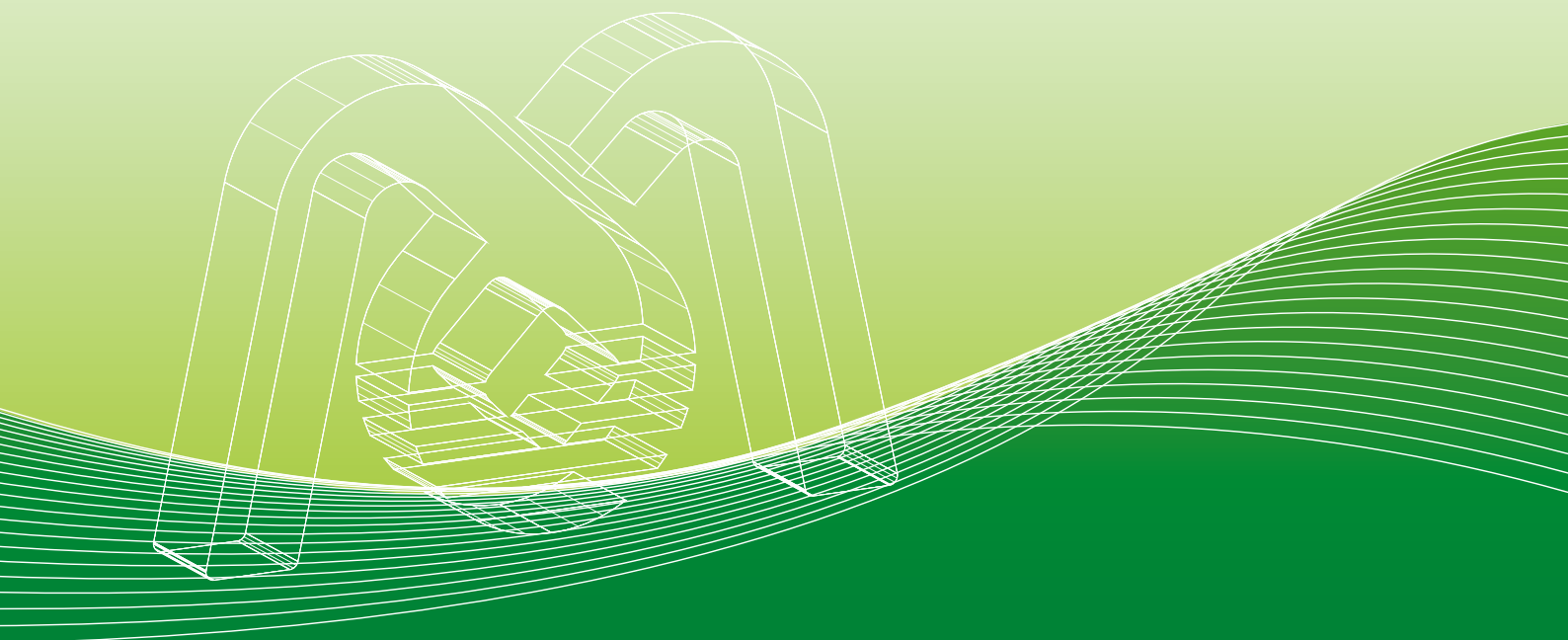




澳門金融管理局
AUTORIDADE MONETÁRIA DE MACAU

White Paper on Macao Special Administrative Region's e-MOP

**Inaugurating a Modern Monetary
and Financial System in Macao**



Design Concept of e-MOP Logo



- ▶ The design of the logo incorporates the four letters of “e-MOP”(digital Macao Pataca), with the shape of the Hong Kong-Zhuhai-Macao Bridge’s arch forming the letter “M”, symbolising Macao’s integration into the national development and the construction of the Guangdong-Hong Kong-Macao Greater Bay Area. While “M” is the first letter of Macao in Portuguese (Macau) and English, it highlights the existence and utilisation of Macao Special Administrative Region (SAR)’s own legal tender within the “One Country, Two Systems” framework.
- ▶ As inspired by the design concept of ancient Chinese copper coins, the logo is characterised by a square hole in the centre encircled by a round outer shape. This design not only symbolises the historical legacy of monetary culture, but also attaches a metaphor that the creation of e-MOP is for adapting to contemporary trends. In addition to embodying the innovative and efficient features of e-MOP, this design manifests its inner attributes of security and legitimacy as a legal tender.
- ▶ The solid lines of the English letter “O” in the middle gradually fade out and become dashed lines, resembling the evolution of physical currency to a digital form. This imagery echoes the green and white ripples of seawater, with the waves gradually widening as they become more distant, resonating the emblem of Macao SAR. Flowing water symbolises the generation of wealth, signifying an optimistic vision for Macao’s future as a smart city and a hub of modern financial services.
- ▶ The seamless integration of the bridge with ocean ripples adds a sense of fluidity and harmony to the overall design, depicting the transition from the past to a modern era, as well as the fusion between physical and digital realms.

Table of Contents

Introduction	1
1. Related Concepts of CBDC	5
2. Development and Evolution of Macao SAR's Payment System	9
A. Ongoing Advancement of the Payment System	10
B. Significant Increase in the Adoption of Cashless Payments	11
C. Strategic Goals for Financial Technology Development	14
3. Objectives and Potential Benefits of e-MOP	15
A. Objectives	16
B. Potential Benefits	18
4. Positioning and Design Principles of e-MOP	23
A. Positioning	24
B. Design Principles	27
5. Technical Features of e-MOP	31
6. Ecosystem of e-MOP	37
A. Operational Model of the e-MOP System	38
B. Design of e-MOP Wallets	40
7. The Implications of e-MOP for Stakeholders	43
A. Consumers	44
B. Merchants and Enterprises	44
C. Financial Institutions	45
D. Institutions of Other Ecosystems	47
E. Financial Supervisory Authority	47
8. The Blueprint for the Development of e-MOP	49
A. Strategic Plans and Progress	50
B. Opportunities for Growth and Development	53
C. Future Outlook	55

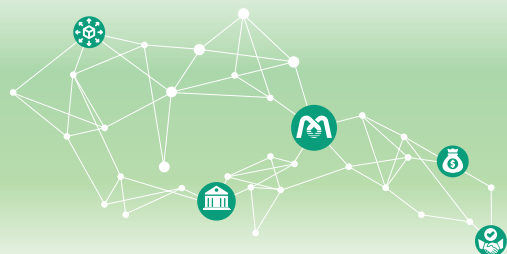


Introduction

Since Macao's return to the Motherland on 20 December 1999, the local economy has witnessed remarkable development, propelled by the gaming and tourism sectors. Under the support of national policies, Macao's financial industry has expanded significantly, alongside rapid progress in business innovation and technology application. These advancements have presented substantial opportunities and challenges for the financial system of the Macao Special Administrative Region (SAR).

The Monetary Authority of Macao (AMCM) is vested with the statutory duties of assisting the Chief Executive of the Macao SAR Government in formulating and implementing monetary, financial and exchange rate policies. The AMCM is also responsible for overseeing the internal stability and external solvency of the local currency to ensure its full convertibility. To this end, as the central-banking institution of Macao SAR, the AMCM has been performing its functions rigorously, including the issuance of the Macao pataca (MOP), supervision of financial institutions, and management of the money market and foreign exchange reserves, in accordance with the legal provisions since the establishment of the SAR.

Over the past few years, the AMCM has demonstrated a strong commitment to advancing Macao's financial infrastructure. To better align with emerging trends in the global payment landscape and address consumers' rising demand for payment services, the AMCM has strived to establish payment systems compatible with international norms. Besides, the AMCM has navigated Macao's financial industry by offering secure, efficient and low-risk innovative payment solutions for residents and businesses in Macao. These are aimed



at effectively maintaining the monetary and financial stability of Macao SAR, protecting the legitimate rights and interests of Macao residents, fostering sustainable economic growth, as well as fulfilling the mandate entrusted by the Macao SAR Government.

Alongside the rapid development of information technologies such as big data, mobile internet, cloud computing and artificial intelligence, the form of currency and its circulation patterns have become increasingly digitalised. With the rising prevalence of electronic payments, the use of cash in daily lives has reduced markedly. Meanwhile, the emergence of cryptocurrencies and digital assets has accelerated the pace at which central banks worldwide in conducting relevant research and experiments, and even sought to introduce a digital form of fiat currency - Central Bank Digital Currency (CBDC). This innovative advancement has prompted the Macao SAR Government to ponder the future, initiating and conducting research to explore the kinds of currency and payment method that could best serve the needs of an increasingly digitalised economy.

In order to keep pace with the international trend and evolving landscape, the Macao SAR Government, with the unstinting support of the People's Bank of China (PBOC), has initiated the research and development of digital MOP (e-MOP) - a brand-new electronic form of legal tender. This initiative aims to uphold the confidence of the public in Macao SAR's legal tender in the digital era, as well as to safeguard the inherent position of the local currency within the payment and settlement ecosystem.

Concurrently, The Second Five-Year Plan for the Economic and Social Development of the Macao Special Administrative Region (2021-2025), formulated by the Macao SAR Government, has emphasised the construction

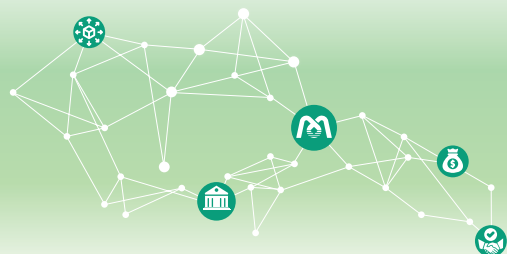


of a “smart city” and the development of modern financial services in Macao. As a novel means of payment and settlement, as well as an inclusive financial instrument, the introduction of CBDC is expected not only to increase the use of risk-free currency issued by the Macao SAR Government for day-to-day payments, but also to play a prominent role in nurturing the digital economy and modern financial services, thus achieving high-quality socioeconomic development.

While CBDC offers substantial opportunities for socioeconomic and financial development in Macao, it is still undergoing continuous changes and evolution. This may pose potential risks and challenges to central banking institutions in maintaining monetary and financial stability. In light of this, the SAR Government will adhere to prudent planning and pragmatism in the course of exploring the introduction of CBDC.

This white paper serves as the first concept note released by the AMCM to elucidate the research and development of e-MOP, following an in-depth investigation on economic fundamentals underpinning CBDC. It is worth noting that e-MOP should not be taken as a substitute for physical legal tender or electronic payment instruments in Macao SAR. That being said, e-MOP will provide a brand-new alternative for local residents, public and private entities, tourists, as well as cross-border trade payment and settlement.

The AMCM hereby expresses its heartfelt gratitude to organisations and individuals who have supported the research and development of e-MOP. Meanwhile, we look forward to the active engagement and support of Macao residents on the advancement of e-MOP, joining hands with the SAR Government to build Macao’s modern monetary and financial system.



1. Related Concepts of CBDC

1.1. In response to evolving trends in the digital economy and financial technology, central banks or monetary authorities worldwide have been devoting resources to actively explore and promote the digitalisation of legal tender. As highlighted in a report published by the International Monetary Fund (IMF), the potential benefits of CBDC include reducing costs of cash management, enhancing financial inclusion, improving efficiency and stability of financial payment systems, as well as strengthening the transmission mechanism of monetary policies. According to a survey conducted by the Bank for International Settlements (BIS) at end-2023, which involved 86 central banks from economies representing approximately 81% of the global population and 94% of the global output, 94% of these central banks had initiated tasks related to the development of CBDC.¹

1.2. At the moment, CBDC remains a term lacking a standardised definition. According to the Committee on Payments and Market Infrastructures of the BIS, CBDC refers to a digital form of central bank currency, which is distinct from the funds held by traditional financial institutions in central bank reserve accounts and clearing accounts.

