WHAT'S IN YOUR SMART WALLET? CHALLENGES AND ROADBLOCKS

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ABSTRACT

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The concept of a digital wallet has been around for a few years. Sometimes the words "digital wallet" and "smart wallet" are used interchangeably. This is not the case in this thesis, however. The smart wallet is more than just an electronic payment card embedded into a smart phone; it truly performs all the functions of the traditional wallet but only in digital format. This thesis will discuss the main challenges and roadblocks that need to be addressed in order to build a successful smart wallet. It is noteworthy that the functionalities of the traditional wallet including the credit and debit cards, cash, driving license, and membership and identity cards can be found in the smart wallet. In addition, the smart wallet also acts as a depository for promotional coupons and receipts enabling the user to take advantage of instantaneous marketing campaigns of all sorts, and it also meets the needs to return unused or unnecessary goods if needed. Furthermore, the smart wallet enables the transfer of business cards to other digital wallets without hassle. The smart wallet is also secure due to the effective built-in security features. In conclusion, the smart wallet is a new immersive technology, but launching it will take a long period of time in spite of the fact that all key technological ingredients for the introduction of the smart wallet already exist.

Key words: Digital wallet, smart wallet, smart card, RFID, NFC, security.

TABLE OF CONTENTS

ABBREVIATIONS AND TERMS

Android	Google operation system for mobile devices.
BLE	Bluetooth Low Energy or Bluetooth LE
Digital certificate	Attachment to an electronic message used for security purposes.
Digital wallet	A digital wallet is an equivalent to traditional wallet, refers to an electronic device enabling the person to make electronic commerce transactions.
Electronic signature	Symbols or other data in digital form attached to an electronically transmitted document as verification of the sender's intent to sign the document.
Encryption	Encryption is a way to enhance the security of a message or file by scrambling the contents so that it can be read only by someone who has the right encryption key to unscramble it.
Hacking	Hacking is the practice of modifying the features of a system, in order to accomplish a goal outside of the creator's original purpose.
ICC	Integrated Circuit Card
iOS	Apples operation system for mobile devices.
NFC	Near Field Communication
NFC Tag	NFC tag is a sticker or wristband with small microchips that can be read by in range of mobile devices.
PayPal	An e-commerce company that facilitates payments via online monetary transfers.
PayPass	A type of wave-and-pay system that employs RDIF technology allowing shoppers to pay for low-value goods by touching their debit or credit card against an electronic reader.
PIN	Personal Identification Number
Phasing	An activity of defrauding an online account holder of financial information by acting as a legitimate company.
Plug-in	Plug-in applications are programs that can be installed and used as part of the Web browser.
QR Code	A machine-readable code consisting of an array of black and white squares to storing URLs or other information for reading by a smart phone camera.
Quick Tap	A normal tap of an icon on a virtual screen.
Secure Element NFC	The secure element NFC is a dynamic environment in which application code and application data can be securely stored and executed.

SEPA	The Single Euro Payments Area is a payment-integration initiative of the EU for bank transfers denominated in euro.
SEQR	SEQR (se•cure) is a mobile wallet in stores and online and enables anybody with a smartphone to pay in stores, at restaurants, parking lots, online and in-app. Users can also transfer money at no charge, store receipts digitally and receive offers and promotions directly through one mobile app.
Smart phone (or smartphone)	A mobile phone that performs many of the functions of a computer, typically having a touchscreen interface, Internet access, and an operating system capable of running downloaded apps.
Smart wallet	A smart wallet is an extension of a digital wallet and in addition performs all the functionalities of the traditional wallet like personal identification cards, driving licenses, membership cards and also acts as a depository of digital receipts and promotional coupons etc.
The cloud	Cloud involves the use of remote servers and software networks that enable centralized data storage and online access to computer services or resources.
USB	Universal Serial Bus; an external serial bus interface standard for connecting peripheral devices to a computer.

1 INTRODUCTION

According to Investopedia (2015a) a digital wallet stores users' payment information and passwords for numerous payment methods and websites, and thereby the user can largely eliminate carrying a physical payment tools like cash and debit cards. WhatIs.com (2015) takes somewhat broader view on this by claiming that "a digital wallet is a software application, usually for a smartphone, that serves as an electronic version of a physical wallet". It is noteworthy that the relevant literature appears to use the concepts "digital wallet" and "smart wallet" interchangeably. This thesis makes a distinction between these two concepts so that the WhatIs.com (2015) definition is used as follows: "A smart wallet is a software application, usually for a smartphone, that serves as an electronic version of a physical wallet". Due to the fact that this definition expands the scope of the digital wallet (Figure 1) outside the payments, it will be used in this thesis.

