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INFORMATION SECURITY OF APPLE PAY

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ABSTRACT

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In the era of high-tech, the mode of payment is no longer just use cash or credit card. There are various payments come to our daily life. Online payment and other kinds of electronic payments are wildly in use by people. Apple Pay is a tool that provides easier and safer payment service for consumer.

The main objective of this thesis is to understand deeply and analyze how easy and convenient Apple Pay is to use and why it is known as most secure form of payment. Besides that, there is a comparison that will be made between Apple Pay, Alipay, PayPal and traditional payments. The weakness of Apple Pay and alternative future improvement are also included in thesis.

The qualitative research method will be used to conduct this thesis, the age of Apple Pay is just more than 24 months and it not mature enough than credit card payment. For many countries, it is unable to use Apple Pay, for example, in Finland. Therefore, using online source like blogs, article and reports could be the most reliable materials for this thesis.

Apple Pay is an easier and relatively safe mobile payment. Although it still has long way to go, consumers who have experienced of using Apple Pay are satisfied with the services. It's Touch ID, new NFC technology; Secure Element and tokenization do provide a secure payment environment for user.

Keywords: electronic payments, Apple Pay, Touch ID, NFC, secure element, tokenization

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1 INTRODUCTION

“In 1983, David Chaum introduced the idea of digital cash. And then in 1990, he founded DigiCash -- an electronic cash company, in Amsterdam to commercialize the ideas in his research” (Chaum 1982, cited 21.06.2016). After that Coca Cola offered buying from vending machines using mobile payments in 1997. (NFC 2016, cited 21.06.2016). Then Paypal emerged in 1998. (Andrew 2014, cited 21.06.2016) Other system such as Ali Pay, Android Pay and Apple Pay followed suit, for offering an easier payment service and making transaction safer. To begin with, online payment system like Paypal only can be installed on your laptop or PC, and before processing the transaction, you have to log in your Paypal account. Since smartphone becomes to necessities of life, more and more new functions and mobile applications are exploited to making our life easier and convenient. There is no doubt that Paypal application is exploited by Paypal Holdings, Inc. Comparing to laptop or PC, smartphone is much more portable. So people can use Paypal to shopping online in anytime and anywhere.

Paypal provides a service that allowing customer shopping at home and pay for the bills online easier and fast (PayPal 2016, cited 22.06.2016). How about shop in department store? It is able that pay with Paypal in store, but you will be asked to insert your phone number or swipe the credit card, the one bind with your Paypal account during the purchase. Next step is to insert the PIN code and then finish purchase (Kay 2016, cited 22.06.2016). However, with Apple Pay, just tap your thumb at home button and wait for verifying and then your payment complete. Apple pay may help payment completed in a fast way, from which cardholders do not need to find where is the credit card. Using Apple Pay may shorten the time of waiting in line as well.

There are so many electronic payments to choose, which is the most secure one to use? Since Apple pay launched, it is known as most secure form of payment (Angie 2015, cited 22.06.2016). On account of Apple Pay adopts some security methods to keep consumer's payment information safe, for instance, tokenization, authorizing via touch ID and a secure element for storing the sensitive data (Rex 2014, cited 22.06.2016). Moreover, Apple Pay will not send your card information to merchants. So consumers do not need to worry about the money will be stolen when using Apple Pay. Meanwhile, Apple is aiming to take the place of wallet with Apple Pay, the one-step payment process avoids people digging through the purse to find cash or credit cards (Macrumors 2016, cited 22.06.2016). Basing on existing near field communication (NFC)


technology, which allows Apple Pay works anywhere with NFC-equipped contactless terminal.

The objectives of this thesis are as follows:

- To get a deeper understand how Apple Pay works
- Analyze how convenient and easy Apple Pay is to use
- Why it is known as the most secure form of payment.

This topic is very close to daily life for nearly majority of people tend to pay with their smartphone. Mobile payment provides a service that payment can be done in anytime and anywhere. In addition, comparing to traditional payments, mobile payment allows an easier, faster and safer way for transaction. There is a trend that mobile payment or electronic payment will replace traditional payment in the future. So it is important to choose a safe mode of payment that keeps money and private information safe. In this thesis I will also explain how Apple Pay processes the transaction and why it is safe to use in an easy way.

2 APPLE PAY

“Apple Pay” comes from the Apple symbol “” followed by “pay” for its service’s name. Apple Pay is a mobile payment system and digital wallet designed to change the way of shopping (Wikipedia 2016, cited 22.06.2016). That allows users using the iPhone 6, 6 Plus, Apple Watch and later models, iPad Air 2, iPad Pro and later models to pay in retail stores using an NFC chip built into the iPhones. Apple Pay is able to buy stuff within target apps, by using Touch ID during checkout. Apple Pay can work with existing contactless terminals directly instead of using Apple Pay-specific contactless payment terminals (Apple 2016, cited 26.06.2016) (see figure 1).

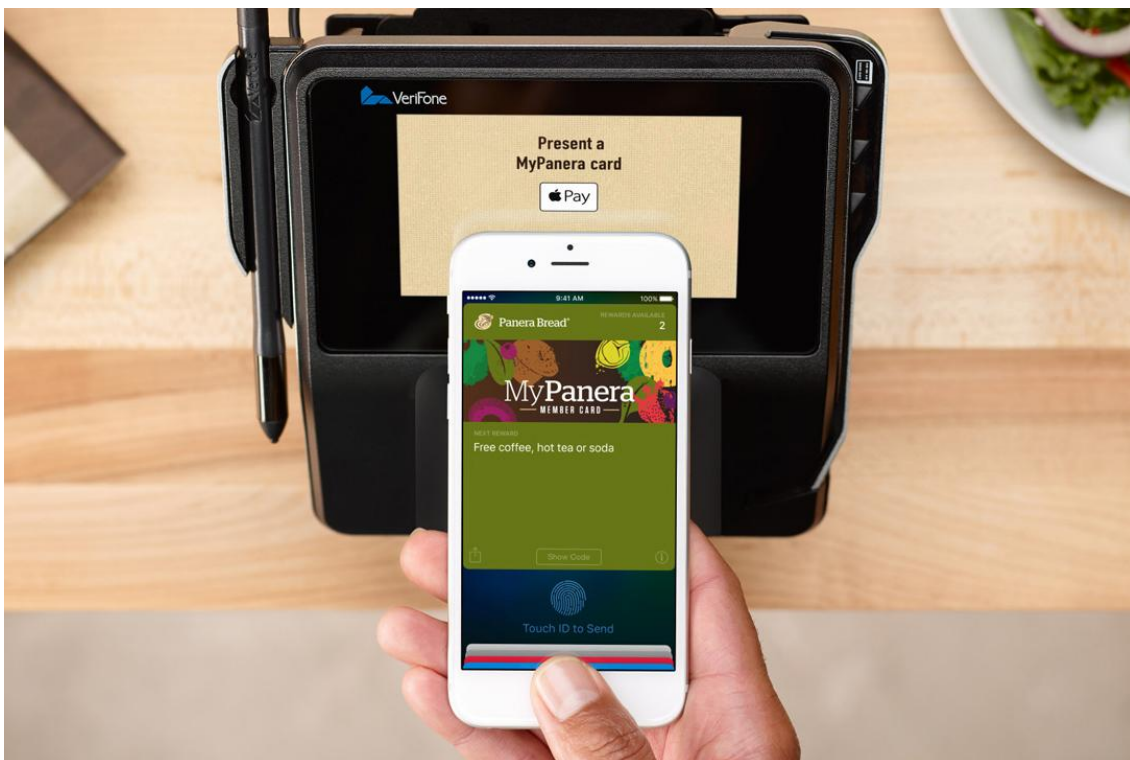


FIGURE 1. Paying with contactless terminal (cited 20.10.2016)

Apple pay does away with need to insert a personal identification number (PIN) code to verify during the checkout. It requires customers holding their iPhone near the contactless reader with their finger on its Touch ID sensor, inbuilt into the iPhone home button. (David 2016, cited 20.10.2016) Keeping a finger on the home button for a short amount time, after which a payment is authenticated and the transaction is completed. Or click the home button twice when the

iPhone is locked that unable to access Wallet and quickly process your purchases. (Christian 2015, cited 20.10.1016).

iPhone was loaded up with a couple of credit card, and it takes about 10 seconds to trigger a transaction from the binding card. If user tend to use another card, keeping his/her finger off the home button and there is a Passbook-style cards present at the bottom of the screen. Then tap on to look through the full card list and choose one card to pay with. After that leave the thumb on the home button and put close to the reader and it is ready to use Apple Pay (Nilay 2014, cited 20.10.2016). A gentle tap and beep confirm that your transaction was made and your payment information was sent also. During the process of making a transaction, debit and credit card number is never stored on customer's device. Apple does not monitor the transaction, which means that when customers pay the card numbers are never sent to merchants. Apple Pay generates a unique number for each transaction. So it builds an easier, safe and private way of payment.

Some people are puzzled about where is Apple Pay, where can start to use Apple Pay. Actually, Apple Pay is not a mobile application. So, people who use Apple devices do not need to download it from App Store. If you use iPhone SE, iPhone 6, iPhone 6 Plus, iPad Pro, iPad Air 2, iPad mini 4, iPad mini 3 and later models, you can find Apple Pay on the Wallet. If users want to use Apple Pay with your Apple Watch, scrolling down My Watch tab to Passbook & Apple Pay. In this section, it allows use to mirror iPhone and show alerts on the iPhone. After that, use iPhone to set up Apple Pay, then it's good to use (Susie 2015, cited 25.10.2016.)

