

A Platform View of Mobile Proximity Payment Technologies

Case: NFC vs. QR code in the Chinese mobile proximity
payment market



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proximity payment market

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Abstract

Nowadays, the rising penetration of smartphones and the important roles of them in people's daily life make the smartphones an ideal medium to conduct payment transactions. The smartphones are capable to store everything that would normally be carried in a physical wallet and also allows the users to make payments anytime and anywhere. The potential added-values of mobile payments, such as generating new revenues, obtaining new users, increasing user stickiness attracted different players to expand their businesses to the mobile payment services, including financial institutions, mobile network operators, mobile device manufacturers, trusted third party providers. To compete in the market, they explored different technologies and business models which resulted in the complexity and dynamics of the mobile payment market. Consequently, mobile payments have only become a standard practice in a few countries. In terms of proximity payments, NFC is widely viewed as one of the most promising technologies due to its security features, compatibility with the existing financial infrastructures, and ease of use. In the Chinese market, compared with QR code, NFC was first introduced and supported by various players. However, the Chinese mobile proximity payment market has become the largest and fastest-growing mobile proximity payment market in the world in few years by utilising QR code. The market is highly concentrated with Alipay and Tenpay which are QR code-based mobile payment platforms. In other words, QR code overtook NFC and became the most popular mobile proximity payment technology in China.

Considering this phenomenon, the main research question in this study is set as "why did QR code-based mobile payments overtake NFC and achieve a dominant position in the Chinese market?". In order to answer this question, the research work is conducted in three steps. Firstly, a historical review of the Chinese mobile proximity payments is performed to identify the mainstream mobile proximity payment solutions based on QR code and NFC technologies and corresponding business models adopted in the Chinese market. Secondly, a desk research is conducted to determine the barriers that mobile payment providers and users face towards to QR code and NFC-based mobile payment solutions using a multi-perspective framework. To obtain the situation in the Chinese market and also triangulate the results of the desk research, in-depth interviews are conducted with technical experts and manager from the Chinese mobile payment industry. Lastly, a proposed research model is used to analyse the strategic actions of the mobile payment providers who support different technological solutions, how they develop the mobile payment platforms and facilitate users' adoption of their mobile proximity payment services in the Chinese market.

In this study, the research model is developed based on relevant business model, platform and business ecosystem theories. The final research model consists of three connected perspectives which are platform technology, platform ecosystems and platform services. It is applied to three Chinese mobile payment platforms, namely, He Wallet, Alipay and QuickPass which have implemented one or several technological solutions based on NFC and QR code technologies. The data for the case studies is collected from the semi-structured interviews and the desk research. The results showed that although NFC technology was adopted first in the Chinese market, the enabling devices of both consumers and merchants were not widely ready at that time for NFC technology,

but good enough for QR code technology. However, the early NFC adopters (both MNOs and financial institutions) were reluctant to make a huge investment in the enabling devices to realise the large-scale deployment in the early stage due to the uncertainties on the technology level and the unclear roles and benefits on the business aspect. Thereby, they missed the best time to capture user and develop users' habit. In contrast, Alipay strategically adopted the independent service provider mode to leverage its obtained platform resources and capabilities which significantly contributed the mass adoption of QR code in the Chinese market. Despite QR code currently dominated the Chinese mobile payment market, it is believed that NFC has its place in the Chinese mobile payment market as China UnionPay adopted an open platform strategy to incorporate all relevant players into its ecosystem to facilitate the development of NFC-based mobile payments.

The research results in this study are not only beneficial to the theoretical research in mobile payments but also useful for the practical development of mobile payments. From the theoretical perspective, this research provides a comprehensive overview of the characteristics and potential barriers of four technological solutions based on NFC and QR code technologies. Besides, it developed a research model which can be used to interpret the status of a mobile payment platform. From practical perspective, it provides some insights to the mobile payment providers in terms of the technology selection, the design of the business model, the service development and the marketing strategies.

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1 Introduction

This chapter consists of five sections. Section 1.1 the research problem, briefly introduces the relevant background of mobile payments and provides an overview of the Chinese mobile proximity payments. The research problem is derived from the current competition status between near field communication (NFC) and quick response (QR) code, which are the two mainstream technologies used in the Chinese mobile proximity payment market. Following the research gaps are described in section 1.2. And then the research questions are proposed in section 1.3. The scientific and practical contributions of this study are provided in section 1.4. At last, the thesis framework including the thesis structure and relevant technological solutions, platform theories, case studies is illustrated in section 1.5.

1.1 Research problem

The rising penetration of smartphones and the important roles of them in people's daily life make the smartphones an ideal medium to carry out payment transactions. Moreover, the smartphones have large storage and communication capabilities which make them suitable to store everything that would normally be carried in a physical wallet and also allows the users to make payments anytime and anywhere. Mobile payments in many cases have advantages over traditional payments (e.g. cash, credit or debit cards) in the aspects of convenience, efficiency and ubiquity (Yang, Lu, Gupta, Cao, & Zhang, 2012). Hence, mobile payments have emerged as a new means of payment.

Besides financial institutions, many other players are also interested in mobile payments, such as mobile network operators (MNOs), mobile device manufacturers, trusted third party providers (TPPs). It can be attributed to the fact that mobile payments can bring many added values to the participants, for instance, generating new revenues, acquiring new users, or enhancing user stickiness (J. Guo, 2016). Different players expanded their businesses to mobile payment services by making use of their competitive resources and capabilities acquired in their respective industries. In order to compete in the market, mobile payment providers explored different technologies and business models which resulted in the complexity and dynamics of the mobile payment market. Despite the advantages of mobile payments and supports from various players, mobile payments have only become a standard practice in a few countries, such as Japan, South Korea, Philippines, Kenya (De Albuquerque, Diniz, & Cernev, 2014; Thakur & Srivastava, 2014). In real-world payment scenarios, mobile payment is only one alternative rather than the only option (Dahlberg, Guo, & Ondrus, 2015). As thus, many end-users are satisfied with their current payment methods such as cash or plastic cards, and reluctant or slow to change their payment habits.

Payments can be categorised into two types which are remote payments and proximity payments (Wang & Chou, 2012). Remote payments refer to the non-face-to-face payments conducted via the telecommunications networks whereas proximity payments are the payments performed in the store

where different technologies can be utilised. This study focuses on the Chinese mobile proximity payment market which has become the largest and fastest-growing mobile proximity payment market in the world. According to eMarketer (2016), China has 134 million smartphone users, and more than one out of five smartphone users have made at least one proximity mobile payment in the past six months of 2015. The number of mobile proximity payment users in China is expected to reach 332.3 million, or 49% of the nation's smartphone users by 2020 (eMarketer, 2016).

Different technologies and business models are adopted in different countries to realise mobile proximity payments. In the Chinese market, NFC and QR code are the most commonly used technologies. NFC technology was first introduced into the Chinese mobile payment market. As early as 2006, Nokia conducted an NFC-based mobile payment field trial in China. Afterwards, major Chinese mobile network operators, financial institutions, and mobile device manufacturers launched their own NFC-based mobile payment platforms with different technological solutions and business models. NFC is widely viewed as one of the most promising technologies in the mobile proximity payments due to its security features, compatibility with the existing financial infrastructures, and ease of use. However, in contrast to the rest of the world (e.g. South Korea, Japan, US), QR code overtook NFC and has become the most popular mobile proximity payment technology in the Chinese market. According to Analysys (2017), China's third-party mobile payment market reached RMB 9041.9 billion in the Q3 2016. It is highly concentrated with Alipay (owned by Alibaba Group) and Tenpay (owned by Tencent company) accounting for a combined 90% market share (Analysys, 2017). Both of them are the mobile payment platforms that rely on QR code technology. In 2011, QR code technology was first introduced into the Chinese mobile payment market by Alibaba Group and integrated into its Alipay platform (Wang & Chou, 2012). When a consumer pays for the purchase, he or she just needs to use the Alipay App to display a dynamic QR code which represents his or her account and be scanned by the merchant. It can also be other way around that the consumer uses the Alipay App to scan the QR code provided by the merchant. And then a payment request is generated and sent by the merchant side to the Alipay backend system to be processed. Initially, QR code technology was mainly supported by the third party providers such as Alipay, Tencent, Baidu. However, at the end of 2016, large financial institutions such as China UnionPay, Industrial and Commercial Bank of China, started integrating QR code to their mobile payment platforms (Yan, 2016). It would further stimulate and accelerate the diffusion of QR code-based mobile payments in the Chinese market.

As described above, despite the fact that NFC technology is superior over QR code in the aspects of security, convenience, being supported by various players, and introduced into the market earlier than QR code, it still lost the battle to QR code in the Chinese market. Hence, the question is raised why QR code can defeat NFC and become the most popular technology in the Chinese mobile proximity payment market by the end of 2016.

1.2 Research gaps

Extensive studies have been conducted on mobile payments in the last decades. A number of studies indicate that most mobile payment studies focus on the consumers' adoption (Dahlberg, Guo, et al., 2015; De Albuquerque et al., 2014). Yet, many consumer adoption studies rely on well-established adoption and diffusion theories such as technology acceptance model (TAM) (Davis, 1989), unified theory of acceptance and use of technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003), diffusion of innovation (DOI) (Rogers, 1995) to determine the factors that affect the intention of consumers towards to mobile payments. These studies provide limited insights to understand the underlying causes that mobile payments failed to reach the mass adoption. Dahlberg et al. (2015) believe that the studies on mobile payment ecosystems are still in an early stage, and further studies using multi-perspective or multi-level approach is needed to fill the research gap.

Some scholars attempted to explain the slow adoption rate of mobile payments and the failures of mobile payment projects at the ecosystem level with platform and ecosystem theories. However, these studies mainly focus on NFC-based mobile payments (Apanasevic, 2013; De Reuver, Verschuur, Nikayin, Cerpa, & Bouwman, 2015; Kazan & Damsgaard, 2013). Despite that NFC is a promising technology in mobile payments, mobile payment providers in some markets started developing the advantages of other technologies such as Bluetooth, QR code, biometric recognition. Few studies have been conducted on the emerging technologies.

In the Chinese market, QR code-based mobile payments supported by two Internet giants Alibaba and Tencent dominate the market. Although NFC technology is superior to QR code in the aspects of security and user experience, its development is now lagged behind the development of QR code in the Chinese mobile payment market. However, to the best of our knowledge, an academic study to interpret this phenomenon is absent. Most of the analysis regarding this phenomenon is from online news coverage. It would be difficult for mobile payment initiatives to easily replicate the success of QR code-based mobile payments achieved in China to other markets without fully understanding the phenomenon.

1.3 Research questions

Given the information described above, the research objectives of this study are to explain the current competition outcome of NFC and QR code technologies in the Chinese mobile proximity payment market and provide insights on the widespread popularity of QR code-based mobile payments achieved in the Chinese market. In order to meet the research objectives of this study, it is necessary to deeply analyse the development process of mobile payment technologies in the Chinese market. Generally speaking, the mass adoption of a mobile payment technology can be divided into two main phases as shown in Figure 1. To get a better view of these phasing concepts, a brief description is provided.

In the implementation phase, mobile payment providers need to build a mobile payment platform to offer mobile payment services to the end-users (i.e. merchants and consumers). As the supply side of the mobile payment platform, mobile payment providers choose a technology to employ and decide on how it is implemented with a technological solution and a business model (e.g. collaborative mode, bank-centric mode). After that, the end-users (both merchants and consumers), as the demand side, need to adopt such a platform to realise mobile payments. In this phase, mobile payment providers can strategically motivate their current users (i.e. merchants and consumers) and attract new users to adopt such payment function provided in the platform and get used to it. They can use different promotion strategies or enhance the platform by offering a variety of payment scenarios. Thus, it can be seen that a mobile payment platform is an implementation of technology which may be a joint effort of various stakeholders. Meanwhile, it links the providers to the users in the adoption phase. Therefore, in order to achieve the research objectives of this study, a platform view is needed to conduct a deep investigation.

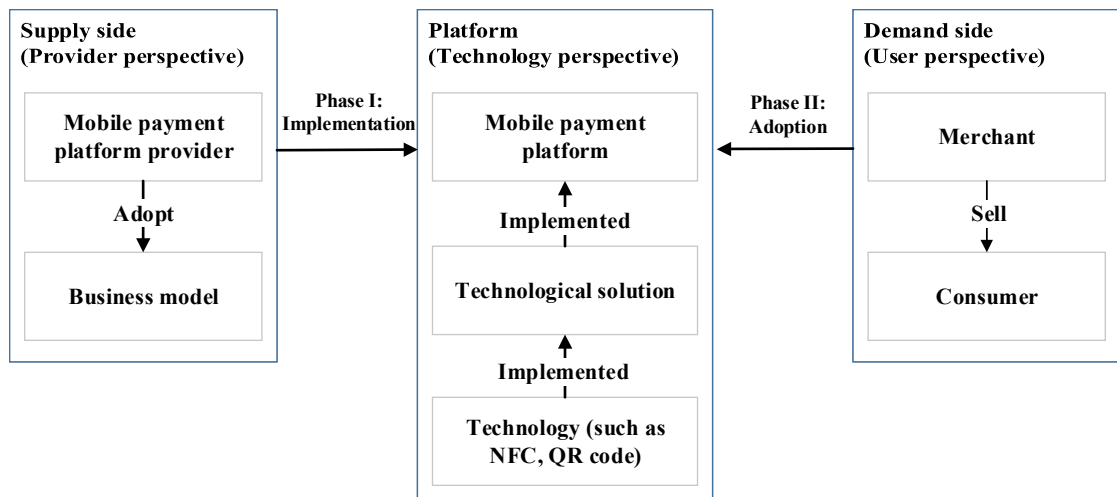


Figure 1: Two phases of mobile payment platform adoption

Based on the understanding above, the research question can be formulated as follows:

Why did QR code-based mobile payments overtake NFC and achieve a dominant position in the Chinese market?

In order to answer the main research question, three sub-questions are developed accordingly and will be addressed step by step.

(I) What are the mainstream mobile proximity payment solutions based on QR code and NFC technologies and corresponding business models adopted in the Chinese market?

There are various technological solutions of QR code and NFC-based mobile proximity payments. Different solutions can also be implemented by stakeholders using different business models.

Hence, it is necessary to perform a historical review of the Chinese mobile proximity payments to answer this question.

(II) What are the barriers (e.g. cost, security, performance) that mobile payment providers and users (i.e. consumers, merchants) face towards to QR code and NFC-based mobile payment solutions in the Chinese market?

To address this question, understanding the architecture and characteristics of QR code and NFC-based mobile payment solutions is necessary. Upon this, the barriers that influence the adoption of those solutions can be determined using a multi-level framework (technology, provider, and user), as proposed by De Reuver & Ondrus (2017). Moreover, interviews with senior experts are used to triangulate the desk research.

(III) How do mobile payment providers strategically develop their mobile payment platforms and facilitate users' adoption of their mobile proximity payment services in the Chinese market?

As mobile proximity payment services are provided to users (i.e. merchants and consumers) by mobile payment providers through a platform, a research model is proposed based on relevant platform, business model, and business ecosystem theories. The proposed research model is applied to analyse the representative mobile payment platforms of different technological solutions in the Chinese market combined with in-depth interviews with experts and managers in this field to answer this question.

1.4 Scientific and practical contributions

From a scientific perspective, this study makes a contribution to the mobile payment research by investigating the competition of QR code and NFC technologies in an emerging market of mobile payments. Moreover, this study enriches existing mobile payment literature by applying a multi-perspective framework and conceptualising a research model mainly from a platform perspective.

In practice, the findings of this study have practical implications for the supporters of NFC technology like mobile network operators, financial institutions to adjust their business strategies competing in the mobile payment market. Furthermore, mobile payments providers in other markets can get practical insights from this study on how to wisely select technologies between NFC and QR code and how to facilitate the adoption of their mobile payment platforms. This research is timely to them as the Chinese market has a leading position in QR code-based mobile payments.

1.5 Research framework

The thesis structure and relevant technological solutions, platform theories, the mobile payment platforms of the case study are presented in Figure 2. Chapter 1 mainly introduces the research

problem, the research gaps and the research questions discussed in this study. Chapter 2 explains the relevant terms in the mobile payments domain and also provides an overview of the Chinese mobile proximity payment history. Upon this, the mainstream mobile payment technological solutions and the underlying business models implemented in the Chinese market are derived and discussed. In Chapter 3, the architecture and the characteristics of different mobile payment technological solutions based on NFC and QR code technologies are elaborated in detail. After that, a multi-level framework is used to analyse and determine the potential barriers adopting these solutions. Chapter 4 develops a research model with the business model, platform and business ecosystem theories related to mobile payments. Chapter 5 discusses the methodology and the background of data collection and analysis. In Chapter 6, the proposed research model is applied to the three representative Chinese mobile payment platforms and thus interpret the strategic behaviours of their providers on how to develop the platforms and facilitate their adoption. Chapter 7 concludes all important findings in this research, gives the scientific and practical contributions and presents the associated limitations.

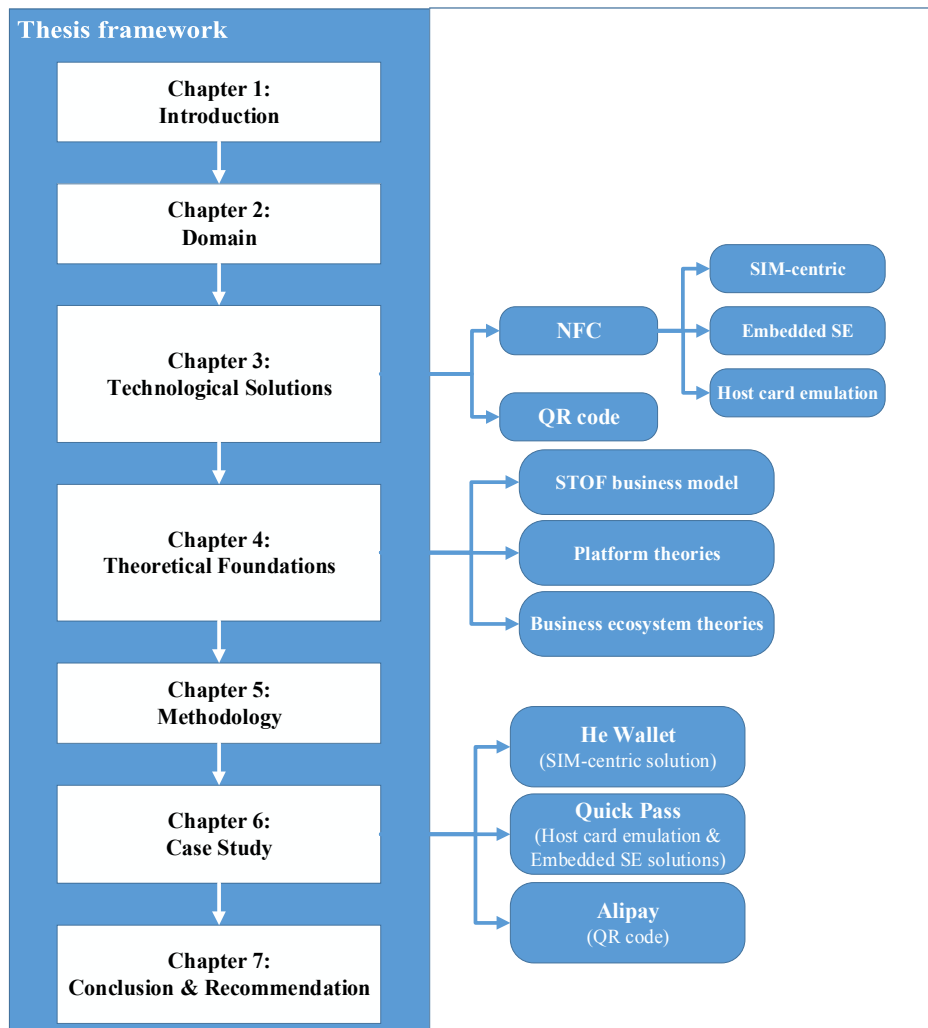


Figure 2: Thesis framework

2 Domain

This chapter firstly introduces the relevant terms in the mobile payments domain. After that, a brief overview of projects and events related to the NFC and QR code technologies in the history of the Chinese mobile payments are presented. At last, the mainstream mobile payment solutions based on NFC and QR code technologies and the underlying business models implemented in the Chinese market are summarised accordingly.

2.1 Mobile payments

In this section, we first present the definition of mobile payments and the classification of mobile payments to understand the research background and scope of this study. After that, different types of mobile payment ecosystems and payment models are described. The main purpose is to better understand the projects and the events launched in the Chinese mobile payment market which are elaborated in section 2.2.

2.1.1 Mobile payment definition

Various definitions of mobile payments are given from different perspectives. Dahlberg, Mallat, Ondrus, & Zmijewska (2008, p.165) define mobile payments as *“payments for goods, services, and bills with a mobile device (such as a mobile phone, smartphone, or personal digital assistant (PDA)) by taking advantage of wireless and other communication technologies”*. It emphasises that mobile payment is realised with wireless and other communication technologies through a mobile device.

In contrast, Au & Kauffman (2008, p.141) shed light on the roles that a mobile device plays in the payment process with the definition as follows: *“any payment where a mobile device is used to initiate, authorise and confirm an exchange of financial value in return for goods and services”*. The powerful functions (e.g. cryptography, calculation, wireless communication) and interaction capability of the mobile device enable it to perform payment transactions in a secure and convenient way.

In this study, mobile payment is defined as *“a payment system to initiate, authorize and confirm a financial value exchange for goods and/or services using mobile devices by taking advantage of wireless and/or other communication technologies while excluding: (i) any type of electronic or mobile money, (ii) access to electronic payment services with mobile devices, and (iii) electronic banking”* (Guo, 2016, p.3). The reasons are that it well elaborates the characteristics, functions, and principle of mobile payments in the present market and also fit the context of this study.

2.1.2 Mobile payment classification

According to Wang & Chou (2012), mobile payment can be classified into four categories as shown in Table 1. By the type of transaction targets, mobile payment can be divided into person-to-person payment (P2P payment) and customer-to-business payment (C2B payment). By the communication range, mobile payment can be categorised into remote payment and proximity payment which are implemented through different technologies.

Table 1: Classification of mobile payments

	<i>P2P payment</i>	<i>C2B payment</i>
<i>Proximity payment</i>	Contactless payment	Contactless payment Mobile device POS
<i>Remote payment</i>	Remote money transfer	Remote online payment (mobile e-commerce, digital products)

Remote payment refers to non-face-to-face online payment usually via the wireless communication network so that it can be exempted from the constraints of time and location (Zhao & Shu, 2013). While proximity payment is achieved by the mobile device at the point of sale (POS) terminal or with physical contactless payment card through short-range communication technologies such as Bluetooth, infrared, near field communication (NFC) (Wang & Chou, 2012; Zhao & Shu, 2013). The working distance is usually within a few centimetres.

Mobile proximity payments allow consumers to make purchases at retail stores without carrying their physical wallets. The electronic wallet in the mobile device can integrate multiple cards, loyalty cards, coupons, tickets together and thus makes it easy for consumers to manage and use them. From merchants' perspective, mobile payments may help them to reduce the operational cost and improve the customer relationship, shopping experience through high throughput at the POS terminals and the ability to send real-time messaging to consumers (Dennehy & Sammon, 2015). In this study, we focus on the C2B proximity payments.

2.1.3 Mobile payment ecosystem

According to Dahlberg, Bouwman, Cerpa, & Guo (2015), an ecosystem is a group of organisations working cooperatively and competitively in production, customer service and innovation with the purpose of generating value to customers, to the group as a whole and to each individual group member. For the traditional payment methods (e.g. cash, checks, debit cards), financial institutions are the main organisations involved in the payment ecosystems to serve the users. However, this is not the case in the mobile payment ecosystems.

Mobile payment is expected to drive the growth of mobile commerce and also become an important channel for conducting payment transactions in future (Yang et al., 2012). Hence, various players

other than financial institutions have been attracted to join in the mobile payment ecosystems, such as mobile network operators (MNOs), mobile device manufacturers, trusted third party providers (TPPs), merchants. By making use of their competitive resources and capabilities acquired in their respective industries, they extend their businesses to the mobile payment services. Besides of getting transaction fee for each payment, mobile payment providers can also generate revenues by offering other value-added services based on consumer's payment behaviour, such as digitised loyalty coupons, targeted advertising, credit scoring services. For example, if a customer has booked a hotel in a city, he or she is most likely interested in the local restaurants nearby. The mobile payment providers can push right ads to the consumers timely based on the consumers' location and hence effectively increase the sales. Another example is Sesame Credit service introduced by Ant Financial which is affiliated with Alibaba Group and owns Alipay. Sesame Credit is to assess the creditworthiness of their registered users based on their transaction data. This service has been used by both the public and private sector to make decisions, such as home loans, car loans, visa applications (Business Wire, 2015). It can be seen that mobile payments have the potential to go further than just payment. It can provide a new way to engage with the users through the mobile devices.

The great opportunities and potentials of mobile payments motivate different players to collaborate and compete. It results in the complexity and dynamics of mobile payment ecosystems. Moreover, the introduction of new technologies, new business models, new applications and the rise and fall of business ventures also change the mobile payment ecosystems (Au & Kauffman, 2008). Depending on the stakeholders involved and their relationship in the mobile payment ecosystems, four potential mobile payment business models are distinguished as follows (Smart Card Alliance, 2008):

- ***Operator-centric mode:*** The mobile network operator deploys mobile payment applications to NFC-enabled mobile devices independently.
- ***Bank-centric mode:*** The bank deploys mobile payment applications or devices to customers and ensures merchants have the required point of sale (POS) acceptance capability.
- ***Independent service provider mode:*** An independent service provider provides mobile payments between customers or between customers and merchants.
- ***Collaborative mode:*** It involves collaboration among banks, mobile network operators and other stakeholders in the mobile payment ecosystem.

The business models that can be used by a stakeholder is closely linked to the technological solution adopted. For instance, the involvement of mobile network operators is necessary if the subscriber information module (SIM) card is used to provide NFC-based mobile payment services. Besides, the payment models described in section 2.1.4 also influence the business models that can be adopted. For instance, the mobile network operators need to cooperate with banks if they want to

enable their users to make mobile payments with their bank accounts in the transactions. Additional detail about the relations between the technological solutions, business models, and payment models is provided in section 2.3.

2.1.4 Different types of payment models

The completion of a payment transaction process requires the involvement of a set of participants. Depending on the types of participants involved and their roles, the payment models come in two main varieties which are the four-corner model (open model) and the three-corner model (closed model). In this section, a brief introduction of these two payment models is provided.

• **Four-corner model (or open model):**

The standard four-corner payment model involves four types of participants which are the payer/consumer, the payee/ merchant, the payer’s financial institution (known as the issuing organisation), and the payee’s financial institution (known as the acquiring organisation) as depicted in Figure 4. The bottom two corners of the model represent the relationship between the consumer and merchant to their financial institutions. The payment networks located in the middle of the figure play a role to route the transactions between financial institutions, just like a hub. With the support of the payment network associations, financial institutions do not have to build the direct connection with each financial institution but with few payment networks which dramatically simplifies the payment network system. Visa, MasterCard are the examples of the global payment network associations.

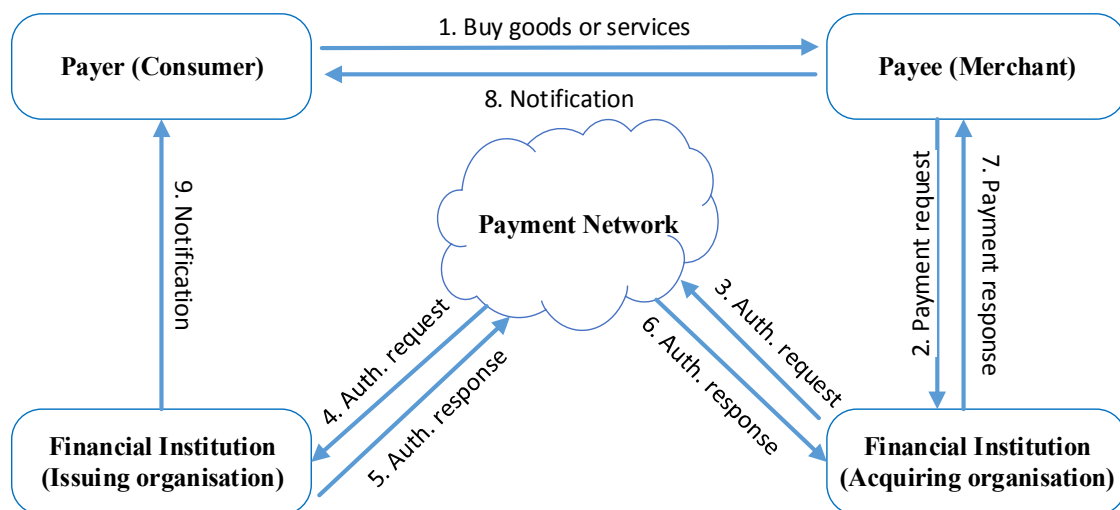


Figure 3: Four-corner payment model (EFIEC, 2016)

As shown in Figure 4, in a payment transaction, the merchant generates a payment order, and then the consumer makes the payment. The payment request is sent to the acquiring organisation by the merchant’s payment system. On behalf of the merchant, the acquiring organisation sends the authorization request to the payment network. The payment network forwards the authorization

request to the corresponding issuing organisation. The issuing organisation conducts a series of transaction verification and risk management of the consumer's account. The transaction result is included in the authorization response generated by the issuing organisation. The authorization response is sent back to the merchant via the payment network and the acquiring organisation. The consumer is informed about the payment transaction result by the merchant. Meanwhile, the consumer may also receive an instant notification about the payment transaction from the issuing organisation. In the next section, we will identify the payment model type of different mobile payment projects in the Chinese market.