1.3. The IMF has stated clearly that, by definition, a CBDC is issued by a central bank. According to the World Bank, CBDC is a liability of

¹ Lorio A.D., A. Kosse and I. Mattei (2024), "Embracing diversity, advancing together – results of the 2023 BIS survey on central bank digital currencies and crypto", BIS Papers, No. 147, Pages 1-3.



a central bank, which is created and recorded digitally either on a centralised or decentralised ledger, and denominated in an existing unit of account. In addition, a CBDC should be convertible into physical cash, commercial bank money, and other forms of money on demand by the holder at authorised entities.

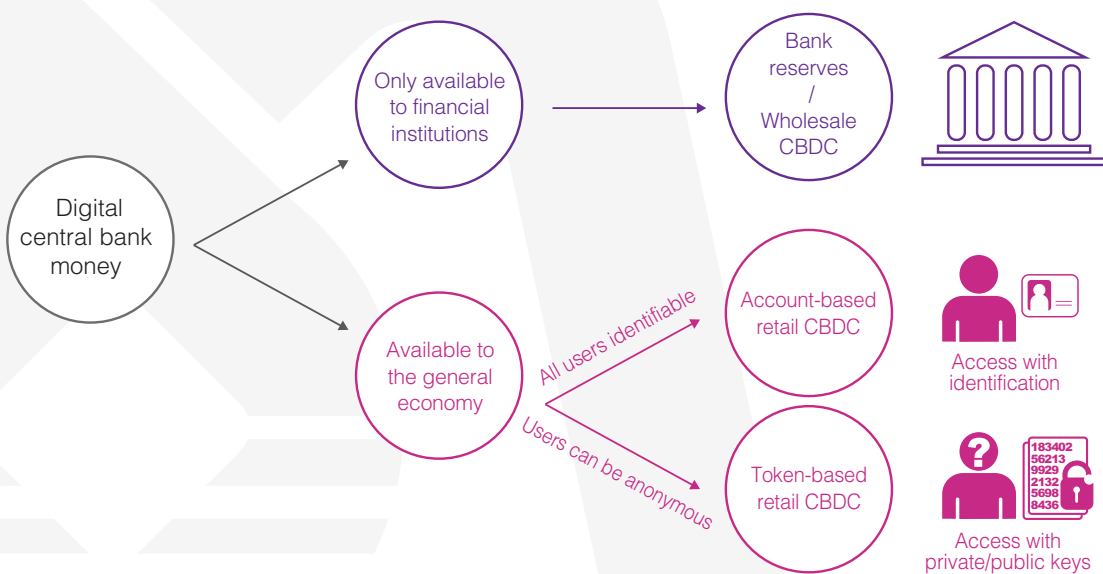
- 1.4. According to the classification by the BIS, from the perspective of the functions of CBDC in the monetary system, it can be categorised into wholesale CBDC and retail CBDC.²
- 1.5. Wholesale CBDC is intended for use by regulated financial institutions, primarily for the settlement of interbank transfers and related wholesale financial transactions, for instance, the clearing of payments (including digital assets or cross-border payments) between financial institutions.
- 1.6. Retail CBDC is akin to the functions of physical money or cash, which is primarily used in retail scenarios facing residents, tourists, enterprises and government agencies. Being directly issued by a central bank and backed by sovereign credit, retail CBDC is a liability of a central bank with legal tender status. For enterprises and merchants, retail CBDC is similar to cash in the sense that transactions are settled upon payment. In this way, retail CBDC bears the credibility of cash and the convenience of electronic payments.

² BIS (2021), "Annual Economic Report", 06/2021, Pages 70-73; Group of Central Banks (2021), "Central Bank Digital Currencies: System Design and Interoperability", BIS Report, No. 2, 09/2021, Page 4.

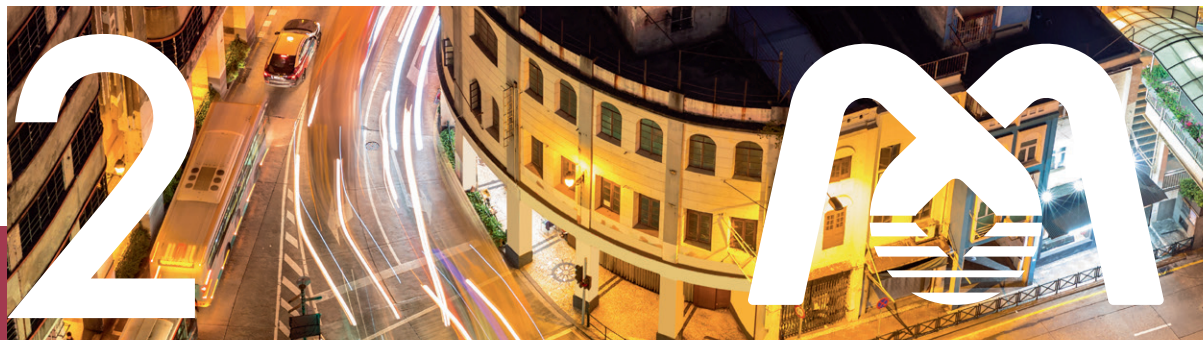


1.7. At present, there are two mainstream designs of CBDC payment models, namely the conventional account-based approach or the token-based approach. Under the account-based model, payments involve updating account balances of the payer and the payee within the CBDC system while currency ownership is linked to the identity of the account holder, hence allowing hierarchical management based on the strength of identity verification. On the other hand, the token-based model resembles the features of cash as a carrier with certain value, of which the value transfer process takes the form of cryptocurrency strings via the utilisation of digital signatures or other cryptographic techniques for verification, thus this model could in principle support anonymous transactions.

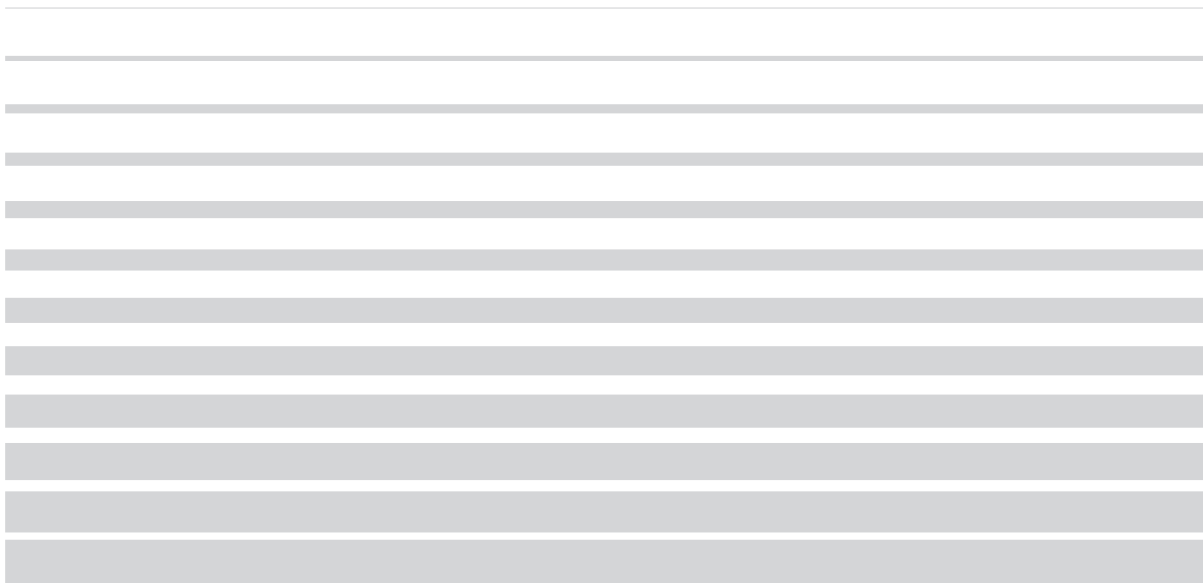
Figure 1 Forms of Digital Central Bank Money

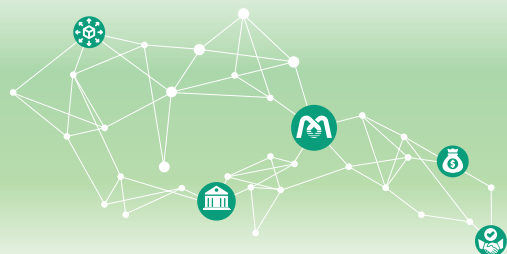


Source: BIS



Development and Evolution of Macao SAR's Payment System





2. Development and Evolution of Macao SAR's Payment System

A. Ongoing Advancement of the Payment System

2.1. Financial technology is an indispensable element in the development of modern financial services. To this end, the AMCM has dedicated to advancing the institutional and physical infrastructure of the financial market. The Real Time Gross Settlement (RTGS) systems for the MOP, the Hong Kong dollar (HKD) and the renminbi (RMB) were successively established, providing a more secure and efficient settlement channel for large-value and batch transfers denominated in these currencies. In the aspect of small-value transfers, the AMCM established the Faster Payment System (FPS) and facilitated local banks and payment service institutions to roll out the “Easy Transfer” service, supporting the speedy transfers of small-value MOP and HKD funds between local banks. Consequently, these efforts have led to a significant advancement in the digitalisation of payments and settlements in Macao SAR.

2.2. Concurrently, the AMCM has been promoting the adoption and development of mobile payments. In particular, the AMCM coordinated financial institutions to launch the “Simple Pay” integrated payment service, under which payment instruments were integrated through collaboration between banks and payment service providers offering quick response (QR) code payment services. This has allowed merchants to accept all local QR code payment instruments



through a single point-of-sale (POS) terminal or a QR code sign. Meanwhile, Macao residents enjoy the flexibility to select any local QR code payment instrument for transactions at participating merchants.

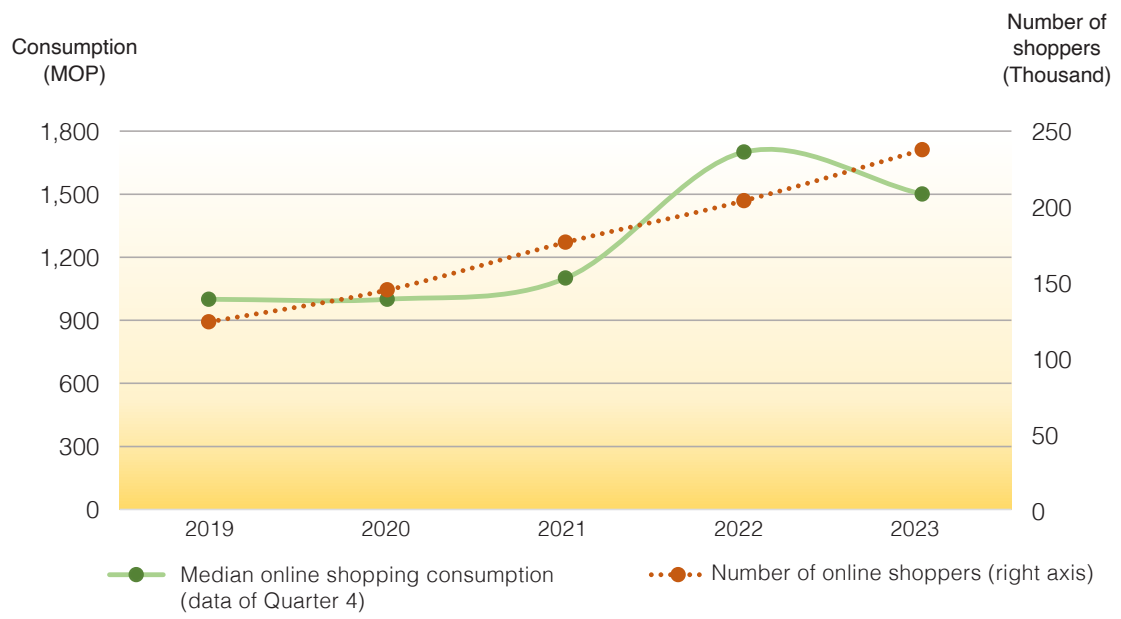
- 2.3. In 2023, the AMCM launched the “Monetary Bills and Notes Trading System” (MTS), which set forth automated trading methods and clearing mechanisms to enhance the trading efficiency of monetary bills. Besides mobilising the secondary market of monetary bills, the MTS has prompted the use of diverse money-market instruments among financial institutions, thereby further enhancing the operational efficiency and security of the financial system in Macao SAR. Currently, the AMCM has taken forward in an orderly manner the upgrades of RTGS systems for the three currencies in the Guangdong-Hong Kong-Macao Greater Bay Area (GBA), expediting the enhancement of core physical financial infrastructure to provide a sound foundation for innovation in financial products and business development.

