



**The University of Hong Kong**

**Final Report of  
FITE4801 Final Year Project  
Discuss the current development and the future practices of  
CBDCs (e-HKD) in Hong Kong**

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## **Abstract**

Hong Kong undergoes digital innovation in the financial sector. The recent launch of the e-HKD Pilot Programme signifies the progress towards the official implementation of e-HKD. This research paper focuses on the practical applications and promotion of e-HKD (electronic Hong Kong Dollar) as a retail CBDC (Central Bank Digital Currency) in Hong Kong. In particular, this paper employs a mixed-methods approach consisting of a comprehensive literature review and case study of e-CNY to discuss potential challenges that may face during the promotion of e-HKD. And based on the analysis, this paper develops corresponding recommendations for effective implementation and adoption of e-HKD.

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## List of Abbreviations

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<b>Abbreviations</b>	<b>Definition</b>
BIS	Bank for International Settlements
CBDCs	Central Bank Digital Currencies
e-CNY	electronic Chinese Yuan
e-HKD	electronic Hong Kong Dollar
HKMA	Hong Kong Monetary Authority
To B	To Business
To C	To Consumer
To G	To Government

## **1. Introduction**

### **1.1 CBDCs and Accelerated Development across the World**

The global monetary and payment system is transforming rapidly due to the accelerated adoption of digital currencies and the booming cryptocurrency market. Private sector organizations and communities have introduced numerous innovative digital currencies, including Facebook's Libra stable coin, contributing to the growth of this ecosystem. However, digital currencies have also brought forth certain risks, such as extreme price volatility, high leverage, and illicit trading, posing threats to the financial system's stability [1]. Governments worldwide have recognized the urgent need to tighten regulations to mitigate these risks [2]. The threats also reinforce central banks' motivation to develop their own Central Banks' Digital Currencies (CBDCs) to adapt to the evolving financial landscape and safeguard monetary sovereignty [3]. CBDCs are digital payment instruments denominated in the national unit of account as a direct liability of the central bank [4]. Recognizing the importance of CBDCs, over fifty central banks have been actively engaged in research, development, and pilot projects related to CBDCs as of 2022 [5]. This demonstrates the global governments' emphasis and determination to develop CBDCs.

### **1.2 CBDCs as Hong Kong's Fintech Strategy Focus**

Hong Kong has actively joined the global movement towards digital finance by introducing a series of encouraging policies. Notably, the "Policy Statement on the Development of Virtual Assets in Hong Kong" demonstrates Hong Kong's ambition to foster the growth of virtual assets [6]. Additionally, the "Fintech 2025 Strategy" highlights Hong Kong's commitment to developing CBDCs at both the wholesale level, targeting financial institutions for their interbank settlements, and the retail level, targeting businesses and individuals for everyday transactions [7]. Significant milestones have been achieved on Hong Kong's CBDC journey. For the wholesale level, Project Inthanon-LionRock, later renamed to mBridge in Feb 2021, is a cross-border payment initiative co-worked by the Hong Kong Monetary Authority (HKMA), Bank of Thailand, the Central Bank of the United Arab Emirates, and the Digital Currency Institute of the People's Bank of China [8]. For the retail level, Project e-HKD was launched in 2021 [9].

### **1.3 Research Motivation**

The development of retail CBDCs, i.e., e-HKD, in Hong Kong is still a work in progress, leaving many unanswered questions. Existing literature or research on e-HKD in Hong Kong has covered various areas, including the impacts on the financial industry [10], technical and systematic foundations [11], and policy and legal frameworks [12]. These studies provide in-depth analysis and insight into the policy, technical, and legal considerations of e-HKD, laying a solid theoretical foundation for exploring technical solutions. However, practical implementation and promotion aspects have received limited attention and discussion so far. The future outlook of the implementation and promotion of e-HKD could help to offer valuable insights and formulate effective strategies in paving the way for potential roll-out. Although the Hong Kong government has yet to make an official decision on whether to launch the e-HKD, Hong Kong has shown a significant stride forward in the path towards its potential implementation, including setting out its policy stance, publishing white paper, and conducting market consultations. Also, the e-HKD Pilot Programme was launched recently to involve 16 companies to study business viable use cases with the industry such as full-fledged payments, programmable payments, tokenized deposits, and settlement of Web3 transactions [13]. Therefore, at this point, the research on the practical implementation and promotion of e-HKD is crucial.

### **1.4 Objectives**

This research paper aims to investigate the practical applications and promotion of e-HKD in Hong Kong. The specific objectives of the study are as follows:

- (1) Identify potential challenges that may arise during the implementation and promotion of e-HKD;
- (2) Develop actionable recommendations to address these identified challenges.

By achieving these objectives, this research paper aims to contribute to the understanding and effective implementation of e-HKD in Hong Kong's financial landscape.

## **1.5 Report Outline**

The remainder of this research paper proceeds as follows. Chapter 2 explains the methodology employed in the research. Chapter 3 discusses the research and analysis process, showcases the findings. Finally, Chapter 4 provides an summary of this paper. Also this chapter states the limitation of the research paper and suggests the further actions.

This paper does not include a literature review section. The aim of this paper is to explore the potential challenges faced by e-HKD and provide solutions. Since e-HKD has not been launched yet, there is limited research available on this topic. The methodology employed in this paper involves a case study of e-CNY, coupled with an analysis of the Hong Kong market, to draw conclusions. This means that the paper primarily focuses on observing and analyzing the actual development of e-CNY in the mainland market and examining the relevant conditions and factors in the Hong Kong market that may impact the development of e-HKD. Consequently, the paper offers the author's insights on how to better promote e-HKD. Throughout the paper, the author may selectively cite relevant literature to support their viewpoints, but an exhaustive review of all related literature is not necessary.



## 2. Methodology

This research employs a mixed-methods approach to investigate the practical implementation and promotion of e-HKD in Hong Kong. The methodology primarily consists of a comprehensive literature review and case study. This section outlines the approach to achieve two objectives mentioned in Chapter 1.4:

As the e-HKD initiative is still in the initial pilot phase and has limited experience, therefore the discussion on the possible challenges and dilemmas faced by e-HKD's roll out cannot be discussed specifically based on actual experience. Conducting a case study on successful retail CBDCs is a feasible strategy that can provide valuable insights. For this purpose, this research chooses the e-CNY as the subject of the case study. The reason for selecting e-CNY is the close relationship between the financial markets in Hong Kong and mainland China, and the relatively advanced development of e-CNY, which has undergone three years of pilot programs and implementation in over twenty cities across the country. By drawing upon the experiences and strategies employed by e-CNY, this research hopes to inform the further discussion of e-HKD.

However, this paper clearly understands that the promotion and application of digital currencies is a complex and fluid process, and each digital currency has its own unique characteristics and challenges. The specific problems and solutions faced by e-CNY or other digital currencies in the promotion process may be inconsistent with those of e-HKD, and thus the experience of e-CNY may not be fully applied to e-HKD. This paper does not rely too much on any specific example or experience in the case of e-CNY. Instead, the paper focuses on the general issues and experiences that arise in the promotion of digital currencies, such as technical challenges, market acceptance, user acceptance, etc. in the discussion and analysis. The paper also focuses on the commonalities and similarities between the mainland China market and the Hong Kong market, such as technical support, user habits of electronic payments, and so on. These similarities can help us better understand the promotion process and common challenges faced by digital currencies, and thus provide some useful thoughts and guidance for the promotion of e-HKD. Although the promotion experience of the e-CNY may not be entirely applicable to e-HKD, there are still

some key success factors and coping strategies of e-CNY that can be drawn upon when discussing the promotion of e-HKD.

Besides, to ensure that the discussions align with Hong Kong's circumstances and vision, several steps should be taken. Firstly, an extensive literature review was conducted to understand the views and stance set forth by the Hong Kong government and the Hong Kong Monetary Authority (HKMA). This involves studying official documents, policy statements, and research papers related to e-HKD. Secondly, the research also keeps track of the latest progress of Project e-HKD. This involves monitoring the e-HKD pilot program, any relevant developments, or updates. Staying informed about the progress provides valuable insights into the direction of e-HKD and help shape the recommendations. Thirdly, understanding public perception and expectations regarding e-HKD is crucial for its rollout. To gain insights from the public, various sources were utilized. These include the results of market consultations conducted by the HKMA, market research reports, surveys conducted by professional institutions, news media coverage, companies report, research articles and so on. These sources provide a comprehensive understanding of public sentiment, concerns, and preferences regarding e-HKD.

Based on the findings from these studies, potential challenges that may arise during the promotion of e-HKD are identified. Subsequently, based on the insights from e-CNY case study, and the unique circumstances of Hong Kong, this paper will then formulate recommendations and strategies to address each challenge identified.