• **Three-corner model (or closed model):**

The three-corner model only involves three parties which are the payer/ consumer, the payee/ merchant and the payment system provider, as shown in Figure 3. The prerequisites of the three-corner model are that both the consumer and the merchant have to hold an account from the same payment system provider and the merchant has built a connection to this payment system. As thus, the payment system provider can establish the linkage between the consumer and merchant. It plays the roles of both issuing and acquiring organisations. In a transaction, the funds are transferred via the payment system provider's network.

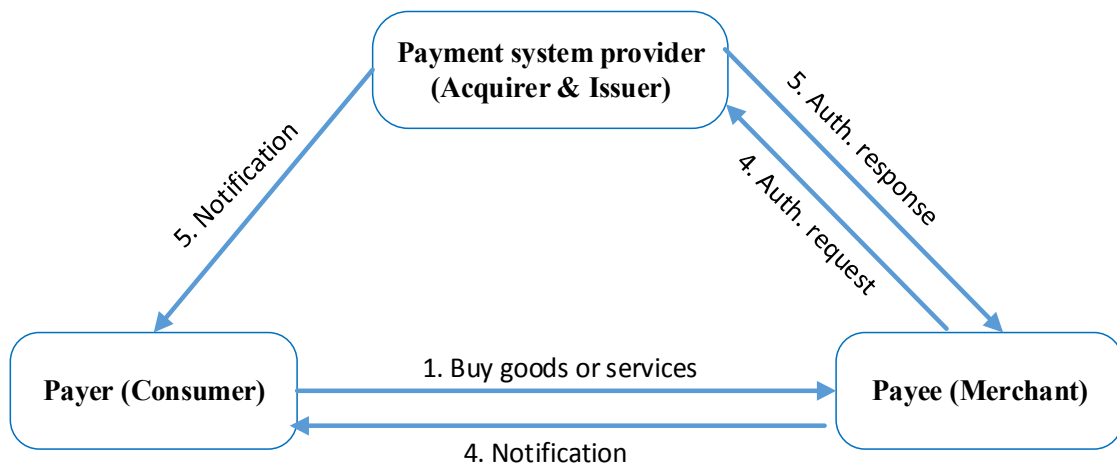


Figure 4: Three-corner payment model

It can be seen that the three-corner model shortens the payment transaction chain and hence reduces the transaction fee. However, the downsides are that it may have a narrow coverage as only one payment provider is involved in such as payment system and the payment provider may need to face the high cost of deploying the exclusive point of sale (POS) terminals. The three-corner model is often adopted by the third-party service providers to offer payment services to their users. To implement the three-corner model, third-party service providers also need to find a way to enable the consumer to top up his or her third-party account, such as online transfer, top up in the physical stores. Therefore, payment providers may still need to collaborate with other companies to make up for its scarce resources.

2.2 Chinese mobile proximity payments history

As mentioned, different countries have employed different technologies and business models for mobile proximity payments based on their own realities. In the Chinese market, NFC and QR code are the mainstream technologies employed to facilitate the development of mobile proximity payments. In this section, the history of the Chinese mobile proximity payments is briefly reviewed to provide a picture of its development process. The information about the projects and the events is mainly from mobile payment news websites and consultation reports.

2.2.1 Market introduction of NFC-based mobile payments

China's first NFC-based mobile payment trial was conducted by Nokia at Xiamen City in June 2006 (Nokia, 2006). Nokia worked together with China largest national mobile network operator China Mobile Xiamen branch and Xiamen E-Tong Card company to implement this field trial using Nokia 3220 cell phone. It is the world first NFC-enabled mobile phone which was introduced by Nokia in April 2005 (Nokia, 2006). In this field trial, each mobile phone was loaded with a ticketing and e-cash application. One hundred consumers of China Mobile used these mobile phones to make payments at the POS terminals covered by Xiamen E-Tong Card in Xiamen City of China (Nokia, 2006). The payment application was stored in the chip embedded in the mobile device, and the transaction was performed with NFC technology. This NFC-base mobile payment solution is known as the embedded SE solution. The detail about the architecture and characteristics of the embedded SE solution is described in section 3.2.2. In this project, only Xiamen E-Tong Card company was involved in the payment network system. Hence, it is the three-corner payment model.

In the early of 2008, Nokia cooperated with China UnionPay performed another NFC-based mobile payments trial in Shanghai (Kapron, 2008). China UnionPay is a major card scheme in China and also the only interbank network that links all the ATMs or banks throughout the country. With the loyalty mobile payment application loaded into the Nokia 3220 handsets, the cardholders of the UnionPay's loyalty cards can collect and redeem points in the payment transactions at Shanghai's NO.1 Yaohan Department Store (Kapron, 2008). This project was also implemented with the NFC embedded SE solution. Compared with the first field trial, the difference is that this project adopted the four-corner payment model.

The adoption of NFC-based mobile payments in China was very slow in next few years. One of the main reasons can be attributed to the lack of NFC-enabled mobile devices in the Chinese market. Most consumers do not have an NFC-enabled mobile device and meanwhile few types of mobile devices in the market support NFC functionality. Moving into 2010, China Mobile, the world's largest mobile network operator, explored other technologies and introduced mobile contactless payments based on Radio Frequency (RF) SIM solution (Clark, 2010a). RF SIM solution operates at 2.4GHz rather than NFC 13.56MHz. The main advantage of the RF SIM solution is that it allows the non-NFC enabled mobile devices to be able to conduct mobile payments. The RF SIM card incorporates both a payment chip and a contactless antenna. Although the contactless antenna on

the SIM card is small, the high operating frequency enables the contactless antenna to generate adequate power to perform payment transactions. Hence, China Mobile no longer needs to rely on the mobile device manufacturers to supply NFC-enabled mobile devices and also the consumers to purchase an NFC-enabled mobile device. However, the downside of this solution is that new POS terminals have to be deployed to support RF SIM solution as the existing terminals of the contactless ticketing and payment systems work at 13.56MHz instead of 2.4GHz. Furthermore, this project eliminates the involvement of financial institutions such as China UnionPay, banks. It means that China Mobile has to deploy all POS terminals by themselves which is extremely costly. After putting efforts for two years, China Mobile still failed to implement it in a large scale and eventually decided to use NFC technology.

In June 2013, China Mobile worked with China UnionPay and launched NFC-based mobile payment services in more than fourteen cities based on NFC SIM technology (Boden, 2013). Rival China Unicom, the country's second-largest mobile network operator, launched its NFC mobile payment services by cooperating with five Chinese banks and five transport operators in June 2010 (Clark, 2010b). Until then, NFC SIM-centric SE solution was the mainstream solution used to provide NFC-based mobile payment services, and the collaborative mode between MNOs and financial institutions fitted more with the Chinese market than the MNOs-centric mode.

2.2.2 Market expansion of NFC-based mobile payments

The advent of host card emulation (HCE) technology dramatically changed the situation and also motivated more mobile payment service providers to support NFC technology. HCE solution is a pure cloud-based solution which allows the mobile payment service providers to provide NFC-based mobile payment services independently. Additional detail about HCE technological solution is described in section 3.2.3. Many banks subsequently released their own mobile payment Apps, such as Industrial and Commercial Bank of China (ICBC) (Balaban, 2015c), China Construction Bank (CCB) (Balaban, 2015a). In 2015 December, China UnionPay also employed HCE solution and integrated it into its QuickPass platform in cooperation with over 20 commercial banks (Balaban, 2015b). QuickPass is a contactless payment product which is similar to MasterCard's PayPass and Visa's payWave. Its mobile client creates backwards to substitute the QuickPass contactless cards. The users can make tap-and-go payments at any POS terminals with a QuickPass logo.

Meanwhile, major mobile device manufacturers such as Apple, Samsung started supporting NFC functionality on their mobile devices and introduced their own NFC-based mobile payment platforms. Similar to Nokia's NFC-based mobile payment solution, they secure the payment applications with the physical chip embedded in the mobile device. In February 2016, UnionPay introduced Apple Pay and Samsung Pay into China (Deloitte, 2016). Subsequently, major Chinese domestic mobile device manufacturers, such as Huawei and Xiaomi, also integrated NFC functionality into some types of their mobile devices and stepped into NFC-based mobile payment industry by establishing partnerships with China UnionPay and other banks (Mittal & Lloyd, 2016).

At this point, the involvement of MNOs is no longer necessary with the emergence of HCE solution and the development of embedded SE solution. HCE solution enables financial institutions to offer mobile payment services with the bank-centric business model. Moreover, the mobile device manufacturers obtained an important position in the NFC-based mobile payment ecosystems with aggregated effort to support NFC functionality on their mobile devices and the advanced embedded SE solution.

2.2.3 Market introduction of QR code-based mobile payments

Alibaba's Alipay was the first platform in China that used QR code technology to conduct mobile payments (Kapron & Meertens, 2017). Currently, Taobao, owned by Alibaba, is the largest e-commerce platform in China. Taobao has a relationship with Alipay similar to the eBay with PayPal. In October 2011, Alipay launched QR code-based mobile payment services (Wang & Chou, 2012). The consumers can use Alipay mobile App to display or scan QR codes to conduct proximity payments in store. Meanwhile, the consumers can easily top up their Alipay accounts by linking them to their bank accounts.

In September 2012, Tencent's WeChat, currently the most popular social media in China, also integrated QR code solution into its platform for both exchanging contact details and mobile payments (Kapron & Meertens, 2017). This digital wallet is known as WeChat Pay. Afterwards, Baidu, China's giant search engine, rolled out its mobile wallet App called Baidu Wallet and allows the users to conduct payments by scanning QR codes in April 2014 (Horwitz, 2014).

It is easy to find that QR code-based mobile payments were mainly supported by the giant Internet companies in the early stage. Those companies were able to implement the solution independently as QR code is a pure software-based mobile payments solution. The third party providers built their own payment back-end systems to process the transactions and thus capture the entire transaction fees. It is the typical three-corner payment model which has been described in section 2.1.4. However, trusted third party providers still have to cooperate with banks to allow their users to top up their third-party accounts easily and efficiently.

2.2.4 Market expansion of QR code-based mobile payments

Third party providers carried out a series of promotional activities to facilitate users' adoption of QR code-based mobile payments and also make users get used to them. For instance, the consumers get an extra discount if they make payments with their cell phones. Moreover, third party providers have been using QR codes as part of its online-to-offline (O2O) collaboration with merchants to boost the shopping experience of users, such as cooperating with Uber, Didi taxi, McDonalds (Hong, 2014). Only in several years, QR code-based mobile payments have gained wide adoption in the Chinese market.

Because QR code can be embedded with malicious information, there are some concerns about the security of QR code-based mobile payments. Additional detail about the security concerns of QR

code-based mobile payments is discussed in section 3.4. At that time, there were no rules and standards to regulate third party QR code-based mobile payment services in China. In March 2014, China's central bank suspended QR code-based mobile payment services due to the concerns over the security of verification procedures (Zhang & Xie, 2014). However, trusted third party providers continued marketing their QR code payment services by recommending the consumers to display QR codes and let the merchants scan rather than be scanned to reduce the potential security risks.

However, it seems that the popularity of QR code-based mobile payments is hard to be reversed in the Chinese market. In the August 2016, the Chinese Central Bank officially approved QR code-based payments for the first time by giving a notification to the relevant organisations to issue QR code payment practices and specifications (Xu, 2016). This announcement played a function to facilitate the development of QR code-based mobile payments in China. In December 2016, China UnionPay announced the standards for QR code payment services and integrated QR code payment to its QuickPass platform (Yan, 2016). Several major bank members of UnionPay such as Industrial and Commercial Bank of China (ICBC) also integrated QR code solution into their mobile payment platforms.

According to Analysys (2017), China's third-party mobile payment market reached RMB 9041.9 billion in the Q3 2016. Alipay continued to dominate China's mobile payment market with 50.42% market share of the total mobile payment transaction volume, followed by TenPay (38.12%) and UnionPay (1.08%) (Analysys, 2017). Tenpay is owned by Tencent, and it is the backend payment system of WeChat Pay. With more and more financial institutions in China choosing to support QR code technology and also the dominant positions that Alipay and TenPay acquired in the Chinese third-party mobile payment market, it is safe to conclude that by the end of 2016 the adoption of NFC-based mobile payments was lagged far behind of QR code-based mobile payments in the Chinese market.

2.3 Overview of Chinese mobile proximity payments

Based on the elaboration in section 2.2, a summary of the mainstream technological solutions of NFC and QR code technologies, corresponding business models and payment models adopted in the Chinese market is summarised in Table 2.

First of all, it can be seen that NFC and QR code currently are the two mainstream technologies used in the Chinese mobile proximity payment market. RF SIM solution was eliminated because of the huge expenses required to deploy exclusive POS terminals and also lacking the supports from other players.

Furthermore, regarding the NFC-based mobile payments, three technological solutions have been adopted in the Chinese market which are embedded SE, SIM-centric SE and HCE. The embedded SE and SIM-centric SE solutions are usually implemented in the collaborative mode. The hardware chip providers (i.e. mobile device manufacturers, MNOs) in these two solutions cooperate with

financial institutions to manage the end-users' payment accounts and process the payment transactions. In contrast, HCE and QR code solutions are the pure software solutions and hence can be implemented by financial institutions or third party providers independently.

Last but not the least, QR code-based mobile payment solution has stimulated the growth of the three-corner payment model in the Chinese payment industry. Third party providers mainly used the three-corner payment model for their QR code-based mobile payment platforms which has severely affected the benefits of financial institutions, especially China UnionPay. As described in section 2.1.4, financial institutions are not involved in the three-corner payment model. Many financial institutions thereby chose to integrate QR code solution to their platforms to better cater for the users (i.e. merchants and consumers).

Table 2: Overview of the Chinese mobile proximity payments

Technology	Solutions	Business models	Payment model	Platforms
RF	RF SIM	MNOs-centric	Three-corner	He Wallet (China Mobile)
NFC	Embedded SE	Collaborative	Four-corner/ Three-corner	Nokia, Apple Pay, Samsung Pay, Huawei Pay, Xiaomi Pay
	SIM-centric SE	Collaborative	Four-corner/ Three-corner	He Wallet (China Mobile), Wo Wallet (China Unicom)
	HCE	Bank-centric	Four-corner	e-Payment (Industrial and Commercial Bank of China) Dragon payment (China Construction Bank)
QR code	QR code	Independent service provider	Three-corner	Alipay, WeChat Pay, Baidu Wallet
		Bank-centric	Four-corner	QuickPass (China UnionPay) e-Payment (Industrial and Commercial Bank of China)

In this Chapter, the sub-question one “the most commonly used technological solutions based on NFC and QR code technologies and corresponding business models in the Chinese mobile proximity payment market” have been answered through the desk research. Next Chapter will elaborate specifically on the characteristics of NFC and QR code technologies and the architectures of the corresponding technological solutions.

3 Technological solutions

This chapter describes and discusses the relevant concepts, architectures and characteristics with regard to the mainstream technological solutions adopted in the Chinese mobile proximity payment market. Section 3.1 provides a brief introduction of NFC technology, including its characteristics, communication modes and functionalities. The purpose is to understand the advantages of using NFC over other short-range wireless communication technologies for mobile payments and also the operating principle of NFC-based mobile payments. After that, section 3.2 describes the architecture and characteristics of the three NFC-based technological solutions adopted in the Chinese market. Section 3.3 describes the features of QR code technology and its widespread and concerns to understand its advantages and disadvantages to serve for mobile payments. In section 3.4, the architectures, payment transaction workflow and involved security mechanisms of QR code-based mobile payments are discussed in detail. In the final part of this chapter, the potential barriers of implementing and adopting each technological solution are discussed using a multi-level framework (provider, technology, and user) proposed by De Reuver & Ondrus (2017).

3.1 Near field communication technology

Near field communication (NFC) is a promising short-range wireless communication technology which established a new way of interaction between two devices when nearby. It was jointly developed by Philips and Sony in late 2002 (Ortiz, 2006). To promote and supervise the use of the NFC technology, Nokia, Philips and Sony founded the NFC Forum in 2004 (Ortiz, 2006).

3.1.1 NFC characteristics

NFC is evolved from radio frequency identification (RFID) technology (Ok, Coskun, Aydin, & Ozdenizci, 2010). RFID can work at different frequencies ranges, including 120-150 KHz, 13.56 MHz, 690-950 MHz, and 2.45-5.8 GHz (Chen & Adams, 2004). Depending on the operating frequency, the working distance ranges from a few centimetres to meters. Regarding NFC, it operates at a specific unlicensed radio frequency of 13.56 MHz and has a working distance of up to 10 cm, but typically around 0-4 cm. As shown in Table 3, NFC, in general, has a shorter working distance compared to other short-range wireless communication technologies such as infrared, Bluetooth. Yet, the short working distance of NFC technology can protect against eavesdropping. It brings inherent security and hence makes NFC more suitable than other wireless communication technologies for mobile payments.

Furthermore, the design of NFC standards makes the technology itself compatible with the existing RFID infrastructure which operates at 13.56MHz. The standard of NFC is defined by ISO 18092 and EMCA 340 (J. H. Cho, Cole, & Kim, 2009). However, it is also designed to be compatible with some parts of RFID standards, such as ISO 14443A, implemented in Philips' Mifare and Inside Contactless' PicoPass products; and ISO 14443B, used with Sony's FeliCa technology (Ortiz,

2006). As thus, an NFC-enabled device can work at many existing contactless payment POS terminals which can significantly reduce the technology adoption cost.

Table 3: Characteristic of wireless communication technologies (Chen & Adams, 2004)

Technology	Radio frequency	Range	Application areas
Infrared	Infrared light	1-5 meters	Data exchange, devices remote control, payment systems
Bluetooth	2.4 GHz	10-100 meters	Data exchange, devices remote control, payment systems
RFID	120-150 KHz	10 cm	Access control, Inventory control
	13.56 MHz	10 cm -1 m	Access control, Smart cards
	869-956 MHz	1-12 m	Railroad card monitoring, Toll collection systems
NFC	13.56 MHz	10 cm	Data exchange, contactless smart card

3.1.2 NFC communication modes

NFC communication involves two different devices which are initiator and target as shown in Figure 5 (Cho et al., 2009). NFC is based on a message and reply concept which means one NFC device A sends a message to another NFC device B and NFC device B sends back a reply. Without first receiving a message from NFC device A, it is impossible for NFC device B to send any data to NFC device A. The NFC device A which stimulate the data exchange is the initiator and the NFC device B is a target.

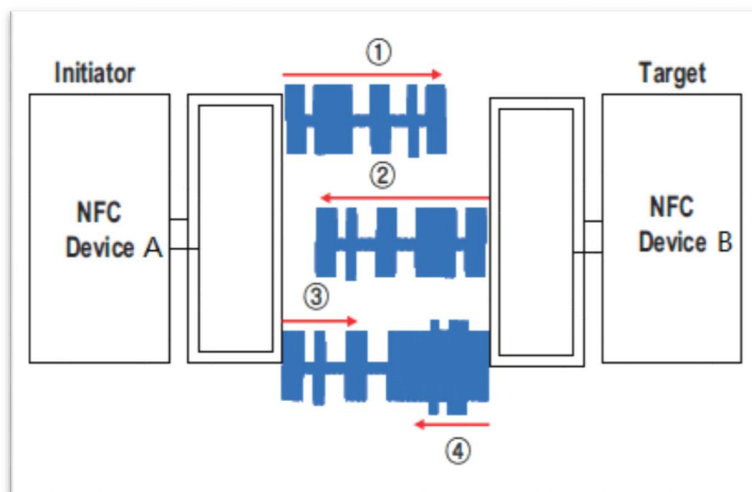


Figure 5: Simplified NFC communication modes (Cho et al., 2009)

NFC has two communication modes which are passive and active mode (Cho et al., 2009). In the active communication mode, both the initiator and the target generate their own radio frequency (RF) fields (1) and (2) as labelled in Figure 5. While in the passive communication mode, only the initiator generates the RF field (3) and (4) as labelled in Figure 5. The target device absorbs its operating power from the initiator by getting close enough to form the magnetic inductive coupling. Once powered up, the target device can communicate and exchange data with the initiator.

3.1.3 NFC functionalities

NFC devices can be distinguished into three types which are NFC mobile, NFC tag, and NFC reader (Coskun, Ozdenizci, & Ok, 2013). Depending on the type of NFC device that works with the NFC mobile, three operating modes are defined by NFC Forum (Arcese, Campagna, Flammini, & Martucci, 2014):

- **Card emulation mode:** NFC mobile acts as a contactless smart card and exchanges data with the NFC reader. NFC mobile is completely compatible with the smart card standards based on ISO/IEC 14443. In this mode, NFC mobile is the target device. Even if the NFC mobile is out of power, it can still work at an NFC reader.
- **Reader/writer mode:** NFC mobile initiates the wireless communication, and can read and write the data stored in the NFC tags/contactless smart cards. NFC mobile acts as an initiator while the NFC tags/smart cards are the target. An example is that NFC device can be used to top up the contactless payment card or check the account balance.
- **Peer-to-peer mode:** two NFC mobiles can exchange data and information at link-level. This mode is standardised on the ISO/IEC 18092 standard and allows data speed up to 424 Kbits/s.

In the NFC-based mobile payments, the NFC-enabled mobile device operates in the card emulator mode, just like a contactless payment card. In a payment transaction, a consumer simply needs to bring his NFC-enabled mobile device close or touch to the contactless payment POS terminal. The contactless payment POS terminal as the initiator will automatically search for the NFC-enabled mobile device in its range and establish the communication to conduct the payment transaction. NFC technology ensures the ease of use of mobile payments.

3.2 NFC mobile payment solutions

As mentioned, NFC-based mobile payments can be implemented with different solutions. They are typically classified based on the location of the secure element (SE). The SE is the core of the NFC-based mobile payment system. It is used to provide a secure platform for containing sensitive applications and data. The most often described architectures for the physical form factor of the SE in literature are an independent embedded hardware module built into the phone (known as embedded SE), making use of the existing SIM as the SE (known as SIM-centric SE), and using a

removable memory component as the SE (e.g. secure digital (SD) memory card) (known as micro SD SE) (Francis, Hancke, Mayes, & Markantonakis, 2010). As most mobile device manufacturers nowadays eliminate the SD slot from the design of their mobile devices, the micro SD based architecture is no longer popular. As thus, this study mainly focuses on the SIM-centric SE and embedded SE solutions.

Other than the physical SE architectures, host card emulation (HCE), a cloud-based SE architecture, emerged in recent years and made a substantial impact on the mobile payment market. Therefore, it is also included in this study. The overview of the Chinese mobile proximity payment history shows that all these three NFC-based mobile payment solutions have been implemented in the Chinese market. In this section, the architecture and the characteristics of each solution are elaborated in greater detail so that a comparison can be conducted using a multi-level framework in section 3.5. The information is mainly from the academic papers and development manuals.

3.2.1 SIM-centric SE solution

• *Introduction*

Mobile network operators use the SIM cards to identify and authenticate the subscribers on mobile devices. The new generation of the SIM card is Universal Integrated Circuited Card (UICC). It is the best and only universal application platform that works with any 3G or 4G mobile device (Gemalto, 2016). Furthermore, the UICC technically can be used in all mobile telecom networks as it can store a number of applications (Gemalto, 2016). In a GSM network, the UICC contains a SIM application and in a UMTS network it contains a USIM application. The UICC can also host non-telecom applications from other service providers such as loyalty, ticketing, healthcare, access control, and ID applications (Coskun et al., 2013). Moreover, the UICC supports multiple PIN codes which can better protect the data from the misuse (Gemalto, 2016). The UICC has proven itself to be robust against attacks and is well suited to hosting sensitive applications and data (Andersen & Munch-Ellingsen, 2014). The UICC, therefore, is employed as the secure element to emulate a smart card.

• *Architecture*

In the SIM-centric SE solution, the payment application and the payment credentials (such as secret cryptographic keys) reside inside the UICC chip. The connection between the UICC and the NFC control is established and securely protected by the Single Wire Protocol (SWP) specification (Andersen & Munch-Ellingsen, 2014). As shown in Figure 6, the direct connection between the UICC and the NFC controller allows the payment application located in the UICC to be able to communicate with the NFC reader. Other applications located in the mobile operating system are not involved at all. Besides, the operation system of the UICC implements a firewall that prevents the applications from accessing and sharing data between them (Alimi & Pasquet, 2009). After the transaction is complete, a client App on the mobile device provides a user interface to the consumer to interact with the payment application for example to check the account balance.

The installation and the content management operations on the SE are secured by the cryptographic keys provided by the SE's owner (Alattar & Achemlal, 2014). In this case, the SE's owner is MNOs. In order for the service providers such as banks, transport operators to provision and personalise the payment applications on the UICC, they have to gain access from the corresponding MNOs. The Trusted Service Manager (TSM) systems were developed to make different actors work together. Both MNOs and service provider have their TSMs as shown in Figure 6. The TSM enables all relevant stakeholders to distribute and manage their applications and data located in the UICC remotely (Arcese et al., 2014). It sets up the business agreements and technical connections between MNOs and other service providers which make it easier to create an interoperable mobile NFC ecosystem.

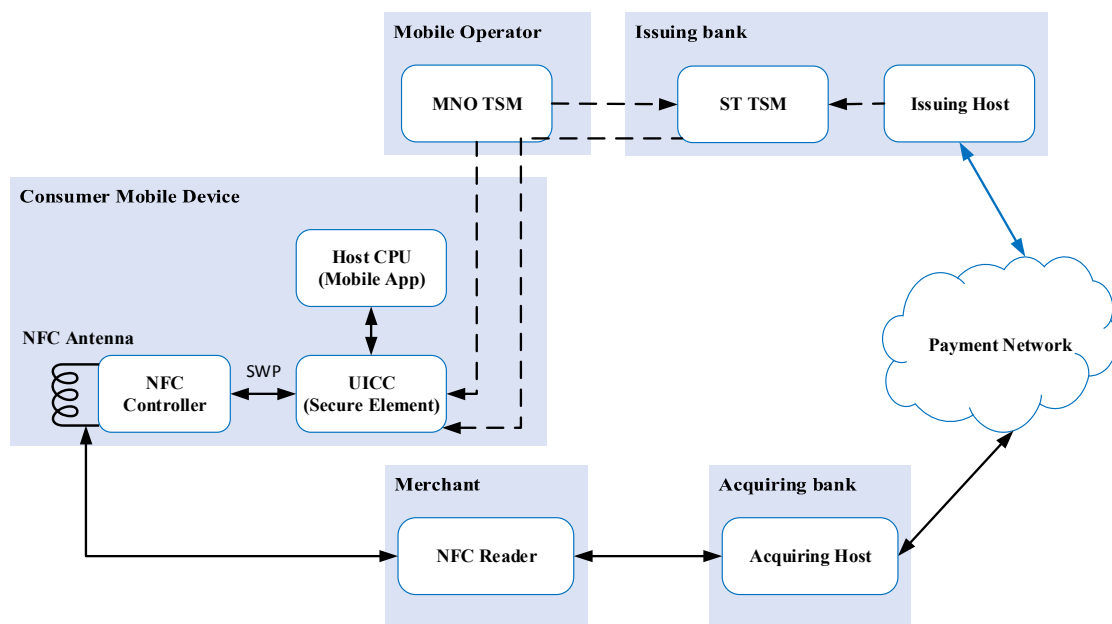


Figure 6: SIM-centric SE architecture

• Characteristics

The inherent security features (e.g. strong cryptographic calculation, tamper-resistance hardware) of the SIM-centric SE solution makes it a secure solution for mobile payment transactions. Besides, as all payment application and payment credentials are stored in the UICC, users do not need an Internet connection in the transactions to fetch data from the cloud server. In addition to the Internet connection, the user can conduct mobile payments regardless of whether the mobile device is powered up or not and its screen is on or off (Pannifer, Clark, & Birch, 2014). Moreover, the UICC is portable which means the user can reuse it on another NFC-enabled mobile device. The user does not need to input his or her information and download the payment application on the new mobile device again.

However, not every NFC-enabled mobile devices can be used with the SIM-centric SE solution. MNOs need to rely on mobile device manufacturers to design and produce SWP-based mobile

devices. Besides, MNOs have to perform the compatibility test between the mobile device and the UICC which is a time-consuming and costly process. Although the released SWP specification has established the physical design rules between the UICC and the NFC chip in the mobile device, the hardware and software implementations of the NFC functionality of mobile devices could differ. To make sure that the SIM card and the mobile device can work together well, a compatibility test between them is needed. From the service providers' perspective, due to the exclusiveness among MNOs, they need to build a connection with the TSM of each mobile network operator in order to serve users that belong to different MNOs. It has the interoperability issue caused by the exclusiveness of the MNOs. Thereby, it is likely hard to expand globally with the SIM-centric SE solution. Besides, they face various charges including renting space on the UICC, setup charges for TSM services and usage charges for each management operation performed by the TSM during the lifecycle of the payment product (Pannifer et al., 2014). These limitations potentially affect the expansion of the SIM-centric SE solution.