B. Significant Increase in the Adoption of Cashless Payments

- 2.4. Empowered by the continuous advancement in financial infrastructure and payment systems in Macao SAR, the use of local mobile payment instruments has become increasingly convenient. Cashless payment methods, such as debit cards, credit cards and electronic wallets, have been more widely used by local residents and accepted by retailers.

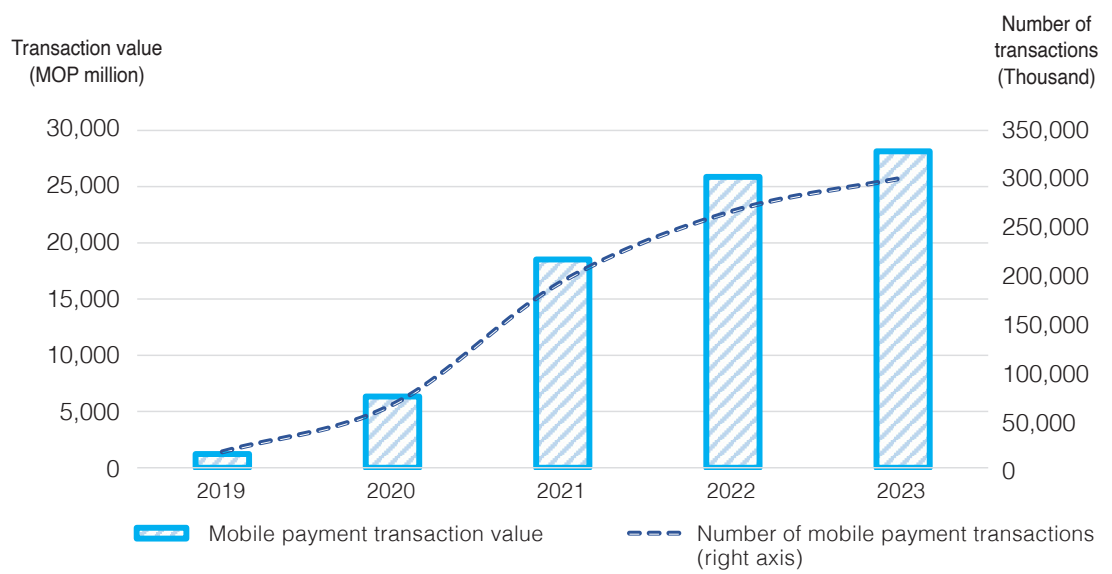


Figure 2 Online Shopping Data in Macao

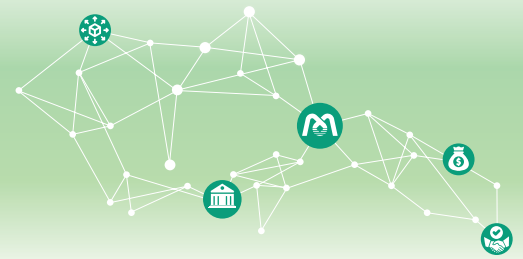


Source: Macao Statistics and Census Service

Figure 3 Mobile Payment Data of Macao's Financial Institutions

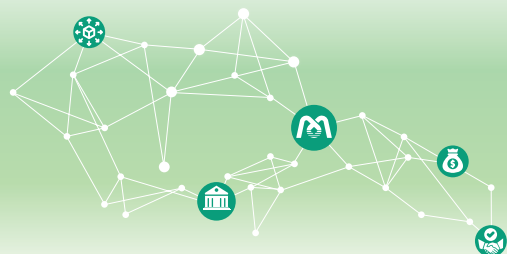


Source: AMCM



2.5. Although Macao's economy was hard hit by the outbreak of COVID-19 pandemic in early-2020, digitalisation sped up in Macao. As several rounds of relief measures against the pandemic were launched by the SAR Government in the form of electronic consumption cards between 2020 and 2022, many traditional small and medium-sized enterprises (SMEs) had POS terminals installed, inducing a rapid acceptance of mobile payments in Macao. Simultaneously, the pandemic has dramatically changed local residents' habits in consumption and entertainment, while e-commerce and delivery service platforms have gained popularity. Given the aforementioned shift in consumer behaviour alongside the emergence and growing prevalence of innovative digital services, mobile payment coverage has witnessed ongoing expansion with notable growth, encompassing more than 90% of physical retail stores in Macao.

2.6. According to available statistics, the number of internet users in Macao engaging in online shopping activities proliferated to 238,000 in 2023, representing an upsurge of 91.8% when compared to the pre-pandemic period (with 2019 as the reference year). In the last quarter of 2023, the median expenditure on online purchases of goods and services amounted to MOP1,500, representing a 50.0% increase from the pre-pandemic level. Concurrently, the volume and the value of mobile payment transactions grew remarkably to 300 million and MOP28.1 billion, respectively, in 2023, equivalent to



an 18.2-fold and 23.0-fold increase compared to the pre-pandemic figures.

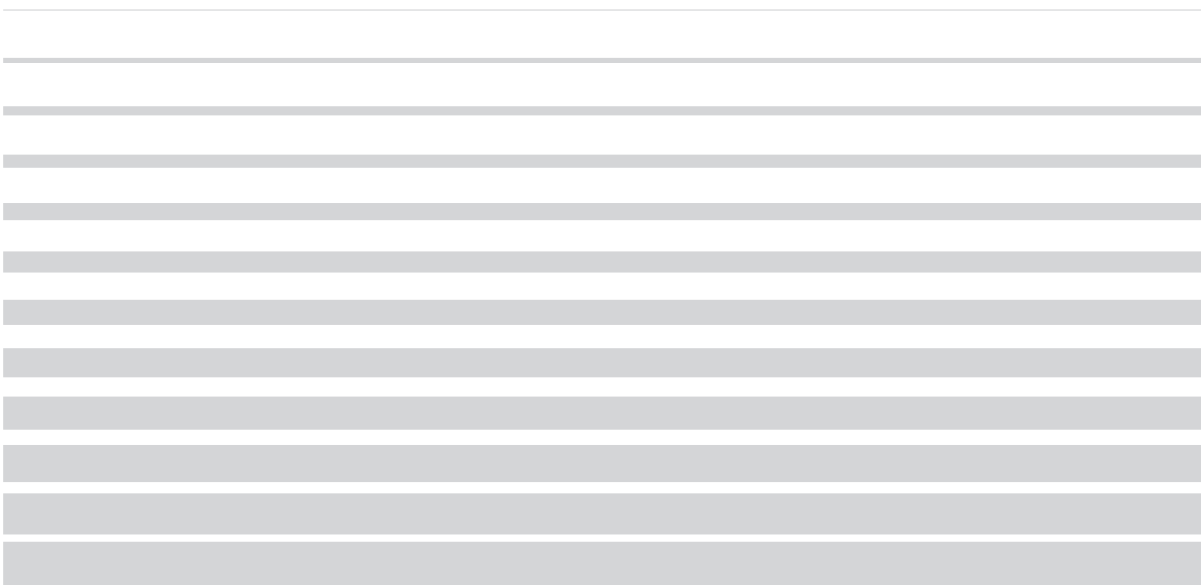
C. Strategic Goals for Financial Technology Development

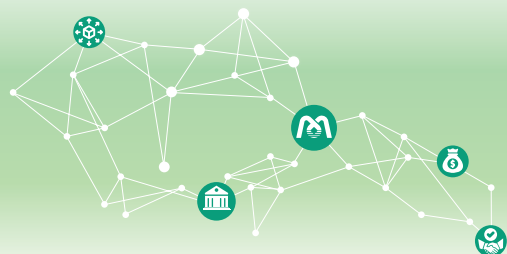
2.7. In November 2023, the AMCM signed the “Memorandum of Understanding on Deepening Fintech Innovation Supervisory Cooperation in the Guangdong-Hong Kong-Macao Greater Bay Area” with the PBOC and the Hong Kong Monetary Authority (HKMA). Based on this Memorandum, the AMCM is dedicated to linking up its Regulatory Requirements for Innovative Fintech Trials with the PBOC’s Fintech Innovation Regulatory Facility and the HKMA’s Fintech Supervisory Sandbox. The key objective is to promote integrated development of digital finance and improve the quality of financial services in the GBA.

2.8. Looking ahead, the AMCM will stay committed to advancing both the institutional and physical financial infrastructure, including the e-MOP system. In addition, the AMCM will strive to encourage innovation among payment service providers and financial institutions in Macao, as well as to promote the popularity of digital payments and broaden financial inclusion. These efforts are aimed at creating a more favourable environment for Macao’s financial institutions to cultivate safe, efficient and reliable digital financial services and products.



Objectives and Potential Benefits of e-MOP





3. Objectives and Potential Benefits of e-MOP

A. Objectives

3.1. In response to the global trend in financial technology development, the Macao SAR Government has been undertaking research and development on the e-MOP, with the goal of creating a digital form of legal tender that aligns with robust advancements in network technology and the digital economy. This initiative aims to meet the growing public demand for convenient, secure, inclusive and privacy-friendly retail payments. Simultaneously, the adoption of e-MOP is expected to enhance financial inclusion, maintain financial stability and provide solid support for Macao's financial industry, as well as the broader socioeconomic development.

3.2. Hence, the institutional design of e-MOP aims to address the demand for payment services from both public and private entities. In addition, the introduction of e-MOP is intended to boost regional competitiveness in trade and finance, aligning with Macao's vision of constructing a "digital city" and a "smart city".

3.3. As a legal tender by nature, e-MOP can be accessed via specialised software and hardware wallets. e-MOP will also be integrated into existing payment tools or online consumption platforms, serving as a basis for cross-platform payments and settlements as well as

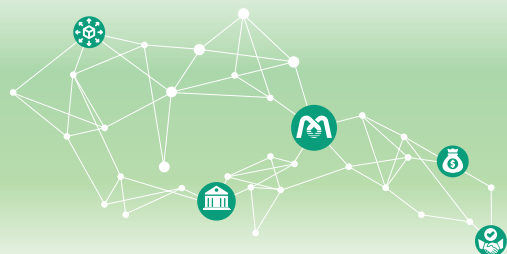


Figure 4 Objectives of e-MOP



accelerating the flow of funds for merchants and enterprises. In this way, e-MOP and existing payment instruments will complement and benefit each other.