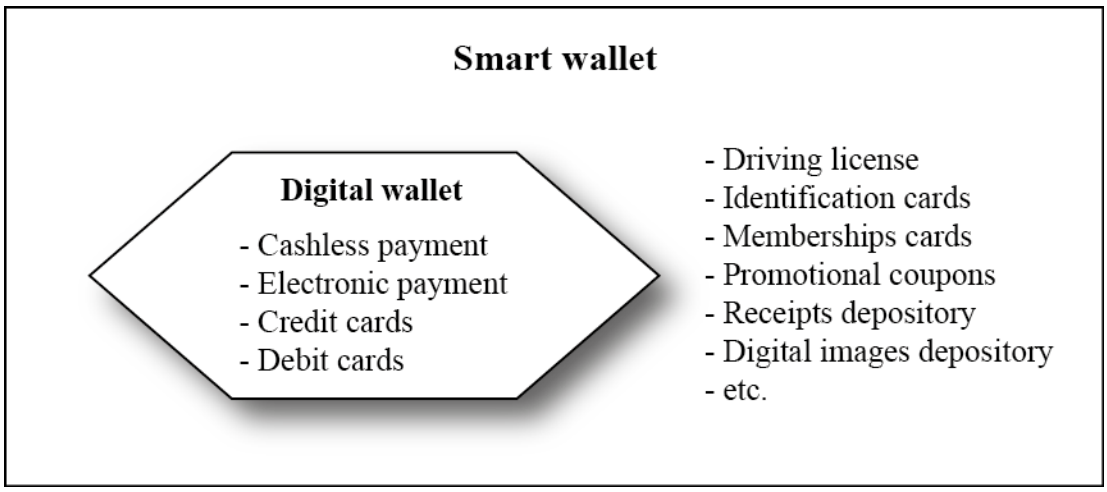

FIGURE 1. The concepts of digital wallet and smart wallet

Almost everything is digital these days, so why hasn't the digital wallet made any significant inroads? The concept of the "digital wallet" has been around for some time but has always been used mainly online; one example of this being PayPal. The idea of using a digital wallet in the real world is something that has started to flourish in the past few years with the introduction of services like Google Wallet, which is a free digital wallet that securely stores digital cards (Google Wallet 2015).

The main purpose of this thesis is to investigate what are the challenges and roadblocks in making a successful smart wallet. There are three main objectives in this thesis. The first objective is to describe to features and functionalities of a traditional wallet. The second objective is to examine and investigate the acceptance of the existing relevant software and hardware technologies in terms of the adoption of the smart wallet. The third objective is to describe a practical application for the smart wallet, and the related challenges and roadblocks. This application will be mainly constructed around the knowledge gained from the review of the extant knowledge relevant to this thesis. In addition the aim is also to take a closer look at what exactly goes into making a successful digital payment application, possibility of a pervasive smart wallet as defined above, migration aspects, customer point of view and the relevant security issues. Since technology plays a key role here, I will also look at presently available relevant technologies and their possibilities from both the consumer's and retailing point of view. Finally the traditional wallet will be compared to the smart wallet.

Building a futuristic prototype for the smart wallet might be a bit too ambitious goal for the thesis, but having a close look at existing technologies, challenges and roadblocks are certainly feasible goals.

1.1. The research problem

A modern smartphone can do almost everything we can think of, from taking pictures to organizing your own calendar. This phenomenon of (digital) convergence allows multiple tasks to be performed on a single device, which effectively conserves space and power (Techopedia 2015). A traditional wallet has not changed very much for hundreds of years and is still mainly used for carrying around paper money, various types of cards and other items. Today we have a club card for every store that we visit, credit cards for different banks and various coupons that fill our wallets. Paper money is slowly becoming obsolete because of credit and debit cards, it's costly to manage and there are numerous other reasons that will be analyzed further into this thesis (Wolman 2009). Coupons and club cards are essentially a nuisance that we use once in a while. Thus the phenomenon of convergence in the traditional wallet has occurred in a very limited way if at all. Taking into consideration other ways the wallet is used there is probably no way to replace the wallet completely. A digital wallet will, however, be more of a viable

alternative for many of us; something that can live alongside a traditional wallet and make our lives somewhat easier. Nonetheless the digital wallet is not tied in any sort of way to a traditional wallet, so it could also be used independently.