3.2.2 Embedded SE solution

• *Introduction*

In the embedded SE solution, the SE is a physical smart chip soldered onto the mobile device motherboard and cannot be removed (Reveilhac & Pasquet, 2009). This chip is embedded onto the mobile device during manufacturing stage and personalised after the mobile device is delivered to the end user (De Reuver & Ondrus, 2017). In 2011, the embedded SE architecture was implemented by Google to Google Wallet on the Nexus phone (De Reuver & Ondrus, 2017). Afterwards, the embedded SE solution gains its popularity with the adoption by two mobile device giants Apple and Samsung. Apple announced their iPhone 6 supports Apply Pay based on embedded SE architecture in September 2014 (Apple press info, 2014). Samsung Electronics also implemented embedded SE architecture in some of their devices and realised Samsung Pay in August 2015 (Samsung Global Newsroom, 2015).

• *Architecture*

The embedded SE solution has a similar architecture with that of the SIM-centric SE. The only difference is that the payment application and payment credentials are stored in a highly secure, tamper-resistant hardware SE chip embedded in the mobile devices which is owned by the mobile device manufacturers. The service providers provisions and personalises the payment applications and users' data on the SE chip through the TSM of the corresponding mobile device manufacturers. The contents in the SE are protected by the cryptographic keys provided by the mobile device manufacturers. This SE chip embedded in the mobile device also has a direct connection with the NFC controller to realise the communication with the NFC reader.

• *Characteristics*

The embedded SE solution can provide a high level of security just as the SIM-centric SE solution due to its hardware-based nature. Moreover, it can provide a better user experience than that of the SIM-centric SE solution. Just like the SIM-centric SE solution, the users can perform mobile

payments no matter if the mobile device is powered up or not and its screen is on or off. Besides, the compatibility test between the SE and the NFC controller is not required as the mobile device manufacturer can make sure that the embedded SE chip can work well with the NFC controller in the design of a mobile device.

However, only several mobile device manufacturers currently introduced their mobile payment systems. In order to use their embedded SE chip, the mobile payment service providers need to cooperate with the mobile device manufacturers to gain access to the SE chip. For some proprietary mobile devices, the NFC controller and the operating system of the mobile device are strictly controlled by the mobile device manufacturers, such as Apple iPhone. In this case, the embedded SE solution is the only option for the service providers to provide NFC-based mobile payment services. Although the embedded SE solution allows the service providers to exempt from the restriction of the country, the service providers can only target the users of the mobile device which they have established the relationship with their producers. To target users of different mobile devices, the service providers need to setup the connection with the TSM of the corresponding mobile device manufacturers. It has the interoperability issue caused by various brands of the mobile devices. From users' perspective, as not all types of mobile devices from the same mobile device brand are designed to support the embedded SE solution, users may need to buy the specific mobile devices in order to use their mobile payment services. Furthermore, the SE chip is bundled with the mobile device which means the SE chip is not reusable. The users need to personalise the SE again if they change their mobile devices.

3.2.3 Host card emulation solution

• *Introduction*

In the technological solutions described above, mobile payment credentials required to complete a transaction are stored on a physical SE within a mobile device. Mobile payment service providers such as financial institutions, merchants have to cooperate with mobile network operators or mobile device manufacturers in order to provide NFC-based mobile payment services. However, players who jointly develop and govern a NFC-based mobile payment platform may have different strategic objectives and interests. The conflicts among them make it tough to collaborate which eventually result in the failure of the projects (De Reuver et al., 2015).

In the early of 2012, SimlyTapp Inc., a US startup, created HCE solution to free the mobile payments ecosystem from the dependence on the physical SE (Alattar & Achemlal, 2014). HCE introduces a new solution of offering NFC-based mobile payment services without the presence of a physical SE and also the involvement of other third parties. Services providers can take control and implement a standalone mobile NFC payment platform and do not need to share user profiles and transaction data with others. According to Sequent (2015), HCE refers to an on-device technology that permits a mobile device to perform card emulation on an NFC reader without relying on access to a physical SE. It is a technology that emulates a payment card on a mobile device purely relying on software. It consists of libraries and application program interfaces (APIs)

implemented at the operating system. These libraries and APIs are used (or overridden) by an ordinary application running on the host central processing unit (CPU) (Alattar & Achemlal, 2014; Yeh, Lo, & Wang, 2017).

- **Architecture**

As described, a physical SE in the mobile device plays two essential functions which are hosting payment application securely and ensuring the safety of the user's data (e.g. confidential payment data and cryptographic key). When there is no physical SE chip, the HCE client application must provide the missing functionalities, and also has a communication connection with the NFC reader through NFC controller. As shown in Figure 7, Android operating system guarantees that the communication from the NFC reader is routed to the HCE client application located in host CPU other than the physical SE for verification and authorization processing.

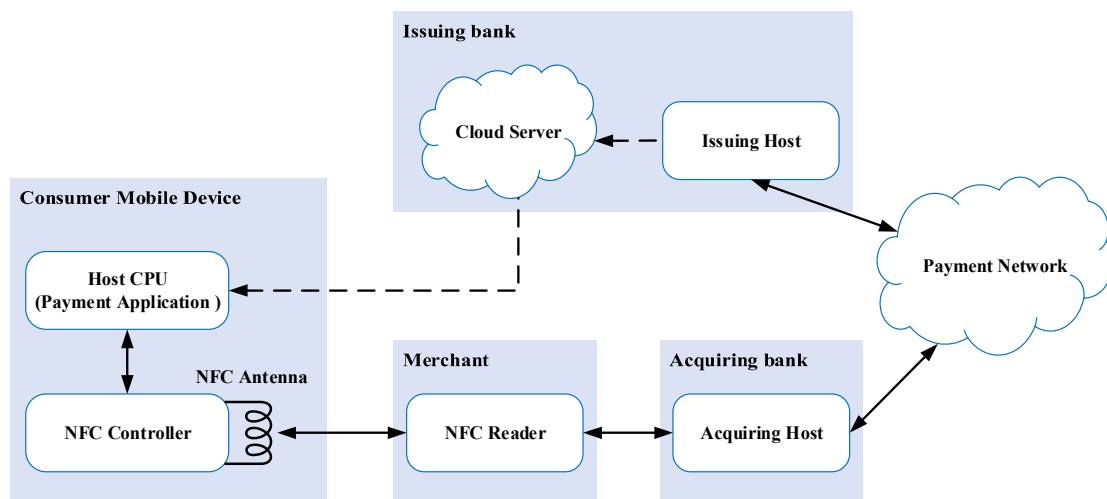


Figure 7: Host card emulation architecture (Android Developers, 2017)

Moreover, several approaches are implemented to ensure the security of data and also the payment transaction process. Firstly, most card credentials are hosted in the cloud server of HCE, only a minimum amount of data is stored in the user's mobile device. Due to the absence of a secure hardware SE, HCE assumes that any data stored on a handset is vulnerable and therefore restricts the storage of sensitive data to the cloud database. Moreover, tokenization technology is employed to enhance the security. According to Sequent (2017), Tokenization is a process of protecting sensitive data by replacing it with an algorithmically generated number called a token. In payment tokenization, the customer's primary account number (PAN) is substituted with a randomly generated number. Tokenization reduces the impact of data breaches significantly. In the payment transactions, the token service provider (TSP) system is used to convert tokens back into a PAN to allow the issuer to process the transaction in the usual way (Pannifer et al., 2014). Furthermore, different types of payment keys have been designed, like Single Use Key (SUK), Limited Use Key (LUK) (Pannifer et al., 2014). With Single Use Key, a number of SUKs are provisioned to the mobile device. Each SUK can only be used in one payment transaction. It will be removed from the mobile device afterwards. With Limited Use Keys, only a single LUK is provisioned to the

mobile device, but the LUK can be used in a limited number of payment transactions. Once payment keys expire or reach their authorised limits, new payment keys need to be fetched from the cloud server. Hence, HCE requires network connectivity once in a while in order to provision payment keys. Finally, risk assessment is performed in real-time with the user, device, account data through the HCE client application and issue backend system to enhance the security (Sequent, 2015). All these methods play roles together to ensure that HCE is a feasible and acceptable solution to offer mobile payment services.

- ***Characteristics***

It is clear that the most important feature of HCE is that it simplifies the NFC mobile payment ecosystem. The NFC value chain is shortened as few parties in the ecosystem need to be involved to deploy and provide mobile payment services. As thus, the service providers have better control over costs, security, partners and management of the platform. HCE solution narrows the gap between service providers and customers. Through HCE client application, the service providers can present their brands and be aware of the needs of customers based on their behaviours. Furthermore, HCE does not require any changes to the acquiring infrastructure nor optimisation to specifically support NFC technology (Rambus, 2017). Compared with the physical SE solutions, additional cost and efforts are not required. In addition, because of no dependencies on the MNOs and mobile device manufacturers, the service providers are capable of expanding globally. From users' perspective, they do not need to replace SIM card or use the specific mobile devices (e.g. iPhone 6) to use the mobile payment platform provided by their mobile device manufacturers. Users only need to upgrade their mobile device OS to the required version or higher and install the HCE mobile App.

However, although various techniques have been used to ensure the security of HCE solution, it is still vulnerable to security threats (e.g. theft of sensitive data, integrity violation) as it is running on the hosting CPU of the mobile device, just beside other applications (Alattar & Achemlal, 2014). Compared with the physical SE-based solutions, HCE solution provides a lower level of security. Another disadvantage of HCE solution is that it is currently only supported in Android 4.4 KitKat and Blackberry OS 10 (Pannifer et al., 2014). It means that HCE solution cannot be implemented in those mobile devices which operating systems other than those, for instance, Apple iOS. Thereby, it has the interoperability issue caused by the mobile device OS.

Regarding user experience, there is a slight difference between HCE solution and other physical SE solutions. HCE requires the mobile device screen to be on (Pannifer et al., 2014). The reason is that current Android implementations turn the NFC controller and the application processor off completely when the screen of the device is turned off (Android Developers, 2017). HCE services, therefore, do not work when the screen is off. It would be a problem in the high throughput environment such as mass transit payment at gate. Moreover, users need the Internet connection once in a while to fetch the payment keys from the cloud server. HCE solution does not support completely offline mode.

It can be seen that all NFC-based technological solutions described above have their advantages and disadvantages. Meanwhile, the stakeholders involved to implement each technological solution are not same as well. Furthermore, there are some differences regarding the usage requirements and user experience. We will come back to this in detail in section 3.5.

3.3 Quick response code technology

The Quick Response (QR) code is one kind of two-dimensional barcode technology which consists of black modules arranged in a square pattern on a white background as shown in Figure 8. It was developed by the Japanese Denso company in September 1994 (Gu & Zhang, 2011).

3.3.1 QR code features

The invention of QR codes was mainly motivated by the small encoding capacity of the traditional one-dimensional barcodes (Denso Wave, 2017a). QR codes have information to be encoded in both the vertical and horizontal directions whereas information can only be encoded in one direction in the traditional barcode as shown in Figure 8. It significantly increases the data capacity of QR codes. Statistically, QR codes are capable of encoding the same amount of data in approximately one-tenth the space of a traditional barcode (Kieseberg et al., 2010). Besides, QR codes can handle most types of data, including numeric characters, alphabetic characters, binary, control codes (Purnomo, Gondokaryono, & Kim, 2016).



Figure 8: QR code vs. One-dimensional barcode (Kieseberg et al., 2010)

Another feature of QR codes is that it has error correction capability. Data can be restored even if QR code is partially dirty or damaged. The QR code error correction feature is implemented by adding a Reed-Solomon Code to the original data (Denso Wave, 2017b). Four error correction levels are available for users to choose according to the operating environment (Denso Wave, 2017b). However, the capacity of a QR code decreases with the error correction level increases. Moreover, QR codes can be read easily at any angle of scanning with the design of position detecting pattern (Denso Wave, 2017a). The position detecting pattern consists of three identical square marks located in all corners of the QR code except the bottom right one. It enables the decoder software to recognise the QR code and determine the correct orientation regardless of the angle of scanning. The numerous features of QR code make it a suitable technology for mobile payments.

3.3.2 QR code widespread & security concerns

QR codes were initially designed for tracking parts in the automotive industry. Because of the advanced features of QR codes compared to the traditional barcodes, they have gained wide acceptance in various industries such as manufacturing (e.g. inventory and equipment management), warehousing and logistics (e.g. item tracking), retailing (e.g. sales management), transportation (e.g. ticketing and boarding passes) (Tretinjak, 2015). QR codes are usually used to store information such as web addresses/ URLs, basic texts or numeric data (Liébana-Cabanillas, De Luna, & Montoro-Ríos, 2015). With QR codes, users can quickly and efficiently to obtain data by simply scanning them. Another important factor that contributed significantly to the widespread use of the QR codes is that Denso Wave's decision to make the specifications of QR code publicly available so that anyone could use it freely (Denso Wave, 2017a). Despite the fact that Denso Wave has the patent rights to the QR code, it declared that it would not exercise them. As the QR code is an open code that anyone is allowed to use, its usage is not limited to Japan anymore but all over the world. In 1997, it was approved as an Automatic Identification Manufacturer (AIM) standard to be used in the automatic identification industry (Denso Wave, 2017a). In 2000, the QR code was established as an international standard (ISO standard 18004) by the International Organization Standardization (ISO) (Denso Wave, 2017a).

The popularity of QR codes is further accelerated with the increasing adoption of smartphones (Kieseberg et al., 2010). QR code is readable by dedicated QR barcode readers and a built-in camera on a mobile phone supported with a decoder software. Most smartphones nowadays are capable of reading and displaying QR codes. Many companies, therefore, make use of QR code technology to authenticate or interactive with users. For instance, many TV programs display their QR codes on the screen. The audiences can get the link to participate in the online activities by scanning the QR codes with their mobile devices. Another example is WeChat, a social media App similar to WhatsApp. It shows a QR code on the login page on its web version, and a registered user can scan it with a verified smartphone to log in. Besides, WeChat members can add other members by scanning the QR code of their WeChat accounts.

Despite the tremendous advantages and widespread of QR code, companies that use QR code technology still need to overcome doubts and concerns about its security. First of all, QR codes are subject to eavesdropping when they are displayed on the smartphone screens due to the visual nature. Furthermore, users' privacy and property safety might be at risk if they scan a malicious QR code. QR codes can be manipulated by an illegal person to be embedded with malicious URLs, Trojan and virus while an ordinary user lacks the ability to detect them.

3.4 QR code mobile payment architectures

In this section, the generic QR code-based mobile payment architectures, the underlying payment transaction workflow and involved security mechanisms are demonstrated.

The QR code-based mobile payment system typically consists of a consumer, a merchant, and the third-party payment platform server. Depending on the role that the consumer plays in the payment transaction process, QR code-based mobile payments can be divided into two categories which are active scanning and passive scanning (Zhu, Hou, Hu, & Zhang, 2016). The active scanning means that a user scans QR code which is provided by the merchant side while the passive scanning refers to the other way around.

3.4.1 Active scanning payment workflow

According to the development manuals of WeChat Pay, the simplified mobile payment process of the QR code active scanning is depicted in Figure 9 (WeChat wiki native, 2017). It consists of the following steps:

Step 1: The merchant displays the QR code to the consumer. The QR code provided by the merchant can be static or dynamic depending on the capability of his existing payment equipment and infrastructure. The merchant can simply generate a static QR code which mainly contains its account ID and prints it out.

Step 2: The registered consumer opens the third-party payment App on his mobile device and clicks the scan function to read the QR code. He might be asked to enter the transaction amount by the mobile App interface if the QR code does not contain such information.

Step 3: The mobile payment App generates the transaction request and sends it to the third-party payment server through the consumer's mobile network for validation.

Step 4: The third-party payment server sends back the payment response to the consumer after conducting a series of risk analysis and management. The transaction amount is transferred from the consumer's account to the merchant's account immediately if the transaction is approved by the third-party payment system.

Step 5: The merchant receives the notification about the payment transaction.

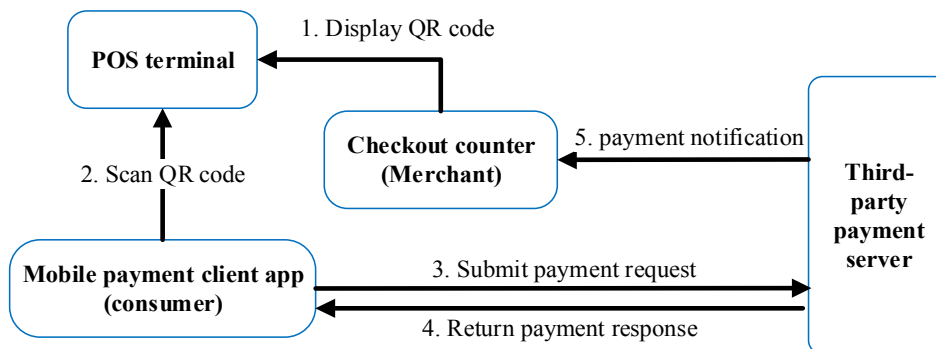


Figure 9: Simplified QR code active scanning mobile payment workflow

This pattern can largely reduce the cost for the merchants such as small retailers or taxi drivers to offer mobile payment services to the consumers. They just need to register their details on the third-

party website and generate the corresponding QR codes. However, the consumer's mobile device needs to access the Internet to initiate the payment transaction. Moreover, consumers face higher security threats compared with the passive scanning payment as the QR codes provided by the merchants might be manipulated by an unauthorised person.

3.4.2 Passive scanning payment workflow

According to the development manuals of WeChat Pay, the simplified mobile payment process of the QR code passive scanning is depicted in Figure 10 (WeChat wiki micropay, 2017). It consists of the following steps:

Step 1: The registered consumer opens the third-party payment App on his or her mobile device and clicks the pay function to generate the one-time QR code. It is not necessary that the mobile device has to connect to the Internet if the mobile payment App supports the offline generation of QR codes.

Step 2: The merchant uses the barcode scanner to decode the one-time QR code displayed by the consumer. The extracted data from the QR code is sent to the merchant's payment system for further processing.

Step 3: The payment request is built with other transaction data by the merchant's payment system and forwarded to the third-party payment server for verification.

Step 4: The third-party payment server sends back the payment response to the merchant after conducting a series of risk analysis and management. The transaction amount is transferred from the consumer's account to the merchant's account immediately if the transaction is approved by the third-party payment system.

Step 5: The consumer receives the notification about the payment transaction.

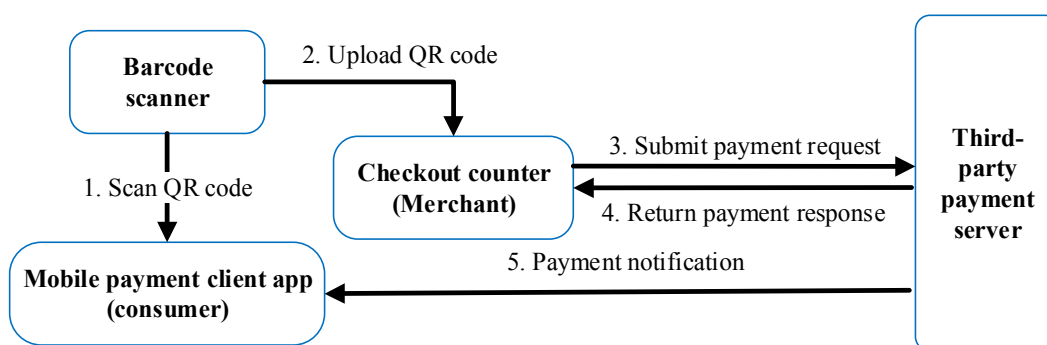


Figure 10: Simplified QR code passive scanning mobile payment workflow

In this case, the merchant needs to be equipped with a barcode scanner and build a payment system which connects to the third-party payment server to process the payment transactions. Despite a higher adoption requirement is needed for the merchants, it reduces the potential security risk that the consumers may encounter in the mobile payments.

3.4.3 Security mechanisms

Different third-party payment platforms have their own rules to define the data content of the QR code and also mechanisms to reduce the security risk. In general, approaches discussed below are often employed.

- **Tokenization (token) technology:** As described in section 3.2.3, tokenization refers to the process of replacing sensitive data with an algorithmically generated number. This technology is also used in the QR code-based solution to protect user's sensitive data to ensure the security of information during storage, processing and transmission and prevent the risk of account information disclosure (Zhao, 2016).
- **Dynamic QR codes:** The QR code that the consumer generates on his mobile devices updates based on a certain time interval to prevent the repetitive transactions and eavesdropping.
- **Password authentication:** The consumers are requested to perform password authentication in the mobile payment transactions based on the rules that the third-party payment providers pre-defined in order to control risks. For instance, the upper limit for each transaction without password authentication is ¥500.
- **Notification:** Both consumers and merchants are notified about the payment transaction details immediately after the transaction is completed.

It can be seen that QR code-based technological solution has solved most interoperability issues due to few requirements on the hardware device of the end-users (i.e. consumers and merchants). Moreover, it significantly reduces the adoption cost because the end-users do not need to have an NFC-enabled mobile device or POS terminal. Furthermore, it provides a means for mobile payment providers to reduce the dependency on MNOs and mobile device manufacturers. We will discuss it in detail with a multi-level framework in the next section.

3.5 Multi-perspective view of technological solutions

In the previous sections, the mainstream technological solutions employed in the Chinese market have been described in detail. However, in order to explicitly shed light on the potential barriers towards each technological solution and also make a comparison between them, an appropriate theoretical framework is needed.

As discussed in section 1.3, the mass adoption of a mobile proximity payment technology can be viewed into two phases which are technological solution implementation by the provider and the mobile payment service adoption by the user. In the process, the mobile payment platform plays a role to connect the technology, provider and user. Relying on this concept known as multi-sided

platform which will be discussed in section 4.2.2, De Reuver & Ondrus (2017) developed a three-level framework which are technology, provider and user. In this multi-level framework, the provider level discusses the roles of the platform providers and their strategy issues. The technology level deals with the cost, performance and security level of a technological solution. The user level examines the adoption factors from consumers' perspective. With the multi-level framework, the authors analysed why MNOs is most likely to lose the battle for control in the mobile payment ecosystem by comparing NFC SIM-centric SE solution with NFC embedded SE and HCE solutions. The multi-perspective nature of this framework makes it very useful to unveil the potential factors towards a technological solution. However, the results of De Reuver & Ondrus (2017) could not be simply referred due to some limitations.

First of all, the authors only investigated mainstream NFC solutions, especially paying attention to the SIM-centric SE solution and exclude other technological solutions (e.g. QR code) in the discussion. Moreover, the authors do not include merchants on the user level. As they mainly focus on the SE in the consumers' mobile device, merchants thereby are not relevant. In our study, merchants are included because they can significantly affect the adoption of the mobile payment platforms. Last but not the least, the interviewees are mainly from the Netherlands which may result in the ignorance of the market difference (e.g. existing infrastructure, the positions of players in the market, regulations). Therefore, in this study, the multi-level framework is applied with these limitations addressed properly. Based on the desk research in the previous sections, the barriers of NFC and QR code-based solutions are identified and presented in Table 4.

Table 4: Multi-level view of technological solutions

<i>Solution</i>	<i>Provider</i>	<i>Technology</i>	<i>User</i>
<i>SIM-centric SE</i>	<ul style="list-style-type: none"> - High dependency on MNOs - High dependency on mobile device manufacturers - Interoperability issue caused by the exclusiveness of MNOs 	<ul style="list-style-type: none"> + High level of security + No need mobile device power + No need mobile phone and mobile App turned on + No need Internet connection - Replacing SIM with UICC is costly - Require to setup TSM system with MNOs - Require compatibility test 	<ul style="list-style-type: none"> - Replacing SIM with UICC - NFC-enabled mobile device - NFC-enabled POS terminal + Personalized UICC reusable
<i>Embedded SE</i>	<ul style="list-style-type: none"> - High dependency on mobile device manufacturers - Interoperability issue caused by the exclusiveness of mobile device manufacturers 	<ul style="list-style-type: none"> + High level of security + No need mobile device power + No need mobile phone and mobile App turned on + No need Internet connection - Require to setup TSM system with mobile device manufacturers + No need compatibility test 	<ul style="list-style-type: none"> + No need to replace SIM - Limited choice of mobile devices - NFC-enabled POS terminal - Need to personalised SE again when changing mobile device

<i>Host card emulation</i>	<ul style="list-style-type: none"> + No dependency - Interoperability issue caused by the mobile device OS & banks 	<ul style="list-style-type: none"> - Less secure than hardware SE solutions - Require mobile device power - Require mobile device screen on + No need mobile App on - Require Internet connection once in a while - Require to setup its own cloud system + No need compatibility test 	<ul style="list-style-type: none"> + No need to replace SIM - NFC-enabled Android/Blackberry OS mobile device - NFC-enabled POS terminal - Need to personalised SE again when changing mobile device
<i>QR code</i>	<ul style="list-style-type: none"> + No dependency + No interoperability issue 	<ul style="list-style-type: none"> - Less secure than NFC-based solutions - Require mobile device power - Require mobile device screen on - Require mobile App on - Require Internet connection - Required to setup its own cloud system + No need compatibility test 	<ul style="list-style-type: none"> + No need to replace SIM + Mobile device with a built-in camera or bar scanner + No need to personalised SE when changing mobile device

It can be seen that QR code-based mobile payments are less superior in terms of performance and security compared with NFC-based technological solutions. While it can significantly reduce the dependencies of initiatives on other stakeholders and the adoption cost for both providers and users (e.g. consumer and merchant). Furthermore, it ensures a good interoperability among different MNOs, mobile devices and banks. However, to what extent those factors actually can influence the implementation and adoption of a technological solution is still related to the environment of the market. For instance, the difference of the adoption cost for merchants between NFC and QR code-based technological solutions might be neglectable if the existing infrastructure of the targeted market is completely upgraded by the time to promote mobile proximity payments. Another example is that regarding the security demand of the micropayments, users in different markets are not same. In order to obtain the situation in China and also triangulate the results of the desk research, in-depth interviews are conducted with experts and managers who have the right technical knowledge or participate in the implementation of these four major technological solutions in the Chinese market. The final results are presented in Chapter 7.

4 Theoretical foundation

The position of a mobile proximity payment technology in the marketplace highly depends on the collective success of the mobile payment platforms which employ this technology. In order to understand the strategic decisions that the mobile payment platform providers made to design and launch a mobile payment platform in the first place, this chapter starts the discussion with a business model theory in section 4.1, more specifically the STOF model which focuses on the customer value design, technical, organisational and financial arrangements. Subsequently, the full potential of a mobile payment platform is explored with a variety of complementary services (i.e. payment scenarios) developed, deployed and delivered on it to meet the needs of different groups of users. The mobile payment platform enables the connection of users and meanwhile plays a role in mediating the interactions among them. The governance of a mobile payment platform is crucial to its viability in the long run. In order to deeply understand its governance and evolution, the platform is analysed from the innovation management and the economic perspectives in section 4.2. Next, as multiple actors are involved in the development of a mobile payment platform, the concept of the business ecosystem is introduced in section 4.3 to examine their roles, relations and strategies in the mobile payment ecosystem. As term “business ecosystem” is similar but more favoured by scholars nowadays than the concept “value network” which is the core theory foundation in the organisation domain of the STOF model, the organisation domain is not discussed in section 4.1 to avoid the repetition. The combination of the STOF model, the relevant platform theories and the business ecosystem concept gives rise to a multi-perspective research model in section 4.4. The proposed research model is used to guide the investigation of the representative mobile payment platforms using NFC and QR technologies in the Chinese market.

4.1 STOF model

Various definitions have been given to the business model with different focuses and approaches. In simple terms, a business model describes the way a single company or network of companies aim to make money and create customer value (Haaker, Faber, & Bouwman, 2006). The definition indicates the two essential functions of a business model which are value creation for the customers and revenue generation for the network of companies (i.e. network value). While realising them, designing a feasible and viable business model is needed.

Different conceptual frameworks are available to guide the design of a business model, including Resource Event Agent (REA) ontology (Bergholtz, Jayaweera, Johannesson, & Wohed, 2003), e3 value (Gordijn & Akkermans, 2001), Business Model Ontology (BMO) (Osterwalder, 2004). In this study, the STOF model proposed by (Bouwman, Vos, & Haaker, 2008) is chosen for a twofold reason. First and foremost, the STOF model places emphasis on the design of business strategies for services that make use of innovative technologies which matches this study context. Moreover, it focuses on how an organisation needs to define its business model in a complex value network. Despite the fact that pure cloud-based mobile payment technological solutions emerged in recent

years which technically can be implemented by a single company, in most cases, the company has to cooperate with other organisations in order to enhance the mobile payment services for the users, for instance, the third-party providers often cooperate with banks to enable the users to top up their third-party accounts easily with their bank accounts. Therefore, the STOF model is used in this study. As shown in Figure 11, the STOF model defines four interrelated components which are service, technology, organisation, finance (Bouwman et al., 2008). For each component besides of the organisation, a brief introduction is given first and then we discuss it in the context of the mobile proximity payments.