2.1 Technique

First of all, enter the iPhone 6, which incorporates a technology, called Near Field Communication (NFC), Which allows user to purchase items via holding their Apple devices in front of contactless payment terminals within a range of a few inches. (Marco 2015, cited 20.10.2016) Besides that, the company uses a plenty of security measures to keep customer's payment data safe. For example, tokenization, it is the process of replacing bank account number with random numbers that maintain your personal information about the data without compromising its security. Moreover, authentication via fingerprint and a secure method are used to store the data (Kirk 2014, cited 20.10.2016).

2.1.1 NFC

NFC stands for Near Field Communication. It's very similar to Bluetooth and WiFi those kinds of wireless signals, NFC works by sending information over radio waves. In fact, the technology used in Near Field Communication (NFC) came from Radio frequency identification (RFID), which is the technology used to tracking products in large warehouses and supermarkets. RFID adopts electromagnetic induction to deliver information within a short range distance so that staff will briefly recognize what kind of things in the box by rough scanning a container (Robert 2013, cited 25.20.2016) "NFC is similar technology, but standardized for consumer smartphones." (Matt 2015, cited 27.06.2016) NFC operates within a radius of 4cm and connects one device with another in a wireless environment. Moreover, NFC allows two- way communication, as opposed to RFID's one-way reading technology. For both NFC equipped devices, they are able to send and receive information. In addition, NFC can induce electric currents within passive components or just send data, which means when it works with passive devices that don't require any power supply.

Meanwhile, it can be charged by the producing electromagnetic field (see figure 2) (electromagnetic field is used in transferring data or induce currents in a receiving equipment) by an active NFC device when it comes close to it. As for the frequency of transmitting data across NFC is 13.56 megahertz, meanwhile data will be sent at the speed of 106,212 or 424 kilobits per second. It means that it is really fast to transferring data, such as contact information, pictures and music and so on.

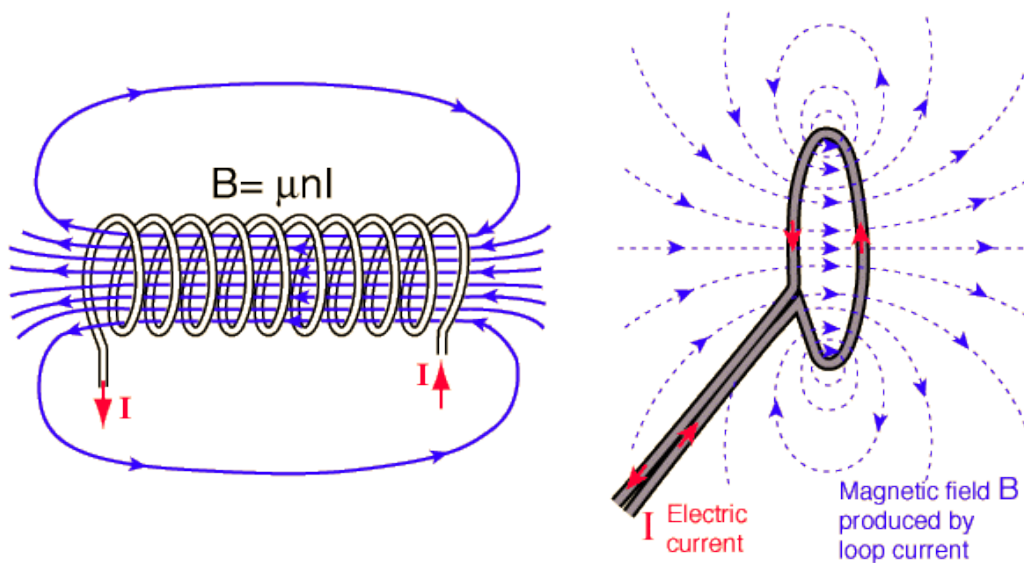


FIGURE 2. Electromagnetic fields (Triggs 2013, cited 25.10.2016)

There are three different modes of operation for compliant devices.

- **Peer-to-peer mode**

It allows two NFC-equipped devices to share a range of data between each other, for example transfer some pictures or music from one device to another. And in this mode, it switches to an active device when sending data, on the contrary, passive states when receiving.

- **Read/write mode**

It is a one-way data transmission. In this situation, the active device has to link up with another device aim to receive information from it. This mode is used in interacting with an NFC advert tag.

- **Card emulation**

It allows the NFC device used like a smart card to tap into public transport system or a contactless credit card to make a transaction

When using an NFC equipped mobile device to tap and pay, the NFC controller turn into card-emulation mode, which means that the NFC controller cannot receive the data and process association with the payment transaction. It just provides communication that the device, merchant and bank can deliver and receiver the settlement request to/from each other by using standard protocols (Ganeshji2014, cited 08.11.2016.)

NFC seems to be an essential part for smartphone no matter for payment or share information. It would be convenient that just tap your phone to a quick payment and be on your way, it would be also convenient that quickly pair with another powered device to exchange files or data. However, Apple did not attach importance to NFC before. In 2012, Apple's Senior VP Phil Schiller claimed that Apple did not regard NFC as a perfect solution to the specific consumer problems during the AllThingsD interview, meanwhile, adding Apple's Passbook is the measure taken to meet consumer's need at the time. Moreover, wired pointed out Apple has nearly 900 million credit cards on file from users' iTunes accounts. And in 2014, the chief executive officer of Apple even went so far as to indicate Apple was "intrigued" with mobile payments. Then, Apple finally decided to add NFC to the iPhone 6 and 6 Plus in September 2014.

After launching the Apple Pay on iPhone, the phone is tapped on the contactless terminal and a connection is made using NFC. At this very moment, phone owner may be asked to scan the fingerprint to permit the transaction. "The transaction is then validated with a separate chip called the secure element (SE), which relays that authorization back to the NFC modem." (Megan 2014, cited 02.08.2016). From there, the payment completes processing the same way it would in a traditional credit card transaction.

2.1.2 Touch ID

Touch ID is a new biometric fingerprint authentication technology, designed and released by Apple Inc., and now is available on the iPhone 5s, iPhone 6 Plus, iPhone 6s, iPhone 6s Plus, iPhone SE, iPad Air 2, iPad mini 3, iPad mini 4, iPad Pro and iPad Pro 9.7. With Touch ID, the Touch ID allows consumer to unlock iPhone and authenticated payment on the iTunes store, App store, iBooks store and other cooperative store. For more safe and convenient atmosphere, many people would prefer to set a strong passcode to keep mobile phone safe, Touch ID aims to authorize what has been restored and backed up in your iCloud, which makes it easy enough when people actually use it. For example, unlock your mobile phone with Touch ID instead of enter a strong password, and log in your iTunes with Touch ID rather than type your password. Meanwhile, even you forget your password, you can log in with your fingerprint. So you do not have to worry about someone wants to know your password when you enter it. Moreover, Touch ID is capable of 360-degree readability. That is to say no matter how consumer puts his/her fingers or in which direction. Touch ID sensor reads the fingerprint and recognizes who you are

(Ritchie 2013, cited 02.09.2016). Touch ID allows you set multiple fingerprints, which will be backed up into your iCloud.

The Home button can be regarded as one of the most important mainstream-computing device like the iPhone. On the one hand, it is an easy way to start the system; on the other hand, it is a perfect place to put the Touch ID sensor for it can return your feeling. Figure 3 shows a structure chart of Touch ID.

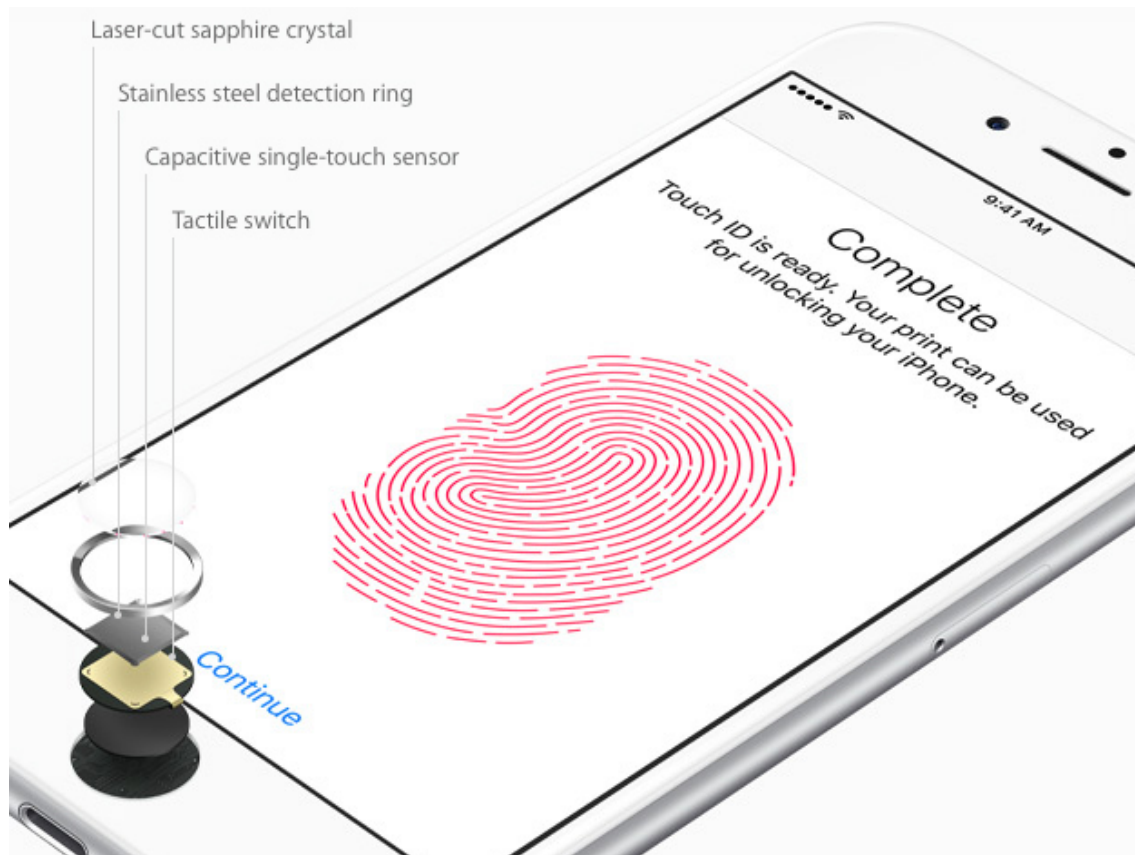


FIGURE 3. Touch ID Sensor (Chris 2015, cited 25.10.2016)

A highly scratch resistant laser-cut sapphire crystal protects the assembly and focuses the Touch ID sensor, and a stainless steel detection ring covers it. When it is triggered, the Touch ID sensor activates and takes a high-resolution snapshot of your fingerprint that will compare to what has been stored in the secure enclave on the Apple A7 chipset, if it matches, you are instantly authenticated to unlock your iPhone devices or your iTunes purchase will be preceded. In addition, Touch ID sensor is very thin and tiny, it is able to take 550ppi scans in a really good level. It is capacitive and can read sub-dermal fingerprint, if there is dead skin upon the finger, it is hard for Touch ID sensor to read. So it only can read the living skin under the epidermis. Thus, it is hard to be swindled by fake fingerprints, severed fingers (Rene 2013, cited 25.10.2016.)

