-added smart contracts to extend the CBDC's functionalities. An interoperable CBDC platform will foster innovation and support competition in the financial ecosystem and beyond. Without such interoperable capabilities, a CBDC would offer little value over existing digital forms of cash such as e-money.

There is already a wave of partnerships working towards using technology to enhance workflow efficiency, lower costs and strengthen trust in the financial sector. For example, the BOT in partnership with Thailand's Blockchain Community Initiative, which comprises of Thailand's leading commercial banks and corporates, has planned to cover around 80% of the total issuance of letters of guarantee on a DLT-based platform within five years⁴. The Stock Exchange of Thailand has also joined its leading international peers in launching a digital asset exchange platform, which is expected to go live in 2021⁵. A CBDC should be designed to be interoperable with such platforms to the highest extent possible.

Alternative policy options:

- Improve the existing payment and digital infrastructure to support digital assets.
- Promote open banking initiatives: Currently, the BOT encourages banks to allow open API access to their database or services (provided the customers grant consent) to enable developers, entrepreneurs, startups and enterprises to build innovative applications connected to the banks' services and products. However, some incumbents may have negative views on open banking as it could introduce new risks and heighten competition.

⁴ Thailand Blockchain Community Initiative

⁵ The Stock Exchange of Thailand (5 October 2020), "News 69/2020"

4.2 CBDC Risks and Challenges Analysis

The issuance of retail CBDC could have possible ramifications on the broader economy and financial system. From an extensive list of possible risks and challenges, we identify three primary concerns associated with CBDC issuance: banking disintermediation, bank runs and maintaining public trust—risks that could directly impact monetary and financial stability. We then assess the availability and feasibility of options to mitigate or manage the risks and challenges. Other secondary risks and challenges are outlined in Table 3 of Appendix 2.

a) Banking disintermediation

If CBDC is interest-bearing and considered an attractive alternative store of value, it could cause banking disintermediation as households and businesses might decide to substitute their bank deposits with CBDC, causing deposit outflows. In such a scenario, banks would be incentivized to increase deposit rates, leading to higher costs of bank funding and revenue depression. Banks can then pass on these costs to borrowers, or engage in riskier activities in search of higher returns. Moreover, banks would need to maintain additional liquidity to support CBDC demand. This would consequently impact the size and risk profile of banks' balance sheets and profitability. However, if CBDC is designed to be non-interest bearing, the general public would have little incentive to switch from holding bank deposits to CBDC, and the effect of banking disintermediation would then be limited.

Mitigation options:

- Design CBDC to induce its use as a means of payment rather than as a store of value, for example, by setting a conversion limit between deposits or cash to CBDC, or paying no interest or lower interest rates on CBDC relative to bank deposits. However, such design choices for CBDC could have a negative impact on the general public's demand for CBDC.

b) Bank runs

In times of economic or financial markets turmoil, a systemic bank run could occur. Given the advantage of technology, a perceived "flight to quality" from bank deposits to CBDCs could take place digitally at an unprecedented speed.

Mitigation options:

- Create frictions to deter runs by setting withdrawal or holding limits to limit CBDC convertibility, or setting lower tiered remuneration rates on CBDC holdings.
- Additional prudential oversight might be required. However, this issue should be in consultation with the industry for further consideration.

c) Public trust

Building and maintaining public trust in the central bank as the issuer of CBDC and the operator of the national system will be essential for a well-functioning, secure and resilient monetary system. The general public must have confidence in the CBDC as a secure store of value. To maintain that trust and understand if a CBDC has value to a jurisdiction, a central bank should proceed cautiously, openly and collaboratively⁶ with all stakeholders involved.

Mitigation options:

- Develop clear standards, regulations, risk-management guidelines and governance structure for the CBDC system. For example, the CBDC could be issued against eligible assets, similar to how banknotes are backed by reserves, to ensure the public's trust in the stability of the CBDC's value. The technology underpinning the CBDC system must meet the highest security standards. In addition, the roles and responsibilities of CBDC operators, service providers and other participants should be specified in the rulebook so as to hold them accountable for their roles in the CBDC ecosystem.
- Develop a CBDC implementation plan as well as a business continuity plan with stakeholder engagement and public communication to promote public awareness, user adoption and build trust.

4.3 Cost-Benefit Analysis Conclusion

Against the backdrop of the fast growth of digital currencies and rapid digitization in the financial sector, we assess CBDC as having the potential to provide a highly trusted and safe digital form of central bank money to the public as well as an open digital payment infrastructure that supports inclusion and innovation in the financial service sector. However, alternative policy options that may be equipped to address the opportunities presented are also available, should we decide that there is no significant benefit to embark on an immediate CBDC launch given the current environment.

As for key risks and challenges, the introduction of CBDC could lead to banking disintermediation or exacerbate bank runs, directly affecting the stability of the financial system. In addition, building and maintaining public trust as the issuer of CBDC is another key challenge for the central bank. However, mitigation options to address these concerns would mainly exist through the design of the CBDC itself. For example, limits on the size of CBDC holdings or tiered interest rates could be applied to prevent disintermediation and deter runs. Such design considerations will be explored in Section 5. To maintain public trust, we should aim to meet the highest technology standards for CBDC as well as develop clear standards, regulations, governance structures and business continuity plans.

⁶ Bank for International Settlements (2020), "Central bank digital currencies: foundational principles and core features"

While there are alternative solutions at hand, some could prove insufficient to manage the risks and address the fast-changing digital financial landscape. Thus, it is critical for the BOT to take necessary preparations and be ready for when the need arises, including closely monitoring the development of digital currencies, business adoption of digital currencies, consumer trends and technological advancements. There is a possibility that these factors could become systematically important in the near future, rendering alternative policies no longer desirable or practical, at which point the issuance of CBDC can become a suitable solution.

For a detailed assessment of all opportunities, risks and challenges we have taken into consideration, please refer to Appendix 2.

A: Questions for Feedback

1. What are some other costs or benefits of CBDC worth noting? (Please refer to Appendix 2 for our full cost-benefit analysis)
2. How can we harness the benefits of or address the risks arising from issuing CBDC?
3. Where and how can public-private cooperation have the most impact in harnessing the benefits of or addressing the risks arising from issuing CBDC?
4. How and in what ways can CBDC and other forms of digital currencies co-exist?



5 | CBDC Design Considerations

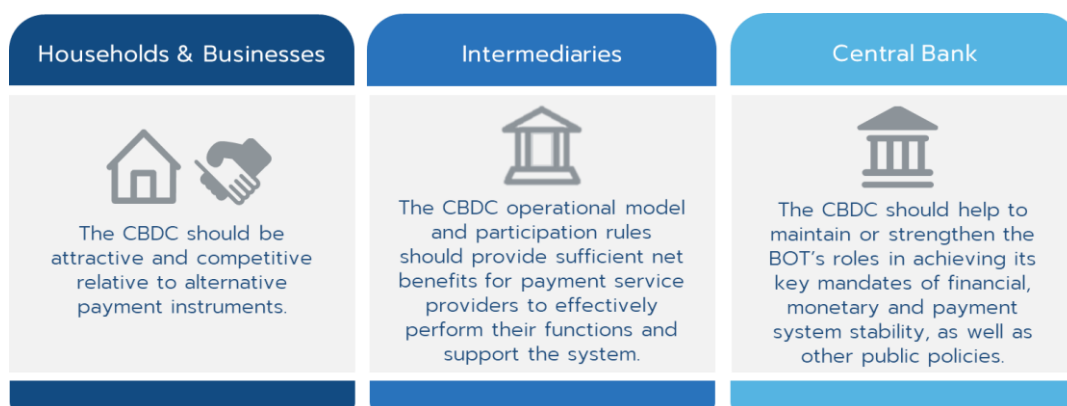
In Section 4, we found that some of the opportunities, risks and challenges with issuing CBDC can be enhanced or mitigated through appropriate designs. In this section, we outline our approach in considering the design of CBDC. We first start by identifying key stakeholders, namely households and businesses as CBDC users, payment service providers as CBDC intermediaries, and the BOT as the CBDC supplier. We then develop design principles and desirable features for each stakeholder, which are mapped to possible design choices that could address the needs of the stakeholders.

It is important to implement the design approach in an iterative manner and engage stakeholders throughout the process. In this regard, the BOT has pursued a prototype project (Box 3) to identify design flaws and concerns, test the capability of DLT and the viability of business and operational models. Some of the key learnings from the project have been incorporated into this section.

5.1 CBDC Design Principles by Key Stakeholders

As retail CBDC would serve as a payment instrument and underlying infrastructure, different stakeholder groups will require different features from CBDC. In Figure 7, we identify design principles based on key stakeholders in the CBDC ecosystem: households and businesses, intermediaries, and the central bank.

Figure 7: CBDC design principles by key stakeholders



Households and businesses

Given the fast pace at which new and innovative financial products are being offered, consumers will typically choose any payment instrument that is most convenient and suitable to their needs. **A CBDC should therefore be able to fulfill or enhance the common functionalities offered by other payment instruments, otherwise it would face challenges in gaining a competitive edge and mainstream adoption.** Conventional methods of payment such as cash, e-money, or mobile payments are well-served in the areas of convenience, accessibility, low cost and high trust in issuers. DLT-based money such as cryptocurrencies or stablecoins are programmable and can more efficiently fulfill cross-border transfers. Thus, a retail CBDC should be designed to fulfill both sets of features, offering the best of both worlds.