By following this systematic methodology, the study provides a comprehensive understanding of the challenges and opportunities associated with the promotion of e-HKD in Hong Kong. The resulting recommendations hope to serve as a valuable guide for policymakers, regulators, and stakeholders involved in the implementation of e-HKD, helping to ensure a smooth and successful transition to a digital currency ecosystem.

### **3. Findings and Discussion**

#### **3.1 Potential Challenges in the e-HKD's Roll-out**

This section discusses the potential difficulties e-HKD may face from three perspectives: user, technology, and privacy. As mentioned in the previous methodology, this paper will focus on the general issues of digital currency promotion, together with insights from e-CNY case study, while discussing it in the context of the actual situation in Hong Kong.

##### **3.1.1 Difficult User Adoption and Retention**

Firstly, considering from the perspective of user, e-HKD will face the problem of difficulty in acquiring users and maintaining them in the long run.

###### **3.1.1.1 Lack of User Awareness and Acceptance**

One of the reasons for the difficulty in acquiring and maintaining users is the lack of user awareness and acceptance. At the initial stage of launch, e-HKD may have yet to be widely known by the public. The Hong Kong University of Science and Technology conducted a survey on public perception of potential e-HKD roll-out in 2022 to explore the public's awareness and views on e-HKD's personal data privacy, design features and adoption intention. Among the public responses, there were concerns with personal data privacy (e.g., leaking of my personal data / financial assets / transaction records) (55.19%), concerns with cybersecurity (51.13%), concerns with financial loss (36.91%), uncertainty about the technology (29.01%) [14]. This indicates that many members of the public are hesitant or even mistrustful when it comes to more innovative and disruptive concept such as digital currency technology.

###### **3.1.1.2 Weak Position in Payment Market as A Late Entrant**

The second reason for the difficulty in acquiring and maintaining users relates to market competition and habit formation. The e-payment environment in Hong Kong

has matured over the years. After the Epidemic, consumers' shopping patterns have gradually become electronic, coupled with the driving force of e-coupons, the usage rate of e-payment has steadily grown. Commonly used electronic payment means by mass consumers and merchants include UnionPay Mastercard, Octopus, Faster Payment System (FPS), Payme, Alipay HK, WeChat Pay HK, and so on. Octopus was introduced in 1997. It is convenient as payment is completed instantly by tapping the card. It already has a first-mover advantage in the payment field. In the past few years, Octopus has gradually evolved from being an offline payment tool for traditional transport and retail to supporting online payments. It has also invented a cross-border e-payment platform, with features such as assisting merchants in marketing, making it more convenient for the general public [15]. For the relatively new Fast Payment System (FPS), as of 2023, five years after its launch, more than 13.6 million registrations have been made, and its application scenarios will continue to expand [16]. These can demonstrate that the existing electronic payment tools in Hong Kong have gradually matured and improved in the market. If the e-HKD is launched as a later participant in the market, it will lack the original accumulation of users. Most of the public have already adapted to the other mainstream payment tools and have already developed the habit of using them. Attracting users must compete with existing payment methods while changing users' habits and getting them to switch to e-HKD, which is very difficult. Therefore, e-HKD is bound to be in a weak position initially. In the study conducted by the Hong Kong University of Science and Technology mentioned above [17], one of the questions was, 'why are you not likely to use e-HKD for daily transactions?' And 60.12% of the respondents chose the answer 'I am satisfied with existing payment options.' We can also find clues in the similar situation that e-CNY faces. China's e-payment market is also highly competitive. Alipay combines high-frequency payments with scenarios in other areas, including finance, education, healthcare, and transport, to attract users and create a diversified payment ecosystem. WeChat Pay, on the other hand, leverages the powerful social function of WeChat to ensure a certain user base. Also, WeChat Pay innovates many payment methods, such as red packet transfer, palm print payments, and code scanning payments. Under the situations, e-CNY is also struggling to survive and look for a breakthrough to accumulate more users in the market. In conclusion, as a later participant in the market, if e-HKD can't cover a lot of payment

scenarios in the market as fast as other existing e-payment tools, it can be foreseen that Digital HKD will be challenging to acquire users in the early stage of its launch.

### **3.1.1.3 Limited Competitive Advantages**

The third reason for the difficulty in acquiring and maintaining users is that e-HKD may not be attractive enough. Referring to the e-CNY digital wallet, e-HKD will also be interest-free. From the government's point of view, introducing e-HKD enriches the channels through which the government distributes money to the public, stimulating public spending. However, from the public's point of view, depositing money in a bank account allows them to earn interest rates. Especially in the market environment of high interest rates in the past few years, investing money in time deposits or other wealth management products means a higher return. Therefore, in terms of interest rate, e-HKD is less attractive. The main strategy currently adopted for e-CNY is bonus rewards. For example, if users open e-CNY payment in a takeaway app, then the user will be rewarded with some spending bonus. This is similar to Hong Kong's electronic consumption vouchers. However, relying on subsidies as a way of promotion is hardly sustainable. Besides, there are some gaps in user experience compared with other digital payment tools. For example, the NFC function of the e-CNY wallet sometimes conflicts with the priority of other NFC-related functions on mobile phones (e.g., traffic cards) [18]. Therefore, concerning the experience of e-CNY, when e-HKD has no apparent advantages or additional services in terms of design, functionality, revenue, and user experience, there is little motivation for the public to use e-HKD in the long run.

### **3.1.2 High Costs in Technical Implementation**

From the perspective of implementation, the introduction of e-HKD incurs high costs related to technological implementation.

#### **3.1.2.1 Direct Costs**

One aspect of the costs directly associated with the technological implementation of e-HKD is research and innovation. As a new form of digital currency and payment

method, e-HKD requires extensive technological research and innovation. The core technology of a central bank digital currency system is likely to be developed by an internal technical team due to its confidentiality, and it may also involve collaboration with social enterprises, core technology companies, academic centers, and efficient cooperation in specific modules. Core technologies include blockchain technology, distributed ledger technology, data processing, encryption authentication, and security technology. These research and innovation efforts require significant human, material, and financial resources. Another aspect is the high cost of infrastructure and supporting facilities. One cost lies in constructing the digital currency system, including core systems, payment networks, settlement systems, data centers, etc. Another cost is related to upgrading and transforming software and hardware systems. The currency issuance system, operational systems of the HKMA, and banks' payment systems need to be upgraded. In addition, participating entities such as banks, third-party payment institutions, and social enterprises need to add modules to their existing account systems to adapt to digital HKD wallets and establish operator interfaces for payments, transfers, and payroll operations. A third cost is the establishment and transformation of terminal devices. From cash to bank cards, QR codes, NFC, and facial recognition payments, merchants' terminal devices are constantly updated and iterated. Cooperation with merchants is required to encourage the deployment of payment terminals or system transformations to support e-HKD payments. Provisioning digital payment terminals involves costs such as research and development, design, production, installation, maintenance, and upgrades. Although there is no precise estimation of software and hardware costs, it can be predicted that the upfront investment and maintenance costs of infrastructure would be substantial.

### **3.1.2.2 Indirect Costs**

Indirect costs brought by technical implementation of e-HKD primarily include promotion and education, maintenance, and supervision, as well as merchant training. Firstly, there is the need for promotion and education. Promoting e-HKD to the public, merchants, and financial institutions requires activities such as advertising campaigns, organizing training courses, seminars, lectures, etc. Collaborating with merchants and financial institutions to promote e-HKD payments also incurs costs

related to establishing cooperation agreements, marketing activities, and incentive measures. Secondly, there are costs associated with maintenance and supervision, including the formulation of regulatory policies, laws, and guidance documents, establishment of monitoring and risk management systems, compliance audits, and risk assessments. Finally, there is the aspect of merchant training. Providing training, technical support, and consulting services to merchants supporting e-HKD payments is necessary.