Fingerprint is regarded as passport. Touch ID is independent, which reads your fingerprint in 360 degrees. To train Touch ID via holding a finger upon the Home button several times until your iPhone record an integrated fingerprint of consumer's finger. Meanwhile, it is possible to train Touch ID to recognize up to five fingers that can be five of yours, or it can be your friends, family members, colleagues, etc. It is quite important for environments where an administrator is controlling plenty of devices for a company where different people need to access to one device (Digimall 2016, cited 25.10.2016.)

About additional security layer, to use Touch ID to unlock iPhone or authorize the payment is not enough, it is necessary to create a passcode as a backup. On account of only the passcode can unlock iPhone if you reboot the phone (e.g. phone battery is empty and when charge to start up the device) or iPhone has not been unlocked for 48 hours. This is a unique feature that is designed to set a time limit for criminals, if criminals steal your phone and try to circumvent the fingerprint scanner. It is significant to aware that there is no payment is 100 percent safe. All security system may be circumvented. There is just a balance between reasonable security and unreasonable security (Brian 2013, cited 02.11.2016).

2.2 Utilisation

Before using Apple Pay, consumers need to set up your Apple Pay first. Setup is quite simple with Wallet. To get started, add the credit or debit card from iTunes account to Wallet simply by entering the card security code. If someone wants to add more cards on iPhone within the Wallet app, just tap the plus sign and follow the instructions. Here are the instructions about set up Apple Pay on Apple devices:

IPhone:

Add your Credit or Debit card on iPhone:

1. Get in the Wallet and tap Add Credit or Debit Card.
2. Choose add a new card. Entering the security code of user's Apple ID.
3. Tap Next. Issuing bank needs to verify use's information and decide whether it is able to add a card into Apple Pay. If bank asking for more information to verify, go back to Settings and then choose Wallet & Apple Pay and tap the card.

4. After bank finishing verification, tap next button. Then start to use.

iPad:

Add a card on your iPad

1. Go to Settings > Wallet & Apple Pay.
2. Tap Add Credit or Debit Card.
3. Choose add a new card. Entering the security code of user's Apple ID.
4. Tap Next. Issuing bank needs to verify use's information and decide whether it is able to add a card into Apple Pay. If bank asking for more information to verify, go back to Settings and then choose Wallet & Apple Pay and tap the card.
5. After bank finishing verification, tap next button. Then start to use.

Apple Watch:

Add your card on Apple Watch:

1. User need to open the Watch app on his/her iPhone; go to the My Watch tab. If there are more than one watch exist, choose the one you want to pay with
2. Tap Wallet & Apple Pay.
3. Follow the steps to add a card. If a card's already added on the iPhone, tap Add next to the card. To add a new card, tap Add Credit or Debit Card. Entering the security code of user's Apple ID.
4. Tap Next. Issuing bank needs to verify use's information and decide whether it is able to add a card into Apple Pay. If bank asking for more information to verify, go back to Settings and then choose Wallet & Apple Pay and tap the card.
5. After bank finishing verification, tap next button. Then it is ready to use.

2.3 Information security

About the payment and transaction, what people care about most is security. Nobody wants their private information leaked by retail, bank or merchants. For example, cyber security is one of the most significant ecommerce features. Without signing any proper protocols, online store owner may put themselves and their customer into risk for payment fraud. Some small stores unequipped with sufficient safety, which makes them facing the greatest threat form cybercriminals. Customer blindly trusts those online shop and shop on it. When they conduct their

transaction, hacker may already have got all information they want. So payment security needs to be top of mind and customer should choose the way of payment wisely.

With Apple Pay, user can use their iPhone, iPad and Apple Watch to pay in a safe and convenient way. It is easy and simple for everyone and it generates an integrated security in both hardware and software, which provides an easier and safer way to conducting transaction than swiping your credit or debit cards. The iPhone 6 and Apple Watch adopt an embedded secure Element to store information for payment (George 2014, cited 25.10.2016.)

2.3.1 Token

To avoid transmitting customer's credit-card information with each transaction, Apple Pay prefers to take "tokenization" technology into account. Token plays an important role during the merchant transfer the highly sensitive data to the card's payment network. In order to reduce security risk. Merchants and some payment processor use tokens replaced the real credit card number. In this case, token acts as a reference that relates to a card number. In addition, tokenization works with cryptogram, which generates a 16 digit number for each purchase. The cryptogram identifies the device and make sure transaction is completed safely and successfully (Rex 2014, cited 25.10.2016.)

There are two forms of tokens, one is used as a mechanism for authenticating the payment and another is used as an item mapped to your card or bank account. If you pay with EMV™ (Euro pay, MasterCard and Visa) chip card, NFC-enable phone at the POS, the device creates a unique token, also known as a "cryptogram", which hides your real information. In addition, tokens are used to tie back to sensitive data stored on highly safe server called the "vault". These tokens are useless without access to the vault. Thus, use's sensitive information is stored secure from hackers (Payments 2014, cited 07.11.2016.)

From a first data white paper, it said that the token just like original card number, which can be uses for business functions such as returns, sales reports, recurring payment, marketing analysis and so on. However, the token cannot be used to carry on a fraudulent transaction outside the merchant environment. The purpose of tokenization is to replace the card information from the merchant environment while maintaining the security (Firstdata 2012, 03-07.) The critical thing

about tokens is that they are no intrinsic value and cannot be used to conduct all types of monetary transaction. In addition, Apple Pay tokens are not mathematically generated, they are created at random. It means that they cannot be decrypted back into a credit card information due to encryption is not part of the equation. In another word, there is no master key to reverse the decryption. When you use Apple Pay to pay with a credit card, the credit card information is replaced by a random string that only the token issuer can back to the credit card account. About another layer of security, some mechanisms are set to ensure the token is bound to the phone on which the data has been stored and can never be used from another device (Yoni 2014, cited 25.10.2016.)

Apple Pay will bring user a new standard for mobile payment security. Tom Noyes – a former credit card executive who published series of in-depth posts about the mobile payment around the world. He said “Apple is the first implementation of the new EMVCo tokenization specification. In my view this is a giant LEAP beyond EMV chip and PIN, and is now (by far) the most secure payment scheme on the planet.” (Tom 2014, cited 04.11.2016) Noyes’s statement point out that Apple pay was exploited in accordance with token-based mobile payments standard which plans to improve security and reduce the incidence of fraudulent transaction.

Figure 4 illustrates how token conduct a transaction and how security level being improved. When customer taps the home button to pay, the token goes to the Merchant. At this time, the Merchant passes the token along to their Merchant Acquirer, then passes to the Network. Once token passed to the Network, the data is within the secure bank vault, which is mean that token substitute sensitive consumer account data for a unique random number that might look like a credit card number in some case. The network consults its “random number” to match the token with the customer’s account number and passes along the token and personal account number to the Bank. The bank verifies funds and authorizes the transaction. The authorization is passed to the network and conducts back to the Merchant Acquirer and to the Merchant. (Alex 2015, cited 26.10.2016) During the whole process, the merchant only stores the token data in their database, not the real card number.

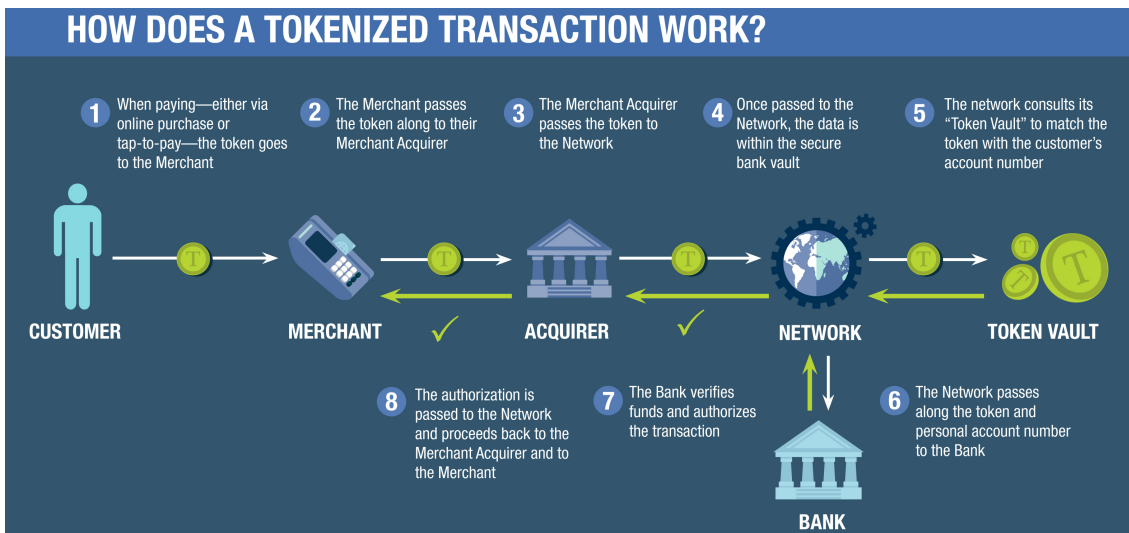


FIGURE 4. Tokenization (Alex 2015, cited 26.10.2016)

The really significant thing is that user no longer care as much about the merchant’s security. For instance, if they get hacked, nothing will happen to them. The tokens are useless to everyone. The acquirers only accept token if they are offered by the original merchant. In addition, if the hacker attempts to use token somewhere else, generally it will not work. When customer buying products form the merchant, the token will be sent to match what has been stored to the acquirer. If the token is available and that it came from the correct merchant, the acquirer will convert it back to the real card number and conduct the transaction. On the contrary, your transaction will be rejected. As a result, consumers never have to worry about their credit card information being compromised in a security breach. Furthermore, security level is effective and impenetrable, the encrypted keys for the cryptogram are all safely stored in the Secure Element (Gendal 2014, cited 03.11.2016.)