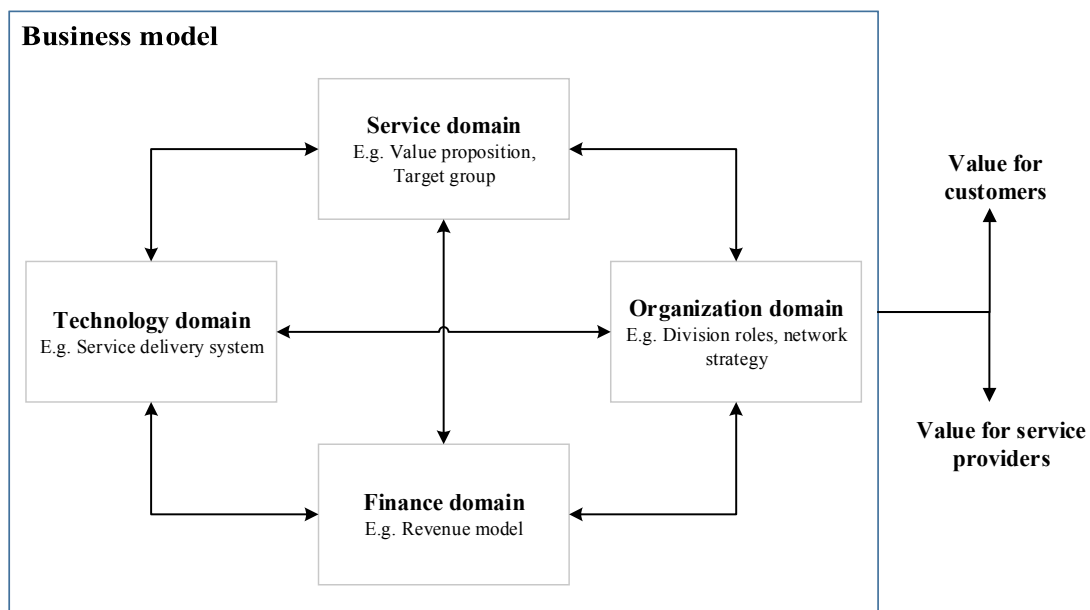


Figure 11: STOF business model domains (Bouwman et al., 2008)

4.1.1 Service domain

It offers a description of the value proposition (added value of a service offering) and the market segment at which the offering is targeted (Bouwman et al., 2008). The central concept in the service domain is value. However, it is not an easy task to create customer value due to the difficulty of extracting user requirements and resolving the conflict on the design requirements (Haaker et al., 2006). To elaborate it, Bouwman et al. (2008) distinguish different values (i.e. intended value, delivered value, expected value, perceived value) related to the providers and users.

Regarding mobile proximity payments, depending on the technology and the technological solution adopted by the mobile payment platform providers, the mobile proximity payment services offered on their platforms exhibit evident differences in various aspects, such as the usage procedure, the transaction speed, the transaction security level, and the adoption cost. Combining with the non-technical settings (e.g. training and support service), they define the actual value of a mobile

payment service from the providers. While the delivered value of a mobile payment platform is determined by the aggregate value of the mobile payment services provided on this platform.

In practice, there are often gaps or mismatches between the delivered value and the perceived value. Users evaluate a product or a service based on their previous consumption experiences, habits and expectations (Parasuraman, Zeithaml, & Berry, 1988). As thus, users tend to use their most familiar way rather than the most superior way to conduct payments. This phenomenon is known as lock-in effects. Users' potential concerns on a new mobile payment platform might include the security, trust or cost (e.g. the efforts required to set up and learn a new payment technology). In order to stimulate the adoption of a mobile payment platform, the mobile payment providers often take different marketing strategies to increase the perceived value. For example, the financial subsidy is offered to the users who adopt a mobile payment platform and its new mobile payment service. Other strategies such as advertising, service bundling can also boost the customer perceived value.

In addition to the marketing strategies, the perceived value of a mobile payment platform could be influenced by the market segments targeted by the mobile payment providers. A mobile proximity payment service is launched and consumed within a specific context (e.g. physical retail stores, metro, parking). Whether a mobile payment service is perceived as a disruptive innovation or just another payment method depends on if it can help users in solving their (daily) practical problems with that specific context. Hence, finding the right niche markets is crucial to the adoption of a mobile payment platform.

4.1.2 Technology domain

It describes the technical functionality and architecture necessary to realise the service offering (Bouwman et al., 2008). Technical functionality refers to the things that a system can do for its users whereas a technical architecture describes the fundamental organisation of a technical system (Haaker et al., 2006). Mobile proximity payments can be realised with different technologies while several technological solutions might be available to implement each technology. When making the choices of the technology and the corresponding technological solution, the mobile payment providers need to take some generic technical issues into accounts.

- **Security:** It describes the security of a service in different aspects, such as the authentication of the user, the access to a service, the security of data communication, the security of information stored. Security is vitally important in the mobile payment services as it involves the users' property and also sensitive personal information. When designing a technological solution, mobile payment providers try to make use of their competitive resources to ensure the security of the mobile payment service offered. For instance, mobile network operators rely on the SIM card to protect payment applications and users' data in its NFC solution. However, security is not the only important thing in a mobile payment service. The mobile payment providers may need to make some compromises on the security to ensure the overall user experience.

• **Customer ownership:** It is an important strategic asset. Having customer ownership enables a company to have access to the users' profile and behaviour data. The mobile payment providers often utilise this information to design their future strategies as they provide feedback on users' true needs. However, depending on the design of the technological solution, the mobile payment platform may be built with the joint efforts of a group of companies while not every company can claim customer ownership. If a company has control over the critical assets necessary for the technological solution, it is likely to have customer ownership.

• **Device compatibility:** The choice of technology determines the requirements of the user's device to access to the mobile payment services and hence the adoption cost. The number of the potential users reduces when it requires a specific compliant device from the users. Take RF SIM solution adopted by China Mobile as an example. Consumers do not need a special mobile device, but merely replace their current SIM card with RF SIM card. However, on the merchant side, they need to install a new POS terminal. As RF SIM technology operates at 2.4GHz not 13.56MHz, it does not comply with the existing contactless payment infrastructure. As thus, the availability of the RF SIM-based mobile payment services highly depends on the willingness of merchants to invest on the new POS terminals. If the lack of infrastructure affects the adoption of RF SIM-based mobile payment services, the mobile payment providers who support the RF SIM technology have to face a significant investment in developing the infrastructure.

• **Platform:** A technology platform is required to realise the mobile payment services. From the information systems perspective, a platform is "*as an extensible code base of a software-based system that provides core functionality shared by the modules that interoperate with it, and the interfaces through which they interoperate*" (Tiwana, Konsynski, & Bush, 2010, p.2). A module refers to an add-on software subsystem that is integrated into the platform to add functionality to it (Tiwana et al., 2010). As thus, the mobile payment providers generally have two options to offer mobile payment services: integrating a mobile payment solution into their existing platform through its interfaces or building an entirely new platform for mobile payments. Making use of the existing platform have the benefits of reusing or accessing to its existing resources and facilities, such as current functionalities, current infrastructure of the platform, the installed base of users. However, the performance and extensibility of such a mobile payment platform might be affected because of the legacy technical architectures and organising principles of the foundation platform. In contrast, establishing a new platform for mobile payments may face the difficulty to obtain a critical user base to take off. Additionally, its initial investment is likely higher than the former option.

4.1.3 Finance domain

It provides a description of the way a value network intends to generate revenues from a particular service offering and of the way investments, risks and revenues are divided across the different actors in the value network (Bouwman et al., 2008). When the providers make decisions, they also consider the potential intangible benefits, such as learning the market, enhancing user experience

(Bouwman et al., 2008). A viable business model should ensure the balance of the division and sharing of benefits and costs in a value network. Some generic issues related to the financial arrangement are discussed here.

- **Pricing:** It is the amount of money that an end-user has to pay for using the service. On the one hand, revenues are affected by the price associated with the service. On the other hand, the price directly affects the end-user perceived value of a service. In order to rapidly increase the installed base and thus achieve the network effect, the mobile payment providers might make the service free of charge at the beginning. After sufficiently penetrating a market, they may adopt another pricing strategy to capture profits.

- **Division of investments and risks:** Developing or introducing a new service to the market usually involves a great amount of investment. However, there is a risk that the investors cannot get a return on investment. There are several ways to mitigate the risks. First, the providers can conduct field trials for those services which uncertainty or upfront investment is high to limit the risk involved. Besides, the providers can collaborate with others to share the risks.

- **Division of costs and revenues:** The allocation of costs and revenues among actors involved highly depends on their individual access to critical resources, the evaluation of these resources, the risks and level of investments, and the existence of intangible benefits (Bouwman et al., 2008). For example, China UnionPay has network connections to all banks in China. By cooperating with China UnionPay, the service providers (e.g. mobile network operators) do not need to build a network connection with the individual bank. It can help the service providers significantly reduce the investment on the network infrastructure and also dramatically simplify the complexity of the value network. However, it also means that the providers need to share its transaction revenues with China UnionPay besides of banks. The transaction revenues that China UnionPay can obtain is determined by how this critical resource is valued by the business partners.

In this study, the financial arrangement is only discussed briefly from the outsider's perspective for a twofold reason. Firstly, this study mainly aims to provide insights from a platform point of view rather than the financial perspective. Thereby, the analysis of the financial arrangement at a detailed level is beyond the scope of this study. Secondly, it is very challenging to obtain the specific financial data (e.g. the pricing of a mobile payment service, the actual division of costs and revenues among stakeholders). Financial information is usually not allowed to be disclosed publicly due to the confidentiality reason.

Based on the analysis of the three domains above, it is possible to investigate the strategic decisions of the mobile payment providers in the establishment of a mobile payment platform. The next two sections discuss the platform and business ecosystem theories to help understand the development of a mobile payment platform.

4.2 Platform concept & theories

The concept of the platform can be viewed from multiple perspectives. In the technology domain of the STOF model, we have discussed the development of a mobile payment platform from the information system (IS) viewpoint. In this section, we analyse a mobile payment platform from the innovation management and the economic perspectives to deeply understand its governance and evolution.

4.2.1 Innovation management perspective

Platforms typically are composed of stable core components and variable peripheral components (Baldwin & Woodard, 2008). From the innovation management perspective, a platform is viewed as “*a set of subsystems and interfaces forming a common structure from which a stream of products can be developed*” (Meyer & Lehnerd, 1997). The notion of platforms was introduced to describe a pattern of generating a new product family. By reusing the platform components, it enables the innovation of products or services to be achieved quickly and systematically (Gawer, 2014).

Relying on the settings of the organisation, Gawer (2009) categorise the platform-based product innovation into three types: **(1) Internal platforms**: it enables the recombination of the sub-units within the firm. **(2) Supply-chain platforms**: it coordinates the external suppliers around an assembler or integrator **(3) Industry platforms**: it utilises the external resources and capabilities from complementors by a platform owner. In the latter two types, external organisations are involved which implies that the platform innovation is closely related to the platform openness. The level of platform openness determines which actors can join the platform. According to Eisenmann, Parker, & Van Alstyne (2009), a platform is “open” when it meets two requirements **(1) no restrictions are placed on participation in its development, commercialization or use** **(2) any restrictions (such as technical standards or licensing fees) are applied uniformly to all potential platform participants**.

Eisenmann et al. (2009) further distinguish four distinct roles to clearly identify the “open” to avoid confusions:

- **Demand-side platform users**, called end users.
- **Supply side platform users**, who offer the complementary products or services employed by the demand-side user in tandem with the core platform, such as application developers.
- **Platform providers**, who serve as user’s primary point of contact with the platform.
- **Platform sponsors**, who exercise property rights and are responsible for determining who may participate in a platform-mediated network and for developing its technology.

As the development of complementary services is the key to the evolution of a mobile payment platform, the platform openness here mainly concerns with the mobile payment platform providers’ strategies for the involvement of the supply side platform users. The impact of platform openness

can be a double-edged sword. On the one hand, opening a platform’s interfaces could increase the accessibility of the critical resources and capabilities. It can encourage outside parties to join the platform and extend the utility of the platform to the end-users. A mobile payment platform is functionally more desirable when a wide variety of complements are available on it which in return can create new revenues to the platform provider. On the other hand, it may stimulate intense competition and give away the platform benefits to the competitors. With more business actors participating in the platform, the platform providers may lose the control over the platform which can reduce their ability to capture revenues. Therefore, determining the “just right” openness level to the supply side platform users is critical to the growth and sustainability of a mobile payment platform. With the platform openness theory, we can shed light on the platform providers’ strategies on platform innovation and the corresponding impacts.

4.2.2 Economic perspective

Economists view platforms as special kinds of markets that play a role in mediating the interactions between different types of users (Evans, Hagiu, & Schmalensee, 2006; Rochet & Tirole, 2003). The term "multi-sided platform" is often used to refer to such kind of platforms. According to Hagiu & Wright (2011, p.7), a multi-sided platform is “an organisation that creates value primarily by enabling direct between two (or more) distinct types of affiliated customers”. The definition distinguishes the multi-sided platforms from re-sellers and input suppliers. As shown in Figure 12, re-sellers are not qualified as multi-sided platforms because there is no direct interaction between third-party providers (side A) and consumers (side B). Input suppliers are also ruled out as not all relevant customer types are affiliated with the multi-sided platform. The typical examples of the multi-sided platforms are Airbnb, Uber, eBay.

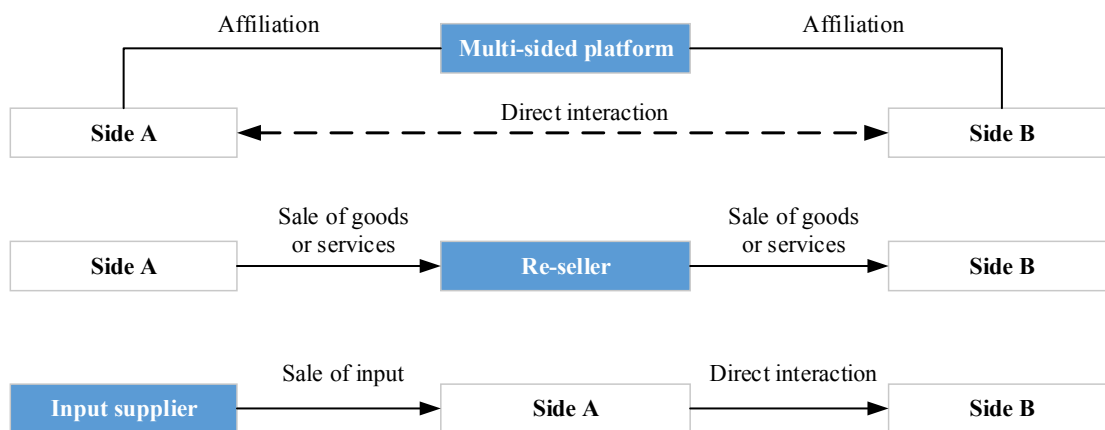


Figure 12: Differences between MSPs, re-sellers and input suppliers (Hagiu & Wright, 2011)

Based on the understanding above, a key feature of a multi-sided platform is that it enables the direct interaction between different groups of users. By providing an infrastructure and setting regulations, it facilitates these interactions (Hagiu et al., 2015). Each side benefits from interacting through such a common platform as it can significantly reduce search and transaction costs on all

sides of the platform. Another key feature of a multi-sided platform is that each side has to be affiliated with the platform. However, at the starting point, a multi-sided platform often faces a chicken-and-egg problem. It means one side users are not interested in the platform until they see the users of the other side is affiliated with the platform (Campbell-Kelly, Garcia-Swartz, Lam, & Yang, 2015). The platform providers need to be creative enough to get both sides on board.

In practice, most mobile payment platforms are the multi-sided platforms. An exceptional example is Venmo which is a digital wallet that is used to make and share payments only among friends. It is not qualified as a multi-sided platform as only one type of users is served on this platform. One-sided platforms are very easy to attack due to their low switching and homing costs. However, in terms of the speed to achieve lock-in effects, they are likely to be faster than two-sided platforms can by adding new sides or features (Staykova & Damsgaard, 2015). A two-sided mobile payment platform can continue to evolve by incorporating third-party services to the platform to become a multi-sided platform to gain competitive advantages. If a mobile payment platform can involve suitable types of users to provide useful complementary services to consumers, it likely to mitigate the multi-homing problem.

A multi-sided platform exhibits network externalities that arise between the two sides of the platform. Network externalities, or network effects, refer to the phenomenon when the value of a good or service to a user increase with the number of other users of the same good or service (Katz & Shapiro, 1985; Schilling, 2013). The classic examples are railroads and telecommunications. Network effects can further be categorised into same-side network effects and cross-side network effects (Katz & Shapiro, 1985). Same-side network effects mean that a user can obtain more value from technology when the number of other users of the same type employs same technology. For instance, Facebook enables a user to get in touch with more friends if the number of Facebook users increases. In contrast, cross-side network effects occur when the number of users of a different type uses this technology. An example is the game console. The number of games will increase if the game console can attract more players. Same-side network effects and cross-side network effects can affect each other and generate a self-reinforcing character (Gawer, 2014; Lee & Connor, 2003).

Regarding Mobile payment platforms, they often exhibit strong positive cross-side network effects. In reality, a new payment network is created by a mobile payment platform in the market. Consumer's decision to adopt the mobile payment network is significantly affected by a number of the merchants using it since that amount determines the opportunities for consumers to use the new payment services (Mallat, 2007). Similarly, the merchants are likely to join the payment network which has a large installed base in order to gain access to the affiliated consumers. Also, mobile payment platforms are subject to positive same-side network effects. Whether a consumer decides to join a mobile payment platform is affected by how widely that platform has been adopted by other consumers. This has been proved in the existing studies on the consumer's adoption of mobile payments (Mallat, 2007; Nyirenda & Chikumba, 2014). Hence, mobile payment providers often take various actions to rapidly increase the installed base rather than skimming marginal profits. Once a platform or technology becomes dominant, it is hard to reverse the situation because of the

substantial switching costs (e.g. the learning cost of using a new platform) that the end-users face to adopt new alternatives even if they are superior (Lee & Connor, 2003).

In order to create the positive network effects, the investment of the financial subsidies might be required. The mobile payment platform providers can offer low prices to one side of the platform to encourage the benefited group's participation which in turn, encourages the non-benefited group's participation due to the network effects. However, the pricing strategy also influences the revenues that the providers can obtain. Furthermore, standardisation or the use of design protocol is also one of the sources of network effects (Lee & Connor, 2003). Mobile payment platforms that provide a standard interface are likely to attract more third parties to create payment scenarios based on the platforms as it can save the cost and also reduce the potential uncertainty. Meanwhile, consumers are more willing to join in and use those mobile payment platforms where many useful payment scenarios are available. As thus, the concepts of the multi-sided platform and the network externalities are helpful to understand the strategies that the mobile payment providers took to compete with other platforms.

4.3 Business ecosystem concept

Platforms are closely related to ecosystems (De Reuver, Sørensen, & Basole, 2017). As indicated by the concept of the multi-sided platform, many different types of actors are connected to the platform. Examining their roles and relations is necessary to better understand the development of a platform. The concept of the business ecosystem is used to gain insights.

The term of the business ecosystem was initially introduced by Moore (1993). Enlightened by the biological ecosystem, Moore (1993) believe that a company should not be viewed as a member of a single industry, but as a part of a business ecosystem that crosses a variety of industries. The introduce of the business ecosystem contributes to the understanding of the business network by considering a company as an interconnected part of its larger environment. In such a business ecosystem, companies work cooperatively and competitively to support new products, satisfy customer needs, and innovations (Moore, 1993).

Iansiti & Levien (2004) develop the concept of business ecosystem further with the definition "*business ecosystem is formed by large, loosely connected networks of entities, that interact with each other in complex ways, and the health and performance of a firm are depended on the health and performance of the whole.*" The definition mainly stresses the interconnectedness of the companies and the fact that they depended on each other for their success and survival. As thus, the company's competitiveness does not only depend on its internal competence but also on its capability to interact with its environment.

Furthermore, learning from the roles found in biological ecosystems, Iansiti & Levien (2004) identify three generic roles in the business ecosystems which are keystone, dominator and niche

player. Each role represents a strategy that a company can take in the ecosystem which is briefly explained below.

- **Keystone:** It serves as a hub in the ecosystem. The main responsibility of a keystone is to generate benefits to the entire ecosystem by increasing the diversity, stability and productivity of the ecosystem. There are several ways that can be used to achieve it, such as facilitate the niche creation by offering new technologies or investing in the fundamental infrastructure. Moreover, it maximises the health of the ecosystem by eliminating those firms which produce the negative effects to the ecosystem. In other words, keystones aim to create benefits to the ecosystem as a whole rather than to every individual firm. Despite that keystones play a positive role in the ecosystem, they do not occupy a large number of nodes in the ecosystem network.

- **Dominator:** It typically absorbs other firm's functions or directly eliminates others in the ecosystem. A dominator thereby is significantly larger than keystones. However, it can result in the decrease of the diversity and competition in the ecosystem network. As a dominator, in order to guard its future, it must continuously invest in internal R&D to develop the product or service which can fulfil the customers' needs to avoid the disruption of substitutes in the market. As thus, an ecosystem network which is led by a dominator is generally less tolerant to the disruptors because of the insufficient diversity.

- **Niche player:** Significant proportions of an ecosystem are niche players. They are firms that focus on specific technical capabilities that can be utilised to leverage the services provided by the keystones. As thus, they form around the keystones. In order to reduce its potential risk, a niche player needs to analyse its ecosystems and identify the characteristics of their keystones to select the right ecosystem. Having niche players within the ecosystem increases the health of an ecosystem as a whole.

Every individual company is constrained by its resources and capabilities. In order to mitigate its restrictions, the mobile payment platform provider can either take dominator or keystone strategy. The provider who takes dominator strategy intends to develop the resources and capabilities which it lacks internally to reduce its dependencies on others and hence have complete control over the mobile payment platform. As thus, it can capture more benefits from the mobile payment business, such as the transaction fee, transaction data, users' profile and users' ownership. However, it also means that the provider is likely to face significant upfront investment. While there is no guarantee that the provider can gain the resources and capabilities timely and successfully, especially in a dynamic and unpredictable environment. If disruptors emerge, the provider is likely to fail to get its investment back.

In contrast, the provider who employs keystone strategy inclines to cooperate with other firms to have access to the critical resources and capabilities rather than developing them internally. The cooperation enables the provider to accelerate the launch and the adoption of a mobile payment platform. In the case of the immature or unstable environment, by adopting keystone strategy, the

provider can better deal with the uncertainties. It has the support from various players and also can seek for new partnership. In order to achieve and maintain the cooperation, the provider has to create a win-win situation for all stakeholders involved. Depending on how the resources and capabilities are valued, the stakeholders receive the corresponding benefits. However, in practice, as different stakeholders value the resources and capabilities differently, it is not easy for them to reach an agreement, for instance on the division of the cost and benefits (both tangible and instantiable). Besides, different stakeholders have their own objectives and interests. It is difficult to make them work together towards a common goal. Consequently, the underlying conflicts create complexity and result in the collapse of the business ecosystem.

To analyse the strategies of the mobile payment platform providers, it is essential to identify the actors involved in the mobile payment ecosystem, determine their resources and benefits, and specify their roles and relations. Due to the limited research time and data, the scope of this study is limited to the key actors of the supply and demand sides of the mobile payment platform which are presented in figure 13.

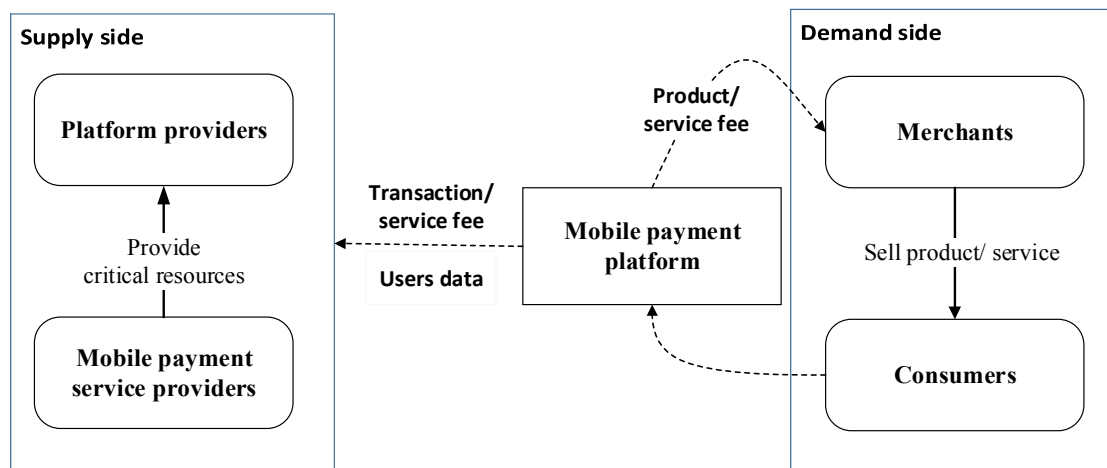


Figure 13: Mobile payment ecosystem

- **Platform providers:** They are the key actor at the supply side of the mobile payment platform. They govern the mobile payment platform and capture revenues via the mobile payment services or other value-added services offered on the platform. Depending on their interests and resources, they strategically involve the mobile payment service providers to realise the mobile payment function, and also merchants to enrich the mobile payment scenarios. In most cases, they possess the ownership of users.
- **Mobile payment service providers:** They are part of the supply side of the mobile payment platform. They support the platform provider to realise the mobile payment function, and in return, they obtain the commission fee and probably user' data. This study only discusses the actors who have access to the critical resources and capabilities, including a secure element, enabling device infrastructure (both POS terminals and mobile devices), third party payment license/banking

license, users' account system, payment network, and the transaction clearing system. Actors who develop or implement them, such as application developers, mobile payment solution vendors, SIM card suppliers, POS terminal suppliers, are excluded in this study. Whether they have the ownership of users or not depending on the critical resources that they control.

- **Merchants:** They are an important part of the demand side of the mobile payment platform. They sell products or services to the consumers and receive payments via a mobile payment platform (e.g. metro providers, retailers, taxi drivers). In some cases, for instance, public transportation, they may also play a function to provide the independent payment transaction system and infrastructure. Their main interests include increasing and sustaining consumers, reducing the operational cost. To achieve them, merchants may need to seek the guidance about consumers' habits and preferences or cooperate with the mobile payment providers to conduct promotions.

- **Consumers:** They are an essential part of the demand side of the mobile payment platform. They purchase products or services from merchants and conduct payments via a mobile payment platform. They are most likely to adopt a mobile payment platform which the perceived benefit outweighs the perceived cost.

4.4 Platform perspective research model

The position of a mobile payment technology in the market is determined by the collective success of the mobile payment platforms that adopt it. The above discussion of the STOF business model, the platform theories and the business ecosystem concept have yielded different types of insights on the critical issues to develop a successful mobile payment platform. Based on the understanding, a research model is developed and depicted in Figure 14. The proposed research model illustrates how important elements related to the platform are linked and function in the life cycle of a mobile payment platform. Regarding the financial related issues (e.g. investment, risks and revenue models, division of costs, service pricing, subsidy), they are discussed as part of each element (i.e. services, technology, ecosystems) in the research model.

In general, the life cycle of a mobile payment platform can be viewed as two main phases which are implementation and evolution. In the implementation phase, depending on the interests and the resources of the platform providers, they make the strategic choices of the technology and the technological solution to realise a mobile payment platform. The mobile payment platform might be built by the platform providers individually or cooperatively with other mobile payment service providers. The collaboration enables the platform providers to access to the resources from the external organisations and also share risks involved. In order to build up a good relationship with them, the platform providers need to create a "win-win" business model, in which each player has incentives (i.e. tangible and intangible benefits) to cooperate. The difficulty for platform providers to facilitate the adoption of their mobile payment platform is largely determined by the choices of the technological solution and the business model. Meanwhile, the introduce of a new technology

and the advancement of the technological solutions also leads to the changes of the positions and relations of the service providers in the mobile proximity payment ecosystem.

In the evolutionary stage, the mobile payment platform providers can strategically increase the competitiveness of their mobile payment platforms in the market. They work with merchants to develop new mobile payment scenarios and increase the reach of their mobile proximity payment services. Moreover, the mobile payment platform providers can influence the users' perceived value of a mobile payment platform using the various marketing strategies. The services on the platform can affect the position of the mobile payment providers in the market. In this stage, the mobile payment platform providers may also employ new technology to meet the market's needs. The specific critical issues are discussed from the following perspectives.