### **3.1.3 Risks Related to Privacy & Data Protection**

Privacy and data protection are significant challenges that e-HKD may face upon its introduction. In April 2022, the Hong Kong Monetary Authority (HKMA) released a policy discussion paper titled "e-HKD: A policy and design perspective," seeking input from various stakeholders [19]. Seventy-five responses were received, discussing potential benefits, issuance mechanisms, interoperability, and privacy protection. Participants included academia, central banks, financial institutions, and technology companies. Among the responses, privacy protection emerged as a highly concerning issue for most of the public. Most respondents emphasized that privacy should take precedence over efficiency in the design of e-HKD and advocated for a "privacy by design" approach. This highlights the public's emphasis on privacy and data protection regarding e-HKD. First and foremost, e-HKD involves the collection and use of users' transaction data and personal information. This data may include users' transaction records and personal identity information. Misusing or leaking data could infringe on users' privacy rights, leading to concerns and mistrust towards e-HKD. The security of e-HKD is a crucial aspect of privacy and data protection. In digital payments, security threats and cyber-attacks such as data breaches, hacking, and identity theft are prevalent. Additionally, some malicious actors exploit the anonymity of digital currency transactions and utilize digital wallets to transfer illicit funds, facilitating money laundering. For instance, in 2023, members of a criminal group in Zhejiang deposited fraudulent funds with e-CNY to the merchant e-CNY account of a tobacco shop; they then instructed the shop owner to withdraw the funds with cash and transfer it, evading law enforcement investigations [20]. This also reflects the challenge of user awareness. With a new digital currency system like e-

HKD, the public may have limited understanding and awareness. Lack of in-depth knowledge and proper usage of e-HKD can lead to user errors and expose them to risks. Typically, digital currencies are designed to protect user privacy to some extent while maintaining a certain level of traceability and regulatory control to mitigate the risks. However, such characteristics may also impact current third-party payment services. Third-party payment platforms play a vital role in data accumulation and customer acquisition. Through these platforms, users can conveniently conduct various payment transactions. Platforms can use the transaction data for analysis and accumulation, further improving services and launching personalized products. This data accumulation and analysis are crucial for developing fintech applications and scenario-based finance. Nevertheless, with the "anonymity" function and the privacy protection of digital currency transactions, user transaction data may not be collected and analyzed like traditional third-party payments. This hinders data analysis and product development for third-party payment platforms, impacting the growth of fintech applications and scenario-based finance. Therefore, striking a balance between user privacy demands and the needs of fintech development remains a challenge.

### **3.2 e-CNY Case Study**

As mentioned earlier, e-HKD is currently in the research and development phase. On the other hand, as one of the most representative central bank digital currency projects globally, e-CNY is already in the pilot stage. According to Qian Zhan industry research institute [21], the e-CNY project was established in 2014 by forming a research team. Since then, it has gone through a lengthy process of theoretical exploration, framework establishment, and research and development design. Starting from 2019, the development of e-CNY entered an accelerated phase. Following the release of the Libra whitepaper in 2019 and the completion of interoperability testing in 2020, pilot programs were launched in multiple cities. In 2021, the six major state-owned banks began promoting e-CNY wallets. The development process of e-CNY has been long and has undergone market tests, making it worth studying as a reference.



This section discusses the strategies e-CNY adopts from multiple dimensions, including its current development status, promotion models, user experience, market feedback, and more. Through these dimensions, the section aims to understand the crucial aspects that the government needs to consider when leading the development of digital currencies. The case study of e-CNY can serve as an essential reference framework for subsequent research. It facilitates a more comprehensive and in-depth exploration of the development potential and challenges of e-HKD in digital currencies. In the case study of e-CNY, this paper primarily focuses on the current status, namely the actual situation and promotion of e-CNY's implementation, without discussing the potential future development of e-CNY.

### **3.2.1 Deployment and Expansion of Application Scenarios in Multi-Location, Multi-Sector, and Multi-Scenario**

#### **3.2.1.1 From the Perspective of Pilot Locations**

In April 2020, China's central bank took the lead in launching a "4+1" pilot test of e-CNY in Shenzhen, Suzhou, Xiong'an, Chengdu, and the Winter Olympics [22]. This round of testing primarily aimed to validate the business and technical design of e-CNY, system stability, product usability, and scenario applicability [23]. It initially attracted attention from a portion of the public and enhanced their understanding of the design concept of e-CNY. In October 2020, the central bank added Shanghai, Hainan, Changsha, Xi'an, Qingdao, and Dalian as pilot locations, forming a "10+1" pilot layout [24]. In addition to expanding application scenarios, the pilot period also focused on innovating the application models of e-CNY, such as endowing it with programmable features through smart contracts. As of January 2024, the pilot scope of e-CNY has expanded to 26 pilot areas in 17 provinces and cities [25]. Currently, the pilot areas cover the four major city clusters in China, namely the Pearl River Delta, Yangtze River Delta, Beijing-Tianjin-Hebei, and Chengdu-Chongqing regions [26]. From the perspective of pilot location deployment, coastal cities and major city clusters are still dominant, while the selection of pilot locations in central cities and autonomous regions is relatively fewer. This can be partly attributed to considerations of the economic development level and maturity of financial infrastructure in the pilot locations. Coastal cities and major city clusters usually have higher levels of economic development and more mature financial systems. They support dense

populations and frequent commercial activities, with relatively diverse and complex business environments and payment scenarios, providing favorable conditions for the pilot of e-CNY. Additionally, coastal cities and major city clusters typically have larger population sizes and higher consumer purchasing power, allowing the pilot of e-CNY to cover a larger number of individuals and merchants, thereby validating its effectiveness and feasibility under large-scale usage scenarios.

### 3.2.1.2 From the Perspective of Application Scenarios

In the early stages of e-CNY development, it was primarily applied in To C (To-consumer) segment characterized by small amount and high frequency transactions. Examples of such scenarios include dining services, shopping, leisure and entertainment, transportation, and other similar contexts. In To C scenarios, e-CNY mostly serves as a payment support role. Below table 1 shows some examples of e-CNY applications in different sectors within the To C context as reference examples.

Field	Typical Case
Supermarkets	<ul style="list-style-type: none"> <li>• Beijing Focusing on the demand for payment services for the Beijing Winter Olympics, innovative application scenarios such as unmanned vending trucks, self-service vending machines, and unmanned supermarkets were deployed in combination with e-CNY. Wearable payment devices such as payment gloves, payment badges, and Winter Olympics payment clothing were launched.</li> <li>• Shanghai In May 2021, shopping festival "e-CNY May 5 Happy Shopping" was held. Users could collect e-CNY red packets for consuming.</li> </ul>
Transportation	<ul style="list-style-type: none"> <li>• Qingdao On-street and off-street parking lots across the city have fully supported car owners to pay for parking through e-CNY.</li> </ul>

Medical services	<ul style="list-style-type: none"> <li>Guangdong e-CNY fully covers scenarios such as online and offline payment for medical treatment, hospitalization, etc.</li> </ul>
Smart campus	<ul style="list-style-type: none"> <li>Suzhou Through the binding of campus cards, teachers and students can pay for campus canteens, campus supermarkets, self-service laundry in laundry rooms and other scenarios in e-CNY. Multiple transaction methods are available, such as QR codes, campus cards, and faces</li> </ul>
Cultural tourism	<ul style="list-style-type: none"> <li>Jiangsu Relying on major cultural and tourism activities such as expos, tourism festivals, to promote e-CNY. Key areas such as tourist attractions, hotels, tourist resorts, and tourism and leisure blocks above 4A level have achieved e-CNY's coverage.</li> </ul>

*Table 1 e-CNY To C Application Scenarios Examples. Adapted from multiple resources.*

The expansion of e-CNY in the To C segment has been remarkably successful. As of the end of June 2023, the transaction volume of e-CNY reached 1.8 trillion yuan, with a circulation of 16.5 billion yuan [27]. The total number of e-CNY transactions reached 950 million, with 120 million wallets being opened [28]. Starting from 2022 and 2023, there has been a gradual trend of e-CNY expanding from the To C segment to the To G (To overnment), To B (To business), and even industrial segments [29]. Below table 2 and table 3 show some examples of e-CNY applications in the To G and To B scenarios as part of this research.