2.3.2 Secure element

The iPhone itself adopt a dedicated chip called a Secure Element, which consist of all the user’s transaction information, credit card numbers. Meanwhile, those data will never be uploaded to iCloud or Apple’s servers. GlobalPlatform published an article which said “a Secure Element (SE) is a tamper-resistant platform capable of securely hosting applications and their confidential and cryptographic data, for example, key management, in conformity to the rules and security requirements set forth by a set of well-identified trusted authorities.” (GlobalPlatform 2016, cited 07.11.2016). Simply put, a Secure Element can be used like a ship that provides a dynamic

environment to save data safely. It may self-destruct if you try to mess with it in any form to have authorized access.

However, not all NFC applications need security, only those that are used for financial transaction do. The Secure Element embedded in high-security crypto chips, which offers classify data for each application stored in it and other functions like encrypt, decrypt and sign the data packet (Ganeshji 2014, cited 08.11.2016).

In today's smartphone, there are three forms of Secure Element:

- Universal Integrated Circuit Card (UICC) or Subscriber Identity Module (SIM) Card provided by network operator
- Embedded SE directly into the phone's hardware
- MicroSD card insert into the smartphone

In the iPhone 6, 6Plus and Apple Watch, the Secure Element is embedded directly into the NFC chip, which is designed to keep user's payment information safely. While the NFC chip stimulates the communication between the payment terminal and Secure Element. To put things into context, the NFC controller goes into card-emulation mode when using iPhone 6 or 6Plus to tap and pay. During the transaction, the NFC controller is unable to deal with the data or processing the payment. The function of NFC is just providing communication.

What's more, a Secure Element stores data of cardholder and create cryptogram encrypt customer information. To be specific, Secure Element emulates the contactless that is stored inside of the secure element in the form of payment applications, which carry out the contact with the terminal, sending the right responses to the right questions, creating dynamic cryptograms, authenticating the stored card and so on. To take a further step and make it more accurate is not to emulate the card but the software that is store inside the SE emulates a contactless card. The Secure Element provides a safe storage and environment for the payment application to complete its task.

When tapping a NFC device in front of the NFC reader, the NFC Controller will ask for authentication from the secure element. As Figure 5 shows. Because of Apple Pay works with embedded Secure Element instead of using HCE technology, it will not store the real card details or token data in the cloud server at all. However, what will be stored in the Secure Element?

When customer adds a credit card to Mobile Wallet, the simplest responsibility of wallet is to store the real payment credentials e.g. the Primary Account Number (PAN) in the SE.

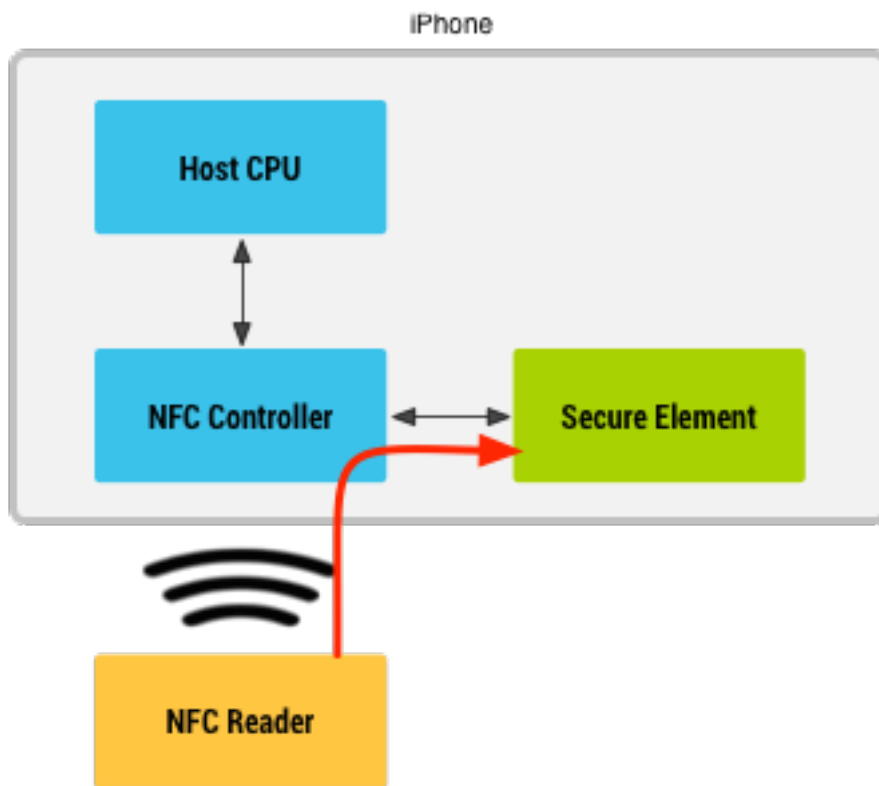


FIGURE 5. Embedded Secure Element (Hsuan 2014, cited 07.10.2016)

But Apple does not work like that, instead Apple Pay store the token data and some related information inside the Secure Element. It is the token that sends to the contactless terminal along with a cryptogram. During the process of the authorization, the payment network recognizes the token, de-tokenizes them into real PAN with the assist of a Token Service Provider (TSP) and then send the real Pan to the issuing bank for authorization. Apple owns and controls the SE that is stored inside the device, avoiding superfluous challenges from the MNOs (Mobile Network Operator). Apple simplified the provisioning model and adopt token instead, which predigest the process to a bare minimum (Marwaha 2014, cited 08.11.2015.)

Finally, Apple embedded Secure Element into SIM card, which is hard to be hacked. And embedded SE can be used without an Internet connection. Besides, the tokenized LUK for the card information will never transmitted or stored in other places. However, there are some disadvantages of embedded Secure Element. Firstly, each device has a different hardware configuration. The embedded SE approach cannot set as a standard to all devices. Therefore,

there is a high rate that a flaw in interfacing with the embedded SE will generate security concerns. Moreover, there are fixed storage and fixed capabilities for the device; you cannot have more storage when memory is full (Connor 2014, cited 08.11.2016.)

3 COMPARISON

We mainly purchase items with our credit card or pay with cash years ago. But nowadays there are large amount of people shopping online. As a consequence, an increasing number of electronic payments come to our life and in order to meet customers need. Thus more and more people start to use online payment services. To some degree, it seems that electronic payment will replace traditional credit card payment and pay in cash. It is obvious that services like Paypal have been around for several years, but there are some obstacles that are blocking the way to Chinese market. Nevertheless, Alipay is the biggest Chinese online payment platform, which is like “Chinese Paypal” (for example, Appendix 1). Paypal and Alipay stand a really positive position in America and China, respectively. However, since Apple Pay launched, both of them are confronting challenges of different degree. Because Apple Pay is known as the most secure form of payment, and it is easier and fast way to pay. Paypal and Alipay are the most important and common modes of payment in worldwide and China, respectively. So that is why I choose traditional credit card payment, Paypal payment and Alipay payment to compare with Apple Pay. As for the comparison, mainly focus on comparing what kinds of function they have and how is it differ from each other. Besides that, it is essential to make a list of advantages and disadvantages for every payment.

3.1 Bank card payment

Bank card payment has been around over the years, which is a payment card issued to cardholders as a method of payment. This payment allows currency and coins to be used to mediate transactions by physical exchange (Uday 2016, cited 01.11.2016). Meanwhile, cardholder is able to pay for products and services based on the holder’s promise. Credit card payment and Debit card payment are common traditional payment. Credit card payment -- The bank creates an account and grants a line of credit to the cardholder, from which they can borrow the money to pay products or use as a cash advance (Steven 2003, 261-262). The big feature of credit card is overdrawing. About Debit card, which is like digitized versions of checkbooks. Your card links to your bank account and money is withdrawn from the account when the transaction occurs.

Even though plenty of people trend to use E-payment or mobile payment, we cannot ignore the fact that bank card payments do make our life easier. The features of bank card payment are as follow:

- It is able to use credit card practically everywhere, especially overseas. They also allow user to shop online, for example buy products on Amazon, book flight ticket or hotel online.
- Credit card allows you purchase items and then pay off at the last date. Sometimes, they offer user discount at store and bonus. Such as, when you pay with credit card you can collect points which can be used to get a present.
- Bank card allows you withdraw in front of ATM.
- The issuing bank will build your credit history when you use credit card.
- They can be used to make loans or financial management.