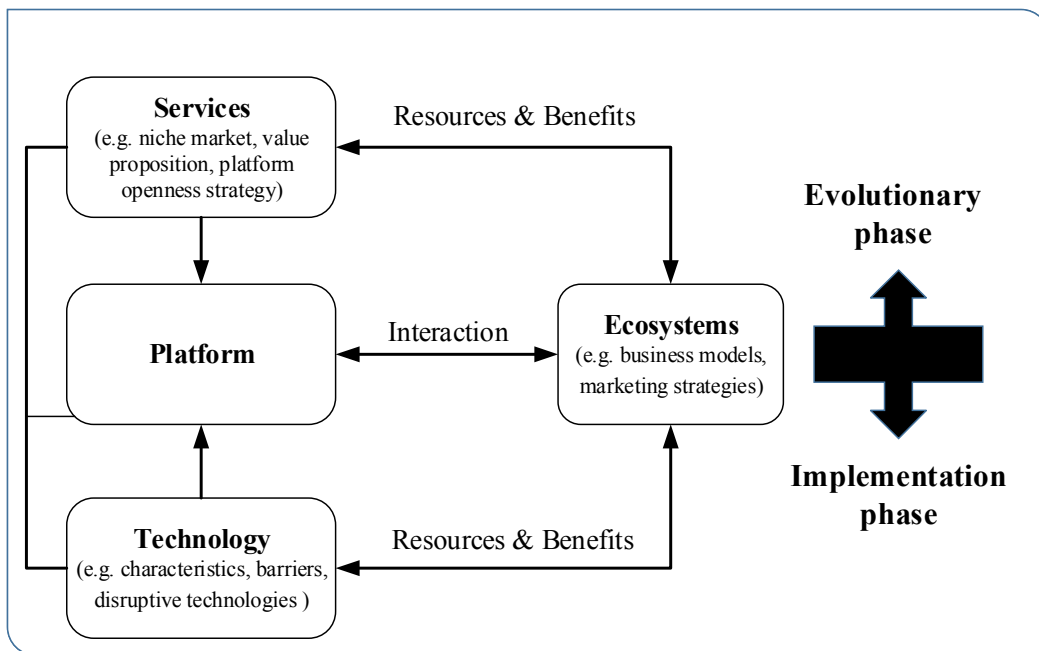


Figure 14: Platform multi-perspective research model for mobile payments

- Platform perspective:** Different angles of the platform concept are becoming increasingly relevant as a means to understand the success of a platform. The introduction of three different perspectives of the platform have linked the above elements to the platform concept and theories. It thereby can provide more comprehensive insights.

From the information system (IS) perspective, the platform is closely linked to the technology perspective. The platform itself can be seen as a part of the technology. The mobile payment platform providers can decide to build a new platform or make use of the existing platform as the foundation to realise the mobile payment technology. A series of decisions related to the technology largely determine the potential issues in the implementation of a mobile payment platform and also towards the mobile payment services provided on it.

From the innovation management perspective, the platform is linked to the service perspective. Various payment scenarios and other value-added services can be developed on a mobile payment platform by reusing the components of the platform. The innovation of the complements is strongly determined by the platform openness strategy taken by the mobile payment platform providers on the complementors.

From the economic perspective, the platform is associated with the ecosystem perspective. A mobile payment platform enables and also mediates the interactions between different groups of users which in return affects the fate of the mobile payment platform. The mobile payment platform providers can take appropriate marketing strategies and platform design strategies to mitigate the issues and thus facilitate the adoption of the mobile payment platform. Users' adoption of a mobile payment technology in return steers the development of the technology which may lead to its dominant position in the market.

- **Technology perspective:** It examines the characteristics (e.g. security, cost, performance, requirements of the infrastructure, interoperability) of different technologies and technological solutions in a given market, and the strategic actions that the platform providers took to overcome the weaknesses of the selected technological solution. Besides, it also analyses the impacts caused by the disruptive technologies and the advancement of the technological solutions on the platform providers' decisions and positions.
- **Platform Ecosystem:** It investigates the roles of different actors, the relations among them and the strategies (e.g. keystone, dominator) that the mobile payment platform providers take to develop a health mobile payment ecosystem. In the implementation stage, the analysis is mainly focused on the degree of interdependency and the collaboration issues between the mobile payment platform providers and other organisations. In the evolutionary stage, the crucial topics are the various strategies that the mobile payment platform providers use to solve the chicken-and-egg issue of the multi-sided platform, and how to attract new users (i.e. consumers and merchants) and retain existing users to achieve the economy of scale.
- **Platform Service:** It deals with the mobile payment platform provider's business strategies to create and maintain mutually beneficial relationships with users (i.e. consumers and merchants) by offering a relevant value proposition that fulfils their needs. The main topics include the strategies of selecting niche market in the initial stage and increasing the range and reach of services on the platform (e.g. make the platform interfaces openly available).

The proposed research model is used to guide the design of the interview questions with senior experts and managers in Chapter 5. Besides, the research model is applied to the analysis of three Chinese mobile payment platforms in Chapter 6. At last, a reflection on the proposed research model is presented in Chapter 7.

5 Research Methodology

Since the research objective of this study is to explain the contemporary competition result of the mobile proximity payment technologies in the Chinese market, the case study approach thereby is appropriate for this study. According to Yin (1993), the case study has the advantage to answer "how" and "why" questions where the study object is not under the control of the researcher. Moreover, the case study is suitable for this study as it has the strength to examine the cases in the real-life context (Yin, 1993). In this chapter, the methodological considerations related to the case study are discussed in detail. Section 5.1 focuses on the selection of the Chinese mobile payment platforms for the case study. And then the techniques used to collect data for the case study are described in section 5.2. Following the semi-structured interview procedures and questions are provided in section 5.3. At last, section 5.4 describes the procedures of the data analysis.

5.1 Case selection

Although the study object is the mobile proximity payment technology, it is implemented with a technological solution. Thereby, it is more appropriate to use the technological solution rather than the technology as the basis to select the mobile payment platform. After reviewing the Chinese mobile proximity payment history in Chapter 2, the mainstream technological solutions employed in the Chinese market to realise NFC and QR code technologies have been concluded which are SIM-centric SE, embedded SE, host card emulation, and QR code. Furthermore, a good overview of the popular mobile payment platforms and influential players in the Chinese mobile payment ecosystem are obtained as well. Based on these understandings, three Chinese mobile payment platforms have been chosen as the cases to study.

Table 5: Representative mobile payment platforms

<i>Mobile payment platform</i>	<i>Technological solution</i>	<i>Technology</i>	<i>Main stakeholders</i>
<i>He Wallet</i>	SIM-centric SE	NFC	China Mobile
<i>QuickPass</i>	Host Card Emulation & Embedded SE	NFC	China UnionPay, Apple, Samsung, Huawei, Xiaomi
<i>Alipay</i>	QR code	QR code	Alibaba

An overview of the selected mobile payment platforms is shown in Table 5. For the SIM-centric SE solution, He Wallet (original name "Mobile Wallet") launched by China Mobile was chosen for a twofold reason. Firstly, China Mobile is one of the main players who was involved in the Chinese mobile proximity payments in the early stage and continues to develop its mobile payment business

until today. Secondly, it has an influential position in the Chinese mobile proximity payment market as it is the largest mobile network operator in China. According to Statistic (2016), China Mobile had 828 million mobile subscribers of January 2016 which amounted to roughly 65% of the total number of mobile subscribers in China by that time.

Regarding the embedded SE and HCE solutions, QuickPass developed by China UnionPay was selected. China UnionPay has an important position in the Chinese payment market. As a bank card network, it operates the China's national inter-bank clearing and settlement system. It traditionally dominates Chinese card payment market with its payment network system and POS terminals. By integrating the HCE solution into its card payment platform (i.e. QuickPass), China UnionPay extended its payment business to the mobile proximity payments. As HCE solution can only serve Android/ Blackberry OS users, China UnionPay subsequently introduced Apple Pay, Samsung Pay, Huawei Pay and Xiaomi Pay to its platform to cater for more users. In general, they are the major embedded SE based mobile payment platforms in the Chinese market. From the mobile device manufacturers' perspective, they also need to rely on financial institutions to get access to the payment network and the POS terminals. The cooperation enables the users of these four embedded SE based mobile payment platforms to make mobile payments at any POS terminals with a QuickPass logo. For the sake of brand development, China UnionPay used its QuickPass to refer to these four platforms in the promotion. In other words, they are part of QuickPass family. China UnionPay has put many efforts to encourage users to use its QuickPass platform, including those four embedded SE based mobile payment platforms. Hence, QuickPass is a suitable mobile payment platform to represent the HCE and the embedded SE solutions.

For the QR code-based solution, Alipay was chosen because it has obtained a dominant position in the Chinese mobile proximity payment market since 2014. Moreover, it is also the first platform that introduced QR code technology into the Chinese mobile payment market. By studying these three cases, we aim at providing answers to the sub-question three.

5.2 Data collection

Semi-structured interviews were employed as the main technique to collect data for the case study since it is an effective way to get different angles on the contemporary phenomena in the Chinese mobile proximity payment market. Moreover, the interviews conducted with the Chinese technical managers and experts can be used to validate the data collected through the desk research in Chapter 3 so that more accurate answers can be provided to the sub-question two.

In general, the interviews can be divided into two categories which are technically-oriented interviews and business-oriented interviews. In addition to that, based on the desk research of the selected mobile payment platforms, some specific questions related to those platforms were also designed. The selection of interviewees has two different screening criteria. Regarding the technically-oriented interviews, managers and experts who have the right technical knowledge or participate in the implementation of the technical solutions were chosen. Regarding the business-

oriented interviews, managers who are in charge of or familiar with the business development or the marketing of the selected three mobile payment platforms (i.e. He Wallet, QuickPass, Alipay) were consulted. Although the author failed to get interviewees from Alibaba who are in charge of Alipay platform, the insights provided by the selected interviewees are valuable as most of them have more than ten years working experience in the payment industry. Besides, the interviewee U1 conducted some interviews with project managers from Alipay Wallet and product managers from banks in China for her research about the Alipay platform. Regarding QuickPass platform, before working in the mobile payment organisation 1, interviewee MP1-4 worked as a product manager in China UnionPay to be in charge of its mobile payment development. Besides, MP1-4 is currently working on the mobile payment projects with China UnionPay and banks. As thus, the interviews in this study are considered valid and reliable. All interviewees were found through the author's friends, former colleagues, the network connection of the supervisors, and social medias (e.g. LinkedIn). The background and details of the interviewees are presented in Table 6.

Table 6: Overview of interviewees

<i>Code</i>	<i>Organisation</i>	<i>Title/ Role</i>	<i>Time</i>
<i>MP1-1</i>	Mobile payment organisation 1-Subject 1	FI Division Senior Operation Manager	4 th July 21 st July
<i>MP1-2</i>	Mobile payment organisation 1-Subject 2	SIM Division Technical Marketing Support Leader	5 th July
<i>MP2</i>	Mobile payment organisation 2	Sales Manager	5 th July
<i>MP3</i>	Mobile payment organisation 3	FI Division Senior Technical Engineer	6 th July
<i>MP1-3</i>	Mobile payment organisation 1-Subject 3	SIM Division Technical Marketing Support Leader	8 th July
<i>MP4</i>	Mobile payment organisation 4	Pre-sales Manager	8 th July
<i>MNO1</i>	China Mobile	Senior Technical Leader	9 th July
<i>U1</i>	University	Doctoral researcher on Chinese mobile payments	9 th July
<i>MP5</i>	Mobile payment organisation 5	Principal Consultant	14 th July
<i>MP1-4</i>	Mobile payment organisation 1-Subject 4	General Manager	15 th July

Interviews were mainly conducted via telephone (i.e. WeChat) since the interviewees and the author are in different countries. Only the interview with MP5 was conducted face to face as the interviewee is a consultant who is familiar with Chinese mobile payment market, but located in the Netherlands. All interviews were conducted within the time range of 4th July until 21st July. The interviews lasted from 30 minutes to 2 hours maximum.

Before each interview, the author examined the interview questions and made minor changes based on the background of the interviewees. All interviews were conducted in Chinese. The interviews

were audio recorded after getting the permission of the interviewees. During each interview, the author took notes of comments from the interviewee. In the event that the author was not allowed to record the interview, the summary of the interview was sent to the interviewee to be checked for consistency. In order to triangulate the interview data, multiple additional data sources (e.g. company websites, industry articles and press releases) were searched to validate the comments from the interviewees after the interviews.

5.3 Interview procedure & questions

The interview consists of following three steps:

- **Introduction of the interview:** a short welcome and a brief explanation of the research is given to make the interviewees in order to make them feel comfortable and confident. Additionally, the interviewee is asked for the permission to record the interview for data collection purpose.
- **Mid-course of the interview:** it was dominated by the pre-defined interview questions in Table 7. During the course of the interview, the order of the questions can be changed if the interviewees initiate other topics in the question list. New questions can also be added if they are relevant to this study. The question in the list can be skipped if the interviewees are lack of the corresponding knowledge or feel not comfortable to share their opinions.
- **End of the interview:** the interviewees are asked if they have any other comments to add to the research topic. Besides, it is the opportunity to express gratitude to the interviewees.

In the previous chapter, a good understanding about the development of a mobile payment platform has been obtained from the theoretical perspective. As its development can be viewed into two phases which are performed by different teams in the firms, the semi-structured interviews are thereby organised into two categories, plus the specific questions related to the chosen mobile payment platforms. The questions for the semi-structured interviews are formulated in accordance with the research objective and the proposed research model.

Part 1: Technically-oriented interviews (platform technology)

<i>ID</i>	<i>Questions</i>	<i>Categories</i>
1	From your point of view, what are the main reasons that providers decided to choose the corresponding technological solution for mobile payments?	Provider perspective
2	What do you see the main obstacles (e.g. security, cost, performance, interoperability, the availability of enabling devices) to implement a specific mobile payment solution in China? And are there any measures that the mobile payment platform providers took to mitigate the issues?	Technology characteristics

3	What do you think of the main barriers (e.g. enabling device, trust, ease of use) that the end-users (i.e. consumers and merchants) face towards such a mobile payment platform in China? Also, are there any measures that the mobile payment platform providers took to mitigate the issues?	Users perspective
4	In your opinion, what are the impacts of the cloud-based solutions (e.g. HCE, QR code) on the Chinese mobile payment market?	Impacts of new technologies

Part 2: Business-oriented interviews

Platform ecosystem

<i>ID</i>	<i>Questions</i>	<i>Categories</i>
1	In your opinion, what are the main interests and resources of the mobile payment platform providers?	Business model
2	Can you identify the actors involved in the establishment of the mobile payment platform and their roles?	Business model
3	What do you see the problems of the business model (independent or collaborative) adopted by the mobile payment platform?	Business model
4	What do you see actions that the mobile payment platform provider overcame the chicken-and-egg problem?	Chicken-and-egg
5	What do you see the actions that the mobile payment platform providers took to increase the number of consumers and retain existing consumers?	Marketing strategies
6	What do you see the actions that the mobile payment platform providers took to attract merchants?	Marketing strategies

Platform service

<i>ID</i>	<i>Questions</i>	<i>Categories</i>
1	In your opinion, what are the niche markets that the mobile payment platform providers targeted in the initial stage? Explain why.	Niche market selection
2	What do you see the value and the characteristics of the services on the mobile payment platform?	Value proposition
3	What do you see the actions that the mobile payment platform providers took to enrich the mobile payment scenarios on its platform?	Platform openness

Part 3: Specific questions related to the mobile payment platforms

<i>ID</i>	<i>Questions</i>	<i>Categories</i>
1	In June 2006, China Mobile conducted NFC-based mobile payment trial by cooperating with Nokia at Xiamen City. However, China Mobile launched its Mobile Wallet until August 2010. From your perspective, why did China Mobile roll out its mobile payment platform four years later?	He Wallet
2	From your perspective, what are the reasons that China Mobile chose RF SIM (2.4GHz) solution instead of NFC technology for its Mobile Wallet in 2010?	He Wallet

3	In your opinion, what are the reasons that China Mobile decided to give up RF SIM solution and turn to use NFC SIM-centric SE (more specifically, NFC-SWP) solution in 2012?	He Wallet
4	In June 2013, China Mobile cooperated with China UnionPay to facilitate the development of Mobile Wallet. What do you think of the relationship change between China Mobile and China UnionPay?	He Wallet
5	From your point of view, why did He Wallet fail to achieve a dominant position in the Chinese market?	He Wallet
6	HCE solution is available since 2012, why did China UnionPay implement HCE solution on its QuickPass platform until the end of 2015? Before that what was the plan of China UnionPay on mobile proximity payments?	QuickPass
7	What do you see the relationship between China UnionPay and MNOs?	QuickPass
8	In HCE solution allows China UnionPay to not rely on other players, why did it still subsequently introduce other pays (e.g. Apple Pay, Samsung Pay) into its platform?	QuickPass
10	What do you see the actions that Alipay took to overcome the security concerns of QR code technology?	Alipay
11	What do you see the actions that Alipay took to overcome the inconvenience of QR code technology?	Alipay
12	From your point of view, why AliPay can achieve a dominant position in the Chinese mobile payment market?	Alipay

5.4 Data analysis

After each interview took place, the author listened to the audio record and made a summary of the interview. For critical viewpoints, they were transcribed word by word. The summary was cross-checked by the author with the quick notes taken in the interview to avoid the loss of valuable information. Regarding any comments which were not clear, the corresponding interviewee was contacted again for additional questions.

After all the interviews were completed and summarised, the author performed a directed content analysis by coding and categorising the unstructured data. As all interviews were held in Chinese, the preliminary classification results of those interviews were translated into English by the author before the in-depth analysis. The results of the interviews are attached in the appendix.

After translation, the author interpreted the findings in accordance with the proposed research model. When different interviewees have the conflicting viewpoints on the same topic, other data sources as well as the background of interviewees were taken into account to resolve the conflict. The results of the interviews are discussed and presented in the next Chapter.

6 Case Study

In order to thoroughly understand the strategic actions of mobile payment providers on developing their platforms and also test the proposed research model, a case study has been conducted on three Chinese mobile payment platforms (i.e. He Wallet, Alipay, QuickPass), led by MNOs, TPPs and financial institutions respectively. They have implemented one or several technological solutions based on NFC and QR code technologies. The information for the case studies is collected from the semi-structured interviews, company websites and online news coverage. Each case study consists of the case description and the case analysis. Regarding the case analysis, it is performed from the three perspectives developed in the research model which are platform technology, platform ecosystems and platform services. At last, a cross-analysis of three platforms is conducted.

6.1 He Wallet

6.1.1 Case description

China Mobile is one of the players involved in the early development of mobile proximity payments in China. It has explored the Chinese mobile proximity payment market since 2006 by supporting Nokia and Xiamen E-Tong Card company to conduct the first mobile payment trial in China. In the same year, China Mobile established an e-commerce product innovation base in Changsha city, Hunan province and assigned Hunan Branch (i.e. Hunan Mobile) to be mainly in charge of it (China Mobile, 2011). The main responsibilities of Hunan Mobile include building the platform of the mobile payment wallet, developing the related products and running the business operations of mobile wallet services.

In August 2010, China Mobile launched its Mobile Wallet platform (renamed as He Wallet in 2013) based on RF SIM solution which operates at 2.4GHz (China Mobile, 2010). In order to use the Mobile Wallet, the users were required to register a new mobile payment account from China Mobile and replace their SIM card with a RFID SIM card at China Mobile's stores. After that, users can make mobile remote payments (e.g. shopping online, paying the cell phone bills) and conduct mobile proximity payments at the POS terminals deployed by China Mobile. In contrast, its two longtime rivals China Unicom and China Telecom chose SWP-SIM and SIM-PASS respectively, which are two different technological solutions based on the NFC. However, in 2012, China Mobile stated to support NFC publicly.

In June 2012, China Mobile signed an NFC collaboration deal with China UnionPay to lead to the introduction of NFC services in up to a hundred Chinese cities (Clark, 2012a). In December 2012, China Mobile demoed its NFC platform for the first time at its Worldwide Developers Conference (China Mobile, 2013; Handford, 2012). In the same month, China Mobile signed a memorandum of understanding (MoU) with Orange, a France-based MNO, with the aim of accelerating the

commercialisation of the mobile proximity payment services by integrating the SIM-based standardised technical protocols (i.e. SWP) into their services (Clark, 2012b). Eventually, in June 2013, China Mobile and China UnionPay launched their NFC payment services based on the SWP-SIM solution in more than fourteen Chinese cities (Boden, 2013). Meanwhile, eight banks in China have signed up to make use of He Wallet for their mobile payment services (Boden, 2013). On 19 December 2013, China Mobile renamed its Mobile Wallet platform as He Wallet (Sina, 2013). It was just one day before that China Mobile launched its 4G mobile business with its new brand “He”, which means “harmonious” in Chinese (Shen, 2013). Thereby, the rename action was interpreted to facilitate the development of China Mobile's new brand “He”. In the Mobile World Congress Shanghai (MWCS) 2016, China Mobile announced its new plan to expand its NFC-based mobile payment services to cover the public transportation in a hundred cities and all-in-one card services in a hundred schools or companies (Iotworld, 2016).

Regarding the payment license, initially, China Mobile acquired a 20% stake in Shanghai Pudong Development Bank in March 2010 to bypass the licensing restrictions imposed by the procedures regulations on the non-financial institutions (Miao & Jayakar, 2016). However, in June 2010, the Central Bank of China announced that the non-financial payment firms have to get the Third-Party Payment Licenses before September 2011 and be supervised (Sina, 2011). In response, China Mobile established its e-commerce company in June 2011 and acquired the Third-Party Payment License in December 2011 (China Mobile, 2017). An overview of the important events of He Wallet is presented in Table 7.

Table 7: Important events of He Wallet

<i>Time</i>	<i>Event</i>
2006	Conducted the first NFC-base mobile proximity payment trial with Nokia and Xiamen E-Tong Card company
2006	Established an e-commerce product innovation base in Changsha city
March 2010	Acquired a 20% stake in Shanghai Pudong Development Bank
August 2010	Launched its Mobile Wallet platform based on RF SIM solution
December 2011	Acquired its Third-Party Payment Licenses
June 2012	Signed an NFC collaboration deal with China UnionPay
December 2012	Demoed its NFC-based mobile payment platform for the first time at Worldwide Developers Conference
June 2013	Cooperated with China UnionPay and launched its NFC payment services in more than fourteen Chinese cities
December 2013	Launched its 4G mobile business with its new brand “He”
December 2013	Renamed its Mobile Wallet as He Wallet
June 2016	Announced its new plan to expand its NFC-based mobile payment services in the MWCS 2016

6.1.2 Platform technology analysis

From the case description above, it can be seen that China Mobile spent several years in exploring alternative technological solutions for mobile proximity payments and then chose RF SIM as its primary solution in the initial stage. Inferred from the insights provided by the interviewees [MP1-1, MP1-3, MNO1, MP5, MP1-4], lacking of NFC-enabled mobile devices and NFC-enabled POS terminals in the Chinese market are the two main reasons that made China Mobile choose RF technology rather than NFC technology at that time. At the late of the 2000s, it was the beginning stage of the Chinese market to popularise the smart mobile devices. Very few Chinese people have an NFC-enabled mobile device. Meanwhile, a small number of NFC-enabled POS terminals were available in China at that time. According to the Europay, MasterCard and Visa (EMV)¹ migration schedule in China, acquiring organisations (mainly financial institutions and third-party firms) started the upgrade of the current ATM and POS terminals in 2009 and were required to complete it before the end of 2012. It means both consumers and merchants face high adoption cost which is most likely to restrict the adoption of He Wallet in China.

However, as other MNOs and financial intuitions chose NFC technology at that time, China Mobile had no other options but to form its closed payment system and deployed the exclusive RF SIM POS terminals throughout the nation by itself. The advantages are that China Mobile can capture the transaction fees and obtain the ownership of users. However, there is a large gap between investment and profit. Interviewee [MP1-4] commented that *“the deployment of RF SIM POS terminals is a pain point for China Mobile without the support from other MNOs and financial intuitions. China Mobile has significantly underestimated the relevant cost and overestimated the adoption speed of the mobile payment platform”*. Another reason that motivated China Mobile to adopt NFC technology is that it gained the support from the Central Bank of China and government. It is a rule that every new POS terminal sold in China has to be equipped with NFC functionality.

In the early of 2010s, two NFC technological solutions based on the SIM card were popular in the Chinese market. One is the SWP-SIM solution chosen by China Unicom and another one is the SIMpass solution, an all-in-one NFC SIM solution (see Figure 14), supported by China Telecom. China Mobile has conducted experiments on both solutions before choosing SWP-SIM solution.

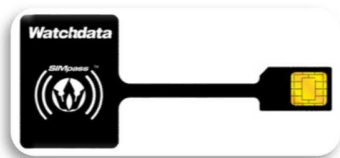


Figure 15: SIMpass (Sohu, 2011)

According to the interviewee [MNO1], who is working at the Research Institute of China Mobile, *“despite that China Mobile prefers to implement the NFC-based mobile payments purely with the SIM card, SIMpass solution has several serious weaknesses, such as not workable on the mobile*

¹ EMV is a technical standard for smart payment cards and for payment terminals and automated teller machines (ATMs) that can accept them (from wikipedia)

devices if its back cover cannot open, SIMpass card itself is fragile, poor user experience caused by the low anti-interference ability, especially when the back cover of the mobile device is metal". In addition to that, the interviewee [MNO1] pointed out that "the SWP-SIM solution is an internationally recognised standard solution. It was another important reason that has motivated China Mobile to adopt the SWP-SIM solution rather than SIMpass". In the long run, it would be easier for China Mobile to develop a harmonised ecosystem based on a standard solution.

However, in the implementation of the SWP-SIM solution, China Mobile faced many obstacles. Table 8 presents an overview of the barriers highlighted by the interviewees. A huge challenge that China Mobile faced is various types of upfront investments. Firstly, the cost of SWP-SIM card is much higher than that of the standard SIM card. According to the interviewee [MNO1], "a regular 4G SIM card only costs less than one RMB while an SWP 4G SIM card costs several RMB". To reduce consumers' adoption cost, China Mobile covered the fee of the SWP SIM cards. Secondly, China Mobile undertook the cost of the compatibility test between the SIM card and the mobile device. As discussed in section 3.2.1, SWP-based mobile devices do not guarantee it can function well with the SIM card. The compatibility test is required to ensure good user experience. Lastly, China Mobile faced the cost of increasing the certified mobile devices. To encourage the production of the certified SWP-based mobile devices, it gave subsidies to the mobile device manufacturers. Besides, China Mobile provided a special offer to users for buying a SWP-based mobile device.

Table 8: Obstacles towards the SWP-SIM solution

No.	Obstacle	Interviewees
1	High cost of SWP SIM card	MP1-1,MNO1,MP5
2	Time-consuming & costly compatibility test	MP1-1, MP1-2,MP2, MNO1
3	The availability of enabling devices	MP1-1, MP2, MP4, MP1-3, MNO1, MP4, MP5
4	Inferior user experience because of the non-standard POS terminals	MP1-2, MP2, MP1-3

In addition to the high upfront investments, another challenge is the availability of the enabling devices. Unlike the RF SIM solution, having a mobile device certified by China Mobile is the pre-requisition for consumers to use He Wallet. Besides of complying with the SWP specification, there is a requirement on the mobile OS as well. According to the interviewee [MP5], "mobile OS is required to include Open Mobile APIs to realise SIM-centric SE solution. If they are removed from the mobile OS by the mobile device manufacturers, the SIM card cannot communicate with the mobile App to realise the functions such as checking the balance. While Open Mobile APIs are optional in the Android OS". In reality, only limited types of mobile devices have been certified by China Mobile. According to interviewee [MP-4], "only 55 types of mobile devices currently have been qualified by China Mobile. Compared with more than 1500 types of mobile devices in the Chinese market, the number of choices is considered very limited". The limited types of certified SWP-based mobile devices hindered consumers' adoption of He Wallet. Moreover, the availability of NFC-enabled POS terminals is also a serious issue in the Chinese market. Although the existing

POS terminals have been upgraded with NFC functionality because of the Chinese EMV migration, NFC-enabled POS terminals are still not widely available in China. It significantly restricted the development of He Wallet.

Furthermore, China Mobile faced another problem caused by the non-standard POS terminals in the Chinese market. It is not an issue with the POS terminals certified by China UnionPay. However, in the cases such as public transportation, various types of POS terminals which may not fully comply with the NFC standards have been used to fulfil their own needs. To reduce the possibility of the inferior user experience, a compatibility test between the mobile device and the POS terminals is essential. However, it is a time-consuming and costly process for both China Mobile and merchants. It can be seen that the weaknesses of the SWP-SIM solution created considerable challenges to China Mobile in various aspects (e.g. upfront investment, targeted users, user experience). Besides, the emergence of HCE and embedded SE solutions in China further diminished the popularity of the SWP-SIM solution in the Chinese market. Although China Mobile and other MNOs have put many efforts, they still failed to steer the wide adoption of SIM-centric NFC solution in China before the emergence of disruptive technological solutions.

6.1.3 Platform ecosystems analysis

In the beginning, China Mobile employed MNO-centric mode to develop the mobile payment business. In 2010, China Mobile has already possessed most critical resources required to develop mobile proximity payments. First of all, it has the full control over the SIM card which can be served as the secure element. Moreover, China Mobile has built its transaction system and acquired the required license for clearing both the Internet and mobile payment transactions. In addition, China Mobile obtained the license to operate both issuing (limited to a pre-paid payment account) and acquiring businesses. Last but not the least, China Mobile has a large customer base in China. As thus, China Mobile theoretically can run the mobile payment business independently. China Mobile indeed attempted to offer the mobile payment services independently with RF SIM solution at the beginning. However, in reality, it is a costly and time-consuming process to deploy exclusive POS terminals and develop users' habit. As other MNOs and financial intuitions chose NFC, China Mobile has to bear the huge upfront investment alone and unlikely get its investment back in a short period. Thereby, in 2013, China Mobile adopted NFC technology and also adjusted the business mobile to the collaborative mode.