Intermediaries

As CBDC distributors or payment service providers, intermediaries would take on the roles of providing payment hardware, applications, digital currency wallets or custodial services in the overlay payment service layer interacting between households, businesses and the central bank. In addition, running a CBDC system requires capital expenditures to operate and maintain the system. Therefore, the decision on who should bear the cost, and to what extent, would have a significant impact on the efficiency, innovation and competition in the CBDC ecosystem. In order to incentivize participation and support healthy competition among intermediaries, **the exploration of business models, participation rules, liabilities and governance of a CBDC ecosystem should be done transparently and collaboratively with potential intermediaries. The cost structure should be transparent and ultimately provide economically viable solutions for all participants.**

Central bank

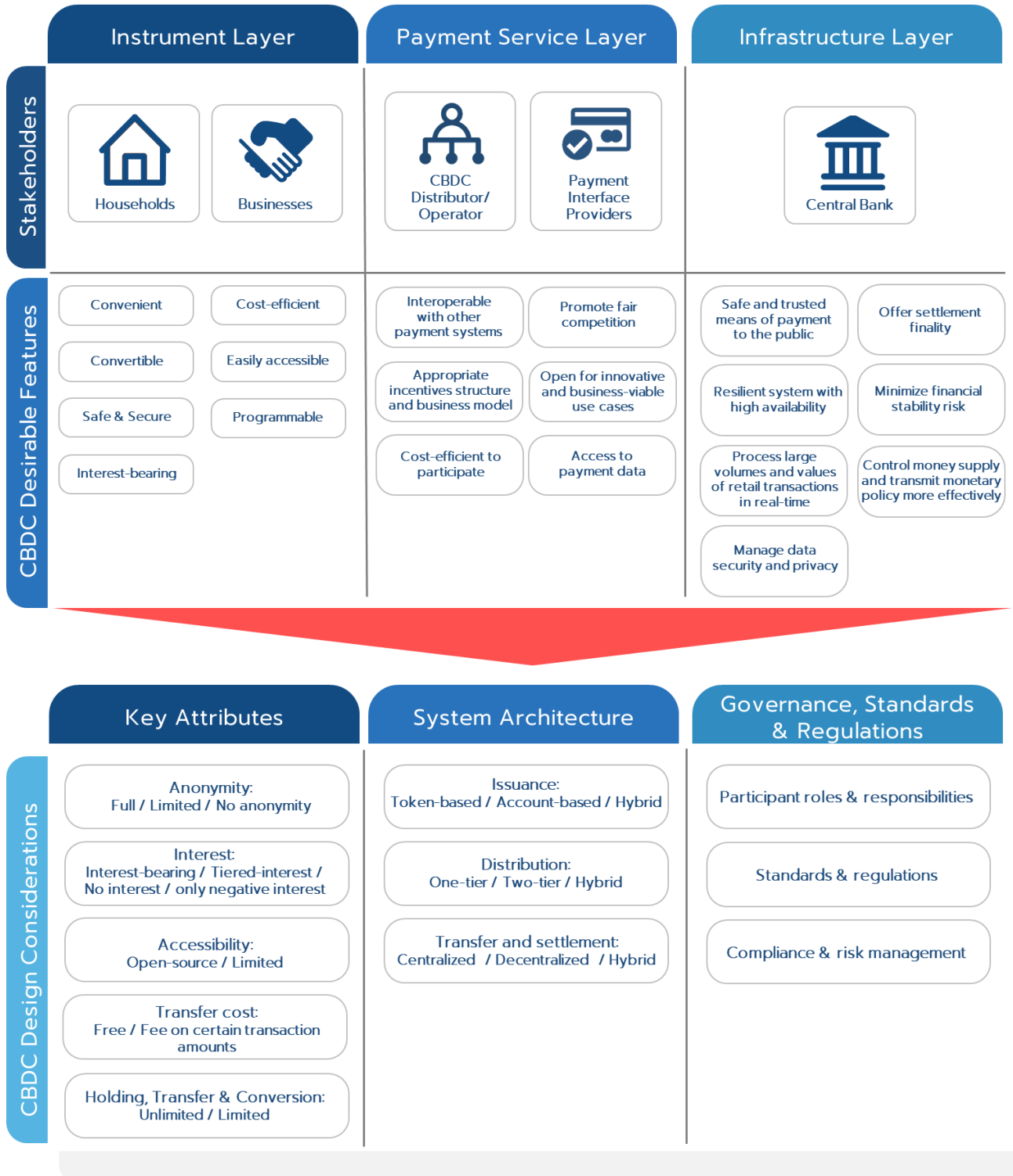
The central bank, as the issuer of CBDC, must ensure that the introduction of the CBDC infrastructure and related services are at least compatible with or enhance the central bank's ability to fulfill its key objectives in maintaining stability of the monetary, financial and payment systems. Therefore, the introduction of CBDC would be to complement other payment systems or instruments, without attempting to replace any. As the central bank would assume the role of overseeing the stability of the CBDC system and its value, the design choices around CBDC architecture and technology should meet the highest payment standards of resiliency, security and performance.

5.2 CBDC Design Considerations

Based on the design principles laid out in Figure 7, we propose a CBDC design approach (illustrated in Figure 8) which outlines design considerations spanning across three layers: 1) Key attributes, 2) System architecture and 3) Governance, standards and regulations.

Note that these design choices are not discrete and entail tradeoffs. Given the relative nascency of and limited research on CBDC, the implications and tradeoffs of one CBDC design choice over another are yet to be determined. Thus, it is important to further analyze the tradeoffs. Please note that this paper will not try to suggest which design choices the BOT should implement as time-specific requirements must be taken into account before we can arrive at a final design.







Figure 8: CBDC design approach



5.2.1 Key Attributes

Retail CBDC, as a means of payment with direct claims to the central bank, should not only possess attributes akin to cash but also other value-added qualities. In Figure 9, we illustrate the design options for the key attributes of CBDC and associated tradeoffs. The details of their ramifications, advantages and disadvantages are further outlined in Table 4 in Appendix 3.

Figure 9: CBDC's key attribute design options and tradeoffs

	Anonymity	Interest Rate	Accessibility	Programmability	Transaction Cost	Holding, Transfer & Conversion
Key Attributes	 <p>Who can see and trace CBDC transactions?</p>	 <p>Does CBDC have the capacity to earn interest?</p>	 <p>Who can access and hold CBDC?</p>	 <p>To what degree can businesses deploy smart contracts on CBDC?</p>	 <p>Will users bear costs in making CBDC transactions?</p>	 <p>Should limits be placed on holding, transfer, or conversion amounts?</p>
Tradeoffs	User Privacy	Attractiveness for Users	Attractiveness for Users	Innovation	Attractiveness for Users	Attractiveness for Users
	V.S.	V.S.	V.S.	V.S.	V.S.	V.S.
	Appropriate incentives structure and business model	Banking Intermediation	Regulatory Oversight	Security	Revenue	Banking Intermediation
Options	V.S.	V.S.		V.S.		V.S.
	Regulatory Oversight	Monetary Policy Effectiveness		Performance		Monetary Policy Effectiveness
	<ul style="list-style-type: none"> • Full anonymity • Limited anonymity • No anonymity 	<ul style="list-style-type: none"> • Interest-bearing • Tiered-interest • No interest • Only negative interest 	<ul style="list-style-type: none"> • Universal • Limited 	<ul style="list-style-type: none"> • Open-source • Limited 	<ul style="list-style-type: none"> • Free • Fee for certain transaction amounts 	<ul style="list-style-type: none"> • Unlimited • Limited

Given the digital nature of CBDC, it is possible to develop flexible conditions on some attributes to accommodate functional requirements and use cases such as interest rate, amount limits, transaction cost and programmability. Our preliminary suggestions on these attributes are as follows:


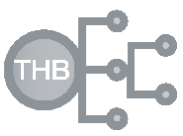

- **Interest rates on CBDC can be set initially at zero** to replicate cash, nevertheless, either a positive or negative rate on CBDC can be later imposed if necessary.
- **There should be specified limits for holding, transacting and conversion of CBDC**, to encourage CBDC usage mainly for transactional purposes and so as to not to have any significant impact on banking disintermediation and bank runs.
- **End-users should not bear any transaction costs**, but the decision on whether other participants should bear system operating costs, if any, will need to be explored further. The cost structure must be transparent and ultimately provide economically viable solutions for all participants.

- **CBDC should be open to intermediaries and payment service providers to “program” value-added and innovative features on top of the CBDC**, to replicate the innovation competitive advantage of digital currencies. Nevertheless, there may be tradeoffs with system security and performance as running complex smart contracts can be computationally intensive. Thus, it is necessary to set clear standards on the functionality of smart contracts that can be executed.
- **A balance of anonymity and regulatory oversight would be optimal for all stakeholders to benefit from CBDC transaction data.** However, it is worth noting that anonymity and accessibility attributes, which are interdependent, could be more challenging to adjust once the design has been set. The level of accessibility will determine the degree of anonymity. CBDC with full anonymity could protect users’ privacy, but would raise major concerns regarding money laundering, tax evasion and terrorist financing. Therefore, users’ identities must be verifiable to a certain extent to ensure proper and secure access to CBDC. In addition, information trails on CBDC transactions and payments could be beneficial for users to build their credit profiles and access better-customized financial services. The BOT could also benefit from this data to better understand economic activities at a more granular level and more informed monetary policy formulations.

5.2.2 System Architecture

As the BOT would play a vital role in overseeing and operating the core payment system, we must ensure that its system architecture can effectively support the retail CBDC’s desirable payment features for end users as well the BOT’s roles in monetary policy and financial stability. In Figure 10, we examine the design choices of the system’s key mechanisms: CBDC issuance, distribution, transfer and settlement. The details of the advantages and disadvantages for each choice are shown in Table 5 in Appendix 3.

Figure 10: System architecture design options

	Issuance	Distribution	Transfer & Settlement
Details	 <p>The BOT would be the sole issuer of CBDC and control its supply in circulation through minting and destroying CBDC. The design choices involve issuing CBDC bearing characteristics similar to cash (token-based), or to bank accounts (account-based).</p>	 <p>The process of distributing CBDC to end users. The design choices involve having the public open CBDC wallets directly with the BOT (one-tier), or through designated intermediaries (two-tier).</p>	 <p>CBDC transfers and payments would involve transaction verification and settlement. The design choices involve the choice of technology and the level of decentralization used in the consensus mechanism.</p>
Options	<ul style="list-style-type: none"> • Token-based • Account-based 	<ul style="list-style-type: none"> • One-tier • Two-tier 	<ul style="list-style-type: none"> • Centralized • Decentralized • Hybrid