Technology convergence, i.e. combining a multitude of technologies in one device is one of the main reasons why the smart phones have become so popular. This happens mainly through the impact of Moore's Law (Moore's Law 2015), which enables the building of smaller and smaller devices with more expanded computing technologies. The convergence phenomenon between the traditional wallet and the digital wallet, likely in a smart phone, is just starting to happen. Users are always looking for the latest in one device. Combining the traditional camera and music player with a phone is what started it all. Today our phones are equipped with quad core processors, high definition cameras, high definition screens, motion sensors, GPS chips and a lot of other technologies that make our lives much easier and enjoyable. More importantly the cell phones are becoming more popular in both developed and developing world with 121 and 90 mobile subscriptions per 100 persons respectively (ITU 2015). Furthermore the share of smartphones of the current cell phone sales is increasing rapidly due to the fact that the sales of smart phones grew 27.2% year over year in the second quarter of 2014 to just over 335 million units (Gartner 2015; IDC 2015).

The main innovations have been mostly to do with the processing power, camera and screen size. There has not been, however, a real breakthrough in digital wallets in a smartphone. The steps have been small and incremental but nothing drastic. Thus it is no wonder that the digital wallet is not among the most popular mobile applications currently (Comscore 2015). Checks as a payment method have become obsolete, and magnetic stripes on credit cards are becoming less of a standard because of security issues. For example in United States where checks have traditionally been quite popular, the popularity of checks has decreased significantly (Bennett et al. 2014; Federal Reserve System 2011). With the use of existing technologies it is feasible to make the smart wallet a reality.

On the basis of the above, the research problem of the thesis is that what are the challenges, and roadblocks when aiming to develop a smart wallet? The topic was chosen because it has received a lot of attention lately, but in spite of the attention no significant breakthroughs have been made yet.

The topic is significant to the field of mobile payments on one hand and even more so for the expansion of the traditional wallet concept. For many innovations like the electric light bulb, it was not enough to develop one core technology (the electric light bulb), but rather it was necessary to have many related technologies (electricity generators, electricity grid etc.). What are those other technologies when trying to launch a smart wallet?

1.2. Method

The aim of this thesis is to examine the challenges and roadblocks when aiming to develop a smart wallet, and what different technologies could be utilized to make it a reality. This will be done by extensively reviewing current and relevant existing technologies in use today and looking at the pros and cons of them including applications like Google Wallet, Apple Pay, SEQR and Coin. The review process will include the appraisal of the following points of view: technology platforms, security and necessary features. Similarly to Ekekwe (2012) no systematic research method on the dynamic development of new technology was chosen. In addition in the consumer adoption section a small selection of lead users will be interviewed regarding the adoption of the smart wallet. The lead user concept was developed by Eric von Hippel (1986). Instead of asking from regular consumers, the reason for identifying and interviewing the lead users is because their present strong needs will become general in a marketplace months or years in the future. Due to the fact that lead users are familiar with conditions, which lie in the future for the majority of the users, the lead users can serve as a need-forecasting entity for marketing research. The approach described by von Hippel contains first the identification of an important market or technical trend (in this case the adoption of smart wallet), identification of lead users who lead the trend in terms of experience and intensity of need, analysis of the lead user data, and finally the projection of the lead user data onto the general market. (von Hippel 1986.) Von Hippel gives two pieces of advice when identifying the lead users: First try to identify users who are at the leading edge of the identified trend in terms of related new product and process needs and second try to identify users who expect to obtain a relatively high net benefit from solutions to the identified need.

It is also the aim of the thesis to come up with a rudimentary demonstration how the smart wallet could be used and to showcase a smart wallet application that takes the best features of services today. The goal is not to develop something that already exist. Rather having a solution, which replaces cash, all sorts of digital payment cards, membership cards and identification cards complemented with marketing promotions might be a feasible goal. It is noteworthy that current payment methods include a multitude of different methods, and not one single method is used universally. On the other hand limiting the viewpoint into one geographic area might not be a feasible due to the fact that many of the current payment methods need some degree of universality. With the vast growth of contactless payment systems, interactive advertising, and the introduction of applications with which payment for services can be done, the question is that could a digital wallet be a viable alternative for the plastic cards and other elements in the traditional wallet that fill them today.