- 3.4. Upon reaching a maturity stage in terms of technology and conditions, the AMCM will give priority to exploring and fostering the interconnection of e-MOP with digital renminbi (e-CNY) and digital HKD. On top of facilitating cross-border payments and capital flows within the GBA, this initiative aims to promote the construction of high-quality digital financial infrastructure in the region, thereby contributing to the national strategy of developing a digital economy. The longer-term objective is to establish linkages with CBDCs of Portuguese-speaking countries (PSCs), so as to give full play to



Macao's role as a "Commercial and Trade Co-operation Service Platform between China and Portuguese-speaking Countries".

B. Potential Benefits

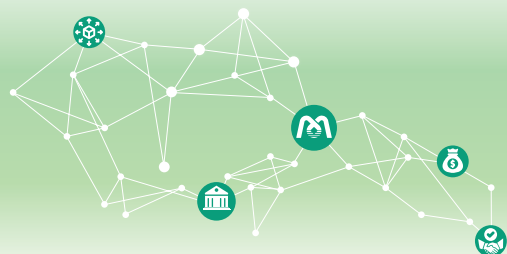
3.5. The introduction of e-MOP is envisaged to yield unique benefits to the existing payment ecosystem in Macao. The distinctive features of e-MOP, like programmability, account-based and value-based hybrid models offering immediate settlement upon payment, are poised to create an environment conducive to more efficient, cost-effective and inclusive financial transactions and trade flows. This will, in turn, stimulate the emergence of novel economic endeavours and establish a strong foundation towards high-quality economic development in the SAR.

3.6. As a digital form of legal tender, e-MOP may draw on the acceptance basis of "Simple Pay" by leveraging wallet application software (apps) and physical carriers (such as cards or smart devices), rendering efficient, convenient and cost-effective payment services to residents and tourists. For merchants, given the distinct feature of settlement upon payment of e-MOP, as opposed to other electronic payment instruments with delayed settlements, this settlement efficiency of e-MOP may enhance cash flow efficiency for SMEs. At the same time, apart from local retail payment scenarios, e-MOP can be deployed in a wide range of applications, such as public transport, parking facilities and e-government services, thereby contributing



to the smart city initiatives. Going forward, the AMCM will actively explore the application of e-MOP in inter-company and cross-border payments and settlements, as well as its exchanges with other digital currencies, with a view to reducing the cost of cross-border settlements and improving overall efficiency.

- 3.7. Based on relevant statistics, alongside the rising popularity of local mobile payments in recent years, the growth in the circulation of MOP banknotes and coins has moderated. In contrast to the double-digit growth observed a decade ago, the circulation of MOP banknotes abated 3.1% year-on-year at end-2023, while the circulation of MOP coins saw a 0.9% increase. It is expected that the launch of e-MOP may further scale down the market demand for MOP banknotes and coins, thus reducing the SAR Government's expenses in the issuance of banknotes and coins.
- 3.8. In the course of promoting the development of e-government, the adoption of a convenient, widely accepted and cost-effective electronic payment instrument will be a prerequisite. At present, in order to accommodate the payment preferences of residents and tourists, government departments have to negotiate with relevant financial institutions on the acceptance of various electronic payment methods. On top of the administrative costs involved, relevant government departments have to bear the processing fees associated with these payments, not to mention the generally low transaction limits. As a digital legal tender with an immediate settlement feature,



e-MOP can be integrated into the master e-government strategy, which may be applicable to various e-government payment scenarios with larger payment amounts at lower costs, benefiting the SAR Government in reducing administrative costs.

3.9. Building on the Mainland's practical experience in distributing government welfare and incentive-based consumption subsidies through e-CNY, the system architecture of e-MOP will be technically equipped to support the Macao SAR Government in disbursing policy-oriented subsidies through e-MOP. This can streamline administrative procedures and disbursement processes between government departments, financial institutions and merchants, lowering the cost of implementing the SAR Government's policies. Furthermore, the e-MOP system is propitious to augmenting the precision of fiscal resource allocation and social welfare distribution, reinforcing policies that are aimed at providing targeted support for SMEs and incentivising consumption.

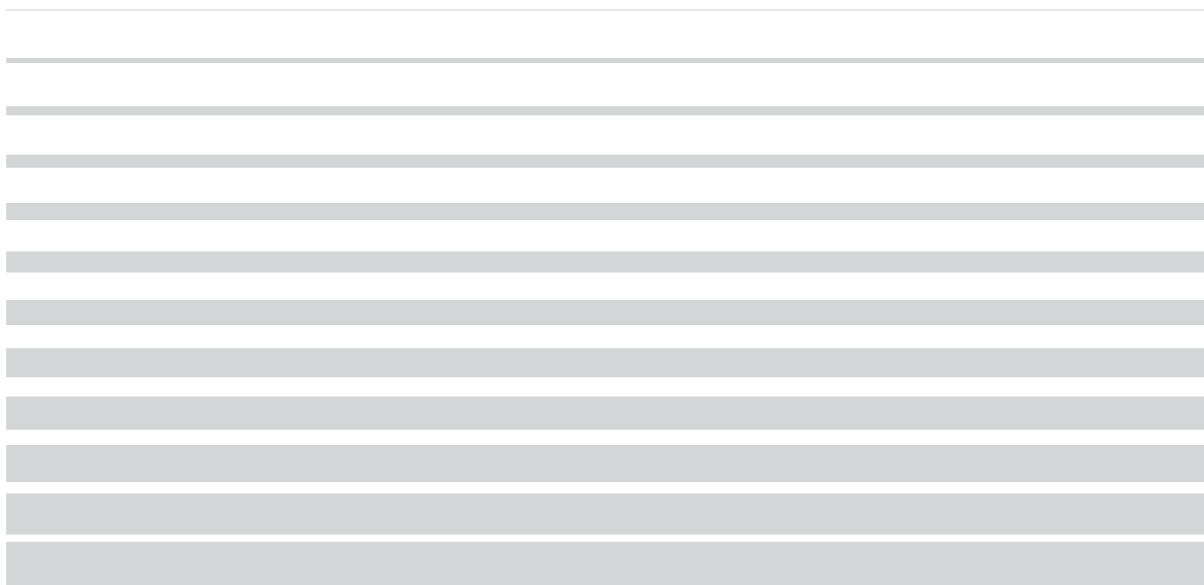
3.10. In the long term, the adoption of e-MOP may set the stage for reducing payment fees. As revealed by a scenario analysis which takes into account the projected share of e-MOP in local mobile payments alongside varying transaction fees levied by financial institutions on merchants, if e-MOP becomes more popular and gains traction among tourists in Macao, local merchants can benefit from lower transaction charges and enhanced service quality. It is expected that the annual operating costs of local merchants will be lowered.

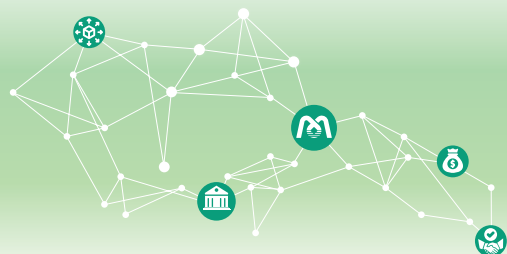


- 3.11. Currently, the acquiring services offered by local financial institutions to merchants cover a variety of domestic and international payment instruments, including QR code payment tools commonly used by tourists from Mainland China and Hong Kong, as well as relevant payment services of international card organisations. However, certain foreign payment instruments (particularly those associated with international card organisations) are not accepted by some merchants in the local community or in specific payment scenarios due to concerns about transaction fees, affecting visitors' consumption experience to a certain extent. Looking ahead, e-MOP can provide an efficient and convenient payment experience to visitors. Together with its recognition as a legal tender, the adoption of e-MOP is envisaged not only to enhance the payment experience for inbound visitors, but also to strengthen Macao's strategic positioning as a "world centre of tourism and leisure".
- 3.12. The day-to-day operation of e-MOP will encompass multiple professional areas, including currency issuance, financial infrastructure, cybersecurity, financial technology and legal compliance. This will create a diverse array of specialised roles in the local job market, attracting young individuals who are aspired to pursuing careers in these fields. The adoption of e-MOP will benefit the nurturing of professional talents and generate new impetus for the sustainable growth of Macao's economy.



Positioning and Design Principles of e-MOP





4. Positioning and Design Principles of e-MOP

A. Positioning

4.1. Pursuant to Paragraph 1 of Article 3 of Law No. 10/2023 (The Legal Framework on Currency Issuance) which took effect on 1 September 2023, Macao SAR's legal tender comprises banknote, coin and digital currency. That is, e-MOP is also the legal tender of Macao SAR, holding the same legal status as banknotes and coins. Equivalent to the physical MOP in circulation, e-MOP is classified as "currency in circulation (MOP)".

4.2. Similar to the physical MOP, e-MOP is a liability of the AMCM backed by its sufficient assets. Being a legal tender, it has the same legal status and monetary value as the physical MOP. Pursuant to Article 108 of the Basic Law of the Macao Special Administrative Region and Paragraph 1 of Article 6 of The Legal Framework on Currency Issuance, the issuance of currency must be 100-percent backed by reserves, which is also binding to the issuance of e-MOP.

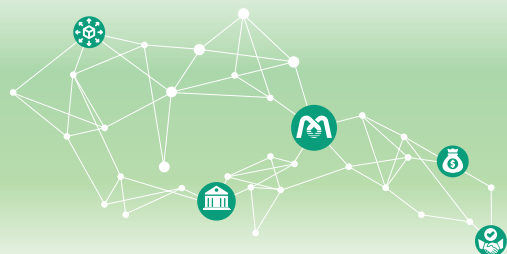
4.3. e-MOP will co-exist with the physical MOP. The issuance of e-MOP, mirroring the existing practice of MOP banknotes and coins, will be administered by the Macao SAR Government in accordance with the currency board arrangement. When the physical MOP is converted



into e-MOP, banks will reduce holdings of the physical MOP while increasing the holdings of e-MOP by the same amount. In principle, the volume of currency in circulation in Macao SAR will not be affected.

4.4. e-MOP adopts a centralised management model and a two-tier operational system, which is compatible with the existing currency board arrangement in Macao. The two-tier operational system can optimally capitalise on the strengths of the designated authorised operators in resources, expertise and technology, so as to come up with a market-driven environment that promotes innovation and competition. Meanwhile, as Macao residents are accustomed to accessing financial services through commercial banks, the two-tier operational system is conducive to increasing the societal acceptance of e-MOP. In addition, this arrangement will facilitate financial stability by mitigating the potential impact on commercial banks stemming from customer withdrawals from deposit accounts.

4.5. e-MOP serves both retail and wholesale purposes. As a currency that is “fully and freely convertible”, the purpose of developing e-MOP is to enhance payment and settlement efficiency, serving local residents, non-residents, as well as public and private entities by meeting their needs of day-to-day payments while reducing associated costs. In the short run, the development and implementation of e-MOP will focus on retail payment scenarios. In the medium to long run,



as relevant institutional and physical financial infrastructure and technology become sophisticated, the AMCM will explore wholesale scenarios of e-MOP, with a view to enhancing its functionality for cross-border payments.

4.6. e-MOP is compatible with both account-based and value-based models, with the former encompassing a quasi-account-based approach. The account-based model resembles conventional electronic banking payment instruments, whose setup is based on accounting categories with a specific format and structure, and serves as a carrier reflecting changes in account balances and transfer of values. For those accounts for which the identity of the accounting entity opening them is uncertain, they may be referred to as quasi-accounts. On the other hand, the value-based model executes value transfers via cryptographic technologies such as digital signatures as expressed credentials. That is, the payment process takes the form of cryptocurrency strings. The choice between account-based and value-based models in the design of the e-MOP system will depend on the specific application scenarios.