The ecosystem of He Wallet based on the SWP-SIM solution for financial mobile payment services is depicted in figure 16. It can be seen that the ecosystem includes China UnionPay, the acquiring organisations, the issuing banks, merchants, consumers and China Mobile. In this ecosystem, the critical resources contributed by China Mobile are the secure element (i.e. SIM card), its mobile payment platform and large customer base. As mentioned in the case description, China Mobile built a connection between its TSM and the TSM of China UnionPay in June 2013. The issuing banks thereby can distribute their financial applications into the secure element (i.e. the SIM card) and manage relevant data through the TSM of China UnionPay. Despite going through China UnionPay increased the length of the value chain, China Mobile can target all issuing banks in

China as all banks in China established a connection with China UnionPay. This business model enables China Mobile to receive the service fee from the issuing banks by using its secure element and TSM. Besides, China Mobile can charge advertisers (i.e. the issuing banks or merchants) to access to its loyal users via He Wallet platform.

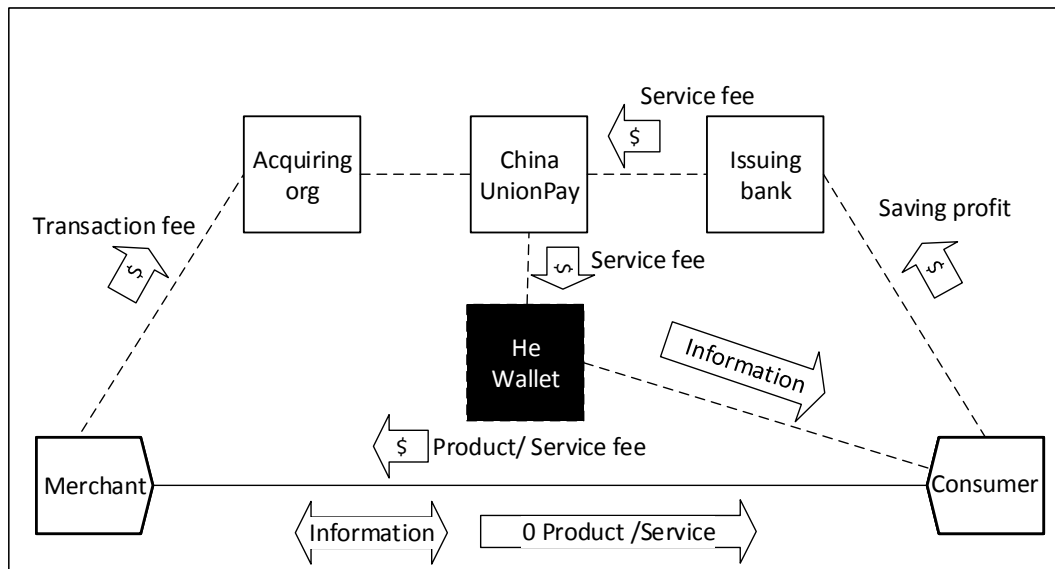


Figure 16: Ecosystem of He Wallet for financial services

The collaboration among different stakeholders was easily achieved as they (i.e. China UnionPay, the acquiring organisations, the issuing banks) can maintain their traditional roles and benefits as in card payment business. They share the transaction fee charged to the merchants by handling the mobile payment transactions. Also, the acquiring organisations and the issuing banks can obtain the ownership of merchants and consumers, respectively. Hence, there is no conflict between China Mobile and them. For non-financial mobile payment services (e.g. public transportation), China Mobile needs to build a connection between its TSM and the TSM of the corresponding non-financial service providers. The role and the benefits of China Mobile remain the same. The non-financial service providers replace the financial institutions to provide the payment applications and the transaction clearing system.

It can be seen that the direct customer of China Mobile in this ecosystem is the payment application providers (e.g. the issuing banks). As the payment application providers aim to increase the number and the stickiness of users via the mobile payment services, China Mobile also has to attract more consumers to use He Wallet. Despite the fact that China Mobile has a huge customer base, they are not real users of He Wallet. Being the member of China Mobile is only the first condition to use He Wallet. Users still have to complete other steps which include register a mobile payment account, install He Wallet App and download payment applications. China Mobile attempted to realise the conversion through offering a certain amount of free phone bill or cash coupon to its customers. The promotions were often conducted together with the payment application providers (e.g. the issuing banks) to encourage consumers to install and use a specific payment application. However,

several interviewees mentioned that *"the promotion activities conducted by China Mobile are considered small and simple. They are not appealing to consumers compared with the one provided by its competitors, especially TPPs. China Mobile was too eager to get its investment back in a short period rather than acquiring user resource"*. Many China Mobile customers, especially those who do not have a certified NFC-enabled mobile device, thereby are not motivated to adopt He Wallet. Moreover, China Mobile failed to take creative approaches to develop users' habit of using He Wallet. For a long time, China Mobile focused on the development of mobile payment products rather than the true needs of users. The interviewee [MP1-1] commented that *"China Mobile thought its members would use He Wallet if it could be used to conduct payments in many situations. It is not exactly true. In the competitive market, increasing the number of users and user stickiness are the keys. He Wallet needs the creative mechanisms or services to lock users"*.

Whether consumers use He Wallet highly depends on the acceptance of He Wallet at merchants. In order to generate the cross-side network effects, China Mobile has to get merchants on board as well. China Mobile took two strategies to increase the acceptance of He Wallet on the merchant side. For the merchants that have integrated into the four-corner payment system, China Mobile chose to cooperate with China UnionPay. The collaboration enables China Mobile to gain access to China UnionPay's payment network and also huge resources of the NFC-enabled POS terminals. It significantly accelerated the acceptance of He Wallet without making massive investments. However, in the four-corner payment model, the acquiring organisations play a role in exploring and convincing merchants to install the NFC-enabled terminals. They capture the transaction fee from merchants and have the ownership of merchants rather than China Mobile. Thereby, China Mobile was less motivated to invest on the merchants. Since merchants do not receive the benefits from China Mobile, they are not motivated to proactively ask consumers to use He Wallet in the checkout process. As thus, He Wallet is used only when consumers require to use it.

For the merchants using the closed payment model (e.g. transport operators, schools, hospitals), China Mobile took the initiative to engage with them by using its social resources and offering subsidies to merchants. However, He Wallet is only an alternative since those merchants normally support card payments. Besides, China Mobile cannot get the ownership of consumers. It has less incentive to offer attractive subsidies. Also, there is the compatibility issue between the mobile device and the non-standard POS terminals. Hence, it often takes time for China Mobile to reach an agreement with every individual merchant in terms of the integration plan, the division of the cost, service pricing, etc. Consequently, the diffusion of He Wallet is slow. It can be seen that lacking the control over the critical resources, the ownership of users and user-centric innovations, focusing on the short-term interest resulted in a limited-scale of He Wallet.

6.1.4 Platform services analysis

China Mobile set clear directions for the development of its proximity payment services in the initial stage. It targeted the public transportation and all-in-one card for schools and companies in the major cities. Those are the places where the contactless card is the primary instrument and micro-payments are conducted. This strategic decision has several advantages. First of all, it is

likely that China Mobile can achieve the critical mass and get the investment back soon because those merchants have a large number of users and daily transactions. Secondly, since NFC-enabled POS terminals most likely have been installed at those places, it can help China Mobile save the cost of subsidising the NFC-enabled POS terminals and also speed up the project. Thirdly, it would not be so hard for China Mobile to develop users' habit of using mobile wallet since they have already got used to tapping cards. Lastly, China Mobile can get the ownership of merchants. However, in reality, the markets of the public transportation and all-in-one card for schools and companies vary greatly from region to region in China. Thereby, China Mobile has adopted a decentralised management model. China Mobile allows its branches to customise the payment scenarios based on the local situation and their resources. Hunan Mobile Branch only provides technical support and shares experiences with provincial operating branches. As a result, the mobile payment services on He Wallet are primarily regional and limited. The multi-homing problem occurs due to lack of national payment scenarios.

Moreover, China Mobile took several measures to encourage the development of payment services on its platform. First, it made its platform tools and APIs openly available on its website to enable the innovators to develop complementary services. Second, China Mobile held the national public innovation competition in 2013 to spark new ideas. Yet, it seems not arouse significant influence. As besides of its website, the author could not find other data source about it.

Furthermore, China Mobile has developed various contactless payment scenarios, but few go beyond that. Interviewee [MNO1] commented that "*China Mobile did not have creative value-added services to generate extra profits and also maintain users' loyalty*". A major reason is that China Mobile is lacking of the ownership of users and hence users' profile and behaviour data. Thereby, it is not easy to develop value-added services. The limited profits from payment business could not make up the investments that China Mobile has made on promotions and reducing users' adoption cost. As a result, China Mobile has a small incentive to continue to invest. Thereby it became even cautious of investment in the later stage which led to the slow adoption of its platform.

Last, two interviewees [MNO1, MP1-4] pinpointed that China Mobile shifted its focus from the application development (e.g. mobile payments) to data development between 2014 and 2016 to seek for greater profits. China Mobile launched its new 4G business at the end of 2013. The 4G data service generated huge profits to China Mobile compared with its mobile payment services which resulted in the slack on its mobile payment business. It made China Mobile lose its best opportunity to acquire its merchant resources and develop users' habits. In contrast, the period between 2014-2016 is the rapid development period of QR code-based mobile payment platforms (e.g. Alipay) which will be discussed in detail in next section.

6.2 Alipay

6.2.1 Case description

Alipay was established by Alibaba Group in April 2004 (Wang & Chou, 2012). At that time, it was a purely Internet-based payment platform and mainly used to support the online payment services of Taobao. Taobao is a consumer-to-consumer (C2C) e-commerce platform which was founded by Alibaba Group in May 2003 (Kapron & Meertens, 2017). The relationship between Taobao and Alipay is similar to that between eBay and Paypal. In April 2008, Alibaba Group launched another e-commerce platform which is Taobao Mall (Tmall), a business-to-consumer (B2C) site (Kapron & Meertens, 2017). Both Taobao and Tmall quickly became China's largest e-commerce sites (Kapron & Meertens, 2017). It is important to emphasise that users are required to have an Alipay account and link it with a bank account in order to make purchases or operate a retail business on Taobao or Tmall. Alipay thereby accumulated a large number of “ready users” for its mobile payments through Taobao and Tmall. In the late of 2000s, Chinese mobile network operators started the development of the 3G network. Some companies, including Alibaba, strategically migrated their online payment function to the mobile devices. In 2009, Alibaba launched the mobile version of Alipay (Kapron & Meertens, 2017). To encourage its members to use Alipay App, Alibaba offered discounts to members if they pay for their orders through Alipay App.

In May 2011, Alibaba received a license from the Central Bank of China to operate an electronic payment system in the country which allows it to handle foreign exchange transactions, Internet payments, mobile payments and debit card services (Huang & Soh, 2011). In order to explore Chinese mobile proximity payment market, Alibaba integrated QR code solution into its Alipay platform in 2011 (Wang & Chou, 2012). Soon after that, Alipay gained a dominant position in the mobile payment market. According to iResearch (2014), Alipay accounted for 82.6% of the third-party mobile payment market in the Q3 2014. With the entry of other companies, especially WeChat Pay, the competition has become more intense. In 2014, Alibaba extended its Double 12 Shopping Day promotion to many physical stores to compete for the mobile proximity payment market (Fu, 2014). Table 9 provides an overview of the important events of Alipay.

Table 9: Important events of Alipay

<i>Time</i>	<i>Event</i>
May 2003	Launched Taobao e-commerce platform
April 2004	Established Alipay online payment platform
April 2008	Launched Tmall e-commerce platform
2009	Developed the mobile version of Alipay
May 2011	Acquired its Third-Party Payment Licenses
2011	Integrated QR code solution into Alipay platform
December 2014	Extended the Double 12 Shopping Day to the mobile proximity payments

6.2.2 Platform technology analysis

Unlike MNOs and financial institutions, Alibaba chose to use QR code technology to realise its mobile proximity payment services. Alibaba placed a higher value on the availability of enabling mobile device and the users' adoption cost instead of putting the security first when selecting the technology. As discussed in Chapter 3, QR code solution has no particular requirement on user's device compared to NFC-based solutions. Almost all smartphones can scan a QR code with the device camera or display a QR code on the device screen. Interviewees [MP1-1, MP4] pinpointed that *"the quick adoption of the smartphones and the rapid development of the 3G network in the Chinese market in the early of 2010s had prepared the way for the development of QR code-based mobile payments while Alibaba recognised the opportunity by being first to introduce QR code to the Chinese mobile proximity payment market"*. Another benefit that interviewees [MP1-1, MP1-2, MP4, MP5, MP1-4] emphasised is that it ensures interoperability among different brands of smartphones. By simply implementing QR code, Alipay can serve almost all smartphones in the market. Moreover, Alibaba chose to integrate QR code into its existing Alipay platform to make use of its installed customer base which significantly reduced the difficulty to take off.

However, Alipay also has to deal with two major weaknesses of QR code which are security and inconvenience. Regarding the security issues, Alipay has taken several measures to mitigate users' concerns. Firstly, Alipay committed to being responsible for any losses users sustain. Secondly, Alipay introduced passive scanning mode in 2014 to tackle the edict issued by the Central Bank of China, calling for the stop of the e-payments made via QR codes. Passive scanning mode can reduce the possibilities of scanning the malicious QR codes. Interviewee [MP1-2] pointed out that *"in fact, QR code-based mobile payments are relatively safe when both consumers and cashiers present in the payment transactions. Fraud or malicious manipulation normally occurs with the unsupervised QR codes in public, such as the vending machine"*. Thirdly, Alipay minimised the security risks by applying various techniques, such as tokenization, dynamic QR code, big data analytics. These measures have substantially improved the security level of Alipay and reduced users' concerns.

With respect to inconvenience, interviewees [MP1-1, MP1-2, MP3, MP1-3, U1] emphasised that *"it consists of two aspects which are ease of use and usefulness. Although consumers have to take several steps to make payments with QR code, the wide acceptance of Alipay among the merchants provides great convenience to consumers"*. Alipay made it real that consumers can leave home without their physical wallet. Alipay has been proved very useful in the daily life. Moreover, after practising several times, consumers will get used to the steps of the QR code-based mobile payments which can dramatically lighten the perceived inconvenience. Hence, the inconvenience of QR code technology has not become an issue to prevent users from using Alipay. In general, it can be found that Alipay has well leveraged the strengths of QR code solution and overcome its weaknesses.

6.2.3 Platform ecosystems analysis

It is found that Alipay adopted the independent service provider mode for its mobile proximity payment business which is the same with that of its remote payment business. As shown in figure 17, the ecosystem of Alipay mainly consists of merchants, consumers and Alipay. The acquiring banks and the issuing banks are only involved when merchants and consumers transfer their money between their Alipay accounts and the bank accounts. In this ecosystem, in addition to providing the mobile payment platform, Alipay also plays the functions to clear the payment transactions and manage the secure element. Therefore, it can capture most transaction fee and obtain users' proximity payment data. Combining with users' remote payment data, Alipay is capable to develop various value-added services, such as targeted advertising, credit scoring service.

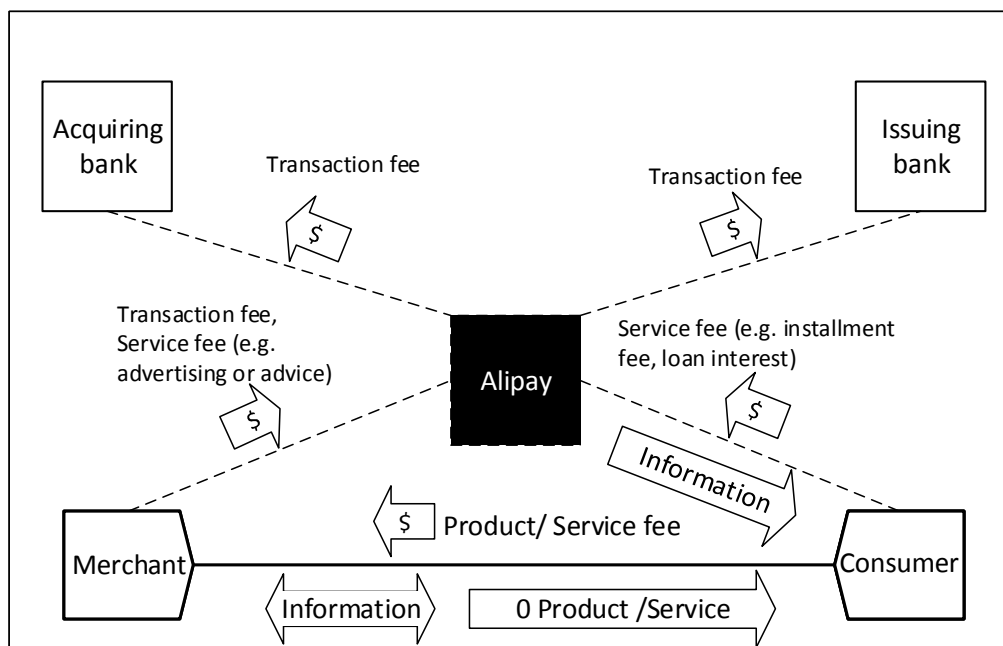


Figure 17: Ecosystem of Alipay for mobile payments

Before expansion, Alipay has already obtained most essential resources and capabilities for mobile proximity payments. In the development of its remote payment business, Alipay has already built a direct connection to major banks in China. This strategic action enables Alipay to shorten the value chain and also reduce the dependencies on a single financial institution. Moreover, Alipay has established a closed payment system and accumulated large customer base (both merchants and consumers) through the long-time development of its remote payment business. Furthermore, Alipay acquired its Third-Party Payment Licenses in May 2011 which allows it to clear both the Internet and mobile payment transactions, and operate both issuing (limited to a pre-paid payment account) and acquiring businesses. As thus, Alipay was only lack of the secure element and the enabling device infrastructure at that time. If Alibaba adopts NFC technology, it has to cooperate with either MNOs or the mobile device manufacturers to get the access to the hardware secure element and use their mobile payment platforms rather than its own platform. Additionally, Alipay

will lose partial transaction fee and the ownership of merchants to the acquiring organisations. Therefore, it is reasonable that Alipay employed QR code solution and adopted independent service provider mode for the mobile proximity payment business. It not only can help Alipay to further enhance its core resources and capabilities but also can reduce the dependencies on other firms and hence avoid the potential delay or collapse caused by the different strategic interests among the partners.

In order to take off, Alipay needs to have a large number of users and make them get used to QR code-based mobile payments. Before launching its mobile proximity payment services, Alipay has accumulated a large number of active users (both consumers and merchants) via its remote payment services for the popular e-commerce platforms. Besides of Taobao and Tmall owned by Alibaba, Alipay has also been integrated into many other large external e-commerce platforms, such as Amazon China, Meituan, Ctrip. It gained mass active users via these popular platforms. According to Alipay official website, it has more than 400 million real-name users by the time of June 2015. Because Alipay members have already linked their Alipay account with a bank account and even have installed Alipay App, Alipay just simply needs to train them how to conduct mobile proximity payments with its QR code tool and develop a habit of using it. Initially, Alipay took the most straightforward approach which is offering attractive subsidies to consumers. For every transaction, consumers can get a random discount by using Alipay at stores which they do not have with cash or card payments. Because consumers found the discount offered is appealing and the adoption cost of Alipay is low, many of them, even old people were motivated to learn how to use Alipay to make payments. Another approach Alipay used to develop new users is to make use of the network of its existing users. Users are rewarded with e-cash coupon if they have successfully invited new users to use Alipay. Besides, Alipay understood that getting consumers to use its mobile payment services a few times is not enough. Finding a way to encourage them to continue to use is of great importance. Thereby, Alipay bundled its mobile proximity payment services with its other services. For example, credit assessment service. Consumers can earn credit points by conducting mobile proximity payments with Alipay. High credit points generate many benefits to users, such as simplifying the Visa application documents for many countries, enjoying the lending services provided by Alipay.

On the merchant side, similar approaches were used by Alipay to attract merchants. Because Alipay adopted closed payment system, it has a direct connection with merchants. Thereby, it is capable of using a flexible pricing strategy and willing to do many kinds of promotional activities to entice merchants, such as making transaction fees free of charge in the initial stage, giving cash rebate or discount. Alipay aimed to increase the installed base as quickly as possible. Compared with the card payment option, merchants generally pay much less for the services with Alipay. Thereby, merchants often recommend their consumers to use Alipay in the checkout process which also helped to develop consumers' habit of using Alipay. For those consumers who do not know how to use Alipay, merchants play a role in guiding them. As merchants are most likely the consumers of Alipay at the same time, they are familiar with Alipay QR code tool. In addition to the subsidies, merchants or third parties are given a reward if they develop new merchants for Alipay.

Furthermore, Alipay accelerated merchants' adoption by reducing their adoption cost of the Alipay platform, such as providing them with a free barcode scanner, helping them generate static QR code. Many individuals, small and medium-sized businesses are attracted as it enables them to realise non-cash transactions in a cheap way. Another approach that has been successfully adopted by Alipay is to hold promotion campaigns with merchants which are often known as online to offline (O2O) strategy. In short, Alipay users can get an exclusive discount at participating merchants within a specified period of time. For example, Double 12 Shopping Day, Double 11 Shopping Day, Alipay Day. It is a cost-efficient way to conduct promotions as it can create a win-win situation. It not only helps merchants to attract more consumers and hence generate better revenues but also allows Alipay to closely engage with its users (both consumers and merchants). With these measures, Alipay easily overcame the challenges of achieving scale and reaped the benefits of network externalities.

6.2.4 Platform services analysis

Alipay strategically targeted merchants (e.g. small retailers, small restaurants, taxi) where cash was the primary instrument to make payments and also micro-payments occur in the initial stage. Those merchants are also the typical places where people make daily micro-payments. Merchants prefer cash mainly because the service charges and the cost of the POS terminal associated with card payments are relatively high for them. Thereby, many of these merchants only allow consumers to use cash. Because Alipay can help merchants to reduce or even eliminate cash payments in a cheap way, convincing merchants to adopt Alipay thereby became not so difficult. Plus, consumers can get benefits by using Alipay as well, it is not surprising that Alipay proximity payment services can take off soon by targeting those merchants. Through word of mouth, the nationwide expansion of Alipay has been achieved quickly.

Furthermore, Alipay has been making innovative attempts in mobile payments by introducing relevant new services or products to Alipay. A popular service is Yu'e bao. In 2013, Alipay worked with Tianhong Asset Management and launched Yu'e bao which is a low-risk financial wealth management product. As Yu'e bao can generate good interest for users on a daily basis, many users thereby keep funds within the Alipay payment ecosystem. According to Kapron & Meertens (2017), Yu'e bao has grown from 0.2 billion RMB in 2013 to more than 810 billion RMB in 2016, and more than 152 million users have used this product. In practice, Yu'e bao can be set as the default account for mobile payments. It means users can gain profits by storing money inside Yu'e bao and use it whenever they need which provides supreme experience and also maximises users' benefits. Through such kind of services, Alipay obtained a large number of loyal users and also made many users keep their funds in the Alipay account rather than the bank account. As thus, Alipay can save the transaction fee to the banks and also obtain the fund precipitation interest.

Moreover, Alipay made it easy for merchants to integrate into Alipay platform to offer their services. Individuals or enterprises can easily generate their QR code on Alipay's website to collect money. In addition to the static QR code, Alipay has made its platform tools openly available on its website.

Alipay makes it easy for any individuals or enterprises to develop a unique payment system upon on the Alipay platform to fulfil their own needs and preferences. Besides, Alipay has shown many actual cases are on its website to enlighten and guide the innovators.

Last, in addition to the domestic market, Alipay has been developing its mobile proximity payment services through worldwide expansion. For example, about 20 affiliated stores in South Korea, including Lotte duty-free shop accepted Alipay in 2005 (Cho, 2015), Thai 7-11 convenience stores supported Alipay in 2016 (Zhao, 2016), ten large overseas airports integrated Alipay in 2016 (Xinhua, 2016). It can be seen that Alipay chose suitable niche market in the initial stage which enables it to take off easily and an open platform strategy to encourage the development of new services.

6.3 QuickPass

6.3.1 Case description

Although China UnionPay established its mobile payment platform relatively late, it has been actively participating in the development of the Chinese mobile payments since 2008. In February 2008, China UnionPay and Nokia launched an NFC contactless payment trial in Shanghai city which is the 2nd trial of NFC-based mobile payments in China (Kapron, 2008). In May 2011, Beijing UnionPay Merchant Services awarded the Third-Party Payment Licenses (Chow, 2011). In August 2011, China UnionPay announced the first mobile device which was developed by HTC. This mobile device complies with China UnionPay's mobile payment standard (i.e. SWP-microSD). In the same year, China UnionPay, Chongqing Rural Commercial Bank and HTC jointly released the first NFC-SD UnionPay standard mobile financial product (Wang & Chou, 2012). Meanwhile, China UnionPay provided the supports to China's three MNOs to roll out their mobile payment services based on the four-corner payment model.

In July 2013, China UnionPay introduced UnionPay Wallet. It is a mobile App that enables users to add their payment cards, loyalty cards, coupons and e-tickets into it, but did not support mobile proximity payments at that time (Smart-payments, 2013). Until December 2015, with HCE solution, China UnionPay built the QuickPass platform in cooperation with over 20 Chinese commercial banks to offer NFC-based mobile proximity payment services (Balaban, 2015b). In order to use mobile QuickPass, consumers need to install the corresponding bank mobile App and add their bank card to generate a virtual QuickPass card in the mobile device. After that, consumers can conduct mobile payments at any POS terminals with a QuickPass logo. However, the downside is that if consumers want to activate the mobile payment services of multiple cards from different banks, they have to install the corresponding bank mobile App for every different bank card. This problem was addressed to some degree in August 2016 when China UnionPay launched its QuickPass mobile App quietly (NFCin, 2016). It provides a unified interface for consumers to add cards that belong to different banks.

In 2016, China UnionPay subsequently introduced Apple Pay, Samsung Pay, Huawei Pay, Mi Pay into its QuickPass platform to better cater for users. In November 2016, China Mobile cooperated with China UnionPay and officially released “He QuickPass” businesses. Besides of the mobile device manufacturers and MNOs, China UnionPay also worked closely with Chinese popular e-commerce platforms. In October 2016, China UnionPay established the cooperation with Meituan firm to develop “Internet+” ecosystem (China UnionPay, 2016). Meituan is a popular Chinese group-buying platform. The collaboration enables users to purchase the coupons on Meituan mobile App with QuickPass remote payment services and then use them at the physical stores with any QuickPass mobile platforms, including Apple Pay, Samsung Pay, Samsung Pay, Mi Pay. In January 2017, China UnionPay signed a strategic cooperation agreement with JD Finance which owns the popular e-commerce platform JingDong in China, to explore the cooperation opportunities in various fields, including payment product innovation (Jiang, 2017). In addition to the NFC technology, China UnionPay implemented QR code to its QuickPass platform in December 2016 (Yan, 2016). An overview of important events of QuickPass is presented in Table 10.

Table 10: Important events of QuickPass

<i>Time</i>	<i>Event</i>
February 2008	Conducted NFC-based mobile payment trial with Nokia in Shanghai city
May 2011	Acquired its Third-Party Payment Licenses
August 2011	Issued its mobile payment standard based on SWP-microSD solution and cooperated with HTC and bank to develop the corresponding products
June 2013	Supported China Mobile to its development of He Wallet
July 2013	Launched UnionPay Wallet to share discount information to users
December 2015	Released its QuickPass platform with HCE solution
February 2016	Introduced Apple Pay into its QuickPass platform
March 2016	Introduced Samsung Pay into its QuickPass platform
August 2016	Launched its QuickPass mobile App
August 2016	Introduced Huawei Pay into its QuickPass platform
September 2016	Introduced Mi Pay into its QuickPass platform
October 2016	Established the cooperation with Meituan to create “Internet+” ecosystem
November 2016	Released “He QuickPass” businesses with China Mobile
December 2016	Integrated QR code solution into its QuickPass platform
January 2017	Established partnership with JD Finance to explore opportunities

6.3.2 Platform technology analysis

From the case description, it can be seen that China UnionPay has expressed its strong support for NFC-based mobile proximity payments all the time. The reasons are twofold. Firstly, NFC-based solutions which rely on hardware SE have been proved to be secure and convenient which fulfils China UnionPay's requirements. Secondly, NFC is compatible with the existing contactless card

payment infrastructure. Thereby, China UnionPay can leverage its core assets in the card payments to develop mobile payment business.

To avoid the situation that MNOs gain the control of the mobile payment market, China UnionPay developed the SWP-microSD standard to reduce the dependencies on the SIM card. With the SWP-microSD solution, China UnionPay and banks can implement mobile payments with the supporting from the mobile device manufacturers (e.g. HTC) rather than MNOs. Although China UnionPay chose SWP-microSD as a primary model, it still supported MNOs on SIM-centric mobile payment projects due to the various uncertainties at the technology level at that time. Because of the various defects of microSD, more and more mobile device manufacturers gradually removed microSD slot from the design of the mobile devices. Consequently, SWP-microSD based mobile payments did not go very far in China.