In spite of Apple Pay is an easier and safer payment, it is more like a moving wallet that allows you to pay at store or online. Unlike bank card, Apple Pay cannot be used to withdraw money. On the other hand, it will not allow user to make a loan or financial management. However, the process of Apple Pay is simple than the bank card payment and the tokenization technology makes Apple Pay safer.

Take Credit card payment as an example. Figure 6 presents a Four-Party Credit Card Model in Canada. the parties being the cardholder, the merchant (or service provider), the card issuer and the payment processor (or acquirer). To start a credit card payment, the cardholder who wants to buy a product shows the credit card in front of the merchant. The merchant delivers the user's credit card information to the payment processor, then forward it to the card issuer to get the promise. Once been authorized, the merchant makes a charge and provides the product to cardholder. Firstly, the bank will pay the payment processor for what the cardholder bought, then payment processor transfers the money to the merchant. At a later date, the cardholders have to pay their purchase to the bank (John 2009, 1-2.)

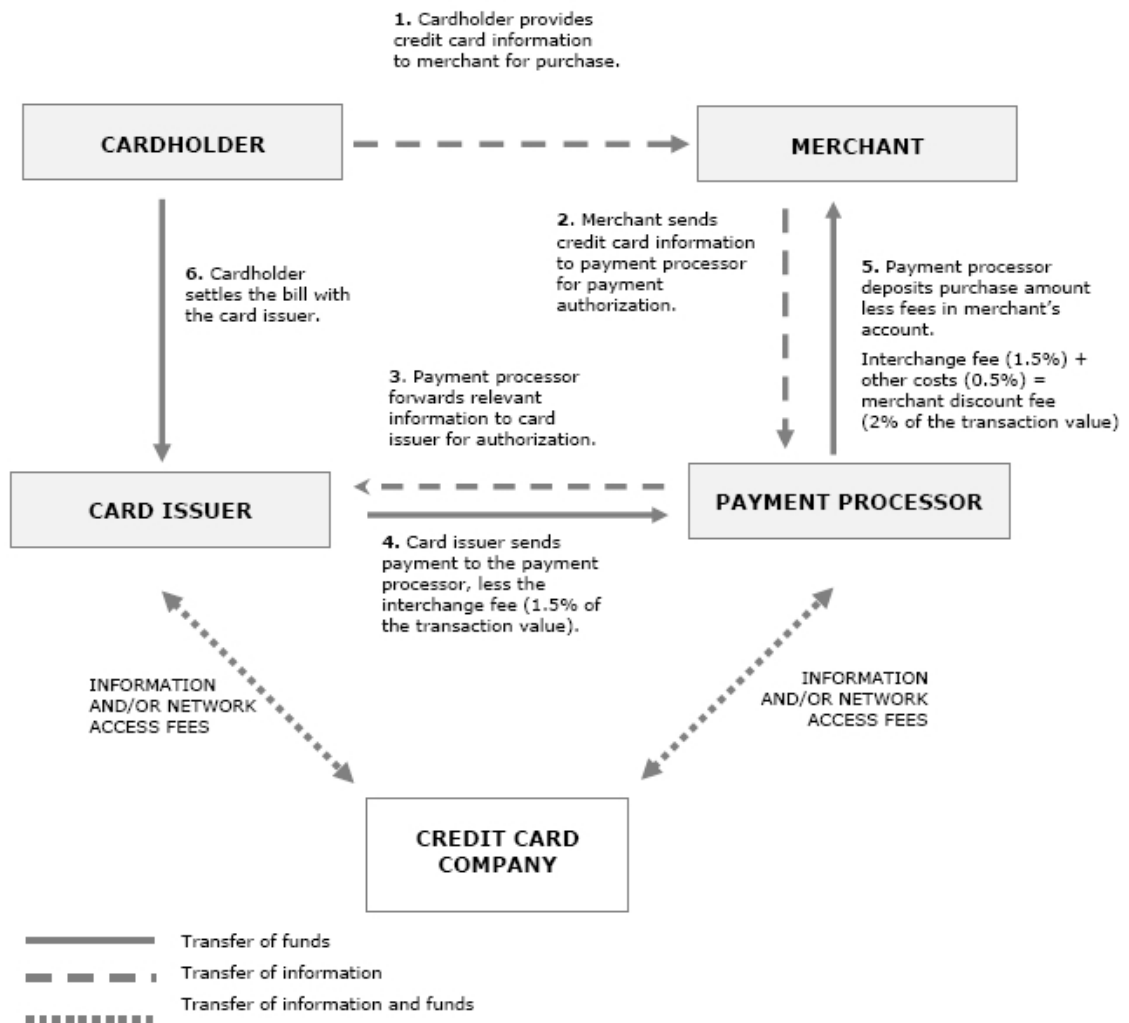


FIGURE 6. Four Party Credit Card Model (John 2009, cited 01.11.2016)

Comparing to Credit card model, the process of Apple Pay is quicker and easier. With Apple Pay, user just need to hold and tap to finish the purchase. There is no need to transfer the money at a later date. Generally, there is a high chance that user forget to pay off the credit card. In addition, it can be seen from the graph, merchant, payment processor and card issuer share the cardholder's information. "It's impossible to do transactions without data, and data is obviously a potential risk," Mr. Anderson said. "Your old fashioned credit card can be cloned by a waiter. Merchants routinely have credit card numbers stolen" Mr. Soghoian said (Danny 2014, cited 01.11.2016). The process of Apple Pay will never use consumers' actual account number. It replaced by an randomly 16-digit number. In this casse, comparing to credit card, Apple Pay is more safer to use.

3.2 Paypal payment

Paypal is a worldwide online payment service which enables individuals and businesses to transfer money electronically to another Paypal account. In addition, it provides a secure trading environment, which allows you to shop online without sharing any sensitive financial details (see more features in appendix 2) PayPal is used for online payments, but also can handle real store payments with optional debit card, which allows peer to peer payments. For example, using PayPal account connected to some apps. Besides, user can request payout and accept payments. The PayPal account works like a prepaid account when user stores money in the account. Meanwhile, user can connect your Bank accounts and credit card accounts to the PayPal account to add funds or for real-time transaction. It also provides direct PayPal payments for online merchants via installing a widget. While using the debit card for in-person payments, you need to enter your phone number or swipe the card at first. Then input your PIN code to complete the purchase (Michael 2013, cited 05.11.2016).

However, Apple Pay does not support peer-to-peer payment. Unlike PayPal, Apple Pay operates like a digital wallet that collects your bank information into an app. To be specific, Apple use Wallet to store the user card details, therefore, user does not need to open an app to conduct a payment.

PayPal owns hundred million of user, including private use and business account. So there is a conspicuous advantage is that large numbers of people already have an account, so it is very easy for them to complete a purchase by logging in the Paypal account. On the other hand, it allows merchants to accept different types of credit card and invoice the customer with lots of methods, for instance, send by email or delivery to the customer directly. Moreover, PayPal developed an application-programming interface (API), which contributes to integrating the website with application. To illustrate, when you are about to check out on an online store, the website will redirect you to PayPal and then send you back to the merchant site. That is one feature of the PayPal API integration, which is more secure than other web store. Due to all bank card and credit card details are stored at PayPal instead of keeping sensitive information on your web server. Another benefit of PayPal is that it is free to use. Some merchant processing sites will charge customer monthly fee to make a profit. Even charge you another fee depending on what type of credit card you used. However, PayPal offer processor service for free, so it is good for customer to use (Logan 2015, cited 07.11.2016.)

Since Apple Pay launched, more and more people trend to use Apple Pay. Figure 7 and Figure 8 present a survey about a mobile payment app reference and mobile payment app rating in North America respectively. The survey conducted by 451 research's ChageWave services, there were 4,168 respondents support the result. From figure 6, Apple Pay ranks the first in terms of mobile payment application users plan to use going forward. There are 45 percentage of respondents claim that they plan to use Apple Pay, which grows up dramatically since June. As seen in the chart, PayPal is definitely being impact by the launch of Apple Pay. It dropped from 54 percentages to 28 percentages. Figure 7 shows satisfaction among consumers who are already using mobile payment apps, Apple wins, with 66% of respondents who have used Apple Pay indicating they are very satisfied with the service (Essery 2015, cited 01.11.2016.)

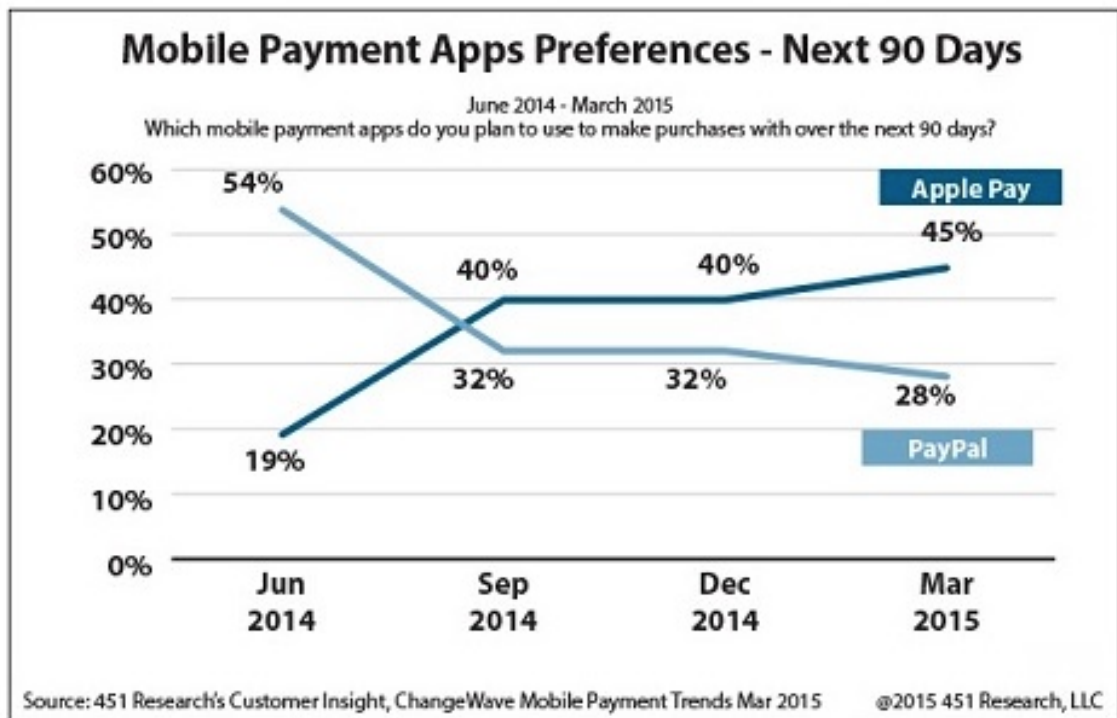


FIGURE 7. Mobile Payment Apps Preferences (Michael 2015, cited 01.11.2016)