The thesis proceeds as follows. First, after the introduction section the rationale for the thesis is discussed including the research problem and research method. Second, in the background section the characteristics of the traditional wallet as well as the traditional payment methods will be reviewed. Third, the competitive field will be described including cash and traditional wallet, credit and debit cards, Apple Pay, Google Wallet, SEQR, Coin, CurrentC and PIVO. Fourth, the various relevant technologies including digital wallet, Near Field Communication (NFC), smart phone, Bluetooth and BLE, QR code, digital camera, finger print scanner, Cloud, mobile security technologies, and contactless bank cards will be reviewed. Fifth, consumer adoption issues will be discussed, and sixth, the implementation of rudimentary proposal will be presented. Seventh, the key issues of the thesis will be briefly discussed, and finally conclusions will be presented.

2 BACKGROUND

2.1. Traditional wallet

The traditional wallet has been around for a long period of time and has evolved a lot over time. According to A.Y. Campbell, "the wallet was the poor man's portable larder; or, poverty apart, it was a thing that you stocked with provisions" (1931). A typical "modern" wallet holds a variety of items such as financial cards (debit cards, credit cards, telephone cards, etc.), miscellaneous cards (driver's license, social security card, access card, transportation or fare cards, health and insurance cards, etc.), cash (notes and coins), check book, various paper receipts (ATM receipts, purchase transactions receipts, etc.), a phone and address book, business and personal name and address cards, a note pad, maybe even a calculator (Daggar 1994) as well as images, and promotional coupons (Ebringer, Thorne and Zheng 2000).

The traditional wallet is a multi-functional depository, maybe even a "treasure chest" of the modern man. Currently we rely mostly on credit and debit cards in different forms, to pay for the products and services. This method of payment was introduced in the late 50s' (Investopedia 2015). Today we basically use the same type of technology to access our personal accounts and information; a wallet full of credit cards and various types of other cards. In terms of security the fundamental issue still holds: if you lose your credit card, or any card for that matter, you are out of luck.

As mentioned above the traditional wallet can be a vast collection of various personal items. It has been in use for hundreds if not thousands of years (for a detailed description of the history of the wallet, see BigSkinny 2015). Figure 2 illustrates various types of wallets from history and modern times. The wallet in figure 2 on the bottom right illustrates the problem of the traditional wallet. With all the credit and debit cards, membership cards, cash, promotional coupons and receipts the boundaries of the traditional wallet have been stretched. The question here is that is the smart wallet able to perform all or part of these functionalities and if yes, how?

Source/Image	
Imgarcade (2015) 	Pininterest (2015) 
	Fashion-Kid.Net (2015) 
Zhejiang New Century Luggage Company Ltd. (2015) 	Jordoncooper.com (2015) 

FIGURE 2. Illustrations of wallets over time

2.2. Traditional payments

Credit cards and debit cards with integrated circuit card (ICC) and/or magnetic strip are mainly used to make payments today. The advantage of a chip card is that it holds the critical data on a computer chip, which enables the processing and storage of information much more securely than a magnetic stripe (Payyourway 2015). This much more secure payment method has led to fast adoption of this technology for example in United States and the change is still under way so that when there was approximately 50 million smart cards in use in 2013 and the forecast is that there will be more than 300 million smart cards in use in 2018 (Payment Cards and Mobile 2015). It is noteworthy

that the chip cards still also have a magnetic stripe in order to enable transaction in countries, which do not yet have chip card enabled terminals.

As regards to payments Ebringer, Thorne and Zheng (2000) state that the traditional credit card is perceived to be a very attractive payment mechanism on a global basis due to the fact that it is always the responsibility of the seller to prove that a transaction in fact happened, and thus the risk of the consumer is minimal. Furthermore cash has been proved to be a reasonably reliable payment system in spite of the fact that some counterfeiting occurs. The key issue for the smart wallet is the security and verification according to the writers of the article.

When reviewing the traditional payments methods it is clear that in terms of the digital wallet that it is not possible to speak about radical or disruptive innovations yet (Christensen 2015). Using the Christensen analogy, it is possible to describe the situation in terms of the emergence of the various payment methods central to the topic of this thesis, the smart wallet, with the following figure.