Field	Typical Case
People's livelihood services	<ul style="list-style-type: none"> <li>e-CNY digital wallet supports living bill payment and mobile phone recharge services. Under the living payment function, users can pay water, electricity, gas, heating, and cable TV fees, etc.</li> <li>Guangzhou</li> </ul>

	<p>Guangzhou Housing Provident Fund Management Centre allows citizens to deposit housing provident fund through e-CNY.</p> <ul style="list-style-type: none"> <li>• Zhangjiagang Citizens' social security cards can be linked to their e-CNY accounts.</li> </ul>
Public spending and welfare payments	<ul style="list-style-type: none"> <li>• Jiangsu Starting from 2023, salaries of civil servants, public service personnel, and personnel of state-owned assets are issued in e-CNY.</li> </ul>
Taxes and levies	<ul style="list-style-type: none"> <li>• Shenzhen Taxpayers can pay tax such as value-added tax, stamp duty, and enterprise income tax in e-CNY via Digital Tax Bureau.</li> </ul>

*Table 2 e-CNY To G Application Scenarios Examples. Adapted from multiple resources.*

Corporate payments	<ul style="list-style-type: none"> <li>• Fujian Relief loans are issued through e-CNY, and enterprises are encouraged to use e-CNY to pay interest and repay principal. By the end of 2022, 12.89 million yuan of relief loans had been issued through e-CNY.</li> <li>• Suzhou By the end of 2022, more than 18.7 billion yuan inclusive loans had been issued through e-CNY</li> </ul>
Cross-border trade	<ul style="list-style-type: none"> <li>• Dalian On March 15, 2021, two fuel trading companies completed a fuel transaction settlement on Shipping Industry Digital Platform in e-CNY, which was the first transaction between enterprises where e-CNY was applied to the B2B platform.</li> </ul>

Digitalization of the industrial chain	<ul style="list-style-type: none"> <li>• Supply chain finance</li> </ul> <p>On September 2, 2023, JD Technology and Industrial and Commercial Bank of China jointly launched a programmable supply chain finance solution based on e-CNY smart contract, providing a full range of services such as online wallet opening application, capital supervision, and efficient financing.</p>
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*Table 3 e-CNY To B Application Scenarios Examples. Adapted from multiple resources.*

### 3.2.2 Combination of Offline and Online Channels

Currently, e-CNY pilot applications in the retail consumer sector are primarily focused on online consumption. Prominent internet companies such as Meituan, Tencent, Didi, Baidu, and others actively participate in the pilot work of e-CNY, providing technical support and optimization solutions and attempting to apply e-CNY in online consumption scenarios. Among them, Meituan's pilot project for carbon-neutral e-CNY is the first inclusive retail consumer activity open to all users [30]. Users can receive e-CNY low-carbon red packets rewards through the "Green Riding" section of the Meituan app. In just three months, this pilot activity attracted nearly 8 million users to participate, of which almost 2 million downloaded and opened personal e-CNY wallets. In addition, numerous well-known internet companies are also actively introducing applications for e-CNY testing. For example, Didi has reached a cooperation agreement with the Digital Currency Research Institute of the People's Bank of China, allowing users to choose an e-CNY wallet for payment of travel expenses [31]. Platforms such as JD, Tmall, and Baidu are also promoting the application and promotion of e-CNY. The pilot version of the e-CNY app has been launched in app stores, and new users can register with their mobile phone numbers to make online and offline payments, similar to Alipay and WeChat Pay.

Offline consumption is also rapidly unfolding. As an example of offline consumption, the Industrial and Commercial Bank of China (ICBC) collaborated with Beijing Ruyixing Technology Co., Ltd. to launch an e-CNY discount activity for subway rides in Beijing, where passengers only need to choose the digital currency payment method to experience subway rides for just 1 cent [32]. In addition, e-CNY has also started to be applied in

physical venues, such as Beijing Capital International Airport, where the e-CNY payment function covers all commercial stores and parking lots. At the 4th China International Import Expo held in November 2021, e-CNY was piloted for the first time at the exhibition venue, with support for e-CNY payments from over 60 merchants and more than 100 self-service vending machines inside the exhibition hall [33]. In Winter Olympics, Bank of China offers a variety of e-CNY products for Chinese residents and international visitors, including mobile app-based software wallets and various forms of hardware wallets such as cards and wristbands [34].

### **3.2.3 Promotion through Government-led Initiatives and Commercial Means**

The promotion of e-CNY is mainly carried out through government-led initiatives and commercial means.

The government-led approach involves the government using policy guidance and administrative measures to promote the use of e-CNY in government agencies, certain state-owned enterprises, and public institutions for employee salaries. It requires employees to download e-CNY wallets and encourages them to use e-CNY for daily payments and transactions. For example, in several areas of Suzhou, the government, public institutions, and state-owned enterprises have implemented e-CNY salary payments and transportation subsidies [35]. This approach has a strong driving force and can quickly form a user base of a certain scale. Moreover, the government-led promotion can serve as a demonstration, conveying the importance and advantages of e-CNY to the public. State-owned banks, as representatives of government institutions, can lead other institutions and individuals to follow suit and promote the use of e-CNY. Additionally, the government-led approach can enhance the credibility and acceptance of e-CNY, reduce public concerns about security and risks, and thereby increase the adoption and usage rate of e-CNY.

Commercial means include the distribution of red packets, gift packages, consumer vouchers, and point rewards, as well as activities such as discounts and promotions. These activities are often common during specific holidays or promotional periods and are typically conducted through registration or lottery selection of users. For example, during the "Double Eleven" shopping festival in 2021, JD innovatively promoted e-CNY in pilot areas such as

Shanghai through a "red packet rain" activity [36]. Users who shared the e-CNY activity with their friends could receive additional rewards in the form of red envelopes, further promoting and popularizing e-CNY. This model encourages users to try the e-CNY payment method and increases its convenience and attractiveness, incentivizing users to make larger purchases. Another approach is themed pilot activities, where e-CNY pilot projects are combined with specific themes or fields, such as green transportation and carbon neutrality. By collaborating with relevant industries, e-CNY is promoted and applied in specific scenarios. For example, the e-CNY pilot in Shanghai introduced a carbon neutrality theme. Meituan organized a low-carbon e-CNY biking activity with a focus on green themes, selecting low-carbon transportation in daily life as a pilot scenario to explore the integration and promotion of e-CNY in different fields [37]. This model not only addresses social concerns but also showcases the diverse applications of e-CNY. Additionally, partner collaboration is another approach. Commercial banks and internet companies collaborate with partners such as e-commerce platforms and transportation institutions to jointly promote and apply e-CNY through collaborative scenarios. The commercial means leverage the extensive channels and marketing capabilities of commercial institutions to promote e-CNY to a wider user base, meet consumer needs, enhance user experience and satisfaction, and attract users to use e-CNY for consumption.

#### **3.2.4 Cooperation among Participants in Industrial Chain**

The promotion of e-CNY also features the collaboration of multiple institutions within the e-CNY industry chain. Taking commercial banks as an example, the current e-CNY adopts a two-tier operating model, with commercial banks responsible for providing e-CNY exchange and circulation services to the public. Firstly, they cooperate with upstream technology providers to carry out system transformation and technology integration to meet the requirements of e-CNY. Technology providers such as Hang Seng Electronics Limited and Guangzhou Guangdian Yuntong Financial Electronics Co., Ltd. have participated in the construction of bank e-CNY systems [38]. Secondly, as the entry point for customer traffic, commercial banks collaborate with downstream service providers to explore application scenarios and expand customer acquisition channels. For example, they work with shops, governments, schools, etc., focusing on key businesses such as social security, salary payments, small-value high-frequency retail, and digital wallet applications, to promote the

development of characteristic scenes such as smart transportation, smart campuses, smart tourism, and smart healthcare. In this way, it becomes convenient for bank customers to flexibly use e-CNY in their daily lives. Thirdly, in addition to supporting e-CNY wallet apps, banks also collaborate with other terminals. For example, China Industrial and Commercial Bank partnered with telecom companies such as China Mobile, China Telecom, and China Unicom to launch SIM card hard wallet products on the e-CNY app [39]. This product has the function of offline and network-free payments, making payments more convenient and user-friendly. The promotion of e-CNY is not only a transformation in the financial sector but also involves changes in the entire payment and financial ecosystem. Through close cooperation among participants in the industry chain, favorable conditions have been created for the promotion of e-CNY. The development of e-CNY also brings new business demands and opportunities for participants in the industry chain, forming a mutually beneficial situation that promotes progress and upgrading throughout the e-CNY industry chain.

### **3.3 Strategies for e-HKD's Roll-out**

Section 3.1 explores the general issues related to digital currencies and the similarities between the Mainland and Hong Kong digital currency markets, to identify the challenges that both e-HKD and e-CNY may face. Section 3.2 reviews the current development status, promotion models and strategies, user experience, and market feedback of e-CNY since its launch. These promotional experiences provide valuable references and can offer beneficial suggestions for the successful launch of the e-HKD. This section will address the challenges that may arise in the promotion of e-HKD, based on the analysis and summary of the successful experiences and lessons learned from the promotion of e-CNY, combined with the promotion strategy of e-CNY. Additionally, due to the differences between Hong Kong and the Mainland in financial systems, laws and regulations, and market environments, this section will comprehensively consider the commonalities and differences between e-CNY and e-HKD, and provide customized solutions tailored to the specific situation in Hong Kong.

#### **3.3.1 User's Perspective: Explore diverse and Innovative Application Scenarios**



As mentioned earlier, e-HKD may face challenges in acquiring users and maintaining their long-term engagement. One of the strategies advocated in this article is to actively expand diversified and innovative application scenarios to create an e-HKD ecosystem, thus acquiring users.