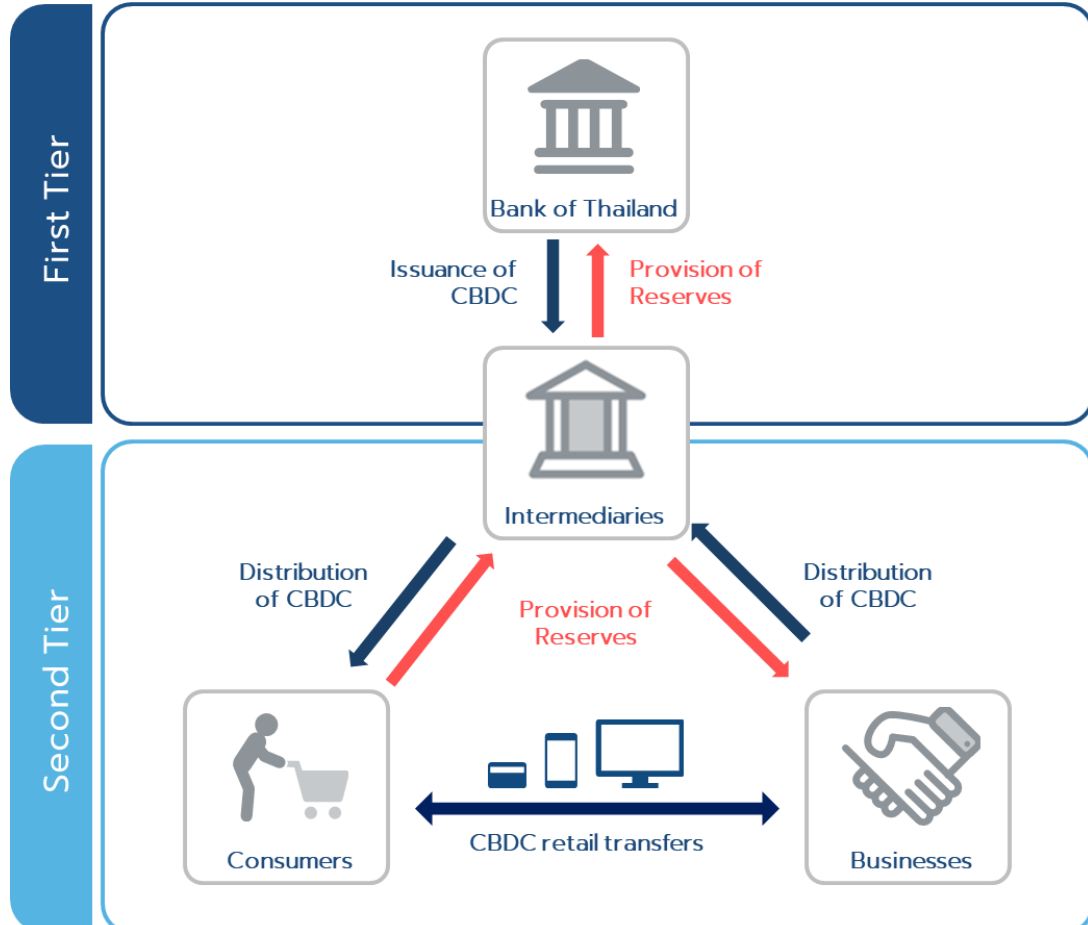
Issuance

We anticipate that a certain level of identification will be required to obtain CBDC. However, the tradeoffs with data privacy and protection would need to be carefully balanced. A token-based CBDC can be considered as a bearer instrument, similar to banknotes. The authenticity of the tokens rather than the owners' identity can be used for transaction verification. A purely token-based CBDC with its ability to make transactions without verifying users' identities could raise serious issues on money laundering, tax invasions and illicit financing. On the other hand, an account-based CBDC is similar to bank accounts, wherein the records of balances, transactions and user identifications would be required for transaction verification. The choices between token and account-based should be made concurrently with the anonymity options laid out in Key Attributes.

Distribution

In order to preserve financial stability and the roles of financial intermediaries in the economy, a two-tier distribution model is initially preferred as it offers a public-private partnership which allows for more effective utilization of existing resources and infrastructure (Figure 11). Banks and payment service providers already possess fully-developed IT infrastructure applications and service systems along with strong distribution channels and customer onboarding capabilities. In addition, a two-tier model could help boost mainstream adoption of CBDC as the Thai public is accustomed to accessing financial services via financial intermediaries.

Figure 11: Stylized two-tier issuance and distribution of CBDC



Transfer and Settlement

We will aim to harness both the strengths of both centralized and decentralized technologies. While centralized technology offers advantages in terms of scalability and performance, decentralized technology (DLT) offers greater security and resiliency through the usage of cryptographic techniques.

Given the anticipated implementation of a two-tier distribution model, this would constitute the first transfer layer between the central bank and intermediaries, and the second layer between intermediaries and end users. The technology choices to support transfers and settlements between the two layers can be traditional centralized technology, DLT, or a hybrid of the two. Centralized technology would allow for higher performance and scalability as it does not rely on consensus mechanisms, which are typically usually used in DLT. Through our CBDC Prototype Project with SCG and Digital Ventures (Box 3), however, we found that the DLT still has some limitations in terms of performance and scalability to handle large retail transaction volumes and preserve users' transaction privacy.

Box 3: CBDC Prototype Project with SCG and Digital Ventures

In 2020, the BOT conducted a project with the Siam Cement Public Company Limited (SCG) and Digital Ventures Company Limited (DV), with technical support from ConsenSys, to explore the potential benefits of using CBDC for payment in business sectors. This joint experiment introduced a CBDC prototype to non-financial institutions based on a two-tier model in which the central bank distributes CBDC through intermediaries before reaching end-users.

Apart from successfully carrying out the basic payment functionalities of issuing, destroying, distributing, transferring CBDC and other related functions, the prototype also demonstrates complex functionalities, namely invoice tokenization and programmable money, by utilizing smart contracts. For invoice tokenization, the Project successfully introduces supply chain financing on the CBDC network, with seamless integration with DV's Blockchain Solution for Procure-to-Pay (B2P), to enhance information sharing and transparency, allowing supplier firms to access liquidity from a broader lender base with more competitive funding costs.

From a technical perspective, six key non-functionalities, including finality, interoperability, privacy, resiliency, scalability, and security were assessed through many scenario tests. However, it is worth noting that DLT has limitations, as the system is still unable to support a large volume of transactions and users or preserve financial transaction confidentiality completely. Therefore, further development and evolution of the technology may be required before it can support widespread usage.

The Project marks the first time the BOT has expanded the scope of CBDC development to users in the private sector. The success of the project reaffirms the importance of public-private collaboration in driving innovation and advancing technology and sets a key milestone in developing a digital currency for the business and retail sectors.

5.2.3 Governance, Standards and Regulations

A robust CBDC ecosystem would inevitably involve several stakeholders in the process, thus it is necessary to design a framework around governance, standards and regulations to ensure that the CBDC is appropriately used, managed and operated. In principle, the CBDC should be treated with equivalent regulatory and prudential standards as entities offering similar services for cash or existing digital monies.

Governance

- **Participant roles and responsibilities:** The CBDC system would require a rulebook specifying the roles and responsibilities of operators, regulators, service providers and other participants. At a high level, there should be a governance body comprising of working committee groups with representatives from key stakeholders to oversee the overall system. The working committees should be responsible for strategic and management direction as well as operational guidelines in order to ensure the CBDC system is well-functioning and robust.

Standards and regulations

- **Eligibility criteria for user and service providers:** The eligibility criteria for users should be set based on the CBDC's user accessibility options (universal or limited), as it would determine how the process of onboarding and verifying users should be integrated with other data services. The eligibility criteria for service providers should help ensure their services are up-to-standard and support healthy competition.
- **Interoperability standards:** For CBDC to be accessible by all consumer groups and gain mainstream adoption, it should be easily convertible to other forms of money or digital assets (and vice versa) and also serve as a common means of payments across a wide array of systems and platforms. Deploying common messaging standards, such as ISO 20022 and APIs can help, but further efforts might be needed to support additional functionalities of CBDC. Moreover, if CBDCs are to be used in cross-border transactions, international standards would also be necessary, suggesting a need for central banks to work collaboratively in this development.
- **Regulatory compliance:** The level of anonymity of the CBDC will face a key tradeoff with regulatory oversight. Thus, there must be a balance between users' data privacy and security with regulatory compliance, particularly AML/CFT regulations. This would require coordination with other regulatory agencies, in establishing a governance structure for data-sharing and privacy setting as well as establishing compliance monitoring and reporting systems.

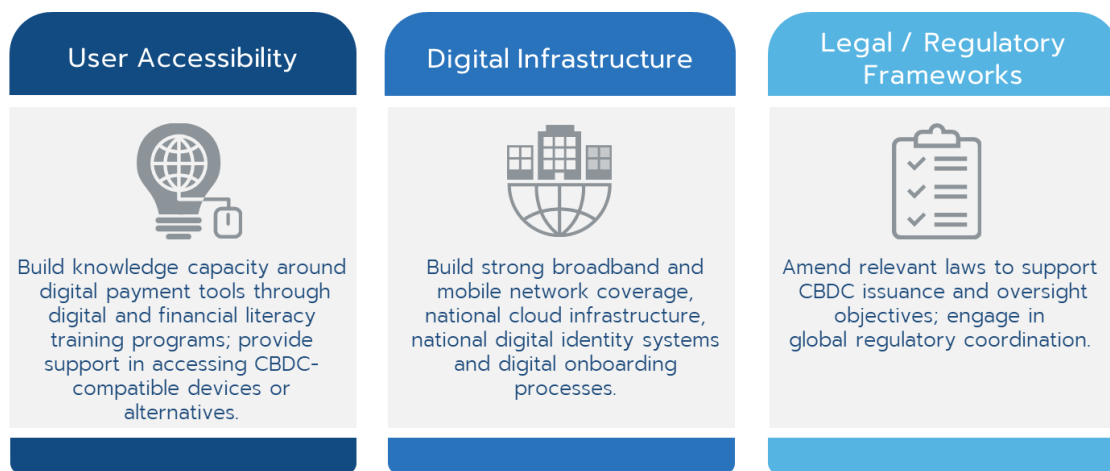
B: Questions for Feedback

1. What other factors may need to be considered in our approach for CBDC design considerations?
2. Are there any specific preferences in CBDC design you would like to see as a user or intermediary?
3. What other technology options should we consider for the CBDC system? What are the advantages or disadvantages involved?
4. Are there any specific recommendations on a governance model, standards and regulations we should take into consideration?

6 | Capacities and Preparation for Retail CBDC Issuance

In this section, we assess Thailand's capacities in adopting a retail CBDC at a national scale by identifying what factors and necessary preparation requirements would be crucial for successful CBDC implementation. We categorize the capacities into three groups: 1) User accessibility, 2) Digital infrastructure, and 3) Legal and regulatory frameworks (Figure 12).

Figure 12: Factors and necessary preparation requirements for successful CBDC implementation



6.1 User Accessibility

Retail CBDC implementation should strive to maximize participation in financial systems and not reinforce existing barriers or create new barriers to inclusion for vulnerable populations⁷. Building capacity in terms of 1) knowledge capacity to adopt new digital payment tools, namely as digital and financial literacy, and 2) accessibility to compatible devices for CBDC, will be of utmost importance to ensure that retail CBDC can be used by the general Thai public regardless of social status, income or location.

a) Digital literacy

Since a retail CBDC will be a digital representation of cash, accessible mainly through digital wallets on smart devices, steps should be taken to ensure users understand and feel comfortable with using such devices to transact. Alternatively, a card-based payment method (smartcards) compatible with CBDC can be deployed for those with difficulty accessing or using smart devices.

⁷ World Economic Forum (2020), "Central Bank Digital Currency Policy-Maker Toolkit"

While there are no universal standards for digital literacy, UNESCO's Digital Literacy Global Framework project⁸ suggests measuring the following five key competence areas: 1) information and data literacy, 2) communication and collaboration, 3) digital content creation, 4) safety, and 5) problem solving. As a country with remarkably high smartphone usage, in which nine out of ten mobile subscribers own a smartphone⁹, and social media penetration rates stand at 75%¹⁰, Thailand appears to have a proficient level of digital literacy in terms of communication, collaboration and content creation. **While consumers are highly engaged in usage of instant messaging and social media applications, online frauds in which users are deceived into giving away personal banking information or transferring money to criminal networks also occur frequently on such channels. These facts suggest that there is still room for improvement in building digital financial literacy among the Thai population, particularly by raising awareness on cybersecurity.**

b) Financial literacy

In order to ensure successful adoption of any kind of digital financial product, including CBDCs, financial literacy will play an important role. In 2016, the BOT conducted a survey on financial skills using the OECD framework which focuses on three financial pillars: knowledge, behaviors and attitudes. Results showed that financial literacy among Thais was lower than the OECD average, especially on understanding key financial services¹¹, such as electronic payments, savings and investments.