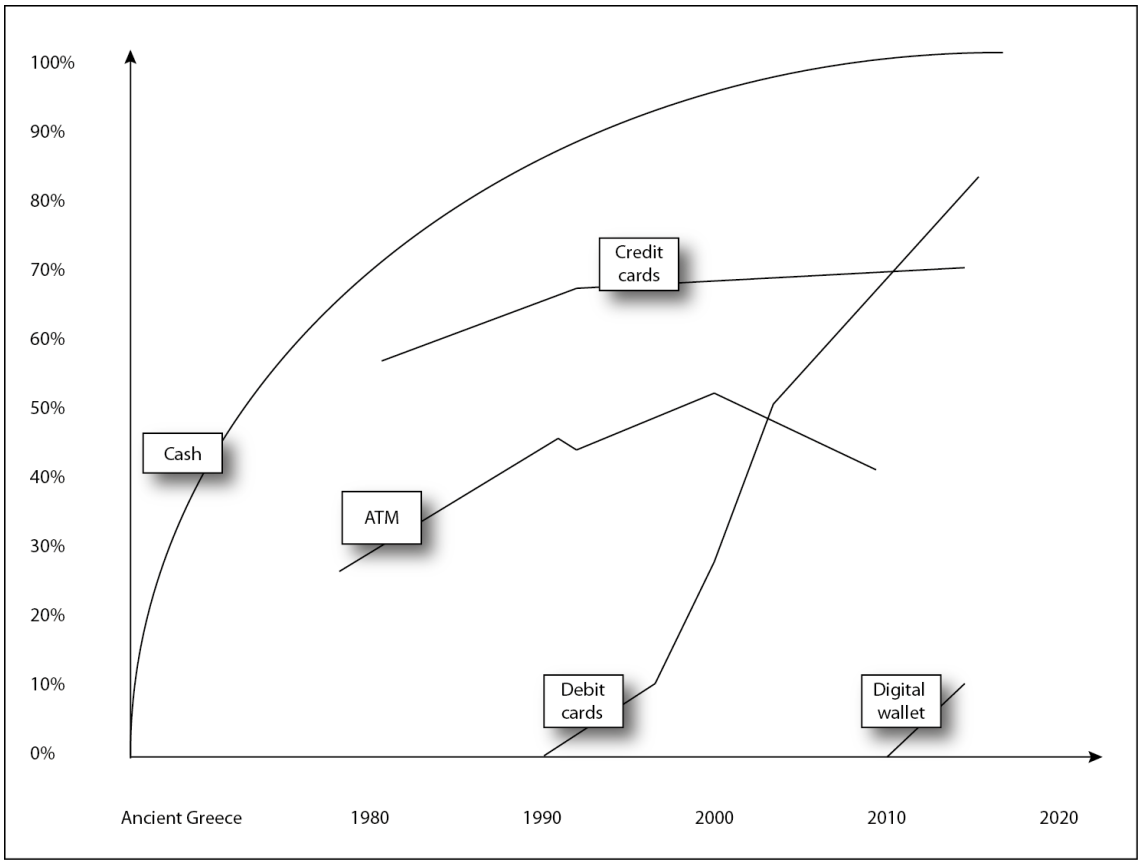

FIGURE 3. Adoption of various payment methods (Strategic Business Insights 2013)

2.3. Cash and Traditional Wallet

The following is a direct quotation from the Wired Magazine: "*Two years ago, Hasbro came out with an electronic version of Monopoly. Want to buy a house? Just put your debit card into the mag-stripe reader. Bing! No more pastel-colored cash tucked under the boar* (Wolman, 2009).

The governments around the world are starting to realize that digital currency is the way of the future. Paper money is extremely expensive to keep in rotation. Governments have to print the money and after circulating, they have to destroy it because of deterioration, which in return forces them to print more. This way the governments are stuck in the past. To maintain the quality of hard currency, the US Treasury for example manufacturers hundreds of billions of dollars' worth of new bills and coins each year. (New York Fed 2013).

The cost to taxpayers of this reprinting in 2008 was $848 million, more than two-thirds of which was spent in minting coins that many people regard as a nuisance. Furthermore the process consumes more than 14,823 tons of zinc, 23,879 tons of copper, and 2,514 tons of nickel. It can be said that traditional money remains frustratingly analog. (Wolman 2009). Obviously paper money is not the main object of this thesis but how the smart wallet could help solving the related paper money issues is of vital importance for the society.

2.4. Credit and debit cards

Before entering the discussion on the emerging smart wallet technologies it is worthwhile to briefly discuss the current credit and debit cards. The use of credit and debit cards appears to be a relatively simple process from the user's point of view but it is a bit more complicated than that. Figure 4 describes the so-called four party system necessary for the execution of the credit card operation and the roles of key players are described in table 1. A more detailed description of the whole four party system is provided by Geuss (2014).