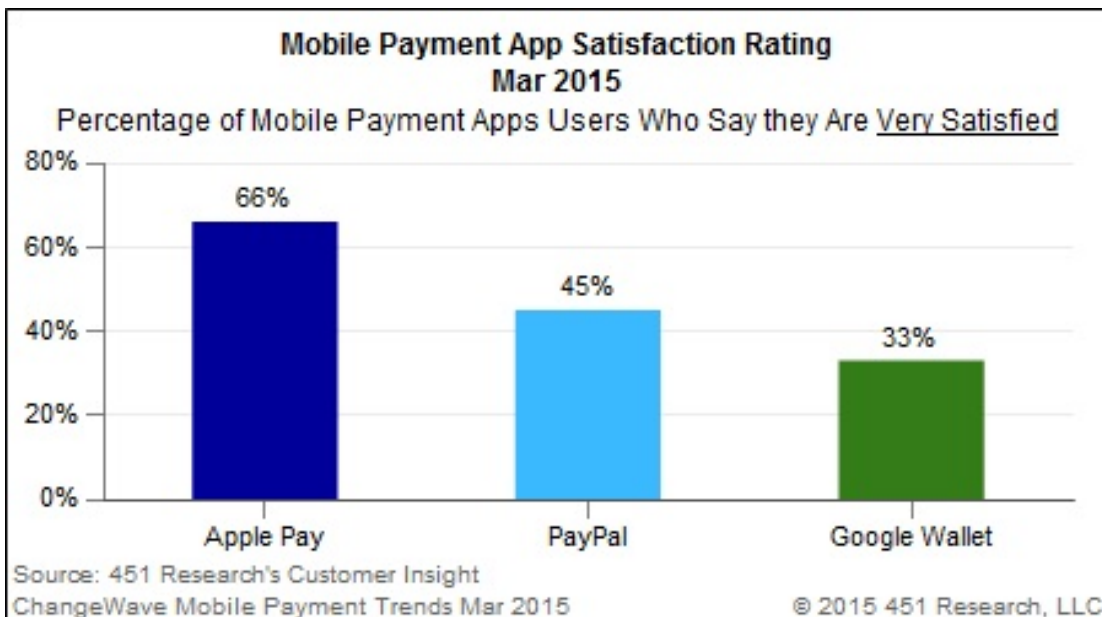


FIGURE 8. Mobile Payment Apps Satisfaction Rating (Michael 2015, cited 01.11.2016)

In terms of operation, Apple Pay is easier than PayPal. It lets user placing iPhone 6 or 6 Plus next to a contactless payment terminal equipped with a NFC signal. Using fingerprint to authorize the payment instead of logging in and accepting payment. On the other hand, “tokenization” method replaces your real card number with an encrypted code and generates a random number for each transaction. In that case, only issuing bank knows your real bank card number. PayPal stores consumers credit card details, during the check-out step it will redirect to PayPal site require logging in your account to confirm the transaction. However, it is possible that your PayPal account suspended for some reason, which will prevent transaction from operating regularly.

3.3 Alipay payment

Alipay is a third-party third-party online payment platform with no transaction fees. Unlike other online payment platforms, Alipay is a Chinese payment platform, which mainly focus on Chinese customers. The payments and shopping application made by the Alibaba subsidiary, and it has 400 million active users each month. In addition, it is now available at a huge number of shops across the China, from roadside vendors to department stores (Jake 2016, cited 24.09.2016.)

Alipay has been called the PayPal of the East. However, Alipay is more than the PayPal or Apple Pay. First of all, it is necessary to understand the background of how Chinese customers use Alipay before comparing with Apple Pay. As far as I am concerned, people prefer to use their

credit card to buy the products they need by tapping the home button upon the contactless payment terminal through Apple Pay instead of inserting the PIN code. On account of it is the easier and fast way to pay. There are 564 million Internet users in China, a large number of them own at least one credit card, but they do not use western bands like Visa and MasterCard to shop online, instead they use Chinese UnionPay. Although credit card has a growth trend in China, the majority of Chinese people prefer to use debit card for saving money. It is partly a cultural phenomenon that you know how much deposit you have and then buy something if you can afford it. However, Alipay can be used alternatively with credit card, much as Apple Pay can be. On the one hand, it can be bound with a bank account (Misha 2013, cited 24.09.2016.)

On the other hand, Alipay is more than a way to shop online. It consists of many different functions that Apple Pay do not have:

- Pay credit card bills without any commission charge
- Pay utility bills without extra fee
- Work with all smart phone, tablets, and computer
- Takes two hours to transfer money to the others
- Top up mobile phone credit
- Buy movie tickets
- Buy bus tickets and Pay for taxi service
- Check bank balance
- Check-out on shopping apps or service apps (For example: Tmall.com and Taobao.com)
- Use for online shopping
- Use for checking out in retail store (Wal-Mart, Carrefour, Metro etc.)

Moreover, Alipay is not only a way of payments; it was initially introduced to settle the problem seller providing fraudulent products on Taobao. When customer pays for the orders with Alipay account, the money will not be transfer to seller directly, instead it is held by Alipay escrow account. The seller has to deliver the products to customer first, and then customer will receive the product and confirm the shipment. Then Alipay start to transfer the money to seller within several days. However, in some online shopping websites, for example Taobao -- a C2C (customer-to-customer) website, customer chose the product based by the pictures and reviews. There is high rate of customers who did not receive the same products with that they chose online. Under the circumstances, customer has right to apply for refund or exchange. In case of

request rejected, you can get Alipay involved to solve the dispute. Until customers are satisfied with their order and confirm the shipment, seller can get the money from the Alipay. This is how Alipay protect customer's right. To the contrary, Alipay also provides protection for the seller. When buyer forgets or they are too lazy to confirm the shipment after they receive it, payment will be released within 10 days. All those services provide a mutual trust platform for buyer and seller. That is why Alipay grows so fast (Bei 2014, cited 24.09.2016.)

What's more, the main difference between Apple Pay and Alipay are the technologies used: Apple Pay use NFC while Alipay adopt QR (Quick Response) codes. In Apple Pay, put iPhone or Apple Watch near a contactless reader with your finger held on Touch ID. Even no need to unlock the phone or open any App. Besides, it allows you to pay without an Internet connected. To some degree, NFC payment is regarded as an update POS (Point of sale) system, but there are not enough NFC enable POS machines around the world to support Apple Pay.



FIGURE 9. Alipay payments (Jana 2016, cited 01.11.2016)

However, Alipay is much more complicated than Apple pay. Alipay is a mobile App that needs to download on your smart phone first. Customer needs to log in with his/her own account. When you pay for the groceries, unlock the smartphone first and then enter the App and tap payment. After scanning QR code you will need to enter passcode or fingerprinting to confirm the payment. Besides that, Alipay allows user to withdraw cash in ATM machines, whereas Apple pay cannot. In general, Alipay has high popularity in China, and it is low barriers to entry. With it you can buy financial products, grab a red envelope and so on. But payment processing is more complicated in than Apple Pay and it is vulnerable to viruses and Trojans (mainly Android phone) invasion lead to pecuniary loss (Karena 2016, cited 26.09.2016.)

4 FUTURE IMPROVEMENTS NEEDED FOR APPLE PAY

Although Apple Pay it is known as the most secure form of payment. It just over 20 months old and it is still not mature enough comparing to other payments. So it still has long way to go.

NFC

Apple use near field communication (NFC) technology allows Apple devices connect with contactless payment terminal, thus complete transaction. But the company's new NFC chip only can be used with the company's "Apple Pay" mobile payment solution and developers will not be able to take advantage of additional features or use in third-party apps. So other developers are unable to use the hardware for other purposes like sending files between phones, pairing speakers or connecting to your new Wi-Fi camera. Apple is preventing NFC closed from other developers at launch. In this case, purchase is limited for you only can use Apple Pay with fixed applications.

Touch ID

Touch ID facilitates easier and safer payment but the fingerprint scanner might not be the most convenient all the time. For example, if you have to fumble around and take off your gloves in the very cold New England winter to buy a magazine. Even some time the weather is so cold that your iPhone turn off (Abby 2014, Cited 07.11.2016). Besides, there are some situations that iPhone will be locked down and it is unable to use Touch ID to unlock the iPhone. It is necessary to enter a passcode to activate the device.

1. When Touch ID hasn't been used in two days, it is necessary to enter a passcode or password to unlock device.
2. If iPhone or iPad has been rebooted, Touch ID is useless at this time. Only by entering the passcode can unlock the device.
3. when a fingerprint cannot be read five times, it is necessary to enter a passcode or password to unlock device.