As a result, we should aim to design CBDC to be as user-friendly and highly accessible by all segments of the population as possible. We should also aim to work with relevant government and private agencies to provide extensive financial knowledge training programs and promote financial discipline and consumer protection among the general public. Lastly, we should encourage financial institutions to educate their customers about products and services at points of service, which are considered the most effective communication channels.

c) Access to compatible smart devices and broadband network

As CBDC would be designed to be stored in digital wallets available on smart devices, there should be minimal frictions for consumers in acquiring one. Moreover, it is important to have easy access to internet connectivity that provides full geographic coverage and reliable connection. As of 2019, 66.7% of the Thai population had access to the internet, with 96.4% accessing the internet via a smartphone device¹². As gaps may still exist in accessing digital infrastructure and devices, especially among vulnerable population groups, we can **design the CBDC to work with minimal-featured, affordable and even offline-compatible smart devices, which can be in the form of simplified smart devices tools such as smartcards.** Lastly, CBDC custody should not rest fully within these smart devices, so that consumers would not lose their CBDC holdings if they lose the smart devices.

⁸ UNESCO (2018), "A Global Framework of Reference on Digital Literacy Skills for Indicator 4.4.2"

⁹ GSMA Association (2019), "Mobile Economic Impact Thailand February 2019"

¹⁰ Hootsuite & We Are Social (2020), "Digital 2020 Global Digital Overview"

¹¹ Bank of Thailand (2016), "Financial Sector Master Plan Phase III (2016-2020)"

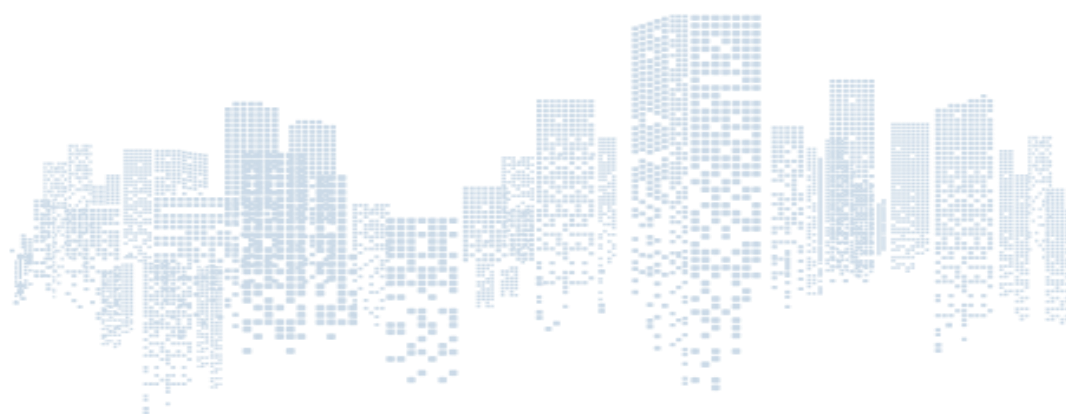
¹² National Statistical Office of Thailand

6.2 Digital Infrastructure

In order to successfully launch a resilient retail CBDC network and ecosystem, proper digital infrastructure will need to be in place. Firstly, strong broadband and mobile network coverage is essential as CBDC issuance, distribution and access processes would mainly occur online. Thailand has seen a rapid increase in mobile network penetration in the past several years, with over 90% of mobile network users in Thailand currently able to access 4G internet¹³ across the country's three major mobile network operators¹⁴. Thailand's 4G availability acts as a strong foundation for 5G adoption. In addition, based on the GSMA Association's 2018 Mobile Connectivity Index MCI, Thailand outperformed other Southeast Asian economies in all four mobile connectivity enabler categories: 1) content and services, 2) consumers, 3) affordability and 4) infrastructure. However, the GSMA suggested there is room for improvement in Thailand infrastructure's network performance and spectrum. As spectrum is a scarce resource, Thai operators will need to balance their resources between the new 5G users and the majority of existing 4G users, especially when 5G device-adoption takes off¹⁵.

Second, the retail CBDC system would entail processing large volumes of transactional data, requiring a high-powered cloud infrastructure. The network, servers and databases can be processed either on-premise or by using a third-party cloud service. As retail CBDC transactions may involve sensitive personal data, data security and sovereignty can become key concerns especially if we decide to utilize foreign cloud service providers, as it would be difficult to directly control and impose data governance outside of our jurisdiction.

Lastly, it is necessary to have a national digital identity system and efficient KYC processes as a foundational step in facilitating user onboarding to the CBDC system¹⁶. Moreover, digital identity verification and management are crucial towards a successful cross-border payment corridor using CBDC, as all countries would need to comply with AML/CFT regulations.



¹³ Opensignal (2020), "Thailand Mobile Network Experience Report November 2020"

¹⁴ AIS, DTAC, TrueMove H

¹⁵ Opensignal (2020), "5G hints from Thailand's 2600 MHz spectrum usage"

¹⁶ A proof of identity would be required for an account-based CBDC system, whereas it would be less necessary if we choose to implement a token-based CBDC system

6.3 Legal and Regulatory Frameworks

As with any new technology, we must assess which laws and regulations would be directly impacted if the BOT decides to issue retail CBDC. Without a solid legal basis for CBDC, the BOT could face legal and reputational challenges.

If the retail CBDC is to be issued as a new form of Thai Baht currency, constructive changes in the Currency Act's scope of enforcement may be needed to avoid unequivocal discrepancies between physical money and digital money. This is due to the fact that under the current legal framework, notes and coin are the only two forms of Thai Baht currency recognized as legal tender by the Currency Act. Secondly, under the Bank of Thailand Act (the BOT's founding law), the BOT's authorized tasks are to attain the key objectives of maintaining monetary stability, financial institution system stability and payment systems stability, as well as issue and manage banknotes. Therefore, any amendment of the Bank of Thailand Act would rest on the policy direction whether CBDC issuance would be considered part of these key objectives, or if it should be treated as an additional operation to be performed by the BOT to retain its capabilities to serve the key objectives. Lastly, possible amendments of other laws could involve the Payment Systems Act, if we consider retail CBDC to be a national and systematically important payment infrastructure rendering the BOT's oversight. Amendments may also involve the Financial Institution Business Act, which sets out the prudential measures for financial institutions in terms of maintenance of capital adequacy and liquidity assets, if they are allowed to hold retail CBDC.

In addition, as Thailand is a country with foreign exchange regulations, we should ensure that transactions involving retail CBDC must adhere to the same foreign exchange compliance and monitoring level as transactions traditionally conducted via banks. Otherwise, any discrepancy in foreign exchange control treatment of CBDC could be a regulatory loophole that cause arbitrage, especially given the potentially borderless and frictionless nature of CBDC. This could ultimately cause volatile capital flows and systemic risks which can be passed onto investors and consumers.

Lastly, if usage of retail CBDC becomes widely used in cross-border transactions, global regulatory coordination will be needed to curb any spillover effects. Given that the level of anonymity programmed into each retail CBDC will vary from country to country, a lack of traceability and information sharing in cross-border transactions could also give rise to channels for money laundering, terrorist financing or the evasion of sanctions. Thus, central banks should collaborate to develop guidelines or best practices when CBDCs transcend national borders, and promote traceability and transparency

C: Questions for Feedback

1. How do you view the general Thai public's readiness in adopting a retail CBDC at a national scale?
2. In what specific ways should the BOT engage with private sector to collaborate on building capacity for CBDC?
3. What other necessary preparation requirements should be addressed in terms of capacity building?

7 | The Way Forward

Rapid advancements in technology are contributing to more accessible, efficient and cheaper payment services in Thailand. The preliminary analysis presented in this paper illustrates that the introduction of retail CBDC as a novel means of payment would pose both opportunities and risks to the Thai economy.

Based on our analysis, we conclude that it is critical for the BOT to prioritize capacity building and take the necessary preparations for retail CBDC issuance. Even though there is no immediate need to issue a retail CBDC to the general public under current conditions, there is a high likelihood that the adoption of digital currencies could become systematically important in the near future, at which point the issuance of CBDC would be appropriate. Thus, in 2021-2022, we intend to focus our efforts on the research and development of a retail CBDC while closely monitoring business adoption, consumer trends and technology advancements. At the same time, we will prioritize capacity building on CBDC to better understand the implications beyond addressing the concerns arising from the involvement of other digital currencies.

The decision of whether to issue a retail CBDC would not rest solely on the central bank. It would require consultation with the government, relevant regulatory bodies and stakeholders. Accordingly, the BOT stands ready to continue our ongoing engagement with industry participants and stakeholders on this issue, as adopting a retail CBDC would require extensive public-private cooperation and coordination.

We welcome all feedback and ideas on the topic of retail CBDC from financial institutions, payment service providers, technology companies, academics, regulatory bodies and the general public. Please send us your thoughts via this [feedback form link](#), the QR code below, or via email to DigitalCurrencyTeam@bot.or.th by 15 June 2021 and clearly indicate your name, organization/profession and contact details so that we can contact you for further discussion.



Appendix 1 | CBDC Projects in Other Countries

Table 1: CBDC projects in other countries and key motivations

	Country	Key motivations (s)
Wholesale CBDC	Saudi Arabia & The United Arab Emirates Saudi Central Bank & Central Bank of the UAE	Explore the technical viability of dual-issued CBDC/ Improve efficiency for cross border payments
	Singapore Monetary Authority of Singapore	Explore the capabilities of DLT and concepts of CBDC for different use cases and future commercial solutions
	Australia Reserve Bank of Australia	Explore the capabilities of DLT for interbank settlement
Wholesale + Retail	South Africa South African Reserve Bank	Explore the capabilities of DLT and implications of CBDC
	Canada Bank of Canada	Explore the capabilities of DLT/ Low cash usage/ Rise of alternative payment service providers/ Preserve domestic payments safety
Retail CBDC	Eurozone European Central Bank	Low cash usage/ Reduce overall costs and ecological footprint/ Innovation/ Adoption of other payment methods
	Sweden Riksbank	Explore the capabilities of DLT/ Low cash usage/ Rise of alternative payment service providers/ Preserve domestic payments safety
	Bahamas Central Bank of the Bahamas	High cash usage/ High financial exclusion and intermediation/ High smartphone penetration/ Encourage usage of local currency
	China People's Bank of China	Decreased cash usage/ Rise of alternative payment service providers/ Rise of digital currencies/ High financial exclusion/ Reaching international reserve status for China's Yuan
	Jamaica Bank of Jamaica	Drive financial inclusion for the unbanked/ Create opportunities for the launch of complementary innovative products and systems on CBDC/ Enhance payment efficiency/ Reduce costs of cash

Sources: 1) Bank for International Settlements (2020), "Rise of the central bank digital currencies: drivers, approaches and technologies"
 2) Payments Canada (2021), "Central Bank Digital Currency (CBDC): Retail CBDC Global Developments"
 3) Bank of Jamaica (2021), "BOJ Prepares for Central Bank Digital Currency, March 2021"

Appendix 2 | Cost-Benefit Analysis of All Opportunities, Risks and Challenges

In Section 4: Cost-Benefit Analysis of Opportunities, Risks and Challenges, we outlined the primary opportunities and concerns regarding CBDC. In this Appendix, we further analyze other potential opportunities, risks and challenges. The framework of our analysis is adapted from the World Economic Forum’s CBDC Policy-Maker Toolkit¹⁷ to help us identify the attractiveness of CBDC as a policy option relative to other alternatives.