### **3.3.1.1 Start with To C Scenarios to Penetrate Citizens' Daily Life Circle**

#### **i) Rational**

Based on the market feedback of e-CNY in To C scenarios, this paper believes that starting with To C is a simple and efficient strategy. Firstly, the frequency of user interaction is high. To C scenarios are the most common and direct payment scenarios in people's daily lives. Citizens visit retail places such as supermarkets, malls, and restaurants in their daily lives. By promoting the use of e-HKD in these places, it becomes more convenient for more users to come into contact with e-HKD, gradually forming usage habits and increasing usage frequency. Secondly, it promotes consumption growth. In To C scenarios, e-HKD can be combined with various promotional activities and preferential policies to provide consumers with better payment experiences and benefits. This involves the support and cooperation of businesses. Retailers can set specific discount, cashback, and loyalty point reward mechanisms through the e-HKD payment channel, attracting consumers to choose e-HKD for payment. These preferential policies not only stimulate consumers' purchasing desires but also increase their loyalty and stickiness, promote repeat purchases, enhance brand recognition, and further drive the development of the consumer market. This is a win-win strategy. Thirdly, it has high visibility of results. By promoting e-HKD in To C scenarios, the promotion effectiveness can be observed and evaluated in real-time. The growth of e-HKD payments, user feedback, and merchant participation can be monitored, allowing for timely adjustment of promotion strategies and improvement of user experience. Fourthly, it offers controllability in regulation and risks. Since To C scenarios are where people conduct daily consumption, the payment environment in To C places is relatively concentrated compared to other scenarios. This concentration makes it easier for regulatory authorities to monitor and manage payment activities. Some may have concerns that To C scenarios involve a large number of people, and if there are

problems, the impact will be extensive. This article agrees with this view, but suggests starting with a pilot program, initially opening it to a small portion of the population and limiting it to small-value payments. After a period of time, when the pilot program becomes more mature and the e-HKD system stabilizes without significant risks, the pilot scope can be gradually expanded to include more citizens. In this way, risks can be minimized as much as possible. Based on the above reasons, starting with To C and penetrating citizens' daily lives is conducive to efficiently acquiring customers.

## **ii) Innovate to Enhance Attractiveness**

In addition to the retail application scenarios already covered by existing payment tools, it is necessary to leverage the technological barriers of e-HKD itself to explore more innovative application scenarios. The completed phase 1 of the e-HKD pilot program has explored potential use cases for e-HKD [40]. These cases are based on the innovative technologies and features of digital currencies, such as programmability and tokenization, which bring unprecedented value to the retail payment ecosystem. For example, the programmability of digital currency can provide consumers with options for prepayment and staged payment of goods/services. After consumers prepay funds for goods or services with e-HKD, the funds will be held in escrow and only automatically transferred to the company after certain conditions are met. Taking education and training as an example, parents can sign a student training contract with an education and training company and agree to use the smart contract feature of digital currency. The training fees are paid in the form of e-HKD, and the funds can be settled after each class, ensuring fairness and safety. This arrangement encourages companies to maintain a high level of service until the contract is completed. If the company breaches the contract, consumers are no longer at risk of financial loss. In this way, e-HKD not only fulfills ordinary payment functions but also captures the shortcomings of current business operations and user needs. It utilizes the characteristics of e-HKD to enhance user experience, attracting more e-HKD users and helping businesses build customer trust at the same time.

### **iii) Emphasize e-HKD Application in Cross-border Scenarios**

As mentioned earlier, the Hong Kong Monetary Authority (HKMA) released a policy discussion paper titled "e-HKD: A policy and design perspective" to seek opinions from various stakeholders. Most respondents expressed the expectation that the e-HKD should be usable across borders and interconnected with other CBDCs, such as e-CNY. Given the close geographic proximity and strong economic ties between Shenzhen and Hong Kong, as well as the significant advantages in innovative financial technology, the application of both e-HKD and e-CNY in cross-border transactions is an inevitable development strategy. Under the guidance of the People's Bank of China, the Digital Currency Institute of the People's Bank of China and the HKMA initiated a pilot project for cross-border e-CNY payments at the end of 2020 [41], demonstrating the central banks' attention to this matter. For cross-border retail transactions, the current pain points include foreign exchange conversion and merchant support. The technology of digital currencies can address these pain points. The pilot project of e-CNY in the cross-border region of Shenzhen and Hong Kong is already in progress. Currently, the main target users are mainland visitors traveling to Hong Kong or Hong Kong visitors traveling to Shenzhen. The most common scenarios are offline cross-border consumption and tourism. For Hong Kong residents traveling north to Shenzhen without mainland residency, they can also apply for a e-CNY wallet. In terms of recharging, Hong Kong residents can use the Octopus app for top-up. Bank of China (Hong Kong) has established a complete cross-border transaction chain and connected cross-border fund channels, which not only supports customers to recharge their e-CNY wallets with their accounts at the bank, but also allows customers from other local partner banks to recharge via the Faster Payment System [42]. As for mainland residents traveling south to Hong Kong, they can use e-CNY to top up their Octopus wallets and make payments and purchases in 180,000 stores and all means of transportation in Hong Kong [43]. Bank of China (Hong Kong) also supports customers to use e-CNY for payment through its all-in-one local and cross-border payment application, BoC Pay [44]. Similar strategies can be adopted in developing cross-border consumer payment applications for e-HKD. The aim is to connect the financial ecosystems of e-HKD and the payment tools and banking systems in Shenzhen, solving the payment issues for residents traveling between the two regions and promoting bilateral cross-border consumption. Currently, the focus is more on expanding business. On one hand, it is

necessary to increase the participation of banks and financial institutions, and on the other hand, more operators, such as cross-border e-commerce platforms, should be involved. In addition to cross-border payments, cross-border wealth management applications are also a feasible direction. The "Cross-boundary Wealth Management Connect" is an important plan under the interconnection mechanism between the mainland China and the capital markets of Hong Kong and Macau, launched in September 2021 [45]. This plan allows qualified residents of the Guangdong-Hong Kong-Macao Greater Bay Area to invest in wealth management products sold by banks in the other region through a closed-loop fund channel established by their respective banking systems. If this platform supports the flow of e-CNY and e-HKD, it can simplify the process of cross-border fund transfers and settlements, reduce transaction costs and time, and provide faster fund clearing. Furthermore, as all transactions are traceable, it can assist regulatory authorities and law enforcement agencies in tracking cross-border fund flows and money laundering activities.

### **3.3.1.2 Extension from To C Segment to To B and To G Segments**

#### **i) Rational**

After the retail application scenarios are essentially covered and the layout becomes more mature, it is necessary to gradually expand into the business sector. Drawing from the experience of digital currencies, there are several reasons for this. Firstly, when consumer scenarios are essentially covered and the initial wave of digital wallet openings subsides, the expansion of ordinary scenarios will gradually slow down. Secondly, the application innovation in the retail sector is limited. Based on the current performance in the mainland China market, the modifications made by regular merchants to support digital currencies mainly focus on establishing payment infrastructure. This may include installing digital payment devices, updating payment systems, and training employees, among others. These modifications are usually one-time efforts aimed at enabling merchants to accept and process digital currency payments. Once the payment infrastructure is established, most merchants rarely pursue further innovation. Despite the disruptive technological innovations of digital currencies, such as programmability, which help attract users and increase user stickiness. But e-CNY's development experience indicates that most ordinary

merchants still have limited demand for utilizing these innovative technologies. The advancement of digital currency pilots relies on expanding the application scenarios. If the expansion of the retail sector has reached a plateau, it is necessary to start exploring To B and To G application scenarios. Here, To B includes digitalization of the industrial chain, industry-specific applications, cross-border applications, and more. One reason is that the business sector market is generally larger, involving more transactions and financial activities. By expanding e-HKD to the business sector, the market coverage of e-HKD can be further expanded, creating more business opportunities. Another reason is that the business sector usually requires more complex and comprehensive payment solutions, involving supply chain payments, cross-border transactions, and more. By expanding into the business sector, e-HKD can provide more functionalities and services to meet diverse payment needs of business users. The third reason is that digital currencies in the retail sector primarily support payment functions, while the transformation in the To B sector focuses more on industrial digitalization. Using the application of the e-CNY in supply chain finance as an example, on one hand, companies can directly settle supply chain credits and debt transfers through e-CNY wallets, eliminating the need to open settlement accounts in different banks and reducing the costs associated with inter-regional and inter-bank account opening. On the other hand, highly digitized real-name e-CNY wallets have strong traceability and can identify the identity of companies through small-scale authentication to the real-name wallets. By establishing this data connection and interoperability, financial institutions can trust each other more and effectively provide diversified financial services to enterprises in the supply chain. This has a positive impact on the entire industry. However, unlike the simple onboarding process for merchants in the retail sector, the expansion of digital currencies to the To B sector is more complex because it involves the transformation and integration of the entire industry chain or even the entire industry system. Therefore, the successful implementation of a large-scale To B application scenario for digital currencies often requires the collaborative efforts of all participants to achieve the digital transformation of the entire industry. This article advocates that e-HKD has relatively broad development space in To G and To B scenarios, but support for retail payment scenarios is a prerequisite. The e-HKD pilot program needs to continuously extend to To B and To G scenarios while ensuring the expansion of To C scenarios.