You cannot use it everywhere

The biggest problem of Apple Pay is that you cannot count on being able to use it. The use of Apple Pay is constrained by what phone you have, meanwhile, you are limited by what retailers will accept. Nowadays, Apple Pay is widely accepted in grocery stores, boutiques, restaurants,

hotels and so on. There are millions of retailers have cooperation with Apple Pay. Theoretically user can use Apple Pay at any retailer that has the latest contactless terminal. Aim to be compatible with new chip enable credit cards, lots of store bought new contactless terminal. However, some retailers like Wal-Mart, CVS are planning to launch their own payment system, they decide to block Apple Pay on their terminal (Cybele 2015, cited 07.11.2016.)

In addition, although Apple Pay it is known as the most secure form of payment. It just over 20 months old and it is only available in several countries, including the U.S., Canada, the UK, Australia and China. So, there is a limitation to extend the footprint of Apple Pay service worldwide. But there are plans to do a lot more now (Clare 2016, cited 07.11.2016.)

Bank

The Wall Street Journal on Monday published a report, said that there are several banks were finding that an increasing number of fraud incident happened on Apple Pay. A mobile payment expert Cherian Abraham, regarding that payment fraud as "growing like a weed." The problem is that bank security is not enough to anchor the transaction. Consumers first add credit card data into Apple Pay; banks have to make multiple verifications to make sure that the person adding the card data is the phone owner or cardholder. Some banks do ask multiple security questions but not good enough. While still some banks never ask those question when adding a card into a payment system (Curry 2015, cited 08.11.2016.)

The expert also identifies when Apple has new accounts, it will be delivered to a "green path," if there were no problem, "a yellow path" – a security team will process the authentication, or "a red path" to stop an account as soon as possible. The expert reported that there is negligible fraud with cards provisioned via the green path. Besides, Abraham posited that "It is unconscionable that Apple did not, and was not strongly advised by its partners — to make the Yellow Path implementation (by an issuer) mandatory sooner than it did, which was four weeks before AP launch. By then, it was too late for any issuer who had been focused elsewhere to put up any effort of merit," wrote Cherian Abraham in a Drop Labs blog post. Nowadays, comparing credit card payment industry, mobile payment is still young (Colleen 2015, cited 08.11.2016.)

Services

The security of Apple Pay does attract more users. But what about the services that Apple Pay provide to us. Unlike Alipay and PayPal, Apple Pay works like a digital wallet that you only used

for paying. Alipay allows consumer to withdraw cash at ATM, financial management, pay for taxi and son on. PayPal can be used to shop online, make an auction and transfer money to other PayPal account etc. Those services that Alipay and PayPal offer to consumer makes our life easier and convenient. So Apple Pay should bring us more surprise and offer consumer more services in the future.

5 CONCLUSION

Apple Pay service was announced at Apple's iPhone 6 events on September 9, 2014 in California. And the name "Apple Pay" comes from the symbol and its "pay" service. Apple Pay is a payment service as well as a feature on the latest iPhone and Apple Watch. It is designed to add your credit card, debit card and other kinds of payment data into Apple Payment system, enabling iPhone 6, iPhone 6, 6 Plus, 6s, 6s Plus, 7, 7 Plus, and SE users in the United States, the United Kingdom, Canada, Singapore, Australia, Switzerland, Hong Kong, China, Japan, and 3 more countries to purchase products and services with their iPhones in retail stores using an NFC chip built into their iPhones.

Touch ID, near field communication, Secure Element and Tokenization are the significant technology that support Apple Pay's high-security environment. Apple doesn't save any consumer's transaction information or card details on the servers. Because of it has a tokenized backend infrastructure, keeps card payments secure via generating a 16-digital number (token) looks like card number replaces your real card details. The token is assigned, encrypted and securely stored in the Secure Element that is embedded into the NFC chip in the iPhone 6, 6Plus and Apple Watch. When the payment initiated, the token is sent to the retailer or merchant. They never have access to your real card information.

Apple Pay does not need PIN code to authorize the payment, with Touch ID; it allows user put thumb on the home button tap the contactless payment terminal and pays the products and services. Your fingerprint is hard to be swindled by fake fingerprint for the Touch ID Sensor is capacitive and can read sub-dermal fingerprint. Thus, someone use your fake fingerprint cannot conduct the transaction successfully.

There were increasing incidences of fraud on Apple's mobile-payment these days. The design of Apple Pay is highly secure, which encrypted customer's real bank detail and never send it to retailer or merchant. Even iCloud only store token data instead of real bank account. The real problem is that banks need to take new measure to increase its security in Apple Pay. Also Apple Pay need more security steps to make sure that the one who add credit card to Apple Pay is self-conducted.

6 DISCUSSION

The objective of this thesis was to make a deeper understanding of what is Apple Pay, what kinds of technology being used to support its security and analysis where Apple Pay could be improved in the future. The method of the research is qualitative. Apple Pay is still new mobile payment for some countries, thus some online blogs, articles and report wrote by people who works on the field are the most reliable materials. Due to unfamiliar with the Apple payment system and the research mainly relies on the articles and blogs online without experiment and survey, therefore, it took more time than expect to collect useful source and data to draw a conclusion.

Apple Pay is still new for me although I use iPhone 6, I had never try Apple Pay in Finland or even in China. It is not available to use Apple Pay in Finland. So, I was unable to make an experiment by myself to test how convenient and easy Apple Pay is to conduct a transaction. During the process of finding reliable source materials, I learnt to use Google search engine efficiently. Besides, wrote this thesis is more like a self-study. I learnt so much knowledge about payment system. Such as Tokenization, near field communication (NFC) and Secure Element (SE) and so on. Sometimes, it was still hard to understand by only reading the articles, there were so many terminologies I had never heard and also I had never studied in my studies. So I had to read the texts with pictures to explaining the content.

The Main result of the Thesis is that Apple Pay is an easier and relatively safe mobile payment. In the future Apple Pay could for example, ask some security question when first add a credit card to Apple's payment system. To make sure the person is a real cardholder or a phone owner. It also could provide more services for consumers, for example, allow consumer draw money from an ATM or use Apple Pay to pay in online shop. That will be more attractive and welcome around the user.

REFERENCES

- Andrew, W. Digital vs. Virtual Currencies, Cited 21.06.2016,
<https://bitcoinmagazine.com/articles/digital-vs-virtual-currencies-1408735507>.
- Aron.H. 2016. What is Paypal and How does it work on eBay? A PayPal Primer. Cited 30.09.2016, <https://www.thebalance.com/paypal-working-on-ebay-1140193>.
- Abby.C.2014. How Apple Pay could improve mobile payment security. Cited 07.11.2016,
<https://www.internetretailer.com/2014/09/18/how-apple-pay-could-improve-mobile-payment-security>.
- Angie, T. 2015. Why Apple Pay is the Most Secure Form of Payment. Cited 22.06.2016,
<https://www.bignerdranch.com/blog/why-apple-pay-is-the-most-secure-form-of-payment/>.
- Apple Inc. 2015. Getting started with Apple Pay. Cited 03.10.2016,
<https://developer.apple.com/apple-pay/Getting-Started-with-Apple-Pay.pdf>.
- Apple 2016. Set up Apple Pay on your Apple devices. Cited 05.07.2016,
<https://support.apple.com/en-us/HT204506>.
- Alex.R. 2015. Payment Card Tokenization. Cited 26.10.2016,
<http://www.paymentscardsandmobile.com/payment-card-tokenization/>.
- A First Data White Paper. 2012. EMV and Encryption + Tokenization: A Layered Approach to Security. Cited 25.10.2016, <https://www.firstdata.com/downloads/thought-leadership/EMV-Encrypt-Tokenization-WP.PDF>.
- Bigcommerce. 2015. Why is online security so important. Cited 03.10.2016,
<https://www.bigcommerce.com/ecommerce-answers/why-online-security-so-important/>.
- Chris.S. 2015. iPhone 6s: How fast is the new Touch ID fingerprint sensor. Cited 25.10.2016,
<http://bgr.com/2015/09/25/iphone-6s-touch-id-fingerprint/>.

Cybele.W.2015. 3 things you really should know about mobile payments. Cited 07.11.2016, <http://time.com/money/3852295/mobile-payment-apple-pay/>.

Clare.H.2016. Apple Pay: Everything you need to know. Cited 07.11.2016, <http://www.channelpro.co.uk/opinion/9552/five-ways-apple-pay-has-transformed-business-13>.

Colleen.C.2015. Banks need to increase Security Measures in Apple Pay, Experts say, Cited 08.11.2016. <https://news.vice.com/article/banks-need-to-increase-security-measures-in-apple-pay-experts-say>.

Christian.Z. 2015. How to quickly access Wallet and Apple Pay on the Lock screen. Cited 20.10.2016, <http://www.idownloadblog.com/2015/10/02/how-to-wallet-apple-pay-lock-screen/>.

David, C. 1982. Blind signature for untraceable payments. Cited 11.10.2016, <http://blog.koehntopp.de/uploads/Chaum.BlindSigForPayment.1982.PDF>.

David.P. 2016. Complete guide to Apple Pay UK: When will my bank get Apple Pay, Apple Pay comes to Mac, and the Co-op Bank supports Apple Pay. Cited 20.10.2016, <http://www.macworld.co.uk/news/apple/apple-pay-uk-when-will-my-bank-get-apple-pay-release-date-mac-clydesdale-3544309/>.

Daniel, H. 2014. What is NFC and why does it matter for the iPhone 6. Cited 29.06.2016, <https://www.yahoo.com/tech/what-is-nfc-and-why-does-it-matter-for-the-iphone-6-96456683964.html>.

Digimall 2016. Professional Troubleshooting and Repair of Touch ID Sensor from DigiMall. Cited 25.10.2016, <http://digimall.org.au/touch-id-sensor-repair/>.

Danny.Y. 2014. Why Apple's Tap-to-Pay Beats Credit Cards. Cited 01.11.2016, <http://www.wsj.com/articles/whys-apples-tap-to-pay-beats-credit-cards-1410394757>.