By making use of HCE, China UnionPay strategically defined the nationally accepted QuickPass standards. It enables to create an interoperable mobile payment platform among different banks and MNOs. However, HCE-based QuickPass has a major problem. It can only be used on Android and Blackberry OS mobile devices while China has a large group of high tie users who are affiliated with Apple mobile devices. In order to facilitate the adoption of QuickPass in China to against the growing QR code-based mobile payment platforms led by TPPs, China UnionPay introduced Apple Pay as well as other embedded SE-based Pay into its QuickPass platform. Besides of providing more options to users, it has another advantage which is to attract the public attention by making use of the brand awareness of those mobile device manufacturers. In reality, QuickPass indeed has drawn great attentions from the public with Apple Pay at that time. However, the volume of mobile payment transactions seems not good as expected. The main reason is that many users have already formed the habits of using QR code and reluctant to learn a new payment technology. To address this issue and increase its position in the mobile payment market, China UnionPay thereby implemented QR code on the QuickPass platform as well. The interviewee [MP1-1] commented *“the main challenges for the fast development and expansion of NFC-enabled mobile payment services are that NFC-enabled devices are not widely in place, especially in rural areas. China UnionPay adopted QR code is to help QuickPass to take-off easily. Otherwise, China UnionPay and other financial institutions would lose their positions in the Chinese mobile payment market”*. It can be seen that China UnionPay has explored various technological solutions to increase the competitiveness of its QuickPass platform in the Chinese mobile payment market.

6.3.3 Platform ecosystem analysis

China UnionPay adopted the collaborative mode for the three NFC-based technological solutions (i.e. SIM-centric SE, HCE and embedded SE) integrated into the QuickPass platform. Regarding the SIM-centric SE solution, as discussed in section 6.1.3, China Mobile established the cooperation with China UnionPay in 2013 which enables the users of He Wallet to add UnionPay cards into the wallet and conduct mobile payments at any POS terminals with a QuickPass logo. To enhance the partnership, China Mobile and China UnionPay officially launched “He QuickPass”

business in November 2016 (Z. Guo & Cao, 2016). As there is no change in the ecosystem, this action can be interpreted as a way of promoting their brands.

The advent of HCE solution significantly increased the position of China UnionPay in the Chinese mobile payment ecosystem. China UnionPay defined relevant HCE technology specifications at the end of 2015 which enables the issuing banks to build their mobile payment platforms upon on QuickPass platform with the bank-centric mode and ensures the interoperability among different banks. As shown in figure 18, the ecosystem of HCE-based QuickPass includes the acquiring organisations, the issuing banks, merchants, consumers and China UnionPay. The collaboration was achieved as the stakeholders involved remain their roles and the benefits as in the four-corner payment model for the card payment business. China UnionPay mainly plays a role in clearing the transactions. It neither makes the consumers to keep funds with its UnionPay account to harm the issuing banks' benefits nor captures users' payment data to affect the acquiring organisations' benefits. The critical resources provided by China UnionPay are the transaction clearing system, the huge resource of the QuickPass POS terminals and the ownership of QuickPass platform. Therefore, China UnionPay receives part of the transaction fee charged to the merchants and also the service fee from the issuing banks or any other organisations which utilise the QuickPass platform. However, as mentioned, China UnionPay launched its QuickPass mobile App quietly in August 2016 which attempted to provide a unified interface to consumers to add UnionPay cards from different banks. It provides great convenience but to some extent harms the benefits of the issuing banks. Currently, this mobile app thereby only can add the UnionPay cards from a limited number of banks.

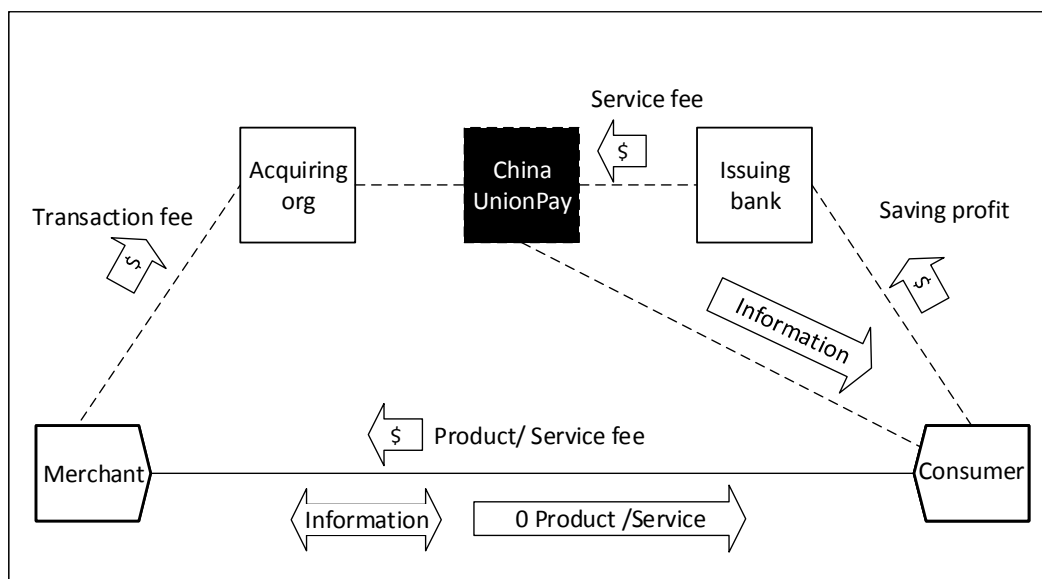


Figure 18: Ecosystem of HCE-based QuickPass

It can be seen that the main interests of China UnionPay are to increase the volume of the payment transactions on its platform. Hence, it is beneficial to China UnionPay to cooperate with the mobile device manufacturers to integrate various Pay into its QuickPass platform. However, it was found

that the introduce of Apple Pay was delayed for more than a year. According to the interviewee [MP1-5], “China UnionPay has completed the integration between its TSM and the TSM of Apple Pay quite early. However, the launch was delayed for a year due to the conflicts on the business side. They cannot reach an agreement regarding the distribution of the transaction fee”. This comment coincided with the speech of Shi Wenzhao, the president of China UnionPay. He stated that “the traditional four-corner payment model has been implemented for so many years. No other stakeholder has ever asked for the division of the transaction fee. However, Appy wants to share the transaction fee. We think Apple has obtained its benefits from the cooperation by increasing the sales of the mobile devices. Thereby, it should not obtain the transaction fee. The new business model with Apple was a big breakthrough to the traditional four-corner payment model” (Caixin, 2016). Nevertheless, China UnionPay and banks eventually compromised due to the popularity and the brand awareness of Apple mobile devices. As seen in figure 19, in the ecosystem of the embedded-SE based QuickPass, in addition to the original stakeholders, Apple is involved as the mobile payment platform for consumers. It obtains the transaction fee and the service fee for providing the secure element and the mobile payment platform. At this point, China UnionPay managed to integrate most relevant players into the ecosystem of the QuickPass platform, including MNOs, the mobile device manufacturers and the financial institutions.

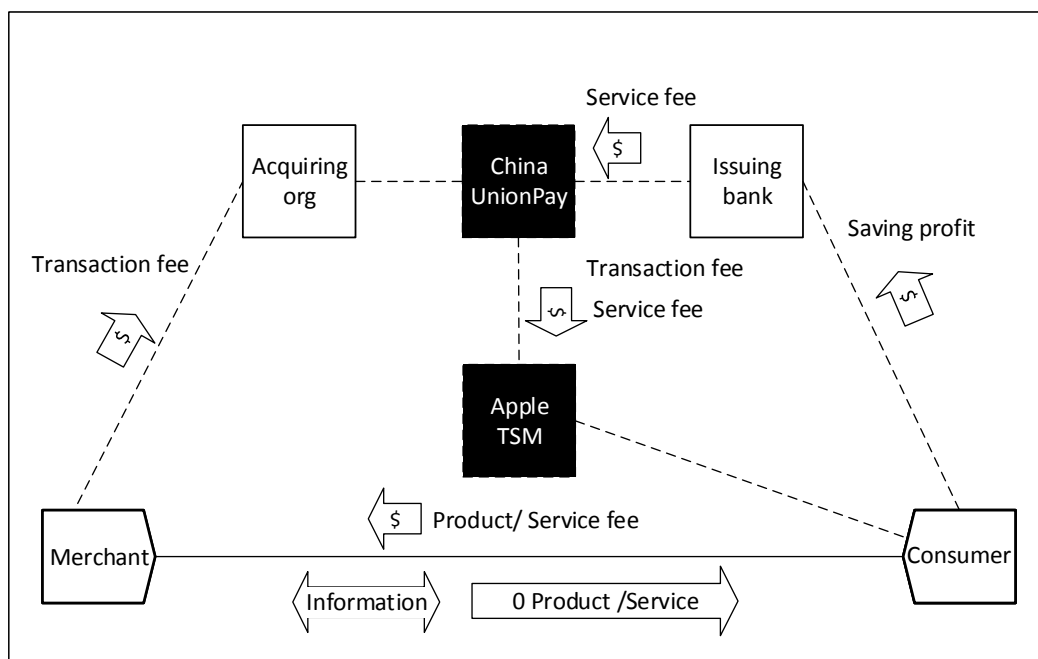


Figure 19: Ecosystem of Apple Pay-based QuickPass

Regarding the development of the consumer resources, China UnionPay does not have a popular platform to convert its card consumers into mobile consumers easily. Although China UnionPay attempted to achieve it via its UnionPay Wallet established in 2013, the results seem not good as expected. It lacks an innovative service to provoke consumers. Additionally, China UnionPay launched its platform too late. Alipay and WeChat have obtained mass loyalty mobile payment

consumers by the end of 2015. In order to change the situation, China UnionPay took two marketing strategies. First of all, it strengthened its cooperation with large e-commerce platforms to promote its QuickPass. Furthermore, it conducted various kinds of promotions together with the issuing banks and the mobile device manufacturers to encourage users to activate mobile QuickPass and use it. For instance, China UnionPay's original "62" card payment promotion activity was extended to mobile payments.

QuickPass has obtained mass merchants through its card payment services. Since the POS terminals of its current merchants have already been upgraded with NFC functionality, they can become the merchants of mobile QuickPass directly. Besides, QuickPass worked closely with the acquiring organisations to develop new merchants. However, there are many organisations involved in the acquiring business. It is hard to coordinate so many parties to reach an agreement in terms of the amount of subsidies, the division of the cost, etc. In terms of the service pricing, as three parties involved in the value chain of sharing the transaction fee, it is also difficult to implement a flexible pricing strategy. Thereby, compared with the subsidies from TPPs, there is a big gap. In addition, several interviewees [MP1-1, MP3, MP4, MP5] highlighted that "*there is no adequate training provided to merchants about QuickPass and how to operate NFC-based mobile payments. In practice, some merchants even don't know their POS terminals support mobile QuickPass. Besides, customers are often required by merchants to input password or make a signature for micro-payments which actually are required*". As a result, the convenience of NFC technology is not fully tapped. It can be seen that China UnionPay has difficulties to engage with users due to lack of a popular e-commerce platform and conduct promotion activities because of various stakeholders involved in the value chain.

6.3.4 Platform services analysis

China UnionPay strategically targeted the large merchants where UnionPay's POS terminals have already been installed in the initial stage. Because those merchants do not need to perform hardware upgrade and payment system integration, they have a low adoption cost. Thereby, it is easier for China UnionPay to convince them to adopt and promote QuickPass. Taking advantage of their mass installed customer base, China UnionPay successfully accelerated the take-off of its mobile QuickPass.

Moreover, China UnionPay has been aggressively developing the cooperative relationship with large e-commerce platforms with the purpose of jointly innovating services. Unlike Alipay, China UnionPay does not have a widely-adopted e-commerce platform. Thereby, it is lack of consumers' online purchase data and also an online channel to entice consumers to the physical store. These restrict its capability to develop services. Strategically establishing the partnership with the e-commerce platforms increased the services develop capability on the QuickPass platform and thus go beyond the payments.

Furthermore, China UnionPay took an open platform strategy to manage its platform interfaces. In order to encourage different players to adopt QuickPass platform, China UnionPay has made its

QuickPass platform support various technological solutions. The relevant tools and APIs are publicly available on its website. Additionally, China UnionPay provided test data and tools on its website to assist developers. These actions are to make it easy for innovators to develop payment scenarios upon the QuickPass platform.

Last, China UnionPay not only focuses on the services development of QuickPass in the Chinese market but also in the global market. It has been actively promoting mobile QuickPass worldwide. Before operating mobile payment business, it has deployed mass POS terminals around the world for its card QuickPass business. China UnionPay attempted to utilise those POS terminals for its mobile QuickPass. In June 2016, China UnionPay successfully made South Korea become the first overseas market to have launched mobile QuickPass (Boden, 2016). In August 2016, a number of daily spending merchants in Canada started to accept mobile QuickPass (Etherington, 2016). It can be seen that China UnionPay well leveraged its resources to develop the nationally and globally acceptance of mobile QuickPass and made up for its weakness by strengthening the cooperation with the popular e-commerce platforms.

6.4 Cross-case analysis

The status of each chosen mobile payment platform has already explained in detail. Upon the explanation, a causal analysis of different elements are presented in figure 20-21. In this section, a comparison on each platform perspective is made to see the difference among chosen mobile payment platforms. The overview of the results is presented in table 11.

From platform technology perspective, it can be seen that both China Mobile and China UnionPay thought security and convenience are the essential features of mobile proximity payments. Additionally, they attempted to leverage its core assets which are the SIM card and the resources of the NFC-enabled POS terminals, respectively. Therefore, they employed NFC technology. In contrast, Alibaba placed a higher value on the availability of enabling device infrastructure rather than the security and convenience. In reality, both NFC-enabled mobile devices and NFC-enabled POS terminals were not widely in place in the Chinese market at that time. The providers cannot mitigate these issues in a short period without a lot of upfront investments and the joint efforts of different players. While Alipay successfully mitigated the security and the ease of use problems of QR code solution in a short period with implementing various techniques, building the trust with users, providing rewards and so forth measures. Furthermore, it was found that the SIM-centric SE solution is gradually losing its competitiveness to the HCE and the embedded SE solutions in China. A major reason is that China Mobile mainly played a role as the provider of the secure element while the SIM card is no longer the only option as the secure element with the emergence of new technological solutions.

From platform ecosystem perspective, it can be seen that both He Wallet and QuickPass adopted collaborative mode while Alipay used independent service provider mode. Despite the business model developed by China Mobile enables it to easily reach an agreement with China UnionPay

and financial institutions which helped to reduce the upfront investment on the enabling device infrastructure and increase the usage of its secure element, it also limited the role, capabilities and benefits of China Mobile. As the secure element provider, China Mobile can only get relevant service fee and cannot obtain the ownership of users (consumers and merchants). Hence, it has less incentive to subsidise the users and also limited capabilities to conduct promotion activities. In contrast, the independent service provider mode enables Alipay to fully leverage its core resources (e.g. its e-commerce and payment platforms, closed transaction clearing system, large customer base) and hence further increase the competitiveness of Alipay. In terms of the marketing, because of having the ownership of users, Alipay is willing and capable of offering appealing subsidies to consumers, using a flexible service pricing strategy to merchants, and conducting promotion together with merchants. China UnionPay developed its mobile payment platform and brand very late mainly because before the emergence of HCE financial institutions lacked the control over the secure element. The main interests and the position of China UnionPay led to its choice of the collaborative mode. China UnionPay aimed at defining the technology specifications to enhance the interoperability of different sub-platforms and hence increase the volume of the transactions of its system. Regarding the marketing, China UnionPay strategically develops its platform brand "QuickPass", coordinates different partners (e.g. the popular e-commerce platforms, the issuing banks, the mobile device manufacturers, the acquiring organisations) to offer subsidies to users (both merchants and consumers). However, it is hard to measure the value of each stakeholder and change the well-established pricing rules in the four-corner payment model which limited its capabilities to conduct the promotions.

From platform service perspective, it can be seen that these three platforms used different strategies to choose the niche market in the initial stage. Among three platforms, Alipay is the one which to a large extent solved users' daily practical problem by realising cashless transactions in a cheap way. And those are the places where people conduct micro-payments. Other two platforms appeared to be an alternative way to conduct digital payments. Regarding platform openness, all three platforms released its platform APIs and tools publicly on their websites to encourage innovators to develop new services on their platforms. Moreover, added-value is another key differentiator for mobile payment wallets. Alipay managed to enrich its platform by fully making use of its core competitiveness achieved in the e-commerce and IT industry. It is difficult for He Wallet to develop services which go beyond mobile payments due to lack of the ownership of users. QuickPass attempted to mitigate it by strengthening the cooperation with the popular e-commerce platforms. In terms of the service reach, besides of the domestic market, QuickPass and Alipay are actively exploring the global market to increase the acceptance of the platform. While He Wallet currently failed to work on it due to its limited resources and also interoperability issue caused by the SWP-SIM solution.

In this Chapter, the sub-question three "how do mobile payment providers strategically develop their mobile payment platforms and facilitate users' adoption of their mobile proximity payment services in the Chinese market" have been answered through the in-depth analysis on the data obtained from the semi-structured interviews and desk research. Upon this point, all sub-questions

have been addressed accordingly. The next Chapter will recap the answers to each sub-question and also give a reflection on the proposed research model.

Table 11: Comparison of chosen mobile payment platforms

	Categories	He Wallet	Alipay	QuickPass
Platform technology	<i>Solution</i>	SWP-SIM	QR code	HCE + Embedded SE + SIM-centric SE
	<i>Characteristics</i>	Secure, convenience, internationally recognised SIM-centric SE solution	High availability of enabling device infrastructure, good interoperability	Secure, convenience, backward to existing payment infrastructure
	<i>Main barriers</i>	NFC-enabling device infrastructure, compatibility test, inferior user experience	Less security, not ease of use	NFC-enabling device infrastructure
	<i>Disruptive tech solutions</i>	SIM card is no longer the only SE option due to the emergence of HCE and embedded SE solutions	NA	NA
Platform ecosystems	<i>Business model</i>	Collaborative mode	Independent service provider mode	Collaborative mode
	<i>Role</i>	Provide secure element & mobile payment platform	Provide the mobile payment platform & clear payment transactions	Clear payment transactions & define platform technology specifications
	<i>Main customer</i>	Payment application providers (e.g. the issuing banks) & consumers	Consumers & merchants	Issuing banks & acquiring organisations
	<i>Revenue</i>	Service fee for using secure elements & TSM Advertising fee for using mobile payment platform	Transaction fee, value-added service fee	Transaction fee, service fee for using QuickPass platform
	<i>Marketing strategies & issues</i>	1. Only capable to conduct promotion to consumers with payment application providers rather than merchants 2. Small and simple promotion activities on consumers (e.g. e-cash coupons, free phone bill) 3. Focus on the development of mobile payment products (i.e. payment service providers) not users 4. Lack of incentive and capabilities to subsidize users	1. Obtained mass active users via popular e-commerce platforms 2. Provided appealing subsidies to gain mass users and develop their habits 3. Used service bundling to increase the stickiness of users and develop users' habit 4. Capable of using a flexible pricing strategy and willing to provide appealing subsidies to merchants 5. Cooperated with merchants to realise O2O promotion activities via its platform	1. Obtained mass users via card payment business 2. Strengthened its cooperation with large e-commerce platforms to realise O2O promotion activities 3. Conducted the promotions together with the issuing banks & the mobile device manufacturers to attract consumers 4. Coordinated different partners to offer subsidies and a flexible service pricing to merchants 5. Lack of advertisement and training on merchants
Platform services	<i>Initial niche market</i>	Public transportation and all-in-one card for schools and companies	Cash-based merchants	Targeted the large merchants with NFC-enabled POS terminals
	<i>Value proposition</i>	Alternative digital payment method	Cheap way to realise cash reduction	Alternative digital payment method
	<i>Platform openness</i>	1. Made its platform tools and APIs openly available on its website 2. Hold innovation competition to encourage the development of payment scenarios	Made its platform tools and APIs openly available on its website	Made its platform tools and APIs openly available on its website
	<i>Service characteristics</i>	1. Mobile payment services are regional and limited 2. Developed various contactless payment scenarios, but few go beyond	1. Actively developed its acceptance in both domestic and global market 2. Developed various value-added services by leveraging its ownership of users	1. Actively developed its acceptance in both domestic and global market 2. Cooperated with other e-commerce platforms to develop the value-added services
	<i>Others</i>	Focus on the 4G development and thus missed the best opportunities to acquire the market share	NA	NA

He Wallet

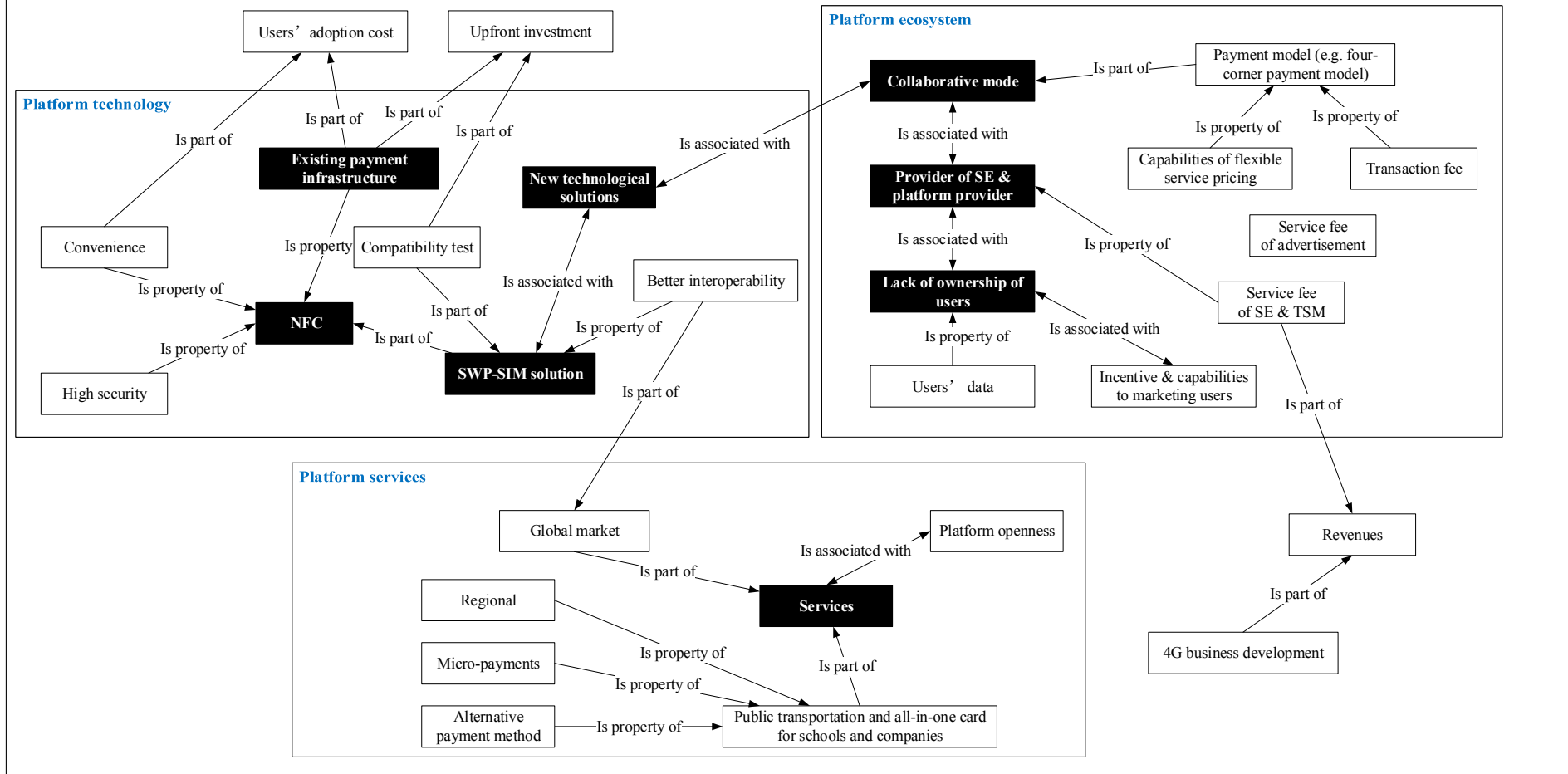


Figure 20: Platform view of He Wallet

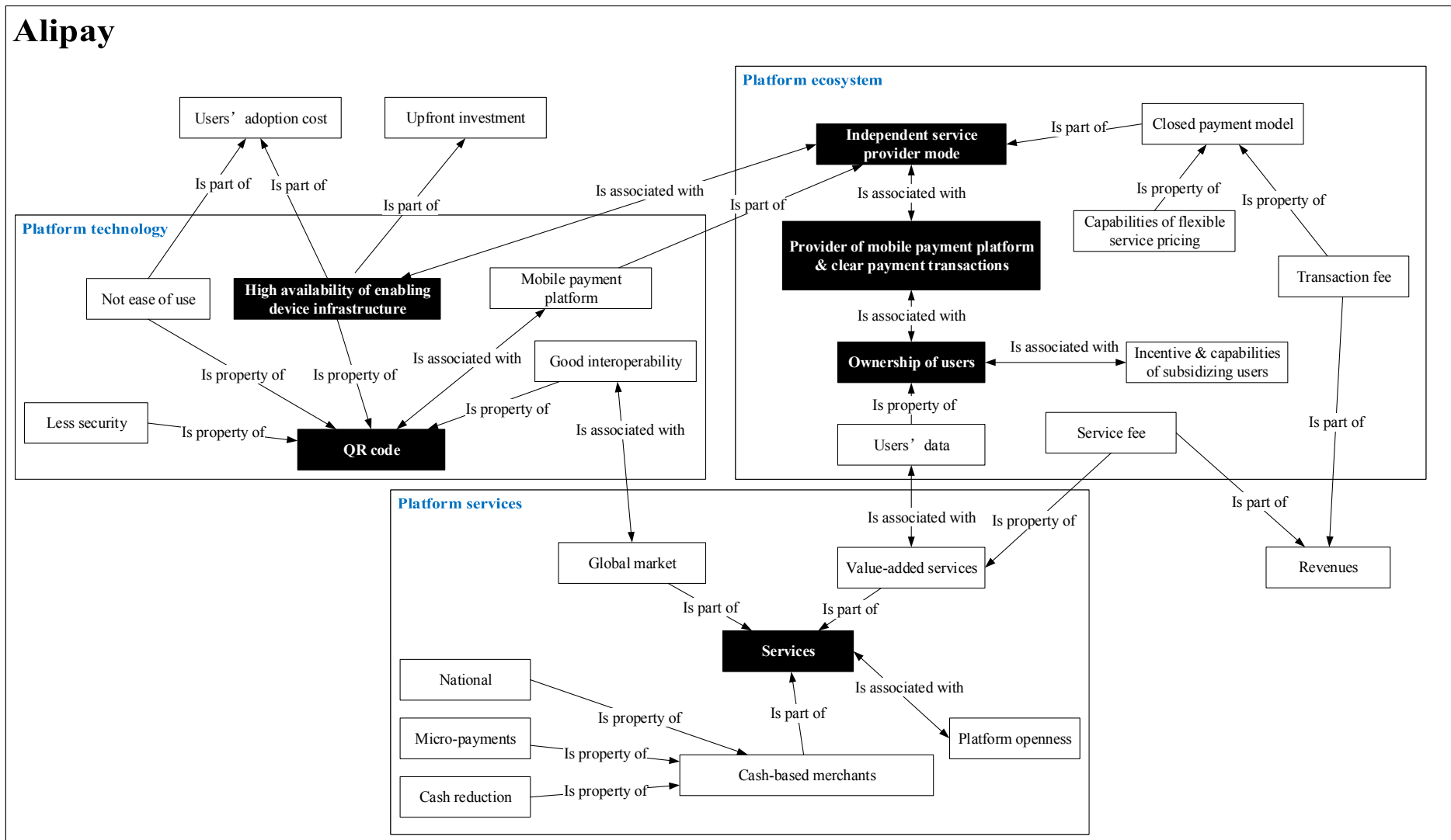


Figure 21: Platform view of Alipay

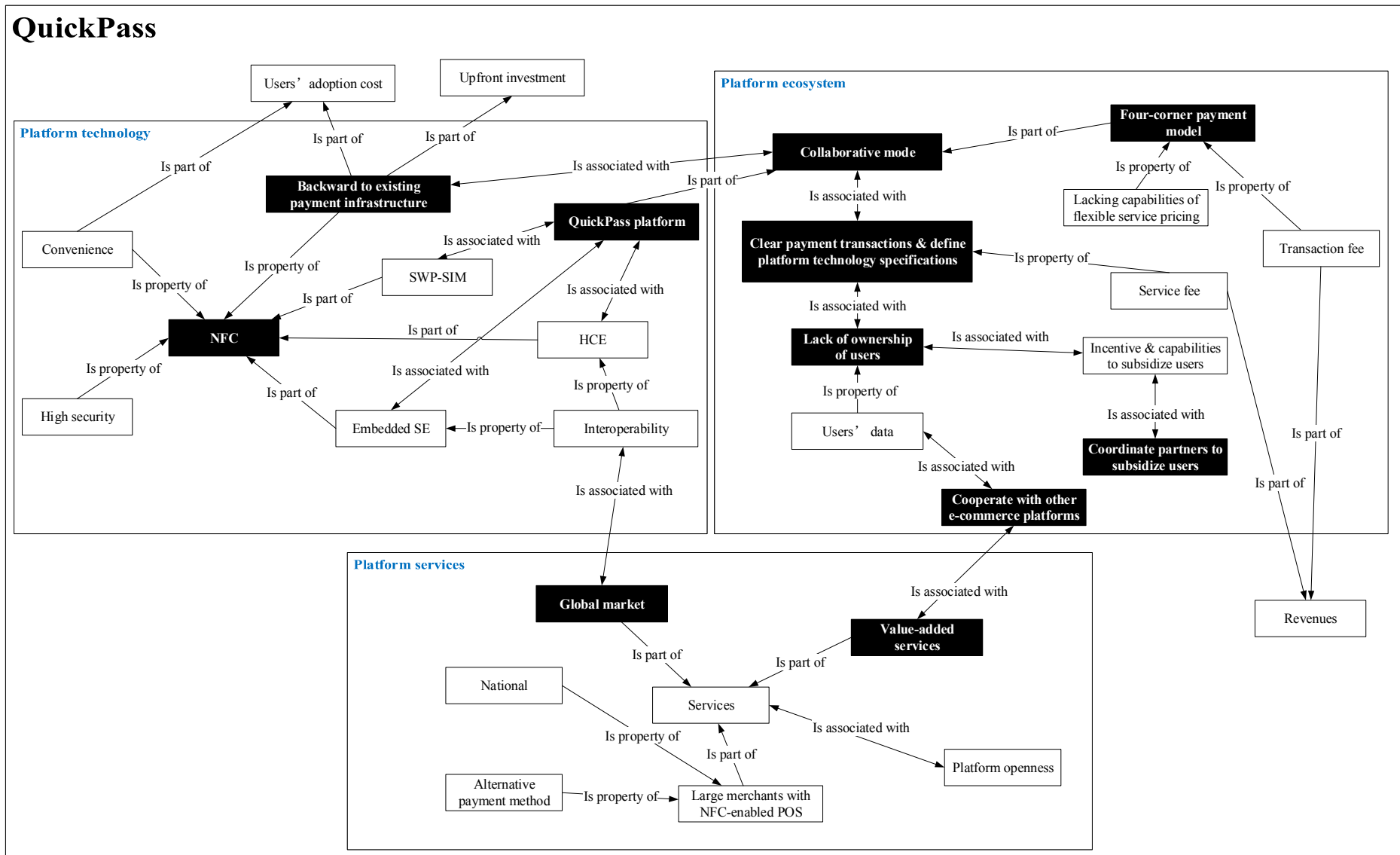


Figure 22: Platform view of QuickPass

7 Conclusions & Recommendations

This chapter consists of three sections. Section 7.1 makes the conclusion for each sub-question which ultimately led to the answer to the main research question. Upon on the findings, section 7.2 provides the practical and academic recommendations. At last, section 7.3 discusses the limitations of this study and also suggests the future study.