We assigned “primary” if the opportunities or concerns are highly relevant and would have significant impact on many stakeholders in Thailand. The opposite situation would be treated as “secondary”, for those that do not seem significant at the moment but could potentially become important in the future. We then analyzed the availability and feasibility of alternative policy options that could offer similar benefits, or mitigate the identified concerns. We define “many” as having many feasible alternative options available at disposal or if the alternatives would be less costly or less challenging to implement, while “few” indicates the opposite. This is to identify the relative attractiveness of retail CBDC as a policy option by suggesting which opportunities would present themselves as a “sweet spot” for retail CBDC—high potential benefits with few alternative options to achieve similar benefits. Similarly, it shows which concerns would be a “bad spot” — high risks with few mitigation options.

¹⁷ World Economic Forum (2020), “Central Bank Digital Currency Policy-Maker Toolkit”

Table 2: Assessing opportunities of retail CBDC for Thailand with alternative policy options

- **Primary opportunity:** Highly relevant and would have significant impact on many stakeholders in Thailand
- **Secondary opportunity:** Less relevant and low impact on key stakeholders in Thailand

Opportunities	Availability and Practicality of Alternative Policy Solutions
<p>● Provide a safe and reliable digital form of central bank money</p> <p>If any forms of private digital currencies become widely adopted, the effectiveness of monetary policy and the stability of the financial system could be undermined. Due to its openness and borderless nature, these currencies may be used to circumvent the BOT's foreign exchange regulations. As a result, users could face high credit, liquidity, foreign exchange risks or price volatility from holding these digital currencies. Moreover, users' security could be compromised if these digital currencies were left unregulated.</p> <p>If such a scenario occurs, CBDC could become a tool to help safeguard monetary and financial stability, while serving as a safer and publicly-accessible alternative to other forms of digital currencies. Thus, by design, CBDC should however maintain the integrity and transparency of central bank money, while also having competitive payment features relative to privately-issued digital currencies.</p>	<p>Medium:</p> <ul style="list-style-type: none"> ● Revise existing regulations or develop new guidelines to regulate the use of private digital currencies. ● Improve the existing payment and digital infrastructure. The BOT could develop programs to enhance innovation and competition in the payment sector, adopt new standards to modernize the current payment system and improve its capabilities to better support the new forms of financial services. Currently, such efforts are in progress under the BOT's Payment Systems Roadmap No. 4, but some roadblocks, such as high entry costs to the core payment infrastructure as faced by non-banks, still exist.
<p>● Enhance innovation and competition in financial services, and support the digital economy</p> <p>DLT has introduced the concept of programmable money, which allows any asset to be tokenized into digital currencies or digital asset tokens, deploying smart contracts directly on the digital tokens to execute transactions automatically.</p> <p>A CBDC could serve as an open digital infrastructure for any entities including non-banks to utilize DLT's functionalities and build value-added services on CBDC, thus enhancing competition and innovation in the financial service sector.</p>	<p>Medium:</p> <ul style="list-style-type: none"> ● Improve the existing payment and digital infrastructure to support DLT-based system. ● Open banking initiatives: Currently, the BOT encourages banks to open API access to their database or services (provided the customers grant consent), enabling developers, entrepreneurs, start-ups and enterprises to build innovative applications connected to the banks' services and products through APIs. However, some incumbents may have negative views on open banking as it could introduce new risks and heighten competition.

Opportunities	Availability and Practicality of Alternative Policy Solutions
<p>● Enhance efficiency in cross-border remittances</p> <p>Thailand has long been a key destination for migrant workers from neighboring countries. Such workers rely on money transfer operators or informal channels to send income home, and the remittance cost of small, personal transfers run high. Remittance costs from Thailand to the CLMV region averages 11-13% of the total transaction value¹⁸, more than two times higher than the target set by the U.N. Sustainable Development Goals¹⁹, while remittances to non-CLMV countries cost even higher. As for cross-border transactions via banks, which are typically channeled through correspondent banks across multiple time zones, there are significant time delays and a lack of traceability.</p> <p>CBDC could help enhance the overall end-to-end cross-border transaction flow, by eliminating intermediaries to lower costs, provide traceability and shorten time delays.</p>	<p>Many:</p> <ul style="list-style-type: none"> • Create interlinkages between regional/ international retail payment systems, beginning with ASEAN countries²⁰. Currently, the BOT and the Monetary Authority of Singapore are working to link Thailand's national retail payment system PromptPay with Singapore's Paynow, enabling retail mobile payments between the two countries. The initiative is expected to launch within the third quarter in 2021, and is hoped to expand to other regional countries²¹. • Reduce burdensome cross-border regulations and compliance processes, which would require amending domestic regulations as well as cooperating with regulatory bodies internationally.
<p>● Reduce money laundering, illicit financing and tax evasion</p> <p>Due to the anonymity attribute of cash and some cryptocurrencies, they are often used as vehicles for money laundering and other illicit financing activities. With CBDC, however, transactions are traceable. This could potentially discourage the use of CBDC to sponsor any illegal activities. Nevertheless, there is a clear trade-off between protecting users' privacy and complying with AML/CFT requirements, which the BOT and any relevant authorities need to balance when designing CBDC.</p>	<p>Many:</p> <ul style="list-style-type: none"> • Encourage the use of electronic money for retail payments to increase traceability and transparency, which would inadvertently reduce cash in circulation and ultimately usage of cash for illicit activities. • Thailand's Emergency Decree on Digital Asset Businesses²² dictates that digital asset businesses are considered as financial institutions and must adhere to AML/CFT requirements, to prevent the exploitation of digital assets as a channel for money laundering.

¹⁸ The World Bank (2020), "Remittance Prices Worldwide"

¹⁹ United Nations, "International Day of Family Remittances 16 June"

²⁰ The Association of Southeast Asian Nations (ASEAN) consists of Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam.

²¹ Bank of Thailand (2019), "ASEAN Payment Connectivity: Singapore and Thailand", ASEAN Central Bank Governors' Meeting in Chiang Rai, Thailand

²² The Securities Exchange Commission of Thailand

Opportunities	Availability and Practicality of Alternative Policy Solutions
<p>● Lower cost of cash distribution and management</p> <p>A PIER²³ study in 2018²⁴ estimated the costs associated with distributing and managing banknotes at 1.26 Baht per transaction, or 0.34 Baht per note usage. The cost is attributed mostly to logistics and transportation burdens²⁵.</p> <p>For CBDC, the costs of implementing and operating the system as well as the cost of transitioning to CBDC are still largely uncertain, and would need to be compared with the costs of cash.</p>	<p>Many:</p> <ul style="list-style-type: none"> • Improve banknote logistic and management process. Some options include pooled logistics between different private cash centers, or white-labeling ATMs. To achieve this, an incentive scheme to encourage bank cooperation is necessary as they have already invested in their own systems and operations. • Encourage the use of PromptPay and standardized QR codes. These initiatives by the BOT have allowed households and businesses to make small-value electronic payments and transfers across different banks with no fees.
<p>● Provide continued access to central bank money for when access to cash is difficult or unavailable</p> <p>In a cashless society, privately-offered means of payment could be the only means of payment accessible to the public. Therefore, central bank-provided digital money in the form of CBDC could be an opportunity to reduce reliance on private systems by ensuring constant availability of a public backup system.</p> <p>However, these benefits may take a long time to materialize. In recent years, the use of cash for transactions has somewhat declined in Thailand, but cash is still widely available and accepted. As of 2019, cash in circulation (CIC) remained relatively high in Thailand at around 11% of GDP²⁶, compare to “cashless” countries like Sweden where CIC stands at 1.3%²⁷.</p>	<p>Few:</p> <ul style="list-style-type: none"> • Promote competition between e-payment providers to prevent the market from being concentrated in the hands of a few large players, which may increase systemic risks. • Continue to require that e-money is fully backed and is strictly separated from lending activities to ensure the robustness of private payment systems.

²³ Puey Ungphakorn Institute for Economic Research (founded by the Bank of Thailand)

²⁴ PIER (2018), “The Journey to Less-Cash Society: Thailand’s Payment System at a Crossroads”

²⁵ The BOT coordinates with private cash management companies (commercial banks’ subsidiaries and cash-in-transit companies) to distribute banknotes to bank branches and ATMs around the country. In addition, they also handle the returning unfit banknotes as well as manage end-of-day outstanding amount of cash available in the commercial banks’ cash centers to be counted towards non-remunerated reserve requirements, which dictate that banks are required to maintain a minimum of 1% in non-remunerated current account deposits at the BOT, of which no more than 0.2% in cash at private cash centers of commercial banks can be counted towards this.

²⁶ One-year quarterly moving average, from Bank of Thailand (2020), “Thailand’s Key Macroeconomic Chart Pack”

²⁷ Bank for International Settlements

Opportunities	Availability and Practicality of Alternative Policy Solutions
<p>● Improve monetary policy transmission</p> <p>Interest-bearing CBDC can allow the BOT to transmit policy rate directly to households and businesses. In addition, it could eliminate the lower bound on the policy rate. However, its effectiveness will largely depend on the availability of cash as an alternative to CBDC. That is, if cash is still widely available, holders of negative-yielding CBDC can always switch to cash and thus bypass the negative rate.</p>	<p>Medium:</p> <ul style="list-style-type: none"> • Increase competitions in the financial service sector, for example by offering financial service licenses to non-banks, in order to enhance monetary transmission to households and businesses • Promote transparency in the setting of commercial banks' benchmark lending and deposit rates.
<p>● Enhance financial inclusion</p> <p>According to the Financial Access Survey of Thai Households in 2018²⁸, Thai households' overall access to key financial services such as savings, payment, insurance, investments, has been largely inclusive and improving. Their access level increased to 98.7% from 97.3% in 2016, while no-access households, whose majority were low-income populations, decreased to 1.3% from 2.7%.</p> <p>We assess the benefits of CBDC for the unbanked and underbanked population²⁹ to be marginal, given Thailand's large strides in expanding digital financial services and products offered by banks and non-banks, and high mobile phone penetration (75% of Thai adults already have registered mobile money accounts³⁰).</p>	<p>Many:</p> <ul style="list-style-type: none"> • Allow banks to verify customer identities digitally e.g. using biometrics data. This would assist people, especially those living in remote areas, in opening bank accounts and accessing financial services. • Provide a supportive regulatory environment to promote more competition and the development of innovation and technology. This could include providing digital banking licenses for non-banks, and supporting microfinance institutions to ensure funds for low-income households. • Increase financial literacy by promoting knowledge of basic financial products to households and empower them to choose products that best meet their needs.