## **ii) Emphasize e-HKD's Application in Digital Government Services**

This paper believes that the application of e-HKD in digital government services is an effective means to promote and acquire a large user base for e-HKD. Firstly, there are economies of scale. Digital government applications cover multiple fields and services, forming a larger user group and a broader market. For example, salary payments to civil servants, traffic fines, medical appointments, subsidy disbursements, tax payments, payment of government service fees, purchase of digital products or services provided by the government, mandatory provident fund contributions, utility bill payments, and more. If multiple government departments and agencies support e-HKD for providing these services, it can be imagined that the user base will be very substantial. We can refer to CNY's experience in developing digital governance services. E-CNY payment services have been enabled on electronic government service platforms in many regions, supporting various types of public utility payments through online and offline channels, as well as procedures related to housing provident funds, individual and corporate assistance funds, and more [46]. Additionally, some provinces and cities are promoting the support of e-CNY payment functionality on social security cards [47]. Social security cards are smart IC cards issued nationwide to the general public in mainland China. They have functions such as electronic certificates, information records, self-service inquiries, medical settlement, payment and benefits collection, financial payments, and more, covering a wide range of areas, such as human resources and social security services, government public services, and people's livelihood services. This accelerates the faster and more extensive integration of e-CNY into the daily lives of ordinary people, yielding significant results. In the case of Hong Kong, developing digital government services is a major government strategy. In the 2023 Policy Address, the goal was set to fully implement electronic payment options for all government fee services by the third quarter of 2024, allowing citizens to choose to pay relevant service fees using "FPS" (Faster Payment System), and government services commonly used by mainland Chinese visitors will also support payment through mainland Chinese e-wallets to facilitate mainland Chinese visitors [48]. As of the end of December 2023, this progress has reached 66% [49]. In addition to electronic payments, the digitization of government services is also a major focus. The "iAM

"Smart" one-stop digital service platform enables citizens to access over 220 government and public-private organization online services through a single digital identity verification [50]. By 2025, all government services in Hong Kong will fully adopt "iAM Smart" to achieve "One-stop Online Access" for government services [51]. It can be foreseen that the government's digital and intelligent transformation is of significant importance in promoting the application of e-HKD in digital government services. Besides economies of scale, developing digital government services, prioritizing the acceptance of e-HKD in government agencies, public service venues, government projects, and more, can showcase the government's role as a demonstrator. As an authoritative institution, the government's adoption and promotion of new technologies or products adds trust and authority, thereby encouraging more people to try and accept them. The government's demonstrative role also implies greater social influence and is more likely to attract public attention. In summary, if the government actively promotes digital government services and utilizes e-HKD as a payment tool within them, it will increase the exposure and awareness of e-HKD, stimulating users' interest and willingness to participate.

This paragraph recommends specific ideas for developing of e-HKD in digital government applications. The first is about digital payments. As mentioned earlier, citizens should be given the option to pay relevant fees using e-HKD for all government fee services. This requires designated operators to integrate e-HKD payment channels into various high-frequency government service scenarios, such as online payment channels on official websites of government agencies and payment for services like hospital registration and utility bill payments. This involves both online and offline coverage. For online scenarios, payment channels on official websites should support e-HKD online payments, and the "Smart Convenience" one-stop digital service platform mentioned earlier should also support e-HKD payments. For offline scenarios, it is necessary to establish e-HKD service channels and transaction windows at government agencies and service points of various operators to cultivate the public's payment habits using e-HKD. This can improve payment convenience and efficiency, provide citizens and businesses with a more convenient government service experience, and promote the development of digital government. Secondly, the development of e-HKD can be combined with a digital identity authentication system to provide a robust identity verification mechanism for digital

government services. In government service scenarios, there are situations where citizens' identities need to be verified and confirmed to ensure service security and trustworthiness. Examples include citizens applying for government welfare, subsidies, or social assistance services, voting and elections, administrative permits and document processing, and more. By verifying citizens' identities, the government can ensure that only legitimate e-HKD wallets can be associated with digital identity authentication, ensuring the authenticity and security of users' identities. This association can achieve a higher level of user identity authentication in digital government services, protecting user privacy and data security. Furthermore, e-HKD can be used to supervise and track public resources, thereby increasing government transparency, reducing human intervention, lowering corruption risks, and improving the transparency and effectiveness of government governance. This involves the use of smart contract technology and traceability features of digital currencies. Smart contracts have the following characteristics. One characteristic is that they are self-executing, meaning they automatically execute relevant operations once the conditions and rules set in the contract are met, without the need for human intervention. Besides, they are transparent, meaning the execution process of smart contracts is publicly accessible, and all participants can view the execution status and results of the contract. Additionally, they are immutable, meaning once smart contracts are deployed on the blockchain, their code and execution records are permanently stored on the blockchain and cannot be tampered with. Traceability refers to the ability to accurately record and track the source, circulation, and destination of something or a process. These two features can enhance the government's governance capabilities and help address issues such as cross-government regulation difficulties and low efficiency. Additionally, they can increase the transparency and accountability of government decision-making, contributing to the establishment of a clean and efficient governance mechanism. These features are particularly useful in government scenarios involving fund flows. In traditional subsidy distribution scenarios, the implementation of subsidies often requires reporting at multiple levels, and there can be significant time gaps between fund flows and information flows, which may lead to situations such as misappropriation or diversion of funds. By using digital currency to distribute subsidies, trigger conditions can be set for the funds and tracking can be conducted. The supervisory department can directly monitor the distribution of subsidies at all levels without



relying on other parties, ensuring dedicated use of funds and improving subsidy distribution efficiency. e-HKD can be applied in scenarios such as the distribution of monthly allowances in Hong Kong's social security allowance scheme and the electronic cash voucher distribution in the government's consumption voucher scheme.

### **3.3.2 Technology's Perspective: Reduce Costs in Technical Implementation**

As mentioned earlier, from the perspective of technology, the introduction of e-HKD may require significant investment in related technological costs. This includes the evolution of payment tools from cash to bank cards, QR codes, NFC, and facial recognition payments. There is also a continuous update and iteration of merchant-side terminal devices, which incurs substantial costs for deployment and promotion. This section discusses two methods to reduce the costs.

#### **3.3.2.1 Utilize Existing Payment System to Reduce Payment Terminal Deployment Cost**

The existing deployment of payment terminals already meets the diverse payment needs of merchants and users quite well. In this case, the promotion of e-HKD can integrate with existing mainstream payment methods, thus saving costs on the deployment and promotion of merchant-side terminal devices.

##### **i) Promote Single Combined QR**

The first strategy is to leverage and promote interoperability of QR code systems. QR code payments are based on existing smartphone payment methods, requiring no additional hardware or specialized terminal facilities. Merchants only need to generate their own QR code and display it for consumers to make payments by scanning. This low-cost and convenient promotion method allows for rapid adoption in the market. Moreover, QR code payments are not dependent on specific payment networks or banking systems, making them widely accepted and used. This means that consumers can use their preferred or familiar payment applications without the need for additional bank cards or payment tools, resulting in high user acceptance. However, inconsistencies in coding rules and standards, as well as independently designed barcode identifiers by different payment institutions, can hinder

interoperability and scanning recognition. In December 2017, the HKMA formulated the "Hong Kong Common QR Code Specification - Merchant-presented Mode." In this initiative, the HKMA established standardized specifications for the Hong Kong Common QR Code, and payment service providers developed QR codes based on these specifications [52]. The HKMA also introduced the "Hong Kong Common QR (HKQR)" mobile application, enabling payment service operators, acquiring banks, and merchants to integrate QR codes developed by different payment service operators into a single combined QR code, as described earlier [53]. This allows merchants, especially small and medium-sized enterprises, to accept payments from customers using different payment service providers through a single QR code, eliminating the need to display multiple QR codes such as Alipay, BOC Pay, WeChat Pay, etc. Therefore, the foundation of interoperability and standardization for barcode payments is already in place. Once the e-HKD wallet is officially launched and joins the payment ecosystem, payment QR codes can be developed based on the common QR code specifications. Users can also use the scanning function of the e-HKD wallet to scan the single combined QR codes provided by merchants or small and medium-sized enterprises. However, many merchants in Hong Kong have not actively promoted the adoption of the single combined QR code and continue to use multiple QR codes. So this paper suggests that when implementing e-HKD, payment QR codes shall be developed based on the common QR code specification. As e-HKD requires linking up multiple payment platforms, operators, merchants or centre-based enterprises, it is important to take this opportunity to promote common combined QR code. In this way, we can save costs and manpower in deployment. It also provides customers and merchants with a more convenient payment experience and creates a fair and open market environment.