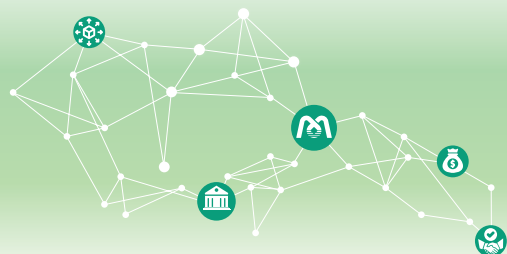
4.7. Payments by e-MOP offer settlement finality. All transactions in e-MOP are settled instantly. This implies that e-MOP fund transfers are irrevocable and completed in real-time to ensure settlement finality – once a payment is made, the legal ownership of the currency (similar to the physical MOP) is transferred immediately.



B. Design Principles

4.8. The design of e-MOP is centered on achieving the goals outlined in its research and development objectives, taking into account user requirements while ensuring the functional design complies with existing laws and regulations, which will be amended as required by circumstances. The institutional design of the e-MOP system is set to reach or surpass the established standards of flexibility and security for financial market infrastructure. Besides, the design of e-MOP rigorously adheres to international standards for anti-money laundering/combating the financing of terrorism (AML/CFT) and complies with relevant laws and regulations on data protection and privacy in Macao SAR. These requirements not only ensure proper transparency, compatibility and transferability within Macao's financial system, but also safeguard personal privacy and security of user information.

4.9. As the legal tender of Macao SAR, e-MOP stands out as the most secure asset in Macao SAR. It is poised to play a pivotal role in facilitating the soundness of the financial system, macroeconomic stability and economic growth. Hence, the design and deployment plans of e-MOP prioritise protecting the legitimate rights and interests of local residents, public and private entities, and foreign investors, thereby safeguarding financial stability.



4.10. The design of e-MOP will carefully cater to the needs of different user groups. The e-MOP project will explore the use of various technologies to enrich products adaptable to different application scenarios, offering services across multiple platforms. In retail scenarios, research will focus on replicating certain convenient features of physical cash, such as the ability to function without a bank account or internet connection, so as to enhance payment inclusivity.

4.11. The design of e-MOP aims to facilitate faster and more cost-effective cross-border payments, in alignment with the principles and recommendations advocated by international organisations regarding exchange measures and regulations for CBDCs. Concurrently, as a fully convertible currency, the design of e-MOP respects the policies and legal frameworks, as well as the monetary sovereignty, exchange rate regimes, and relevant exchange and remittance rules of other jurisdictions, in an endeavour to fulfill their regulatory and compliance requirements.

4.12. e-MOP supports financial inclusion. e-MOP can seamlessly interoperate with electronic payment systems, enabling connectivity between wallet apps of designated authorised operators, e-MOP wallets and bank accounts, with an overarching vision to foster financial inclusion.

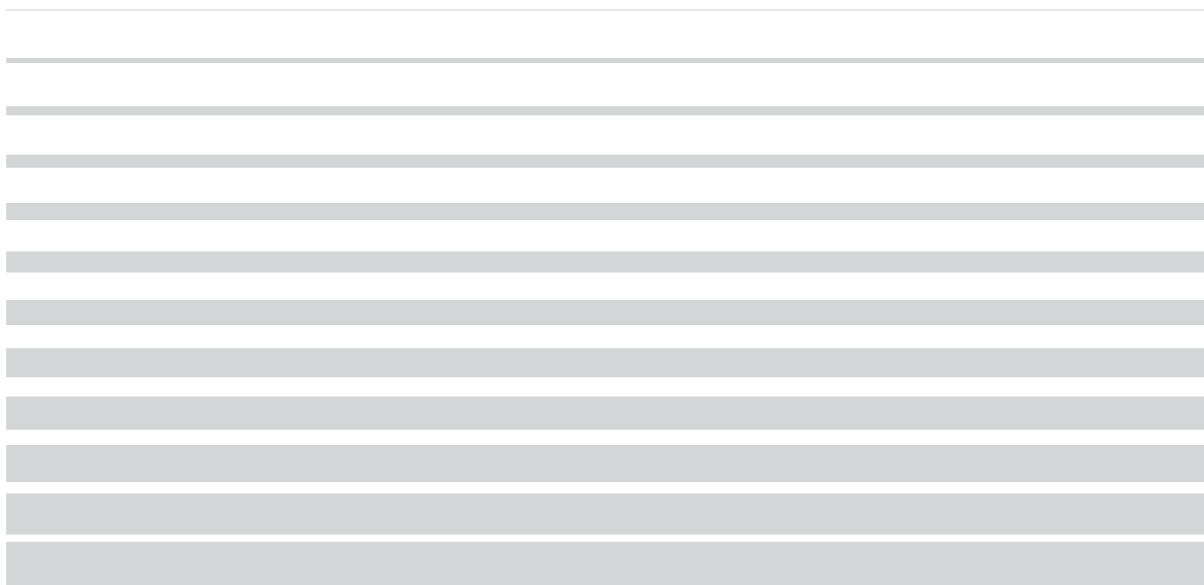


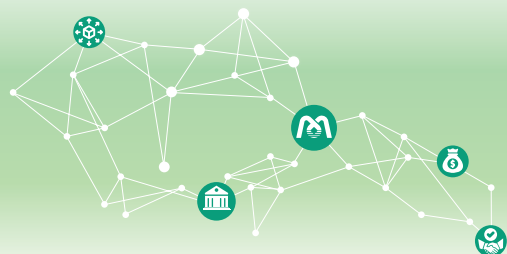
Figure 5 Design Principles of e-MOP





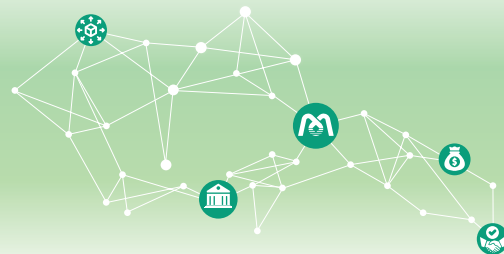
Technical Features of e-MOP





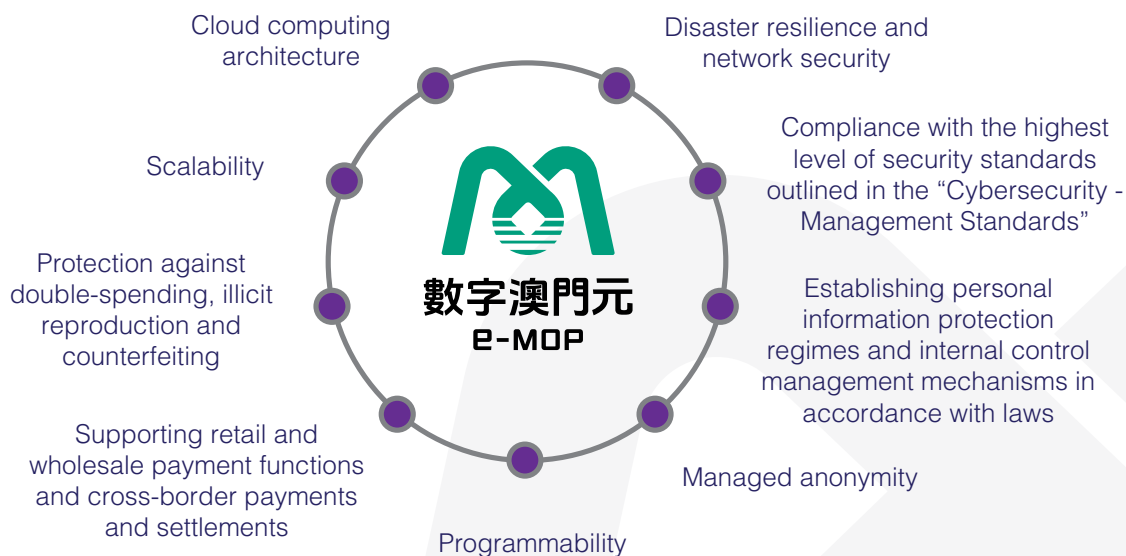
5. Technical Features of e-MOP

- 5.1. Digital currencies and payment systems make extensive use of internet technology. As a result, the evolution of internet technology could have a significant impact on digital finance and digital currencies, necessitating thorough consideration in the aspects of network and information security management.
- 5.2. The e-MOP system utilises a cloud computing architecture to combine the stability and security inherent in conventional financial technology, with the high-performance and enhanced flexibility offered by internet technology. By integrating the traditional centralised architecture with the technical advantages of Distributed Ledger Technology, a hybrid technical architecture will be formulated to harmonise the development of centralised and decentralised methodologies. Besides meeting the need for efficient system processing for a massive customer base, this hybrid architecture ensures account security and a reliable reconciliation process across multiple institutions.
- 5.3. The e-MOP system is devised with scalability features to support deployment with multi-site high availability, coupled with the flexibility in resource expansion or contraction. Specifically, the system is able to horizontally scale across data centres and possess parallel processing capabilities. In the future, the system deployment and resource capacity can be dynamically calibrated to align with the scale and development of the e-MOP business.

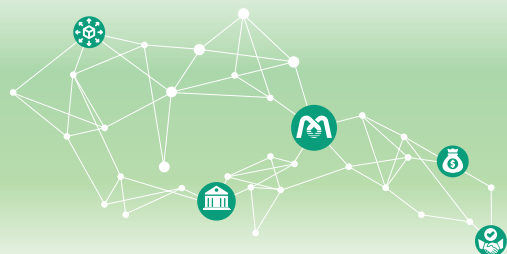


5.4. The e-MOP system harnesses the technical advantages of cloud computing technology to enhance capabilities across infrastructure, application design, data security and operational maintenance. With these, the e-MOP system adheres to the best practices for disaster recovery in the financial industry, aligning with business continuity standards.

Figure 6 Technical Characteristics of e-MOP



5.5. e-MOP strictly adheres to relevant regulations, including Law No. 13/2019 (Cybersecurity Law) and Law No. 8/2005 (Personal Data Protection Act). The three-pillar security system of technology, operation and management, supported by adequate resources and



capabilities, will ensure security in the business operation of e-MOP. Following the highest standards in network security protection and design requirements, a secure and controllable physical environment and communication network will be constructed, forming a comprehensive and multi-layer security system for e-MOP. In addition, the security system incorporates a mix of technologies, including digital certificates, digital signatures and storage encryption, offering protection against double-spending and illicit reproduction and counterfeiting, as well as tamper-proof and non-repudiable features, ensuring security throughout the entire lifecycle of e-MOP.

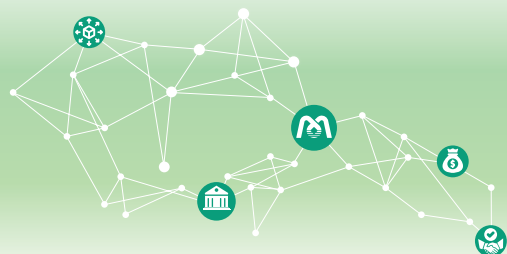
5.6. The functional model of e-MOP covers currency issuance and circulation, as well as retail and wholesale payments. Apart from local retail payment scenarios, e-MOP will support cross-border payments and settlements.

5.7. On the front of system security, as the legal tender and official medium of payments and settlements in Macao SAR, the design of the e-MOP system adheres to the highest standards of disaster resilience and network security. In order to attain the core functions of e-MOP, the production environment is meticulously organised and configured with network, computing, storage and security infrastructure in line with the highest standards of production security. Following the guidelines of graded protection of cybersecurity, a network segmentation approach will be adopted in the planning and



architectural design of the e-MOP system. Furthermore, a defense-in-depth strategy will be rigorously implemented for system security, along with a set of operational maintenance measures on data security, encryption and auditing.