George.A.2014. Banks and retailers hop on Apple Pay bandwagon. Cited 25.10.2016, <http://www.retailwire.com/discussion/banks-and-retailers-hop-on-apple-pay-bandwagon/>.

- Ganeshji, M. 2014. Mobile payments FAQ. Cited 08.08.2016,
<http://www.gmarwaha.com/blog/2014/09/01/mobile-payments-what-is-a-secure-element/>.
- Giorgia. 2016. What is PayPal and How does it work. Cited 30.09.2016,
<https://depop.zendesk.com/hc/en-gb/articles/209921857-What-is-PayPal-and-how-does-it-work->.
- GlobalPlatform 2016, GlobalPlatform made simple guide: Secure Element. Cited 07.11.2016,
<https://www.globalplatform.org/mediaguideSE.asp>.
- Hsuan.C.2014. EverydayNFC, Cited 07.11.2016. <http://everydaynfc.com/?tag=secure-element>.
- John.B.2009. Payment System: The Credit Card market in Canada. Cited 01.11.2016,
<http://www.lop.parl.gc.ca/Content/LOP/ResearchPublications/prb0910-e.pdf>.
- Kay, T. 2016. 10 Most Asked Questions About PayPal. Cited 22.06.2016,
<http://www.hongkiat.com/blog/paypal-most-asked-questions-solutions/>.
- Karena.H. 2016. Apple Pay aims to dethrone Alipay. Cited 26.09.2016,
<https://beijingtoday.com.cn/2016/03/apple-pay-aims-to-dethrone-alipay/>.
- Kirk. 2014. How Apple Pay really works and Why you should begin using it immediately. Cited 20.10.2016, <http://www.kirklennon.com/a/applepay.html>.
- Logan.W. 2015. Pros and Cons of using PayPal as your credit card processor. Cited 07.11.2016,
<http://emaginemore.com/blog-post.php?post=35>.
- Macrumors 2016. Apple Pay. Cited 22.06.2016, http://www.macrumors.com/roundup/apple-pay/#apple_pay_overview.
- Matt, E. 2015. A guide to NFC and how to use on your smartphone. Cited 27.06.2016,
<http://www.pcadvisor.co.uk/how-to/mobile-phone/what-is-nfc-how-nfc-works-what-it-does-3472879/>.
- Megan, G. 2014. How Apple Pay actually work. Cited 02.08.2016,

<http://arstechnica.com/gadgets/2014/10/how-mobile-payments-really-work>.

Misha, M. 2013. Online payment services in China: How does Alipay differ from Paypal. Cited 24.09.2016, <https://www.nanjingmarketinggroup.com/blog/chinese-internet-users/online-payment-services-china-how-does-alipay-differ-paypal>.

Marco.T. 2015. Wallet no more: How the tech behind Apple Pay can change our lives. Cited 20.10.2016, <http://www.macworld.com/article/2903337/wallet-no-more-how-the-tech-behind-apple-pay-can-change-our-lives.htmls>.

Nilay.P. 2014. Apple Pay hands-on: is this the future of payments. Cited 20.10.2016, <http://www.theverge.com/2014/9/9/6128371/apple-pay-hands-on>.

NFC. 2016. History of Mobile & Contactless Payment System. Cited 21.06.2016, <http://nearfieldcommunication.org/payment-systems.htm>.

Payments Leader 2014. The future of Payment Security: Tokenization. Cited 07.11.2016, <http://www.paymentsleader.com/the-future-of-payment-security-tokenization>.

PayPal 2016. It's Quick and Easy to Get Started with PayPal. Cited 22.06.2016, https://www.paypal.com/cgi-bin/webscr?cmd=_merchant-get-started-outside.

Rex, S. 2014. Why Apple Pay Is the Most Secure Payment Platform on the Planet. Cited 22.06.2016, <http://mashable.com/2014/10/23/apple-pay-is-more-secure-than-your-credit-and-debit-cards/#3UK8vdKFNSqJ>.

Rene, R. 2013. How Touch ID works: Making sense of Apple's fingerprint identity sensor. Cited 02.09.2016, <http://www.imore.com/how-touch-id-works>.

Robert, T. 2013. What is NFC&How does it work. Cited 25.10.2016, <http://www.androidauthority.com/what-is-nfc-270730/>.

Steven.M. 2013. Economics: Principles in action. Cited 01.11.2016, https://college.lclark.edu/faculty/members/arthur_o_sullivan/.

Susie.O. 2015. How to use Apple Pay on the Apple Watch? Cited 25.10.2016,
<http://www.macworld.com/article/2919859/how-to-use-apple-pay-on-the-apple-watch.html>.

Uday.S. 2016. What is the Traditional Payment System in Management Information System?
Cited 01.11.2016, <http://inkpageindia.blogspot.fi/2016/03/what-is-traditional-payment-system-in.html>.

Wikipedia 2016. Apple Pay. Cited 21.06.2016, https://en.wikipedia.org/wiki/Apple_Pay.

Yoni.H. 2014. Apple Pay: An in-depth look at what's behind the secure payment system. Cited
25.10.2016, <https://www.engadget.com/2014/10/02/apple-pay-an-in-depth-look-at-whats-behind-the-secure-payment/>.



Chart 3: 2015 Q3 third party payment marketshare

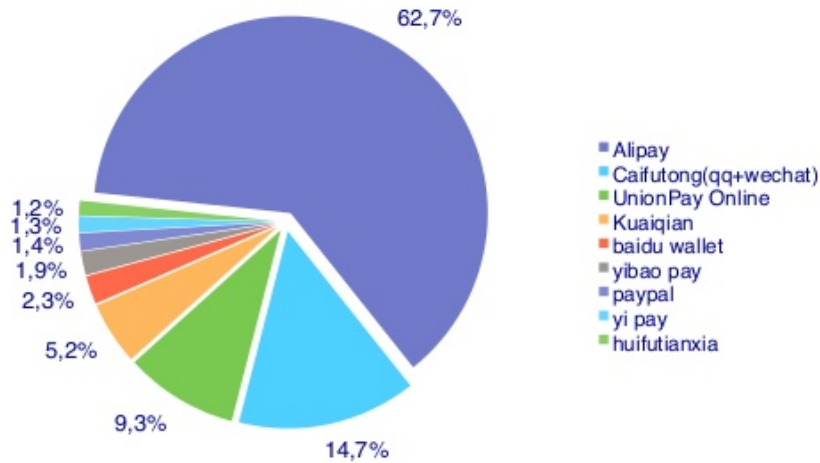


Table 1: Market shares and volumes of third party platform







Apps	2014 VOLUME	2014 MARKETSHARE	2015 VOLUME	2015 MARKETSHARE
Alipay Wallet	48,778.1	81.4%	66,626.0	72.4%
qq+WeChat	6,891.3	11.5%	17,024.6	18.5%
lakala	2,456.9	4.1%	2,760.7	3.0%
baidu wallet	599.2	1.0%	2,208.6	2.4%
kuaiqian	179.8	0.3%	552.1	0.6%
yibao pay	119.8	0.2%	552.1	0.6%
jingdong pay	59.9	0.1%	644.2	0.7%
lianlian pay	59.9	0.1%	276.1	0.3%
others	779.0	1.3%	1,380.4	1.5%

In Table 1 an overview is given of the market shares and absolute volumes in 2014 and 2015 within the third party platform category. As in Chart 4 Alipay and Caifutong (QQ + WeChat) are again in the lead. Nonetheless, the area of competition is remarkably transferring from online to offline, with Alipay strongly supporting Koubei and WeChat supporting Meituan. The reason for this transformation is an attempt to enlarge market share by creating new 'payment possibilities'. Baidu Wallet and Jingdong Wallet are gaining ground whilst relying on their own resources; Baidu is the biggest search engine in China and Jingdong is the largest B2C online retailer. Another provider is Lakala, a community O2O retailer whose market share is decreasing because its offline benefits have been compromised by the upcoming services of Alipay and Caifutong. In contrast,

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COMPARISON OF MOBILE PAYMENT

APPENDIX 2

 Apple Pay	 Samsung Pay	 Google Wallet	 PayPal	 Bitcoin
AVAILABILITY				
Only iPhone 6.	Only Samsung Galaxy S6.	Any device with the app.	Any device with the app.	Any device with the app.
HOW YOU USE IT				
 Fingerprint OK for tap-to-pay (at new registers) and online purchases.	 Fingerprint OK for tap-to-pay (at new registers)	 Tap-to-pay (at new registers, only on NFC-enabled Android phones). Send money via app or email.	 Send money via email or phone number.	 Scan QR code
HOW IT WORKS				
Uses NFC (radiowaves) to send your encrypted payment information.	Uses NFC. At old credit card machines, uses MST (magnetic fields).	Like a debit card. You recharge it. At new registers, uses NFC.	Uses PayPal network to transmit credit card or debit transactions.	Totally independent money system.
SECURITY				
 Most secure. Retailers don't even get your credit card.	 Most secure. Retailers don't even get your credit card.	 Secure. Retailers don't get your credit card, but Google does.	 Secure. Retailers don't get your credit card, but PayPal does.	 Tricky. Secure, but you're on your own. Lose a password? Get hacked? Your money is gone.
PROS				
Quick and easy.	Quick and easy. Works everywhere.	Easy. Great for sending money to friends.	Easy. Great for sending money to friends.	Very private. Easy. Great for sending money to friends.
CONS				
Doesn't work everywhere. Only some places have NFC-enabled registers.	Magnetic option is annoying. You must hold it a certain way above the magnetic stripe reader.	Doesn't work everywhere. Only some places have NFC-enabled registers.	Only works at merchants who accept PayPal. It's a bit rare in person.	Difficult to obtain bitcoins. Rarely ever accepted. Few merchants use this.

APPENDIX 2. Payment market share (Mobiqurity 2016, cited 15.11.2016)