²⁸ Bank of Thailand (2018), "Financial Access Survey of Thailand Households 2018"

²⁹ Unbanked populations refer to those without bank accounts, while underbanked populations refer to those lacking sufficient access to mainstream financial services and products.

³⁰ IMF (2019), "Financial Access Survey 2019"

Table 3: Assessing risks and challenges of retail CBDC for Thailand with mitigation options

- **Primary risk:** Highly relevant and would have significant impact on many stakeholders in Thailand
- **Secondary risk:** Less relevant and low impact on key stakeholders in Thailand

Risks and Challenges	Availability of Options to Mitigate or Address
<ul style="list-style-type: none"> ● Banking disintermediation <p>CBDC, if sufficiently attractive, could lead to deposit outflows and reduced bank lending. However, we assess that the risk of disintermediation is low as the deposits of Thai banks currently exceed loans. Moreover, there are motives for the recipients of CBDC to convert the money back to deposits which would help to offset deposit outflows, such as the need to access financial services offered by banks.</p>	<p>Many:</p> <ul style="list-style-type: none"> • Design CBDC to induce the use of CBDC as a means of payment rather than as a store of value, such as imposing a cap on conversions between deposits or cash to CBDC, or paying lower interest rates on CBDC relative to bank deposits. • Provide strong prudential oversight, maintenance of adequate capital and liquidity buffers, deposit insurance, and commitment to clear interbank payments in reserves at parity.
<ul style="list-style-type: none"> ● Bank runs <p>In times of economic or financial markets turmoil, a systemic bank run could occur. Given the advantage of technology, a perceived “flight to quality” from bank deposits to CBDCs could take place at an unprecedented speed. The need for the banks to acquire more liquidity to serve large withdrawals could lead to a liquidity squeeze in the money markets, with knock-on effects on monetary policy and wider financial stability.</p>	<p>Many:</p> <ul style="list-style-type: none"> • Create frictions to deter runs by setting withdrawal or holding limits to limit CBDC convertibility from bank deposits, or setting tiered remuneration rates on CBDC holdings. • Adjust banks’ capital and liquidity requirements. • Provide an adequate deposit guarantee scheme to help deter runs.

Risks and Challenges	Availability of Options to Mitigate or Address
<p>● Public trust</p> <p>Building and maintaining public trust in the central bank as the issuer of CBDC and the operator of the national system will be essential for a well-functioning, secure and resilient monetary system. The general public must have confidence in the CBDC.</p>	<p>Many:</p> <ul style="list-style-type: none"> • Develop clear standards, regulations, risk-management guidelines and governance structure for the CBDC system. For example, the CBDC could be issued against eligible assets, similar to how banknotes are backed by reserves, to ensure the public's trust in the stability of the CBDC's value. The technology underpinning the CBDC system must meet the highest security standards. In addition, the roles and responsibilities of CBDC operators, service providers and other participants should be specified in the rulebook so as to hold them accountable for their roles in the CBDC ecosystem. • Develop a CBDC implementation plan as well as a business continuity plan with stakeholder engagement and public communication to promote public awareness, user adoption and build trust.
<p>● Data privacy and security concerns</p> <p>Similar to any other digital means of payment, CBDC users' transactional data could be tracked, thus raising serious concerns regarding managing security and privacy of personal data involved. The BOT, as the overseer of the CBDC system, would need to consider the appropriate technologies and governance as it would need to deal with an immense amount of data in its role of national surveillance.</p>	<p>Many:</p> <ul style="list-style-type: none"> • Consider a token-based versus an account-based design • Establish safeguards to store and protect the security, privacy and confidentiality of user data, compliant with the Personal Data Protection Act³¹. For example, explicit user consent must be obtained before collecting or processing data. Users must be informed about the purpose of data collection and have the right to access, dispute the accuracy of, or have erroneous data corrected or deleted.

³¹ Personal Data Protection Act of the Kingdom of Thailand, effective since 28 May 2020

Risks and Challenges	Availability of Options to Mitigate or Address
<p>● Capital flow management</p> <p>Due to the potentially borderless and frictionless nature of CBDC (subject to its design), it could be utilized to circumvent foreign exchange regulations in Thailand, which currently limit certain outbound transactions and non-resident³² holdings of Thai Baht to prevent currency speculation. In addition, high-volume and high-value transactions could take place instantaneously via CBDC, possibly stimulating higher capital flow volatility. Lastly, if both residents and non-residents are allowed to transfer and transact the CBDC freely abroad, this could lead to rapid unintentional internationalization of the Thai Baht which would ultimately challenge the BOT's ability in maintaining exchange rate stability.</p>	<p>Many:</p> <ul style="list-style-type: none"> • Establish limits or restrictions on CBDC transfers and non-resident holdings, to prevent speculative capital flows and/or unintended internationalization of the Thai Baht • Treat CBDC transactions with the same level of regulatory compliance and build supervision mechanisms to allow for the same level of regulatory oversight as traditional bank transfers.
<p>● Public adoption and networks</p> <p>Users typically select services that are most suitable for their needs and offer the best user experience. The challenge will be incentivizing users to adopt CBDC and establishing a strong payment network. CBDC should be able to offer a relatively user-friendly payment experience, and low cost to access. Moreover, it should be universally accepted and interoperable with other payment systems. Lastly, digital and financial literacy will determine the degree at which users are able to safely and confidently transact with CBDC.</p>	<p>Many:</p> <ul style="list-style-type: none"> • Design CBDC to be accessible across a wide range of devices, both online and offline methods (not limited to smartphones), such as payment cards. • Build knowledge capacity through provision of free digital and financial literacy training programs, targeting populations that would be otherwise excluded, such as elderly and rural communities.

³² Non-residents of Thailand include corporations, institutions, funds, financial institutions, juristic persons, entities of foreign governments, branches and agents of domestic juristic persons, that are located outside Thailand; natural persons not of Thai nationalities and not having alien identity or residence permits.

Risks and Challenges	Availability of Options to Mitigate or Address
<p>● The central bank's balance sheet</p> <p>CBDC would constitute as part of the monetary base along with cash and current accounts, all of which are liabilities of the BOT. The impact of CBDC on the BOT's balance sheet would largely depend on whether CBDC is remunerated. If CBDC does not pay interests the impact of issuing CBDC would not differ from that of issuing cash. However, if CBDC pays positive interest, seigniorage income would instead be reduced proportionately to the level of interest rate paid as well as the rate at which CBDC replaces cash. In this case, the cost of liquidity absorption could increase.</p>	<p>Many:</p> <ul style="list-style-type: none"> The negative impact on the balance sheet would be more likely if CBDC is remunerated. If the BOT decides to pursue this model, we would need to have strategic plans for possible higher cost of liquidity absorption so as to not lead to unsustainable financial impacts on the balance sheet, for example, explore ways to increase returns on the asset side of the balance sheet.

Summary of Cost-Benefit Analysis

The quadrants below summarize our assessment of CBDC opportunities, risks and challenges for Thailand from the Tables above. In Figure 13, it is clear that not all of these benefits are relevant in the Thai context. Opportunities for CBDC that appear to be most promising for Thailand are: 1) Provide a safe alternative to privately-issued digital currencies and 2) Enhance innovation and competition in financial services, and support the digital economy. However, when weighed against the availability of alternative policy options that may be better equipped to address the opportunities presented, we see no immediate benefit to embark on pursuing these opportunities at the time of writing. Although we conclude that there are alternative solutions that the BOT can deploy to deliver similar outcomes, it is still necessary for the BOT to closely monitor the development of digital currencies, business adoptions, consumer trends and technology advancements. There is a possibility that these factors could become systematically important in the near future, rendering alternative policies no longer desirable or practical, at which point the issuance of CBDC can become a viable solution for the BOT.

In addition, it is clear from our analysis that CBDC issuance and implementation will lead to several risks and challenges that the BOT would need to carefully consider (Figure 14). We assess that while many risks fall under the direct purview of the central bank, such as the risks of banking disintermediation and bank runs. However, some risks fall under the purviews of other regulatory bodies as well, such as data protection and money laundering. Through policy coordination with relevant agencies, most concerns can be mitigated through the design of the CBDC itself and other measures.