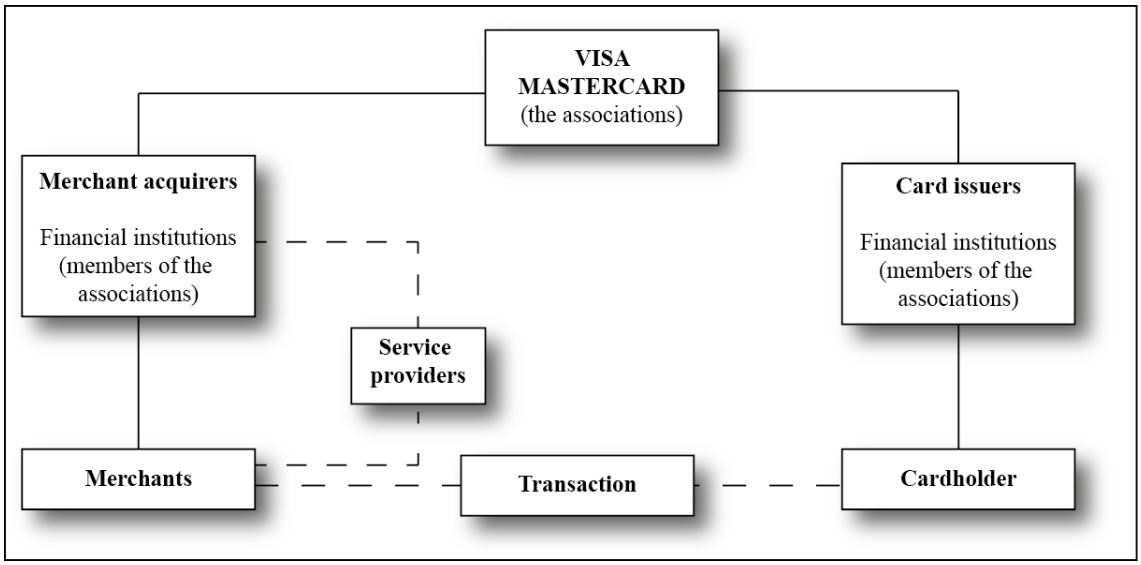

FIGURE 4. The four party network enabling the credit card transactions (modified from DeGennaro, 2006)

TABLE 1. The roles of the four party members in the credit card system

Phase	Party	Roles
1	Merchant	Entity offering goods or services that the customer wants to buy.
2	Card issuer	Distributes cards to customers, extends lines of credit to them in the case of credit cards, and bills them.
3	Merchant acquirer	Signs up merchants to accept cards and routes each transaction to the card network's processor.
4	Processor	Sends the transaction information to the correct card issuer so the funds can be taken from the customer's account and delivered to the merchant.

3 RELEVANT SMART WALLET TECHNOLOGIES

Smart wallet is a technological tool and thus most of the challenges will be technological. If not properly addressed these challenges might turn into roadblocks for the implementation of the smart wallet. These challenges will be discussed in this part of the thesis.

3.1. Near Field Communication (NFC)

Today NFC is still more of a special feature in smart phones but when it becomes more of a stand-ard, we might see these digital wallet locations become more viable on a mass scale.

NFC in the digital wallet enabled payment technology takes care of the identification part from the phone to the receiving end. Therefore NFC is used as the ‘connector' between a smart phone and a payment terminal device as the following figure demonstrates.