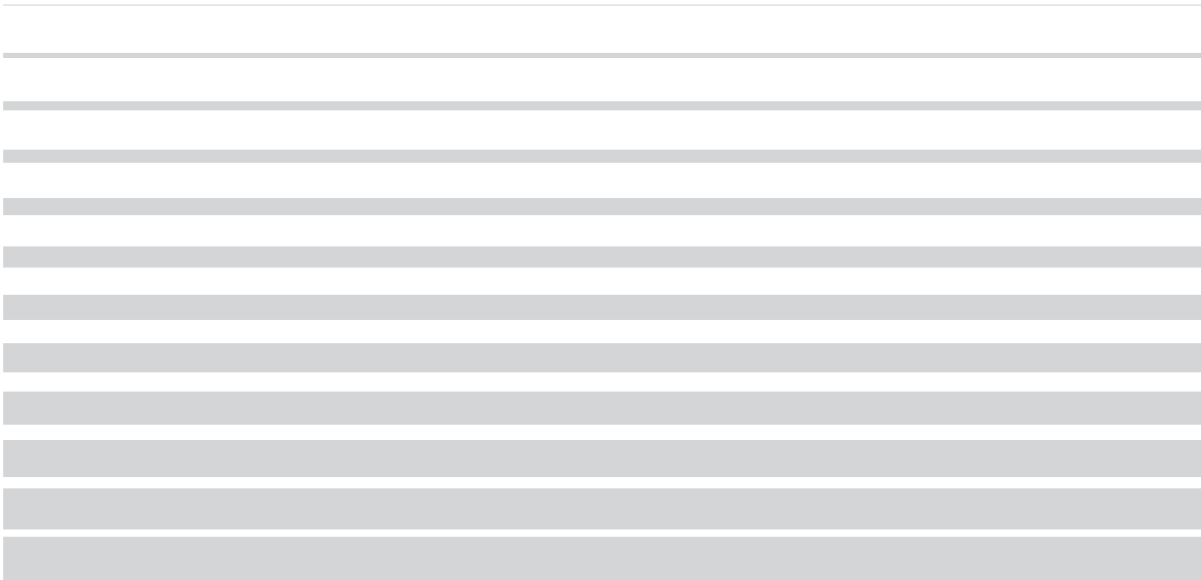
- 5.8. On the front of cybersecurity, the operation of the e-MOP system adheres to the highest level of security standards outlined in the “Cybersecurity - Management Standards” set forth by the Cybersecurity Incident Alert and Response Centre as per Law No. 13/2019 (Cybersecurity Law). The system will be monitored 24/7 by a team of specialists.
- 5.9. Regarding information security, it is necessary for both the AMCM and designated authorised operators to establish personal information protection regimes and internal control management mechanisms that comply with the legal requirements.
- 5.10. e-MOP will support the feature of managed anonymity, where privacy and data protection are important aspects of its design. The e-MOP system offers privacy to consumers, strictly protecting personal information and data security. Concurrently, the system ensures that e-MOP transactions comply with recommendations and best practices advocated by the Financial Action Task Force (FATF). In addition, the e-MOP system fulfills the AML/CFT regulations and supervisory requirements in Macao SAR, effectively combating illicit transactions and tax evasion.



5.11. e-MOP will support programmability. On the premise of preserving the functions of currency, smart contracts with tamper-proof features and mechanisms to guarantee execution will be embedded into the system. Smart contracts are system protocols whose conditions are pre-determined, which are immutable during execution. The system is able to automatically conduct compliance checks and verify the terms specified in the contract, while transactions may be automatically completed without human intervention. Given the merits of smart contracts, including transparency, trustworthiness, automatic execution and obligatory performance, they are well suited to facilitate the monetary functions of e-MOP, fostering ongoing innovation in business and payment models.



Ecosystem of e-MOP

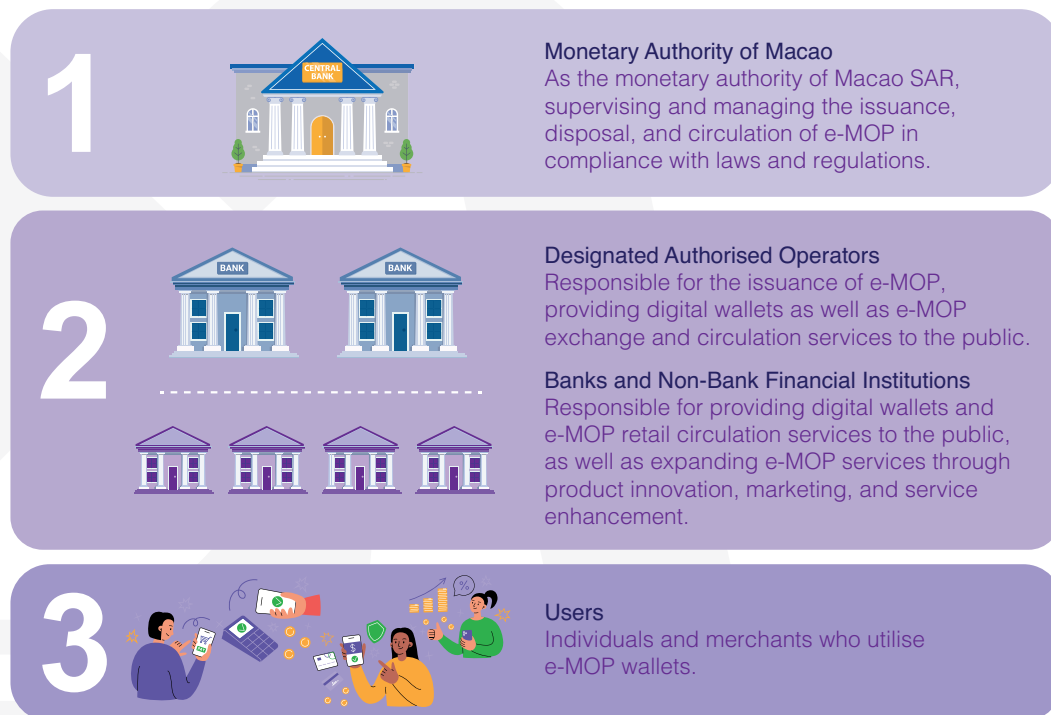


6. Ecosystem of e-MOP

A. Operational Model of the e-MOP System

6.1. e-MOP adopts a centralised management model and a two-tier operational system. As the monetary authority of Macao SAR, the AMCM plays a central role as the first-tier within the two-tier operational system. In compliance with relevant laws and regulations, the AMCM is responsible for supervising and managing the issuance, disposal and circulation of e-MOP. Concurrently, the AMCM will prudently select commercial banks with sufficient capital and adequate technological capabilities to be designated as authorised

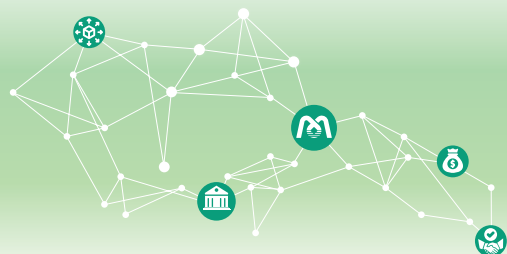
Figure 7 The e-MOP System Operational Model





operators of e-MOP that will provide e-MOP exchange services to the public and other entities. Under the AMCM's centralised management, other commercial banks and institutions may unleash their creativity to collectively provide services for e-MOP circulation.

- 6.2. Under the two-tier operational system, the designated authorised operators are classified as the second-tier. Subject to the quota permitted by the AMCM, the designated authorised operators offer various types of e-MOP wallets and provide e-MOP exchange and withdrawal services for their customers, based on the strength of user identity verification. e-MOP and funds in the electronic accounts of the designated authorised operators are analogous, forming cash-like payment tools. In the two-tier operational system of e-MOP, the number of authorised operators in the second-tier will be increased in order to foster technological and financial innovation.
- 6.3. Concurrently, the designated authorised operators, in collaboration with other commercial institutions, will jointly provide circulation services for e-MOP and manage the retail aspects. These encompass tasks such as innovation in payment product design, system development, expanding scenarios, marketing, business processing, as well as operational maintenance. Throughout this process, the AMCM will strive to maintain a fair and competitive environment, ensuring market-driven resource allocation to stimulate enthusiasm and creativity of stakeholders. These initiatives are aimed not only at upholding the stability of Macao SAR's financial system, but also fostering the development of modern financial services.



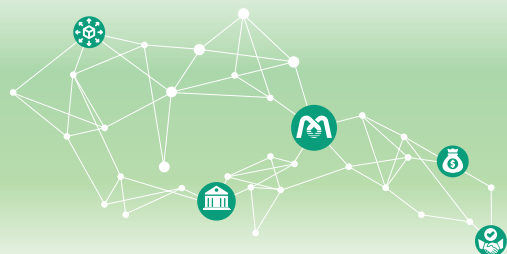
B. Design of e-MOP Wallets

6.4. Digital wallets serve as carriers of e-MOP and the media interacting with users. On the premises of centralised management, unified recognition and anti-counterfeiting features, the AMCM will formulate relevant regulations for e-MOP. On the other hand, guided by the principle of joint contribution and shared benefits, the designated authorised operators will develop apps for mobile devices, manage digital wallets and authenticate e-MOP. An ecological platform for e-MOP wallets will be established, with operator-specific visual systems and distinctive features. e-MOP will be usable in both online and offline applications across different scenarios, to meet the diverse demand across different types, levels, categories and states of users, thereby ensuring the inclusivity of e-MOP wallets.

6.5. e-MOP wallets are categorised into personal wallets and corporate wallets based on the type of holders. Personal wallets can be opened by natural persons, with transaction and balance limits being classified and managed according to the strength of customer identity authentication. On the other hand, corporate wallets serve as carriers for enterprises (merchants) to accept payments made in e-MOP. As a payment instrument within the statutory e-MOP circulation system, corporate wallets are used in handling business operations such as payments, receipts and transaction inquiries of e-MOP. Legal persons, natural person proprietors (sole proprietors), and non-legal person entities can open corporate wallets, whose transactions, balance limits and wallet functions can be customised to suit user needs.