Figure 13: Quadrant diagram showing opportunities of CBDC in the Thai context

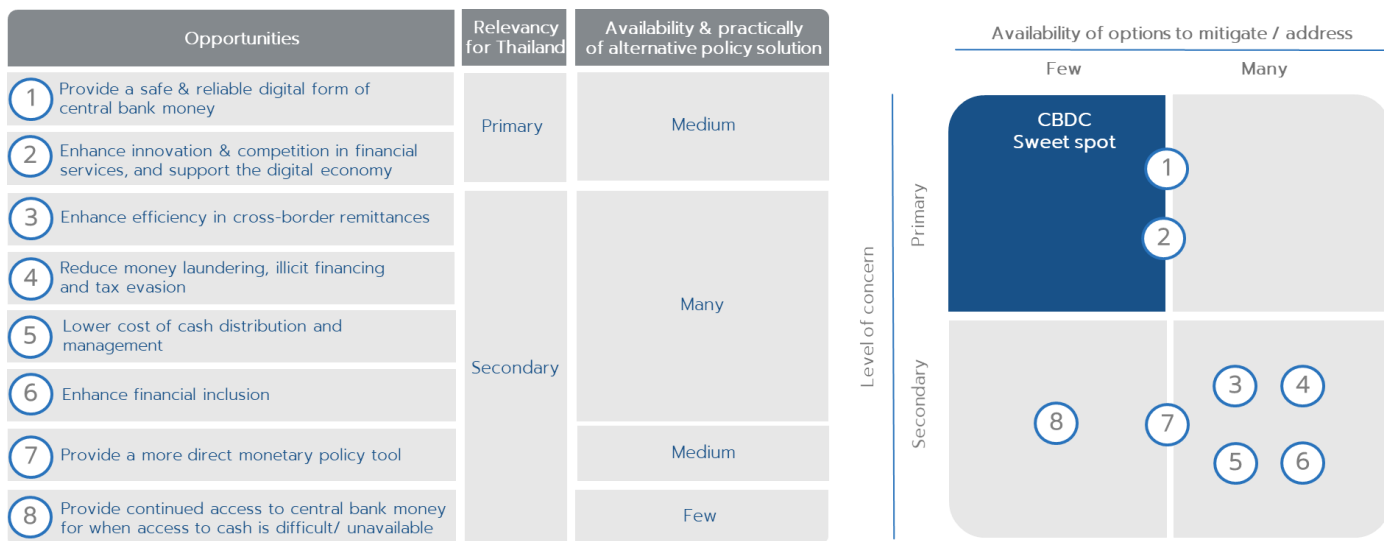
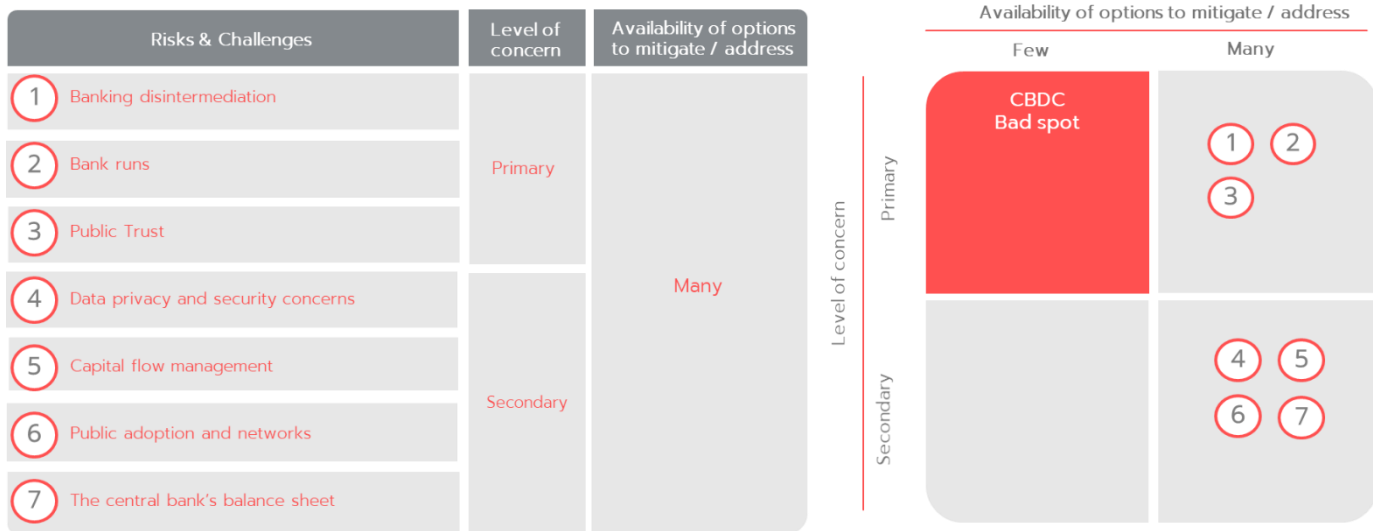


Figure 14: Quadrant diagram showing risks and challenges of CBDC in the Thai context



Appendix 3 | Assessment of All CBDC Design Considerations

CBDC, as a means of payment with direct claims to the central bank, should not only possess attributes akin to cash but also other value-added qualities. In Table 4, we explore all possible advantages and disadvantages of various key attributes of CBDC, in order to best understand the key tradeoffs of each design option.

Table 4: Key attributes, tradeoffs and design options for CBDC

Design Options	Advantages	Disadvantages
Anonymity <i>Key Tradeoffs: User privacy vs. Economic value of Big Data vs. Regulatory oversight vs. Decentralization vs. Scalability</i>		
Full anonymity CBDC transactional information would not be revealed to the operators (similar to cash)	<ul style="list-style-type: none"> • If cash usage declines, an anonymous CBDC helps ensure the public's access to financial anonymity • Well-suited in a fully decentralized system 	<ul style="list-style-type: none"> • Could facilitate shadow economy activities, tax evasion, money laundering and other illicit financing
Partial anonymity CBDC transactional information is revealed partially, or only to designated parties, or if some conditions are met	<ul style="list-style-type: none"> • More flexible as we can create layers of privacy and choose to reveal only some parts of transaction history, or only to relevant parties 	<ul style="list-style-type: none"> • Could still allow for shadow economy activities, tax evasion, money laundering and other illicit financing • Might need to utilize various privacy-enhancing techniques for different layers, stakeholders and conditions, leading to high complexity and costs in running the system³³
No anonymity CBDC transactional information can be tracked by payers, payees, operators, regulators and auditors (similar to e-money)	<ul style="list-style-type: none"> • Allows for complete regulatory oversight and compliance • Helps reduce shadow economy • Increased level of granularity can leverage Big Data benefits 	<ul style="list-style-type: none"> • Adoption reluctance from users • Central bank (or agency on its behalf) is liable for storing data • Could impact the performance or scalability of the system

³³ European Central Bank (2019), "Exploring anonymity in central bank digital currencies"

Design Options	Advantages	Disadvantages
Interest rates		
<i>Key Tradeoffs: Attractiveness for users vs. Banking intermediation vs. Monetary policy effectiveness</i>		
<p>Interest-bearing</p> <p>Holders of CBDC receive interest (either a fixed or floating rate). In addition, the central bank could choose to charge a tiered interest, or impose only negative interest rate to overcome the effective lower bound</p>	<ul style="list-style-type: none"> • Strengthens monetary policy transmission, allowing for setting negative interest rates (subject to high level of cash substitution) • Encourages the public to switch from holding 0%-yielding banknotes to CBDC • Enhances financial inclusion as it does not require holders to have a bank account to be able to receive interest 	<ul style="list-style-type: none"> • Could lead to financial disintermediation and associated risks by encouraging the public to shift from bank deposits to CBDC • Directly reduces central bank's seigniorage revenue in proportion to the level of interest rates charged
<p>No interest</p> <p>Users holding CBDC would not receive any interest</p>	<ul style="list-style-type: none"> • Serves mainly as a means of payment while maintaining the ability to be used as a unit of account (similar to cash) • Can increase the central bank's seigniorage revenue 	<ul style="list-style-type: none"> • The central bank would be ruled out of the option to implement negative interest rates
Accessibility		
<i>Key Tradeoffs: Attractiveness for users vs. Regulatory oversight</i>		
<p>Universal</p> <p>Anyone, regardless of status or nationality, can access and hold CBDC</p>	<ul style="list-style-type: none"> • Maximizes inclusivity and offers a positive experience for all users • Can facilitate cross-border transactions 	<ul style="list-style-type: none"> • If accessible by non-residents, it could facilitate currency speculation and increased capital flow volatility
<p>Limited</p> <p>Only specific users can access and hold CBDC</p>	<ul style="list-style-type: none"> • Limited access for non-residents could preserve financial and exchange rate stability 	<ul style="list-style-type: none"> • Could lead to financial and economic exclusion of already vulnerable population groups • Other benefits of CBDC may be eclipsed by privately-issued digital currencies that are more accessible

Design Options	Advantages	Disadvantages
Programmability <i>Key Tradeoffs: Innovation vs. Security</i>		
<p>Open</p> <p>Platforms that allow and enable developers to create applications on top of the existing infrastructure, that provide solutions for various problems</p>	<ul style="list-style-type: none"> • Allows for value-added innovative products and other commercial services to be built on the ecosystem, stimulating competition • Encourages public-private collaboration and interoperability • Can accelerate mainstream adoption by leveraging the existing customer base and network 	<ul style="list-style-type: none"> • Clear rules, standards and governance, especially around information disclosure and transaction visibility, must be established to protect users
<p>Limited</p> <p>Access to the platform is limited or restricted to certain conditions</p>	<ul style="list-style-type: none"> • More emphasis on privacy and security 	<ul style="list-style-type: none"> • Limited interoperability, scalability and performance • Might cause fragmentation of systems or low levels of adoption
Transaction cost <i>Key Tradeoffs: Attractiveness for users vs. Revenue</i>		
<p>Free</p> <p>Users would not incur any transaction fees</p>	<ul style="list-style-type: none"> • Appealing and accessible by users of all income groups, easy to gain traction 	<ul style="list-style-type: none"> • If the cost of running a CBDC system is very high, a free-for-all model might not be cost-feasible
<p>Fee on certain transaction amounts</p> <p>A fee would be imposed on transactions exceeding certain amounts</p>	<ul style="list-style-type: none"> • Discourages the use of CBDC for illicit activities • The CBDC operator can earn transaction revenue to cover the cost of CBDC operations 	<ul style="list-style-type: none"> • Might discourage some users from using CBDC

Design Options	Advantages	Disadvantages
Holding, Transfer and Conversion		
<i>Key Tradeoffs: Attractiveness for users vs. Banking intermediation vs. Regulatory oversight</i>		
<p>Unlimited</p> <p>Users can hold, transfer and convert unlimited amounts of CBDC</p>	<ul style="list-style-type: none"> High convenience and appeal for users 	<ul style="list-style-type: none"> Might lead to large-scale bank runs Might facilitate shadow economy activities, money laundering and other illicit financing
<p>Limited</p> <p>Holdings, transfers and conversions of CBDC would be limited either by amount, time or other conditions</p>	<ul style="list-style-type: none"> Discourages bank runs Discourages the use of CBDC for illicit activities 	<ul style="list-style-type: none"> Adoption reluctance from users as it creates many frictions

As the operator of the payment system, the BOT should ensure that its system architecture and technology can effectively meet the retail CBDC's desirable payment features for end users as well the BOT's roles in monetary policy and financial stability. In Table 5, we analyze the advantages and disadvantages of system design choices that serve the key mechanisms of CBDC: issuance, distribution, transfer and settlement.

Table 5: System architecture design options

Design Options	Advantages	Disadvantages
Issuance		
<p>Token-based</p> <p>Similar to printing money, the central bank issues a specific denomination for each CBDC token, but does not need to keep accounts. Transactions are verified based on the authenticity of the token.</p>	<ul style="list-style-type: none"> Extends attributes of cash to the digital world by enabling universal access, anonymity and security for CBDC holders 	<ul style="list-style-type: none"> Requires significant monetary law reforms; must consider whether a token-based CBDC should and could be granted legal tender status Risk of users' private keys being forgotten, leaked or hacked, which would introduce risks to the system Difficult to trace money laundering or fraudulent transactions.