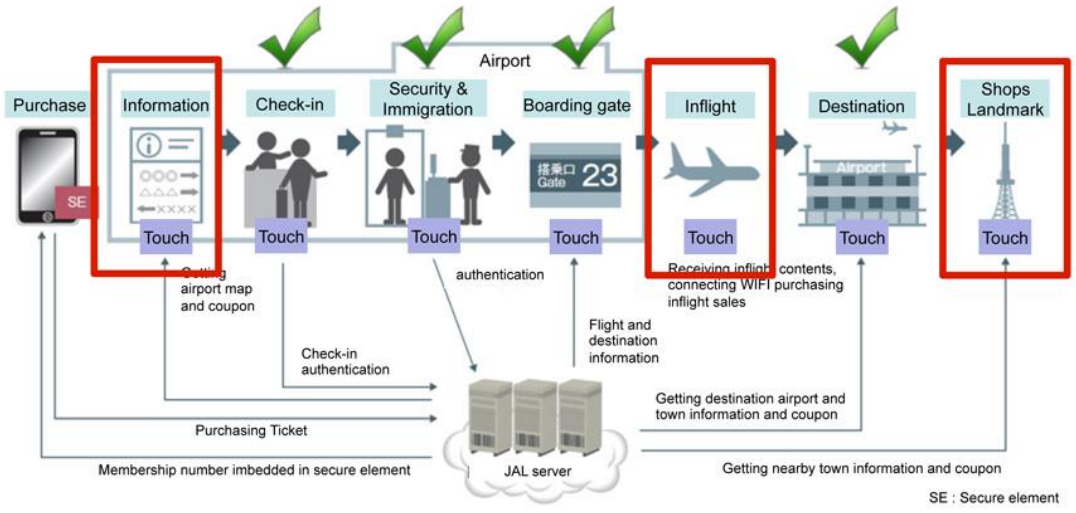

FIGURE 9. Schematic illustration of a Japan Airline traveler with NFC technology (Pixelpallads 2013)

NFC has a number of significant advantages. NFC works only in close proximity thus improving the security of the technology. This is one of that main reasons why mobile

based payment technology has a great potential. Using a phone to pay is not only convenient and simple, but allows for two way interaction between devices. For example if the user were buy a coffee and pay it with the smart wallet, the user could receive a virtual loyalty card or coupon from the shop at the same time.

Near field communication allows devices to establish a peer-to-peer radio communication, passing data from one device to another simply by putting them close together (Identive NFC 2015). This close range makes NFC perfect for interaction and means that two NFC devices can't 'accidentally' be read or used for unwanted tracking (Rapid NFC 2015). The tap action is an integral part of the payment process and part of the appeal of NFC as opposed to other longer range RFID technologies. NFC works by sending data over radio waves, which is also used in Bluetooth and Wi-Fi but the advantage of NFC is that the devices never have to create a link due to the fact that NFC can be used to induce electric currents within passive components as well as sending data. An additional advantage of NFC is that it can be used with passive components that do not require their own power supply, like NFC smart chips, which are small chips that can be write or read off of with a NFC application. These applications are practical since the user with a NFC compatible smart phone can use their devices in a multitude of different instances (Android Authority 2015).

The first signs of NFC can be traced back to early 1980s and was then known as radio frequency identification or RFID (Search Manufacturing ERP 2015). This technology basically allows the sending of radio frequency information to a specific receiver, which would in return identify the original information; therefore NFC is actually a subset of RFID with a shorter communication range for security purposes (Near Field Communication 2015). One important aspect of NFC technology are the security tags in retail locations. This technology worked well for around 20 years with no real improvements however.

In 2002 Sony and NXP Semiconductors invented a new NFC technology. In 2004, Nokia, Sony and Philips climbed on the bandwagon to create the NFC Forum, which was dedicated to promoting the security, ease of use and popularity of NFC (NFC Forum 2015). The idea of the forum was to educate other businesses about the possibilities that NFC could bring to the tech world, not only in mobile but also in other platforms.

Those companies who wished to use the technology would have to meet certain standards set forth by the NFC Forum.

By 2006 NFC started being introduced into more applications. The first phone produced to include NFC chips to be compatible with NFC smart points or tags (also called as reader points) was also introduced same year. These NFC tags, smart posters and smart tags available in buses, retail stores and other payment points, were the main technologies that would help NFC to become what it is known today. These technologies would allow the user to receive and send data by waving their device close to the receiving data point. (Ortiz 2008) The first NFC compatible cell phone was introduced about the same time, which was the Nokia 6131.

In 2009 peer-to-peer applications were introduced into NFC technology, which allow mobile devices with Bluetooth to send larger packets of data like music or pictures (How-To Geek 2015). Today multiple manufacturers sell devices that enable listening music from a mobile device through a NFC connection with mobile speaker. The first smartphone with the Android operating system to incorporate NFC was the Nexus S, which was a phone made by Samsung. This phone was introduced in 2010 and is considered to be the phone that got the NFC technology off the ground since users could now use it in multiple applications. Consequently this technology can be considered to be the first step for the digital wallet technology. Later companies have started to come up with ideas on how they could incorporate the online digital wallet by Visa or MasterCard into the smart phone.