- 6.6. e-MOP wallets are categorised into software wallets and hardware wallets based on the type of carriers. Software wallets provide services to users through mobile payment apps, software development kits, and application programming interfaces. On the other hand, hardware wallets make use of security chips and relevant technologies to enable functions of e-MOP, providing services to users through cards, mobiles and internet-connected devices. The harmonised development of software wallets and hardware wallets is expected to enrich the e-MOP wallet ecosystem, so as to meet the needs of different user groups.
- 6.7. Based on the current payment norms in Macao SAR, e-MOP wallets adhere to the principle of “anonymous for small values, traceable for large values in compliance with the law”. Personal software wallet apps are divided into different levels according to the strength of the “Know Your Customer” (KYC) process. The designated authorised operators manage e-MOP wallets based on the level of customer identity authentication, where different wallet levels are allotted different transaction limits and balance caps. The classification of e-MOP wallet levels draws from the common practices in Macao’s existing payment landscape, which includes: (i) anonymous wallets that only require phone number authentication for activation; (ii) wallets that require phone number authentication and linkage with a bank account in Macao; (iii) wallets that require the completion of online identity authentication via an e-KYC process or in-person

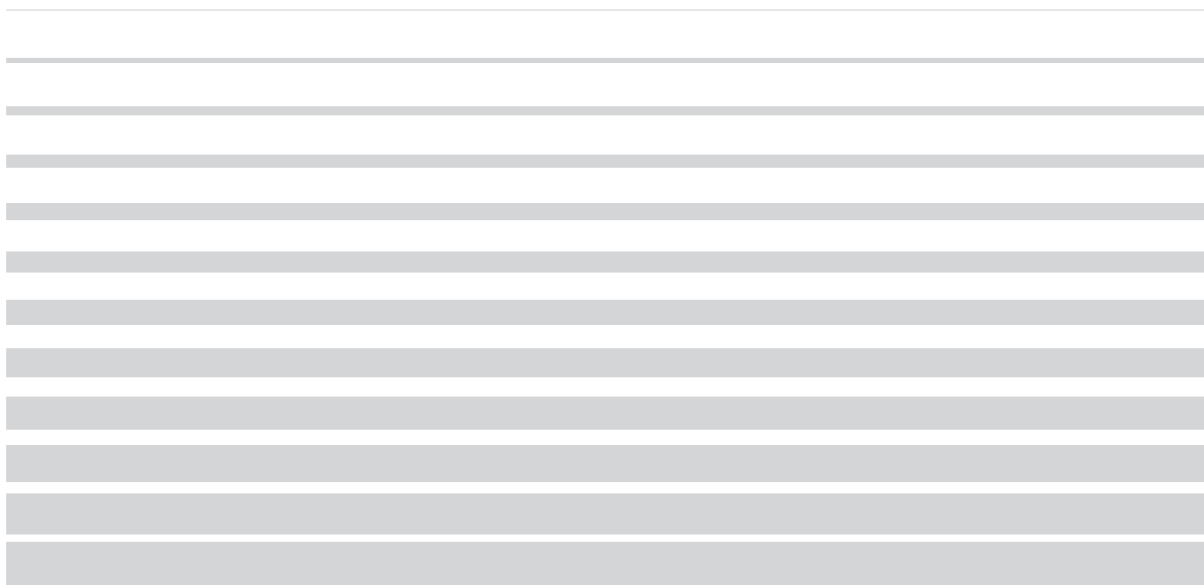


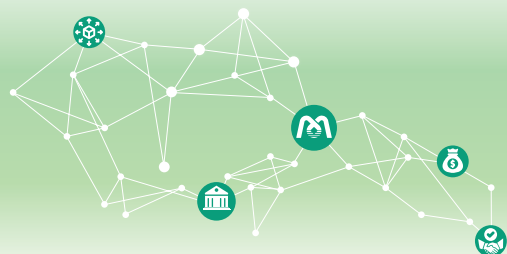
authentication at bank counters of authorised operators; and (iv) wallets for youths that require in-person authorisation from their guardians.

6.8. A matrix of e-MOP wallets will be developed across various dimensions. Under this framework, the AMCM will formulate relevant regulations, while the designated authorised operators will cooperate with relevant market players to advance the development of payment and financial products on the basis of providing various basic functions of e-MOP. It is envisaged that an e-MOP wallet service ecosystem, which will meet diverse needs across different scenarios and deliver distinctive functionalities, will be established.



The Implications of e-MOP for Stakeholders





7. The Implications of e-MOP for Stakeholders

A. Consumers

- 7.1. As the legal tender of Macao SAR, issued by the Macao SAR Government, e-MOP will benefit consumers by bringing in more payment options with user-friendly features.
- 7.2. In contrast to traditional cross-border bank transfers, which involve multiple intermediaries and are time-consuming, transactions are real-time with e-MOP. Besides shortening the processing time of cross-border payments for consumers, the costs of cross-border payments will be reduced.
- 7.3. The convenience of accessing and using e-MOP will incentivise manufacturers or service providers to develop more consumer-centric, innovative products and services, ultimately benefitting consumers.

B. Merchants and Enterprises

- 7.4. The design and programmability features of merchant wallets are poised to radically enhance payment flows of enterprises, offering advantages in various scenarios, including fund settlements for both upstream and downstream enterprises.

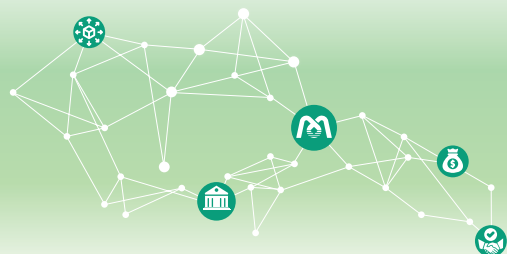


7.5. At present, acquiring service providers in the payment market typically charge merchants a certain percentage of the transaction amount as processing fees. Meanwhile, merchants may have to bear certain costs for cash handling. Hence, as a cost-effective retail payment instrument, e-MOP will contribute to lowering costs for merchants within Macao SAR's payment ecosystem. Besides, given its efficiency and instant settlement feature, the adoption of e-MOP is conducive to reducing costs for merchants in terms of money and time involved in receiving and making payments.

C. Financial Institutions

7.6. The e-MOP system is set to link up with participating institutions of the "Simple Pay" integrated payment service scheme, through which a unified linkage will be established. In addition to preserving the payment experience offered by the "Simple Pay" initiative, the system is positioned to establish connections with external nodes to facilitate cross-border payments in the future.

7.7. The introduction and adoption of e-MOP is envisaged to complement, maintain and reinforce the existing role of commercial banks as financial intermediaries and key service providers to consumers. By enhancing customer experiences in various domains of financial services, including payments, settlements, consumption, investment and financing activities, the adoption of e-MOP is poised to enhance the overall quality of financial services and market competitiveness.



7.8. Besides, the adoption of e-MOP will inevitably foster the digital transformation of commercial banks in customer bases and service models. As the legal tender shifts to a digital form, the digitalisation of traditional operations of local commercial banks will naturally accelerate, thus driving innovation and advancement of financial products and services.

7.9. The legal tender status and other distinctive characteristics of e-MOP, such as settlement upon payment, coupled with the global trend of digital economy and financial technology, will render financial innovation opportunities for payment service providers to develop full-chained and diverse payment scenarios of e-MOP.

7.10. According to a research paper published by the IMF, the introduction of CBDC can promote competition and innovation in payment systems, making it possible to deliver better and cheaper services to consumers while lowering payment costs.

7.11. Looking ahead, the development of e-MOP will rely on technological advancement in a market with well-established payment systems. Meanwhile, payment service providers will be able to capitalise on e-MOP to facilitate technology transfer and optimise their business models.

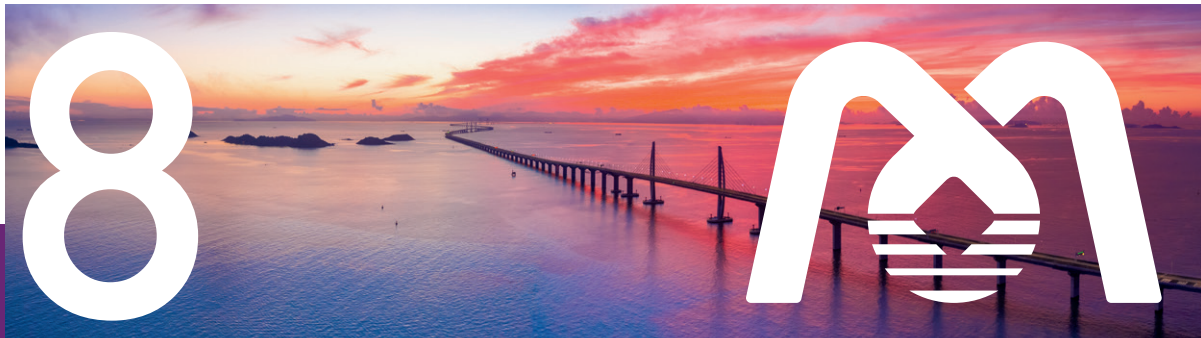


D. Institutions of Other Ecosystems

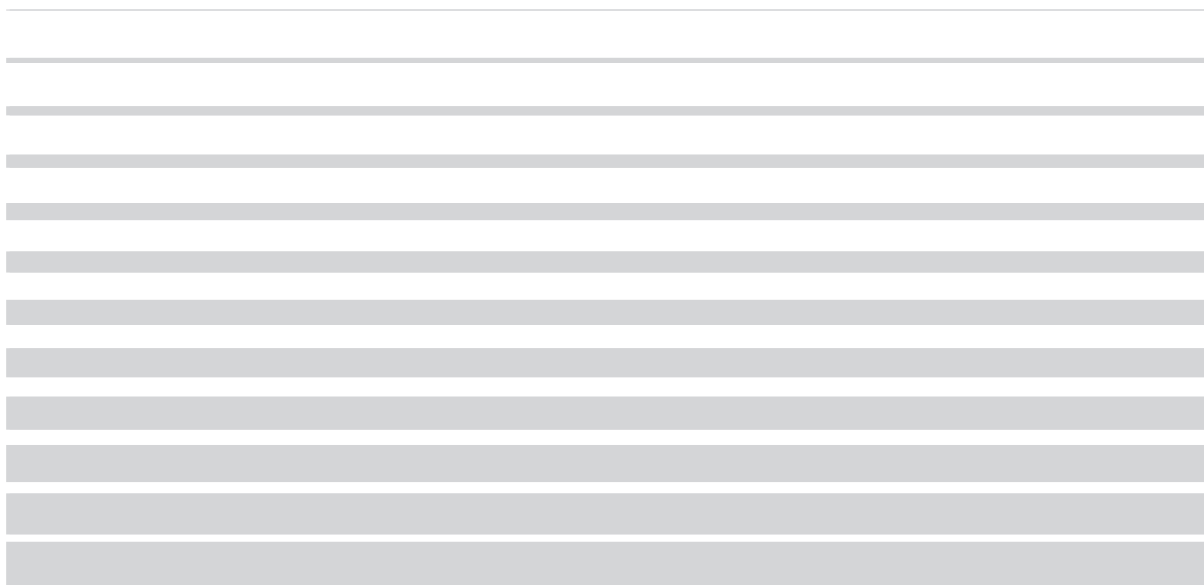
7.12. The e-MOP ecosystem is expected to further enhance financial inclusion, creating new opportunities for technology firms. For instance, they may engage in application development and provide innovative digital products and services to public and private entities. Besides, institutions of other ecosystems, such as e-commerce platforms and public utilities, may integrate e-MOP into diverse application scenarios in the course of the e-MOP system's operation, thus fostering further advancement in their financial technology capabilities and service quality.

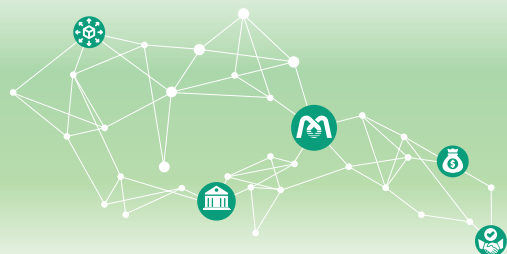
E. Financial Supervisory Authority

7.13. With the adoption of emerging technologies, e-MOP has brought new vitality and innovation to traditional financial risk management. As the statutory body responsible for guiding, coordinating and overseeing the currency, financial and foreign exchange markets in Macao SAR, the AMCM will stay committed to advancing the application of regulatory technology. In particular, the AMCM will explore the utilisation of novel technologies, such as artificial intelligence and cloud computing, to enrich its financial supervisory tool kits, as well as to strengthen the risk prevention capabilities of e-MOP.



The Blueprint for the Development of e-MOP





8. The Blueprint for the Development of e-MOP

A. Strategic Plans and Progress

8.1. The development of the financial industry will trend towards digitalisation and intelligence, with a strong focus on innovation. Meanwhile, the digital legal tender is set to play a central role in Macao SAR's financial infrastructure. In line with this vision and with the support of the PBOC, the AMCM established the e-MOP Construction Working Group in August 2023, embarking on concrete tasks for the research and development of e-MOP. The roadmap for the research and development of e-MOP was formulated with reference to the principles of stability, safety, controllability and pragmatism followed by e-CNY and the successful experience of its phased development. Coupled with Macao SAR's market environment, payment landscape and financial infrastructure, a roadmap for the research and development of e-MOP has been devised, to be implemented progressively in three phases.