7.1 Conclusions

All research work is conducted to answer the main research question "*Why did QR code-based mobile payments overtake NFC and achieve a dominant position in the Chinese market?*". The main research question is addressed in separate research on the three sub-research questions derived in section 1.3. Thereby, this section first provides an answer to each of the three sub-questions and ends with a conclusion of the main research question.

(I) What are the mainstream mobile proximity payment solutions based on QR code and NFC technologies and corresponding business models adopted in the Chinese market?

Literature review reveals four types of technological solutions are available to implement NFC. They are microSD-SE, SIM-centric SE, embedded SE and HCE. Besides of HCE, the other three technological solutions rely on a hardware secure element. In comparison, the implementation of QR code is purely software-based. Regarding mobile payment business models, they can be generally categorized into four types which are the operator-centric mode, the bank-centric mode, the independent service provider mode and the collaborative mode.

The mainstream mobile proximity payment solutions based on QR code and NFC technologies and corresponding business models adopted in the Chinese market are identified and summarized through reviewing online news. It was found that all types of the technological solutions and business models mentioned above have been explored by different players involved in the development of the Chinese mobile payments. However, as microSD-SE was not supported by many mobile device manufacturers and they even gradually eliminated the microSD slot from the design of the mobile devices, it thereby did not become a mainstream solution in China. Besides of NFC and QR code technologies, China Mobile tried RF technology which operates at 2.4GHz in the initial stage, but gradually shifted towards NFC technology. Without the support from other players, China Mobile faced the huge cost of deploying RF POS terminals throughout the nation by itself. Therefore, RF technology did not become a mainstream technology for mobile payments in China.

In terms of the business models, it was found that all other three modes except MNO-centric mode have gained popularity in China. As presented in Chapter 2, only China Mobile adopted MNO-

centric mode when implementing RF SIM solution. Other MNOs in China chose the collaborative mode for their SIM-centric SE solutions. As discussed, collaborating with financial institutions enabled MNOs to have access to the payment network and mass China UnionPay’s POS terminals which can help MNOs significantly reduce the upfront investments and also the risks. The results of this sub-question are presented in Table 11.

Table 12: Overview of the mainstream technological solutions and business models

Technology	Solutions	Business models	Platforms (not the full list)
NFC	SIM-centric SE	Collaborative	He Wallet (China Mobile), Wo Wallet (China Unicom)
	Embedded SE	Collaborative mode	Apple Pay, Samsung Pay, Huawei Pay, Xiaomi Pay under QuickPass in China
	HCE	Bank-centric mode	QuickPass (China UnionPay), e-Payment (Industrial and Commercial Bank of China), Dragon payment (China Construction Bank)
QR code	QR code	Independent service provider mode	Alipay, WeChat Pay, Baidu Wallet
		Bank-centric mode	QuickPass (China UnionPay), e-Payment (Industrial and Commercial Bank of China)

(II) What are the barriers that mobile payment providers and users (i.e. consumers, merchants) face towards to QR code and NFC-based mobile payment solutions in the Chinese market?

This sub-question is answered through two steps. First of all, a literature review is performed in Chapter 3 to deeply understand each mainstream technological solution adopted in the Chinese market. Upon on this, the potential barriers towards to each solution are identified and discussed using a multi-perspective framework (provider, technology, and user) proposed by De Reuver & Ondrus (2017). To obtain the situation in the Chinese market, semi-structured interviews were performed with managers and experts from China. The final results are provided in Table 12.

- SIM-centric SE solution has high dependencies on MNOs and the mobile device manufacturers, especially SWP-SIM solution. As discussed, it requires the mobile device manufacturers to supply SWP-based mobile devices which created great uncertainty on the technological solution. In addition, the mobile device has to be certified by the MNOs which is a time-consuming and costly process. The compatibility test is not only required between the mobile device and the SIM card but also exists between the mobile device and the POS terminal due to many non-standard POS terminals in the Chinese market. Furthermore, there is interoperability issues caused by the exclusiveness of MNOs. It means building a connection to the TSM of every individual MNO is needed in order to serve the users that belong to different MNOs.

- Embedded SE solution provides the best performance among all solutions discussed in this study. The mobile device manufacturers can ensure the performance of the NFC functionality by customising hardware and software implementations in the design stage. The main problems are that not every type of the mobile devices support such function and the interoperability issue exists among different mobile device manufacturers.
- HCE solution significantly reduces the provider's dependencies on others. It enables the provider to establish and govern the mobile payment platform independently. However, it is only supported on the Android/Blackberry OS-based mobile devices. The provider needs to adopt other solution to serve the users of non-Android/Blackberry-based mobile devices. For instance, China UnionPay introduced Apple Pay into its QuickPass platform to serve the users of iOS.
- QR code solution provides good interoperability among different types of mobile devices and dramatically reduces the provider's dependencies and users' adoption cost. The major problems are security and performance (not ease of use). However, they can be strategically mitigated with a series of measures. In the sub-question three, it can be seen how TPPs creatively overcame them.

Table 13: Multi-perspective view of technological solutions

<i>Solution</i>	<i>Provider</i>	<i>Technology</i>	<i>User</i>
<i>SIM-centric SE</i>	- High dependency on MNOs - High dependency on mobile device manufacturers - Interoperability issue caused by the exclusiveness of MNOs	+ High level of security + Good performance - Require to setup TSM system with MNOs - Require compatibility test	- Replacing SIM with UICC - Certified NFC-enabled mobile device - NFC-enabled POS terminal
<i>Embedded SE</i>	- High dependency on mobile device manufacturers - Interoperability issue caused by the exclusiveness of mobile device manufacturers	+ High level of security + Superior performance - Require to setup TSM system with mobile device manufacturers + No need compatibility test	+ No need to replace SIM - Limited choice of mobile devices - NFC-enabled POS terminal
<i>HCE</i>	+ No dependency - Interoperability issue caused by the mobile device OS	- Less secure than hardware SE solutions + Good performance - Require to setup its cloud system + No need compatibility test	+ No need to replace SIM - NFC-enabled Android/Blackberry OS mobile device - NFC-enabled POS terminal
<i>QR code</i>	+ No dependency + No interoperability issue	- Less secure than NFC solutions - Inferior performance - Required to setup its cloud system + No need compatibility test	+ No need to replace SIM + Mobile device with a built-in camera or bar scanner

(III) How do mobile payment providers strategically develop their mobile payment platforms and facilitate users' adoption of their mobile proximity payment services in the Chinese market?

To systematically answer this sub-question, a research model was designed in Chapter 4 by combining the STOF model, the platform theories and the business ecosystem concept. After that, the proposed research model was applied to the case study of three Chinese mobile payment platforms which are He Wallet, QuickPass and Alipay in Chapter 6. The platforms were selected by using the mainstream technological solutions concluded in the sub-question one as the basis. The data of the case study were collected using the semi-structured interviews and desk research methods. The case studies were analysed from three perspectives which are platform technology, platform ecosystems and platform services.

Considering the inherent security, convenience features and being backwards compatible with the existing contactless payment infrastructure in China, NFC technology was chosen by both China Mobile and China UnionPay for mobile proximity payments. However, in the early of 2010s, it was the beginning stage of Chinese EMV migration and also popularising the smart phones, both NFC-enabled mobile devices and POS terminals were not widely in place. The provider has to put huge investment on the enabling devices infrastructure and also develop users' habits. Regarding He Wallet, in order to reduce upfront investment and share the risks, China Mobile strategically cooperated with other players in the Chinese payment industry to get the access to the existing contactless payment infrastructure. However, they have already established a mature card-based transaction clearing system and formed a stable payment model. While at that time there were many uncertainties about Chinese mobile payments. China Mobile thereby failed to break the payment model and involved in the transaction process. As a result, it only worked as a provider of the secure element and the mobile payment platform which restricted its obtained resources and benefits. Lacking the control over the transactions and the ownership of users resulted in China Mobile's less incentive and capabilities to conduct marketing and hence get more users on board. Losing the ownership of users also limited its capabilities to develop value-added services on He Wallet to increase the revenues and the number of users. In terms of the niche market (i.e. public transportation and all-in-one card for schools and companies) that China Mobile chose, mobile payment is only an alternative payment method which also made the platform not easy to take off. Furthermore, China Mobile shifted its business focus to 4G network development between 2014 and 2016 which made it lose the optimal time to capture market share. The emergence of HCE and embedded SE further harmed the competitiveness of China Mobile in the Chinese market.

In comparison, Alipay chose QR code technology which the high availability of enabling devices is the main advantage. It helped Alipay to reduce users' adoption cost and the upfront investment. By making use of its core assets acquired in remote payment business, Alipay successfully built its mobile proximity payment platform independently. Having the control over the transaction process and the ownership of users made Alipay capable of using a flexible service pricing strategy, providing appealing subsidies to the end-users (both merchants and consumers) in the initial stage

to attract users and develop their habits' of using QR code. Additionally, it enables Alipay to obtain mass users' data which can be utilised to develop value-added services, for instance, Yu'e bao. With respect to the niche market, it targeted the places where cash was the primary payment method to help the merchants to realise cashless transaction in a cheap way. The good interoperability and the brand awareness also enable Alipay to explore the global market.

Due to lack of the control over the secure element, China UnionPay only established its QuickPass platform after the emergence of HCE solution which is late. The HCE solution enables financial institutions to develop an NFC-based mobile payment platform independently. However, QR code-based platforms, such as Alipay, WeChat Pay, have already dominated the market. To reverse the situation, China UnionPay strategically cooperated with the mobile device manufacturers and introduced various Pay (e.g. Apple Pay) into its platform. It also worked closely with MNOs to integrate their platforms to QuickPass. It can be seen by the end of 2016 China UnionPay managed to incorporate all relevant stakeholders of NFC technology to its QuickPass platform. In terms of the marketing, China UnionPay faced the similar problems that China Mobile encountered. It also lacked the capabilities to use a flexible service pricing strategy, conduct marketing on users and develop value-added services. To mitigate these issues, China UnionPay coordinated different parties and also strengthened the cooperation with the large e-commerce platforms. Also, China UnionPay endeavoured to explore the global market by making use of its mass POS terminals deployed around the world.

By addressing the sub-questions above step by step, the main research question "***Why did QR code-based mobile payments overtake NFC and achieve a dominant position in the Chinese market?***" is well answered. In general, although NFC technology was adopted first in the Chinese market, the enabling devices of both consumers and merchants were not widely ready at that time for NFC technology, but good enough for QR code technology. However, the early NFC adopters (both MNOs and financial institutions) were reluctant to make a huge investment in the enabling devices to realise the large-scale deployment in the early stage due to the uncertainties on the technology level and the unclear roles and benefits on the business aspect. Thereby, they missed the best time to capture user and develop users' habit. In contrast, Alipay strategically adopted the independent service provider mode to leverage its obtained platform resources and capabilities which significantly contributed the mass adoption of QR code in the Chinese market. Despite QR code currently dominated the Chinese mobile payment market, the author believes that NFC has its place in the Chinese mobile payment market as China UnionPay adopted an open platform strategy to incorporate all relevant players into its ecosystem to facilitate the development.

7.2 Research contributions

7.2.1 Theoretical contributions

The first contribution of this study is that it applied the multi-perspective framework proposed by De Reuver & Ondrus (2017) to compare the mainstream technological solutions based on NFC and

QR code technologies in the Chinese market. In addition to confirm the results of De Reuver & Ondrus (2017), there are some new findings. It was found that the SIM-centric SE solution also has the dependencies on the mobile OS due to the Open Mobile APIs. Moreover, HCE solution has some enhancements. The emergence of different types of payment keys (e.g. SUK and LUK) made the Internet connection is not required all the time. Besides, the tokenization technology significantly improves the security of HCE solution. The results provide a comprehensive overview of the characteristics and potential barriers of each solution from the provider, technology and users' perspectives which can be utilised by the mobile payment providers.

Furthermore, this study developed a research model by combining different perspectives of the platform with the STOF model, relevant platform and business ecosystem theories. The proposed research model helps to provide a good explanation of the status of a mobile payment platform. By applying it on three Chinese mobile payment platforms, we were able to understand the strategic actions of the actors involved in a mobile payment platform which leads to the relevant strengths and issues of the mobile payment platform. The analysis showed that in the implementation stage, the platform technology and the platform ecosystems perspectives well explained how the mobile payment platform providers choose the solution based on the technology characteristics and their core resources while the resources required and the benefits associated to implement the chosen technological solution and the mobile payment platform lead to the collaboration between the mobile payment platform providers and other stakeholders. In the evolutionary stage, the platform services and the platform ecosystems perspectives interpreted how the mobile payment platform providers select the niche market and use marketing strategies to attract users while the obtained user resources are of great importance for the mobile payment platform providers to develop new services on the platform. Moreover, it is also found that there is a connection between the platform technology and the platform services. The characteristics of the technology and the technological solution can also influence the development of services, for instance, the interoperability of a technological solution affect the service reach of a mobile payment platform. Hence, the research model is a useful tool to make a comprehensive analysis of a mobile payment platform.

Last, by applying the proposed research model to explain the contemporary phenomenon of two competing mobile payment technologies in the Chinese market, this research contributes to the existing body of literature on mobile payments. As indicated in section 1.2, few studies have been conducted on emerging technologies other than NFC.

7.2.2 Practical contributions

The research results in this study are not only beneficial to the theoretical research in mobile payments but also useful for the practical development of mobile payments. For the new mobile payment platform providers, the first recommendation is to take the market conditions and trends (e.g. the availability of enabling devices, the characteristics of the payment model in the market, the competitiveness of the market) into account when selecting a technological solution. The second recommendation is for the providers who have to adopt the collaborative mode to gain the

access to the critical resources. It is necessary to work out a mechanism to get the access to users' data and reduce the slack possibility of other stakeholders.

For the MNOs, the first recommendation is related to the technological solution. It is necessary to mitigate the compatibility and interoperability issues to improve the solution. It can be enhanced by strengthening the collaboration among different MNOs both nationally and globally to jointly support the SWP specification and develop a hub of TSM to link different MNOs (just like the TSM of China UnionPay which is link to different banks). The second recommendation is to offer new technologies to attract relevant stakeholders and facilitate the service development on the mobile payment platform instead of merely focusing on the SIM-centric SE solution. The last recommendation is to develop the cooperation with e-commerce platforms and merchants to enable the close engagement with users. It only can help MNOs to conduct the promotions in a cost-efficient and effective way but also get the data resources to develop value-added services. In this study, it was found that China UnionPay has adopted such strategy to address the issue of lacking the ownership of users for its QuickPass platform.

7.3 Limitations & future study

Despite the contributions of this research, there are several limitations. The first limitation is related to the type choice of the case study. For each technological solution, only one mobile payment platform has been selected for the case study. Although the chosen case is typical, mobile payment platforms which adopted the same technological solution may have some differences. For example, besides of Alipay, WeChat is another mobile payment platform which adopted QR code solution. Despite the fact both Alipay and WeChat Pay are led by TPPs and used the same technological solution, they have different core businesses which are e-commerce and social media, respectively. It might be an influential factor. The multiple case study can better ensure validity and reliability by comparing the differences and the similarities between the cases. However, given the time and resource limitations of this research, it would not be possible to conduct more case studies in this research.

Another limitation posed by the research comes from the interviews. This research failed to interview the managers who were in charge of the business development of the chose mobile payment platforms due to the limited network resources of the author. Although the selected interviewees have deep knowledge and rich experience in the Chinese mobile payment industry, the insights from them may have a certain level of bias. Additionally, the number of interviewees is a limitation as well. Only one subject from China Mobile, China UnionPay and the academia has been interviewed. And there is no subject from Alipay. In order to minimise the bias, desk research was adopted in the case study.

The final limitation is from the analysis of the collected interview and desk research data. In this study, the author attempted to elicit a broad range of strategies taken by the chosen mobile payment platform providers rather than ranking the elicited strategies to each other. Therefore, specific new

services and promotion activities were not particularly investigated to evaluate their effectiveness precisely. The impact is that the causal relationship between the action and the result might be not strong and but also included.

Considering the limitations discussed above, several suggestions for future research are thereby reported.

- This study conducted a single case study for four technological solutions based on NFC and QR code technologies. Subsequent research may be performed on the multiple mobile payment platforms using the same technological solution.
- As mentioned, besides of TPPs, financial institutions, such as China UnionPay and ICBC also implemented QR code in their platforms at the end of 2016. It may offer new insights by comparing the mobile payment platforms adopted QR code solution but led by different types of players.
- As mentioned above, because of the limited network resources in this study, the results are only primarily tested. Therefore, a comprehensive verification and validation analysis with the more managers and experts, particularly who were directly involved in the business development of those chose platforms, is recommended in the future study.
- This study did not investigate specific new services and promotion activities launched by the mobile payment platform providers which can be another future research to figure out the degree of their positive impacts.
- The research in this study is mainly conducted from the platform perspective. However, the intervention from the government and the impacts of the regulations are also an important factor that influences the technology selection and the innovation of new services which can be included in future research.

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9 Appendix

Appendix A-Interview results of He Wallet

Key words	Code results	MP1-1	MP1-2	MP2	MP1-3	MP4	MNO1	MP5	MP1-4
Platform technology									
RF SIM (2010-2012)									
Reduce consumers' adoption cost (+)	Availability of NFC-enabled mobile device	MP1-1			MP1-3				MP1-4
Consumers using an ordinary mobile device can be targeted (+)		MP1-1			MP1-3				MP1-4
No need to be affected by the small number of NFC-enabled POS terminals in the Chinese market (+)	Availability of NFC-enabled POS terminals	MP1-1			MP1-3				MP1-4
High adoption cost on merchant side (deploy and upgrade POS terminals) (-)		MP1-1					MNO1		MP1-4
Focus on the service fee of SE rather than other value-added services, a big difference between revenues and investments (-)	Large gap between revenues & investments						MNO1		MP1-4
NFC-SWP (2012-Now)									
Tap-and-go feature	Ease of use	MP1-1					MNO1		
Adopt the internationally recognized standards (+)	Interoperability						MNO1		
More stable performance than SIMpass	Performance						MNO1		
Enable the cooperation with FIs to share the risks and gain their merchants resources (+)	Access the existing NFC-enabled infrastructure	MP1-1			MP1-3				
Avoid the cost on the deployment of 2.4GHz POS terminals (+)		MP1-1			MP1-3		MNO1		
High cost of NFC SIM card (-)	High cost of SIM card	MP1-1					MNO1	MP5	
Compatibility test between SIM cards, mobile devices & POS terminals (i.e.	Compatibility test	MP1-1	MP1-2	MP2			MNO1		

time cost & monetary cost) (-)									
Only a small number of POS terminals supports NFC functionality at that time (-)	Availability of enabling devices	MP1-1		MP2	MP1-3	MP4	MNO1	MP5	
Limited types of SWP-enabled mobile devices (-)		MP1-1	MP1-2	MP2		MP4			
Inferior user experience due to non-standard POS terminals (-)	Inferior performance		MP1-2	MP2	MP1-3				
Rely on mobile device manufacturers to include Open Mobile API (-)	Open Mobile APIs							MP5	
Platform ecosystems									
Rely on mobile device manufacturers to support NFC SWP standards	Rely on mobile device manufacturers	MP1-1							
Rely on the acquiring organisations to deploy NFC enabled POS terminals	Rely on FIs	MP1-1							
A few payment scenarios, not convenient	Limited types of payment services	MP1-1	MP1-2	MP2				MP5	
Target the large merchants (e.g. super markets) rather than the merchants where consumers conduct their daily micro payments		MP1-1				MP4			
Target specific users (e.g. students, employees)			MP1-2		MP1-3				
Small and simple subsidy on consumers (e.g. e-cash, phone bill)		MP1-1				MP4	MNO1		MP1-4
No attractive subsidy on merchant side to gain large number of merchants in the early stage	Less marketing	MP1-1	MP1-2						
Focus on its own short-term benefits rather than considering the acceptance of market and users	Focus on short-term interests	MP1-1				MP4	MNO1		
Less experience on the promotion of merchant side	Lack of capabilities on promotions	MP1-1				MP4			

Fees for connecting the TSM and using SE	Role		MP1-2				MNO1		
Platform services									
Target public transportation and schools in the initial stage	Niche market: public transportation & schools	MP1-1				MP4			
Allow each branch of China Mobile to customise services for local area, especially focus on transit, universities			MP1-2		MP1-3				
Lack of value-added services	Lack of value-added services						MNO1		
Move the focus to mobile payments to development of 4G connections in 2014	4G development						MNO1		MP1-4

Appendix B-Interview results of Alipay

Key words	Code results	Interviewees								
Platform technology										
Make use of existing bar scanner resources at merchants	High availability of enabling devices	MP1-1	MP1-2					MP4		MP5
Popularization of smartphones in early of 2010s		MP1-1						MP4		
Low implementation cost, mainly cloud system	Upfront investment	MP1-1	MP1-2							
Good interoperability, support Apple devices	Interoperability	MP1-1						MP4		
No dependencies on MNOs and mobile device manufacturers	Dependencies	MP1-1								
3G Internet environment, good enough for QR code	Enabling network environment	MP1-1						MP4		
Established trust mitigate the security issue	Security issue	MP1-1								
Different technologies used to mitigate the security concerns						MP1-3	MP4			
Willing to pay for the loss of users. Besides, small security issue when merchants and consumers are present			MP1-2	MP2	MP3		MP4			MP5
Not ease of use, but useful, many places support it	Convenience	MP1-1	MP1-2		MP3	MP1-3			U1	
Platform ecosystem										
Make use of its existing e-commerce platforms and remote payment business	Existing platform resources	MP1-1			MP3				U1	
Know users' needs better as Internet company, fast response	Users' perspective	MP1-1	MP1-2				MP4			
Attractive subsidies (e.g. random cash-back), merchants have cash-back as well	Marketing	MP1-1	MP1-2	MP2						
Use the penetration strategy to capture the market share										
Change service pricing easily because of closed payment model	Flexible service pricing				MP3					
Low service fee for clearing payment transactions	Low payment service fee	MP1-1					MP4			

Focus on the development platform ecosystem, make profits via users' data (e.g. lending services, credit scoring service)	Service fee from users' data			MP2					MP5
Merchants proactively recommended users to use Alipay, develop users' habit	Merchants' advice				MP3				
Put huge investment on promotion in 2015 due to competition from WeChat	Large promotion					MP1-3			
Develop merchants via the agents and provide free bar scanners	Marketing						WMJ		
Combined online and offline payments	O2O strategy								
Platform services									
Enabled small size merchants to realise cashless transactions	Small size merchants where payment method is cash only	MP1-1							
Involved in different businesses, capable to develop services easily	Existing platform resources							U1	
Aggressively explore global market	Global market			MP2					

Appendix C-Interview results of QuickPass

Key words	Code results	Interviewees						
Platform technology								
Focus on microSD solution in the early stage	MicroSD solution	MP1-1		MP1-3				
Early stage of EMV migration, not many NFC-enabled POS terminals	Availability of enabling devices			MP1-3				MP1-4
HCE solution								
Only be used on the Android mobile devices	Interoperability	MP1-1		MP1-3				
Reduce dependencies on MNOs and mobile device manufacturers	Dependencies	MP1-1						
Embedded SE solution								
Not every type of the mobile device support the NFC functionality	Limited types of mobile devices	MP1-1						
Interoperability of different mobile devices brand	Interoperability	MP1-1						
Platform ecosystems								
Seek for the cooperation to realise mobile payments, not expertise in managing users' account system	Role							MP1-4
Four-corner payment model, cannot use flexible pricing	Capability of flexible pricing							MP1-4
Low subsidies compared with TTP	Marketing	MP1-1						
No adequate training on merchants (require password or signatures)	Training on merchants	MP1-1	MP3		MP4		MP5	
Rely on FIs to realise payment function	Business model	MP1-1						
Slow response to the market needs as the state-owned company		MP1-1			MP4			
Enter the market late, do not care micro-payments	Late mover					U1		
Develop its platform late; users have formed QR code payment habit		MP1-1						
Platform services								
Targeted large merchants first, normally they have compatible POS terminals	Large merchants							MP1-4
Cooperated with e-commerce platforms to developed value-added services	Value-added services				MP4			
To protect its card business	Protect card payment business		MP3		MP4			

Comments from Interviewee MP1-4 on QuickPass

As early as 2006, China UnionPay cooperated with Nokia to develop mobile payments, and conducted field trials in 2008. China UnionPay has always been trying to do mobile payments. From the earliest SMS-based mobile payments to the NFC-based pilots. But China UnionPay did not try to build its own account system until recently. China UnionPay was not slow to react mobile payments, but hoped that through the partners to realise the mobile payments. The role that China UnionPay has been played and wanted to pay is not the account system manager. Its main resource is the payment clearing system. When selecting the partners, there is a default rule for China UnionPay - go to the large size companies. When promoting NFC-SWP solution, China UnionPay thereby only worked with three large mobile network operators. However, it is a solution which relies on multiple parties to realise. It depends on the mobile device manufacturers to supply the devices, the mobile network operators to provide the network, the financial institutions to offer the financial applications. China UnionPay was willing to cooperate with the three major operators. But at that time they focused on the development of 4G network. In addition, different parties have the difficulties to reach an agreement in terms of the role, value distribution ect. As a result, the entire NFC-SWP promotion is very slow.

Before the launch of the HCE solution, China UnionPay has made several different aspects of the attempts, including launched UnionPay wallet, cooperated with MNOs to promote the NFC-SWP, tried the NFC sticker, NFC microSD solutions. A key problem at that time is that it was still the early stage of the Chinese EMV migration. If the development of mobile payments is before the development of IC cards, the backend system of many banks were not ready at that time. While China UnionPay does not manage the users' account, it cannot on behalf of banks to issue an IC card. It has to rely on banks to issue the card. Therefore, the entire cycle of the project is slow. In other words, China UnionPay relied on the bank side to upgrade their IC card system while the IC card system migration relied on the Central Bank of China EMV migration plan. On the other hand, it needs to rely on MNOs to implement the NFC-SWP solution or the mobile device manufacturers to support NFC-microSD. Hence, it often took more than six months for a mobile payment project. It made the outsiders feel they are very slow. Before considering the HCE solution, China UnionPay did not know that it did not need to rely on the banks to issue a physical card. Actually, it can issue a virtual IC card with the support of token technology. It is enough for mobile payments as long as the virtual card is linked to the bank account.

In terms of the various Pay, mainly because of Apple Pay. Apple pay and China UnionPay integration has completed very early. The main problem was lied in the business side. Apple and China UnionPay cannot reach an agreement in terms of the distribution of transaction fees. Hence, compared with Visa, the launch of Apple pay was delayed in the Chinese market for two years. As mentioned, China UnionPay did not want to control the account system, thereby, it chose to cooperate with MNOs and banks. It wanted to fully utilise its clearing payment system. But now, it seems that China UnionPay did not want to make those Pay grow. It will harm the brand awareness of China UnionPay. Thereby, China UnionPay started to develop its own brand QuickPass and also increase the users' awareness.