Design Options	Advantages	Disadvantages
<p>Account-based</p> <p>Similar to how banks manage deposit accounts, the central bank keeps record of holders and their account balances of CBDC on its balance sheet i.e. users hold accounts directly with the central bank and transactions are verified based on the identity of the account owner.</p>	<ul style="list-style-type: none"> • Allows the central bank greater transactional traceability • Better scalability than token-based 	<ul style="list-style-type: none"> • Central bank would take on additional operational responsibilities i.e. KYC and onboard every user • Could increase financial intermediation risk, raise funding costs for banks and facilitate digital runs during periods of distress
Distribution		
<p>One-tier</p> <p>The central bank is responsible for all aspects of the system including issuance, account-keeping, transaction verification and CBDC</p>	<ul style="list-style-type: none"> • Central bank will have full visibility on payment data; can utilize data to improve policies 	<ul style="list-style-type: none"> • Directly competes with the banking sector for deposits; creates ambiguity on who would provide credit or complementary financial services • Central bank would take on additional operational responsibilities and build a customer-facing infrastructure
<p>Two-tier</p> <p>The central bank assigns intermediaries to distribute CBDC to customers and handle all customer-facing activities</p>	<ul style="list-style-type: none"> • Intermediaries (especially banks) already have a comparative advantage over the central bank in account-keeping services, such as KYC processes, AML/CTF checks, and transaction verification. • Allows more effective usage of existing resources and infrastructure, supports innovation and promotes competition 	<ul style="list-style-type: none"> • A well-functioning and robust two-tier system will only be as strong as the rules, standards and governance of participant roles and responsibilities established

Design Options	Advantages	Disadvantages
Transfer and Settlement		
<p>Centralized</p> <p>The central bank runs the entire system and manages the end-to-end process</p>	<ul style="list-style-type: none"> • The central bank can unilaterally control transactions, such as withholding or reverting transactions 	<ul style="list-style-type: none"> • Low resiliency to system attacks (single node of failure) • Technology may soon become outdated
<p>Decentralized</p> <p>Usage of DLT allows payments to be processed and finalized without involving a central party</p>	<ul style="list-style-type: none"> • Greater resiliency and robustness • More open and flexible for programmability, thus supportive of innovation 	<ul style="list-style-type: none"> • Low transaction throughput as consensus process is computationally intensive • Technology is still nascent, requires continuous system adaptation
<p>Hybrid</p> <p>DLT is used for only specific functions such as recording data, limiting the number of nodes or specifying functions participants can perform in the system</p>	<ul style="list-style-type: none"> • Greater resiliency and robustness than a centralized system, with higher performance than a decentralized system 	<ul style="list-style-type: none"> • Requires interoperability between centralized and decentralized systems, which might entail operational complexity

Glossary

AML/CFT	Anti-Money Laundering/Combating the Financing of Terrorism
API	Application Programming Interface
ASEAN	Association of Southeast Asian Nations
BOT	Bank of Thailand
CBDC	Central Bank Digital Currency
CLMV	Cambodia, Laos, Myanmar, Vietnam
DeFi	Decentralized finance
DLT	Distributed Ledger Technology
FinTech	Financial technology company
ICO	Initial coin offering
KYC	Know-your-customer
OECD	Organization for Economic Co-operation and Development
PET	Privacy-enhancing technologies
REIT	Real estate investment trust
UNESCO	United Nations Educational, Scientific and Cultural Organization

Acknowledgements

This paper was prepared by the Bank of Thailand's Digital Currency Team.



Authors

Tansaya Kunaratskul

Tunyathon Koonprasert



Content Contributors

Amporn Sangmanee

Archari Suppiroj

Aunshulee Horsombat

Chanokkarn Mek-yong

Chanutaporn Boonsongsawat

Chanya Phanthajarunithi

Chiranuwat Tanyacharoen

Kasidit Tansanguan

Nalin Nookhwun

Natta Piyakarnchana

Passawuth Nuntnarumit

Pim-on Wacharaprapapong

Pornvipa Tangcharoenmonkong

Prapat Teerakathiti

Premmanat Kanchanawila

Roong Mallikamas

Sarun Youngnoi

Suparit Suwanik

Thitima Chucherd

Tuln Sermsiriviboon

Vachira Arromdee



Graphic Designers

Panita Tantisunthorn

Rungthong Yuwaphan



Interviewees, Design Thinking Workshop & Policy Forum Participants

Advanced Info Service Public Co., Ltd.

Ascend Group Co., Ltd.

Bangkok Bank Public Co., Ltd.

Bank of Ayudhya Public Co., Ltd.

Bitkub

Chulalongkorn University

Digital Ventures Co., Ltd.

Kasikorn Bank Public Co., Ltd.

Kasikorn Business-Technology Group
(KBTG)

Kasikorn Line Co., Ltd.

Kiatnakin Bank Public Co., Ltd.

Krungthai Bank Public Co., Ltd.

Kulap

Minor International Public Co., Ltd.

Satang Corporation Co., Ltd.

SCB10x Co., Ltd.

SE Digital Co., Ltd.

Sea Limited

Securities and Exchange Commission,
Thailand

Siam Commercial Bank Public Co., Ltd.

Standard Chartered Bank (Thai) Public
Co., Ltd.

Thanachart Bank Public Co., Ltd.

The Hongkong and Shanghai Banking
Corporation Limited

The Siam Cement Group Public Co., Ltd.

The Stock Exchange of Thailand



Special Thanks

Anupap Kivinichkul

Dej Titivanich

Mathee Supapongse

Nuttawut Atiratana

Ronadol Numnonda

Subhak Siwaraksa

Thammarak Moenjak

Vijak Sethaput

Chananun Supadulya

Don Nakornthab

Nawaron Dejsuvan

Rapee Sucharitakul

Siritida Panomwon Na Ayudhya

Tarin Thaniyavarn

Tharith Panpiemras

Yongsak Seanglaw

References

- Allen, S., Čapkun, S., Eyal, I., Fanti, G., Ford, B., Grimmelmann, J., . . . Zhang, F. (2020). *Design choices for Central Bank Digital Currency: Policy and technical considerations*. Retrieved from https://www.brookings.edu/wp-content/uploads/2020/07/Design-Choices-for-CBDC_Final-for-web.pdf
- Bank for International Settlements. (2020). *BIS Working Papers No 880: Rise of the central bank digital currencies: drivers, approaches and technologies*. Retrieved from <https://www.bis.org/publ/work880.pdf>
- Bank for International Settlements. (2020). *The technology of retail central bank digital*. Retrieved from https://www.bis.org/publ/qtrpdf/r_qt2003j.pdf
- Bank of Jamaica. (2021). *BOJ Prepares for Central Bank Digital Currency*. Retrieved from Jamaica Information Service: <https://jis.gov.jm/boj-prepares-for-central-bank-digital-currency/>
- Bank of Thailand. (2016). *Financial Sector Master Plan Phase III (2016-2020)*. Retrieved from <https://www.bot.or.th/English/FinancialInstitutions/Highlights/FSMP3/FinancialSectorMasterPlanIII.pdf>
- Bank of Thailand. (2018). *Financial Access Survey of Thailand Households 2018*. Retrieved from https://www.bot.or.th/English/FinancialInstitutions/Highlights/FSMP2/2018Financial_Access_Survey.pdf
- Bank of Thailand. (2019). *Payment Systems Roadmap No. 4 (2019-2021)*. Retrieved from https://www.bot.or.th/English/PaymentSystems/PolicyPS/Documents/PaymentRoadmap_2021.pdf
- Bank of Thailand. (2019, April 4). *ASEAN Payment Connectivity: Singapore and Thailand. ASEAN Central Bank Governors' Meeting*. Chiang Rai, Thailand. Retrieved from https://www.bot.or.th/Thai/AboutBOT/Activities/Documents/ASEANPaymentConnectivity_BOT_MAS.pdf
- Bank of Thailand. (2020). *Thailand's Key Macroeconomic Chart Pack*. Retrieved from https://www.bot.or.th/Thai/Statistics/Graph/Chart_Pack/Chart%20Pack.pdf
- European Central Bank. (2019). *Exploring anonymity in central bank digital currencies*. Retrieved from <https://www.ecb.europa.eu/paym/intro/publications/pdf/ecb.mipinfocus191217.en.pdf?3824c3f26ad2f928ccea370393cce785>
- GSMA Association. (2019, February). *Mobile Economic Impact: Thailand*. Retrieved from <https://www.gsma.com/betterfuture/wp-content/uploads/2019/08/Mobile-Economic-Impact-2019-Thailand.pdf>
- Hootsuite & We Are Social. (2020). *Digital 2020: Thailand*. Retrieved from Datareportal: <https://datareportal.com/reports/digital-2020-thailand>

- International Monetary Fund. (2019). *Financial Access Survey*.
- Khatri, H. (2020, August 10). *5G hints from Thailand's 2600 MHz spectrum usage*. Retrieved from Opensignal: <https://www.opensignal.com/2020/08/10/5g-hints-from-thailands-2600-mhz-spectrum-usage>
- Opensignal. (2020). *Thailand Mobile Network Experience Report November 2020*. Retrieved from <https://www.opensignal.com/reports/2020/11/thailand/mobile-network-experience>
- Payments Canada. (2021). *Central Bank Digital Currency (CBDC): Retail CBDC Global Developments*. Retrieved from https://www.payments.ca/sites/default/files/paymentscanada_centralbankdigitalcurrency_retail_globaldevelopments_2021.pdf
- Positive Money. (2020). *Money We Trust: Designing Cash's Digital Counterpart*. Retrieved from <https://positivemoney.org/wp-content/uploads/2020/04/Positive-Money-Money-We-Trust.pdf>
- Puey Ungphakorn Institute for Economic Research. (2018). *The Journey to Less-Cash Society: Thailand's Payment at a Crossroads*. Retrieved from https://www.pier.or.th/wp-content/uploads/2018/12/pier_dp_101.pdf
- The Securities and Exchange Commission of Thailand. (2018). *Summary of the Emergency Decree on Digital Asset Businesses B.E. 2561*. Retrieved from https://www.sec.or.th/TH/Documents/DigitalAsset/enactment_digital_2561_summary_en.pdf
- UNESCO. (2018). *A Global Framework of Reference on Digital Literacy Skills for Indicator 4.4.2*. Retrieved from <http://uis.unesco.org/sites/default/files/documents/ip51-global-framework-reference-digital-literacy-skills-2018-en.pdf>
- World Economic Forum. (2020). *Central Bank Digital Currency Policy-Maker Toolkit*. Retrieved from http://www3.weforum.org/docs/WEF_CBDC_Policymaker_Toolkit.pdf
- Yanqing, Y. (2017, September 13). *China Should Push Global Regulatory Coordination on Virtual Currencies*. Retrieved from YiCai Global: <https://www.yicaiglobal.com/news/china-should-push-global-regulatory-coordination-on-virtual-currencies>

The background is a dark blue gradient with various currency symbols (Dollar, Euro, Yen, Bitcoin) and network-like graphics (circles, lines) scattered across it.

Contact Us

DigitalCurrencyTeam@bot.or.th

Digital Currency Team
Bank of Thailand