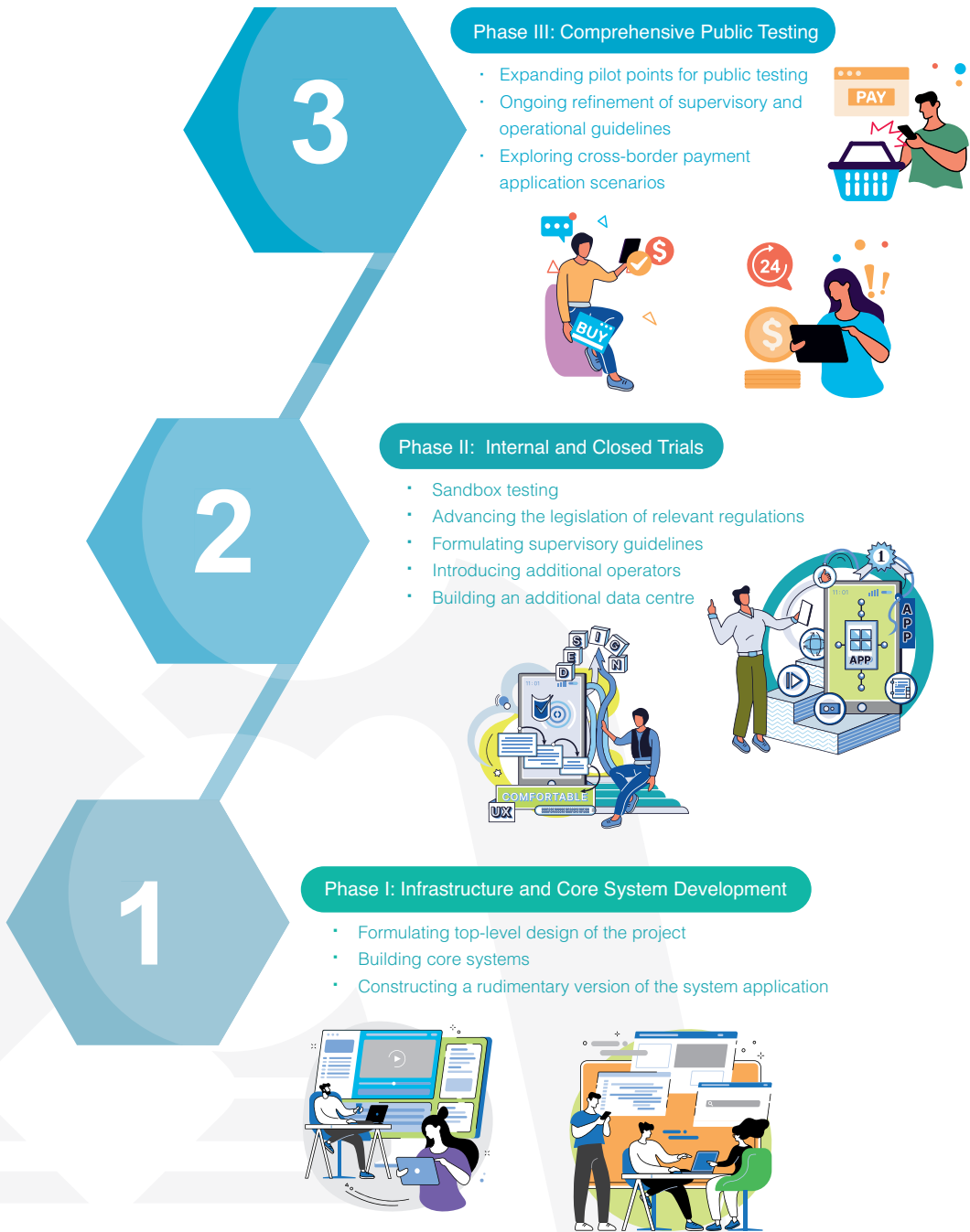
8.2. The first phase focuses on infrastructure and core system development. In this phase, under the AMCM's centralised management and two-tier operational system, designated authorised operators will be supported to scale up and interoperate across institutions while e-MOP's top-level design, business planning and function development will be carried out. Based on Macao's data centre, a rudimentary version of the system application will be constructed. This phase is expected to be completed by 2025.



- 8.3. The second phase entails internal and closed trials. Following a whitelist approach, e-MOP will undergo validation across various application scenarios through internal and closed trials (“sandbox testing”), progressively covering scenarios including retail payments, large enterprises and government payments. During this phase, outcomes and validation from the closed trials will inform actions in four key areas: advancing the legislation of relevant regulations, formulating supervisory guidelines, introducing additional authorised operators, as well as building an additional data centre.
- 8.4. The third phase then moves on to comprehensive public testing. Given established regulations, guidelines and standards, and on the premise of a stable high-availability service system, pilot points for public testing will gradually be expanded, integrating e-MOP into payment scenarios of the public in an orderly manner. On top of this, a study on wholesale e-MOP will be launched to investigate extending its adoption to cross-border payments.
- 8.5. So far, the AMCM has completed the prototype design of the system as outlined in the first phase of the project. This involved a series of tasks, such as establishing the technical architecture, specifying the functional scope and formulating the product requirement documents of e-MOP, as well as designing its user interface. These developments will lay a solid foundation for subsequent phases of the project.
- 8.6. The introduction of e-MOP will certainly be a key milestone in the history of Macao SAR’s monetary development. While e-MOP is set to



Figure 8 Roadmap for the Research and Development of e-MOP



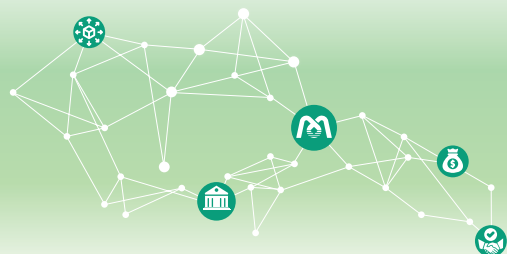


bring forth new opportunities, it also calls for a thorough assessment of potential risks and challenges. To this end, the AMCM has been conducting meticulous assessments of e-MOP, exercising prudence in decision-making at every phase of its design. These efforts are aimed at effectively preventing various risks that may arise in the course of the e-MOP operation, so as to safeguard the safety and stability of Macao SAR's monetary system. Going forward, e-MOP will only be rolled out when the relevant foundation is sound and in place while authorised operators have conducted comprehensive testing under diverse scenarios to ensure that potential risks are manageable.

- 8.7. To ensure that the launch of e-MOP will genuinely enhance payment efficiency in Macao SAR, the AMCM will strive to foster the interoperability of e-MOP with other payment systems. Efforts will also be made to facilitate its integration with other financial infrastructures, with the objective to establish a modern financial system that adapts to the evolving digital economy.

B. Opportunities for Growth and Development

- 8.8. In 2019, the “Outline Development Plan for the Guangdong-Hong Kong-Macao Greater Bay Area” was promulgated by the State Council of the People's Republic of China, which highlighted the progressive interconnectivity of financial markets within the GBA. In February 2023, the PBOC, in collaboration with the China Banking and Insurance Regulatory Commission, the China Securities Regulatory Commission, the State Administration of



Foreign Exchange, and the People's Government of Guangdong province, jointly issued the "Opinions on Financial Support for the Development of the Guangdong-Macao In-Depth Cooperation Zone in Hengqin" ("the Opinions"). The Opinions have outlined policy measures to promote appropriate economic diversification in Macao, strengthening ties between the financial markets of Macao and the In-Depth Cooperation Zone, as well as establishing a financial ecosystem facilitating Macao residents to live and work in the In-Depth Cooperation Zone. In particular, the Opinions indicated conducting feasibility studies to explore the use of MOP or renminbi in payment transactions by market entities in the In-Depth Cooperation Zone and gradually extending such usage scenarios. Provided that the associated risks are manageable, the MOP will be permitted progressively to be used in small-value transactions in the In-Depth Cooperation Zone.

8.9. Since the launch of the e-CNY pilot programme by the PBOC in 2019, pilots have been carried out not only in Mainland cities such as Shenzhen in the GBA, but also cross-border payment pilots in Hong Kong SAR. The GBA possesses unique institutional advantages of "one country, two systems, three customs zones and three legal tenders", not to mention the Central Government's policy support for financial development in the In-Depth Cooperation Zone. In the future, the AMCM will prioritise initiating trials of cross-border payments between Macao and the Mainland in the In-Depth Cooperation Zone. This endeavour aims to explore the use of e-MOP in Hengqin, creating a financial environment facilitating Macao residents to live and work in the In-Depth Cooperation Zone.

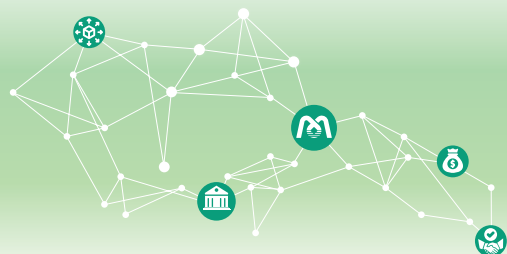


8.10. Concurrently, the AMCM will collaborate closely with the monetary authorities of Mainland China and Hong Kong SAR to foster seamless integration of e-MOP with e-CNY and digital HKD. This initiative aims to enhance the circulation and credibility of the MOP while promoting the interconnectivity of payment systems in the GBA. Ultimately, this will facilitate Macao SAR to better align with the national development strategy, fully capitalising on the institutional advantages of the “One Country, Two Systems” framework.

C. Future Outlook

8.11. According to the IMF’s research findings, enhancements in payment efficiency will have significant implications for the use of currency in international trade and financial transactions. Therefore, the innovative payment technologies underpinning CBDC will drive broader adoption of these new forms of currencies across the international community, thereby expediting the integration and interconnectedness of global financial markets.

8.12. In the long run, given the rapid development of the digital asset ecosystem, the Macao SAR Government will continue to explore CBDC-related advancements, such as privacy protection and cybersecurity, and enhance the integrity of Macao SAR’s financial infrastructure. In line with the recommendations of the Group of Twenty (G20) and other international organisations on enhancing cross-border payments, the Macao SAR Government will adhere to the principles of “compliance, do no harm, and interoperability”, and proactively engage with international organisations, regulatory bodies



and financial service institutions to seek participation in multilateral CBDC pilot projects. Additionally, the Macao SAR Government will explore the integration of e-MOP with CBDC project platforms in other countries or regions, and collaborate with the PBOC on investigating the advancement and extension of cross-border payment and settlement systems for the three currencies used in the GBA, with a vision to facilitate the internationalisation of the renminbi.

8.13. Simultaneously, the AMCM has maintained a long-standing cooperative relationship with central banks of PSCs. While facilitating the use of e-MOP in PSCs, which is based on Mainland China's cutting-edge technology, the AMCM is dedicated to using e-MOP as a practical model to promote the Motherland's relevant technical standards to PSCs. This endeavour will support the research and development of CBDCs in PSCs, thereby embodying Macao's role as a "platform between China and Portuguese-speaking countries".

8.14. Looking ahead, the Macao SAR Government will be committed to enhancing the legal and supervisory framework for the development of e-MOP. Efforts will be made to advance financial infrastructure while preventing potential risks associated with the adoption of CBDC. Our ultimate goal is not only to create a modern monetary and financial system with an efficient and innovative CBDC, but also to safeguard economic and financial stability for the sustainable development of Macao SAR.

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