## **ii) Develop NFC Payment**

As previously discusses, HKAM sought opinions from various stakeholder via "e-HKD: A policy and design perspective." Respondents generally recognized that supporting dual offline payments is a key element in maintaining the robustness of the CBDC system, with particular significance in cases of power or network disruptions. This paper believes that NFC (Near Field Communication) payments present a more mature starting point for reducing reliance on QR code payment

methods. By adopting NFC technology, offline payments can be made without the limitations of a network, meeting the payment needs in special environments such as basements, parking lots, mountainous areas, or even during geographical disasters. Phones can also be used in situations with no electricity, turned off, disconnected from the network, or with the screen off. Therefore, this article considers NFC technology as the core of dual offline payment functionality. NFC is a close-range, high-frequency wireless communication technology that enables communication within a distance of less than 10 centimetres in a peer-to-peer manner, without the need for a third-party device to relay the signal. This requires both the payer and payee devices to have hardware wallet functionality with built-in secure chips. This is primarily achieved through the "tap-to-pay" feature, such as between a phone and an NFC tag, between phones, or between a phone and a POS terminal. Most of the POS terminals used by merchants in Hong Kong support NFC payments, providing a good foundation for innovation and expansion of NFC in the realm of e-HKD. By promoting the NFC feature of e-HKD, there would be no need to build a completely new payment network but rather utilize existing supporting infrastructure and networks, namely POS terminals and payment channels. However, the POS terminals may require some modifications and upgrades, such as installing software upgrade packages or software patches, to adapt to e-HKD payments. Therefore, the cost is relatively low compared to completely replacing terminal devices. For phones, using the Secure Element (SE) allows for periodic connectivity-free, fully offline, and even more secure transactions. This includes the SE chip, typically built-in by phone manufacturers, as well as SIM cards and SD cards developed by telecommunications operators. Currently, the NFC-SIM card solution is the mainstream model for NFC mobile payments. It can adapt to most phones without NFC functionality and the interface is standardized, making it the most well-developed solution supported by the SIM card industry, terminal manufacturers, and operators. The e-CNY has already introduced the Super SIM Card Hardware Wallet payment [54]. The launched Super SIM cards are jointly developed by China Mobile and Industrial and Commercial Bank of China, and supported by Bank of China, China Telecom, and China Unicom. Users can insert the Super SIM card into their phones, use e-CNY app to add the hardware wallet, associate the digital wallet with the SIM card, and then select the SIM card as the default payment application under the NFC functionality to enable tap-to-pay transactions [55]. The Super SIM card can also

support additional applications such as transportation cards and access control cards. In addition to phones, NFC can be extended to other hardware devices such as wearable devices, watches, wristbands, badges, ski gloves, etc. However, it should be noted that dual offline payments also pose certain security risks, such as the "double-spending problem." To prevent double spending, third-party payment platforms usually validate each transaction. However, "dual offline payments" cannot be instantly validated, so they are generally used for small-value payment scenarios like public transportation to reduce risks. One way to mitigate this risk is to set limits on the transaction time and frequency for dual offline payments based on risk control rules. When the "offline usage limit" is exhausted, synchronization with e-HKD wallet backend through a communication method is required to ensure consistency between the money in the hardware wallet and e-HKD wallet backend. Payments can be rejected when the offline usage limit is exceeded. In summary, the modification and upgrade of terminal devices based on NFC functionality for e-HKD not only saves promotion costs but also has the potential to stimulate the NFC payment innovation market and cultivate user habits.

### **3.3.2.2 Scale E-CNY to Leverage Cost Advantages**

Additionally, the cost of issuing and maintaining e-HKD may decrease with the increase in circulation only when it achieves market-scale adoption. Firstly, economies of scale play an important role. As the market size expands, the cost of issuance and maintenance can be shared among more market participants. More users imply more transaction volume, which can effectively offset the increase in average costs of issuing and maintaining e-HKD. Secondly, technological advancements during scale adoption can also be beneficial. As technology matures and improves, the costs of issuing and maintaining e-HKD typically decrease. For example, automated contract execution can reduce manual intervention, improve efficiency, and lower costs. Advances in data and transaction security can reduce potential fraud and data tampering risks, thereby reducing associated risk management and security costs. Additionally, as more technology providers enter the market, there may be competitive behaviors to lower the prices of technological solutions and services, leading to a potential decrease in related costs. Finally, increased market liquidity also positively impacts the issuance and maintenance costs of a digital currency. As the circulation of the digital currency market increases,

market liquidity improves. A market with higher liquidity can facilitate higher trading activity and lower transaction costs, which helps reduce issuance and maintenance costs. As mentioned earlier, factors such as technological market competition, innovation, and economies of scale contribute to cost reduction. While cost reduction is a trend, the specific timeframe may vary depending on the circumstances. The timing of cost reduction depends on various factors, including the maturity of the technology, market demand, competition, and government support, among others. The case of e-CNY can be for reference, where although the pilot projects have progressed smoothly, they have been limited in scale, and the widespread adoption and maturity of the technology, as well as the supporting infrastructure and acceptance environment related to payment settlement, are still to be verified. The process of introducing a digital currency, from its launch, pilot phase, widespread usage, to the formation of a comprehensive and mature ecosystem, is not an overnight process.

### **3.3.3 Industry's Perspective: Connect Relevant Resources and Build e-HKD Industry**

#### **3.3.3.1 Link Social Resources to Create Scenarios**

As mentioned earlier, the payment market in Hong Kong is highly competitive, and citizens are accustomed to using products such as Octopus Card, UnionPay cards, and PayMe. However, unlike these third-party payment products on the market, the operation of e-HKD involves commercial banks and third-party payment institutions, which have significant advantages in terms of resource support. HKMA can mobilize the merchant and user resources of commercial banks and third-party payment institutions to connect various online and offline application scenarios, including public transportation, supermarkets, public utilities payment, healthcare, dining, and entertainment. This can be achieved through API integration between e-HKD wallet app and application platforms, allowing resource sharing and bringing together multiple advantageous scenarios to establish a more comprehensive and diverse ecosystem. For example, in mainland China, Alipay has joined the acceptance network of the e-CNY and became the first payment platform to support e-CNY wallet quick payment feature. After users access e-CNY wallet through the e-CNY app, they can use the wallet's quick payment feature on Alipay and use the e-CNY for consumption on any platform or scenario serviced by Alipay, such as Taobao,

Shanghai public transportation, Ele.me, Tmall Supermarket, Hema, and more [56]. This is an experience where citizens may not perceive significant differences between using digital currency and third-party payment systems. In fact, digital currency and third-party payment are not on the same dimension. Digital currency is money, a tool. In the process of digital currency circulation, it is often not the central bank that directly provides exchange and circulation services to the public, but designated operational institutions that offer these services to consumers. Therefore, the entire process of digital currency exchange and circulation requires the participation of all social forces. As a carrier and infrastructure, third-party payment can still serve as a carrier for digital currency and jointly provide digital services to people. HKMA's document "e-HKD: Charting the Next Step" mentions the need to ensure comprehensive interconnection and interoperability between the e-HKD and other payment systems, allowing the public to conduct payments more quickly and conveniently without obstacles. The significance of this goal lies in breaking down payment barriers, providing greater flexibility and convenience, enabling the public to freely choose payment systems that meet their own needs, and enjoying a seamless payment experience. People can easily transfer, pay, and settle across different systems, whether it's online shopping, offline consumption, or other financial transactions. Therefore, overall, if e-HKD wants to gain popularity in the fiercely competitive payment market, the key is to maintain close cooperation with commercial banks and third-party payment institutions, indirectly accessing the scenario resources covered by these institutions and their solid existing user base. At the same time, e-HKD serves as a bridge between commercial banks, between third-party payment institutions, and between commercial banks and third-party payment institutions, promoting resource interconnection and sharing among operational institutions, and enhancing the wide penetration of e-HKD throughout the city.

### **3.3.3.2 Build e-HKD Industry Chain and Create Innovative Business Environment**

As mentioned earlier, one of the strategies for promoting the e-CNY is close cooperation and coordinated pilot programs among various institutions in the industry chain, which creates favourable conditions for the promotion of e-CNY. Riding on the wave of the development of e-CNY, participants in the industry chain can capture new business opportunities. This paper believes that the development of

e-HKD is a reflection of the local financial innovation atmosphere. The atmosphere and application environment are crucial in the initial stage of launching and promoting. Building a favourable environment with an innovative atmosphere, cooperation, and sustainable business development can leverage the aggregation effect of the industry chain, facilitate efficient and high-quality development of e-HKD, and attract more enterprises and individuals to participate in the development ecosystem of e-HKD. The core participants in the digital currency industry chain cover various commercial banks, technology providers, service providers, business operators, users, and so on. Examples of specific upstream, midstream, and downstream participants are shown in below table 4. The development and promotion of digital currency rely not only on a single institution or sector but involve the cooperation and resource integration among different stakeholders in the entire industry chain ecosystem. Building a cooperation platform is the foundation. The current approach adopted in Hong Kong is led by supervision in the form of policy initiatives. For example, e-hkD Pilot Scheme is a joint effort of companies from the financial, payment, and technology sectors to collectively research and explore potential use cases of e-HKD. In addition, a CBDC expert group has been established to draw on research experience from top local universities [57]. In mainland China, there has been a spontaneous effort by industry players, with various institutions in the industry chain forming e-CNY Industry Alliance [58]. The alliance covers participants from different fields such as digital technology, high-tech enterprises, telecommunications operators, commercial banks, investment institutions, and universities. These institutions can jointly research industry innovation, promote application development, hold forums and conferences, and more based on this cooperation platform. Regarding cooperation models, the first is technology integration. One form is cooperative exchanges, where different technology providers and research institutions exchange and jointly develop technologies such as various payment solutions, applications, and more. Participants can also share intellectual property rights and technological achievements. Particularly, collaboration and integration across different fields, such as artificial intelligence, blockchain, the Internet of Things, and other technologies, can enhance the innovation capabilities of e-HKD. The form can also be operating open and standardized API interfaces, developer platforms, testing environments, and data sharing mechanisms, so as to enable systems of various banks, payment institutions,

telecommunications operators, and other participants to connect, interact, converge, and share. Through technology integration, the iterability and interoperability of technology can be improved, thereby promoting the progress and widespread application of e-HKD technology. The second cooperation model is the integration of business resources. For example, collaborating with merchants to accept e-HKD payment and provide corresponding support and incentives. Merchants include offline retailers, the catering industry, the service industry, online e-commerce, and other industries. By integrating merchant resources, the application scope of e-HKD in various consumption scenarios can be expanded. Business resource integration also includes the joint use of de-HKD's innovative technology by business operators, technology service providers, and others to explore new business models and launch innovative products and services. This helps to promote business diversification and enhance competitiveness while providing consumers with more choices and convenience. For example, in e-HKD Pilot Scheme, Standard Chartered Bank conducted research on the programmability of e-HKD in the field of supply chain finance [59]. It mentioned using smart contracts to transfer ownership of goods to supply chain finance institutions as collateral to obtain financing or automatically execute supply chain finance payments based on the transportation status and delivery confirmation of goods [60]. These innovative technologies hold tremendous business potential. The resource integration model also includes academic resources, social resource integration, and more, which are not elaborated here due to the limitations of the article's length. Of course, this also requires guidance and encouragement from the government and regulators. The government provides corresponding policy support, including tax incentives, reward measures, financing support, technology support, and more, to create a favourable atmosphere and encourage the application and innovation of e-HKD.

	Participants	Example of goods or service provided by Participants
Upstream	Technology providers	Chips, blockchain technology, identity authentication, digital wallets



	Data security and privacy protection agency	Digital encryption, network security technology
Middle reaches	Central bank digital currency system, commercial bank digital currency system	System transformation and support involved in services such as issuance, access, and circulation of digital currency
Downstream	Terminal	ATMs, POS, smart bracelets, IC cards, wearable devices, NFC
	Third-party payment institutions	Support digital currency third-party payments
	Service providers, Carriers	Online shopping platforms, e-commerce applications, physical stores, and public services that support digital currency payments

*Table 4 Example of Participants in CBDC's Industry Chain*

### 3.3.4 Cope with Privacy and Data Protection Issue

This paragraph aims to address the issues of privacy and data security mentioned earlier. First is the control of anonymity in digital currency design. It should be determined whether the design should be completely anonymous or develop a controllable anonymity approach. This means providing privacy protection and anonymity for small transactions while ensuring that large transactions can be traced to ensure compliance with anti-money laundering and counter-terrorism financing requirements. For example, the design of the e-CNY follows the principle of 'small transactions anonymous, large transactions traceable.' [61]. The People's Bank of China has implemented a tiered design for e-CNY wallets. Service providers identify customers and categorize wallets into different levels based on the strength of customer identification [62]. Different levels of e-CNY wallets have different daily and per transaction limits and balance limits. The lowest level wallet has lower transaction and balance limits, but users only need to register e-CNY app with their mobile phone number and can make anonymous payments. Higher-level wallets have higher transaction and balance limits but require registration with a Chinese ID card to ensure

compliance with anti-money laundering and counter-terrorism funding regulations. Essentially, it introduces a payment method between anonymity and real-name registration. It allows users to receive and make payments without the need for a bank account or inputting their ID card number. Only mobile phone registration is required. This is what differentiates e-CNY wallet from bank cards, WeChat Pay, and Alipay, which require personal identity information for registration. Therefore, e-CNY wallet can be considered anonymous. However, since mobile phone numbers currently require real-name authentication, it is still possible to trace the user's identity through the registered phone number. Therefore, its level of anonymity is not comparable to cash. Secondly, it is necessary to establish a comprehensive system for obtaining user information. When users use e-HKD, they should be clearly informed about which information will be collected and how it will be used. Users should have the right to decide whether to consent to the sharing of their information and should receive clear and explicit information disclosures before giving consent. It is also important to clarify whether merchants, digital service providers, and telecommunications operators have the right to access and utilize user information. In the policy discussion document "e-HKD: A policy and design perspective" published by HKMA for public consultation, some respondents suggested that privacy safeguards should be built into the system rather than relying solely on regulation. This may include the implementation of strict access control mechanisms within the system to ensure that only authorized users or entities can access sensitive data. This may involve the use of strong passwords and multi-factor authentication as security measures. It may also involve collecting and storing only necessary user data and automatically deleting or anonymizing the data after use.

## 4 Conclusion

In conclusion, this research paper explores the practical implementation and promotion of e-HKD in Hong Kong. The paper mentions three main potential challenges that e-HKD might face from the perspectives of users, technology, and privacy. With insights from e-CNY case study, this paper then provide actionable recommendations for promoting e-HKD, such as exploring diverse and innovative application scenarios, utilizing existing payment system to reduce payment terminal deployment cost, building industry chain to enjoy benefits from resource integration, means to protect privacy, etc. This research paper hopes to offer a valuable reference for advancing digital currency initiatives in Hong Kong if e-HKD will be launched. For the limitation, while this paper attempts to focus on general issues and experiences in the promotion of digital currencies, it also focuses on the commonalities and similarities between the mainland China market and the Hong Kong market to ensure that the discussion in this paper is more generalizable and relevant to the Hong Kong market. However, the promotion and adoption of digital currencies is a complex and dynamic process. In particular, there are few official details about the design and policy of digital currencies. Therefore, this paper can only serve as an overview of the outlook based on the current status quo, and hopefully provide a better understanding of what it will be like if e-HKD rolls out. Future studies will need to continue to track the latest developments and re-analyze the situation with more information.

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## Appendix

Table A1. List of Companies and proposed use cases under e-HKD Pilot Programme [13].

No.	Company names	Proposed use cases
1.	Alipay Financial Services (HK) Limited	Programmable payments – Merchant reward programme
2.	ARTA-Emali HK Limited	Programmable payments – Investment
3.	Bank of China (Hong Kong) Limited	Programmable payments – Government grant disbursement
		Programmable payments – Prepaid services
4.	China Construction Bank (Asia) Corporation Limited	Programmable payments – Prepaid services
5.	Fubon Bank (Hong Kong) Limited	Settlement of tokenised assets
	Ripple Labs Inc.	
6.	Giesecke+Devrient	Offline payments
	Standard Chartered Bank (Hong Kong) Limited	
7.	Hang Seng Bank Limited	Programmable payments – Government grant disbursement
		Programmable payments – Merchant reward programme
8.	Hang Seng Bank Limited	Tokenised deposits
	The Hongkong and Shanghai Banking Corporation Limited	
	Visa Inc.	
9.	Industrial and Commercial Bank of China (Asia) Ltd.	Offline payments

10.	Mastercard Asia/Pacific Pte. Ltd.	Settlement of Web3 transactions
11.	The Boston Consulting Group HKT Payment Limited ZA Bank Limited	Settlement of tokenised assets
12.	The Hongkong and Shanghai Banking Corporation Limited	Full-fledged payments