As discussed NFC is one possible technology, which can be considered to be used in the context of a smart wallet; Bluetooth and RFID are also able to engage into electronic dialogue between devices. NFC comes however both with passive and active capabilities, including P2P mode, which is suitable for exchanging information (e.g. business cards or contact information) and SecureElement NFC (Carter & Faulkner 2013; Soft-Nuke 2015). SecureElement NFC is a technology where the machine that is receiving the payment recognizes the NFC phone as basically a bankcard (Carter & Faulkner 2014). The implication of this is that NFC has a lot more potential than other similar technologies.

Mobile payments are starting to become established in Europe but are already further along in the United States. Where they are really starting make significant inroads is in Asia as the following figure illustrates. Interestingly the amount in Africa is quite large in comparison to the developed world.

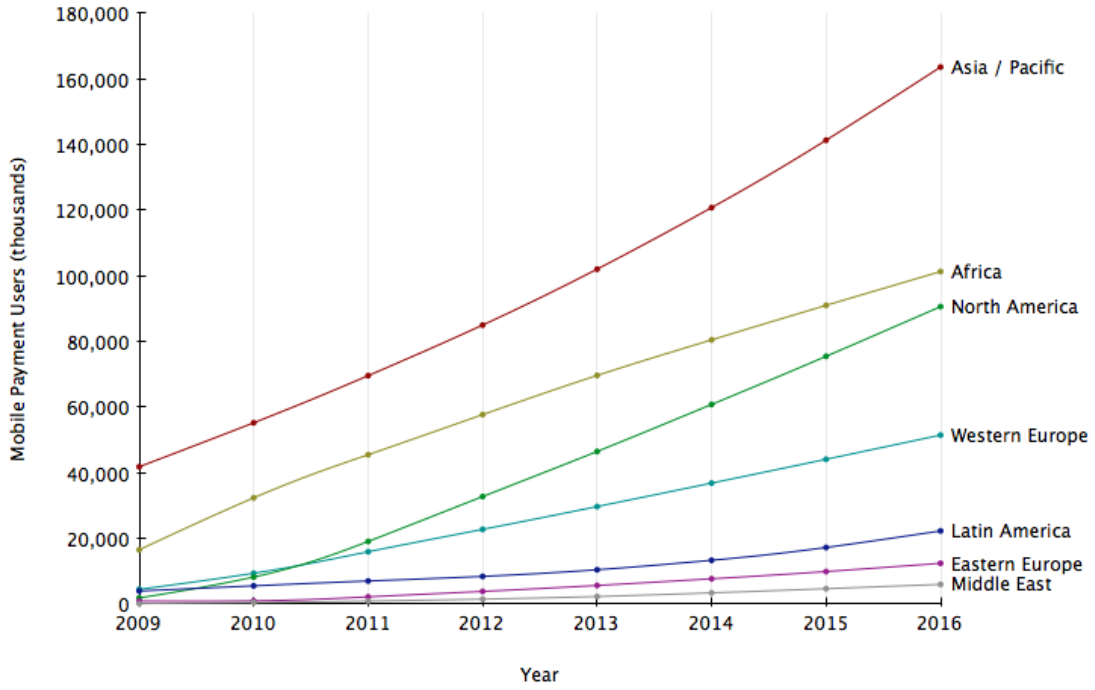

FIGURE 10. Mobile payment users by region (Whatley 2012)

As an example Orange's QuickTap allows purchases of £15 at 50,000 shops in UK (including Pret a Manger, EAT, Little Chef, Wembley Arena, Subway, Wilkinson and McDonalds stores). This can be done by tapping an NFC-enabled smart phone with an application that has been credited with sufficient funds (Carter & Faulkner 2013).

This technology has many practical uses today, most of which are not well known to the public. This is due to the fact that NFC is still a relatively new technology that is making inroads to the mass market. In the time that NFC has been available on smart phones there have only been around a 100 phone models with NFC. Samsung for example has exactly 20 models available while Apple iPhone 6 somewhat surprisingly was the first Apple phone model with NFC technology. Nonetheless many of the new smartphones being manufactured today have NFC. In fact, nine out of the top 10 handset makers support NFC (Balaban 2013.)

NFC’s potential is what's making it very popular. NFC has many uses and for example in San Francisco it can be used to pay for parking meters (Qfuse 2013). BMW has also started incorporating NFC into their vehicles by making it possible to open your car door with a NFC embedded key (BMW Group 2010; Life Hacker 2012). Companies have also started developing ways in which access passes could use NFC to gain physical access into another location for example to ski lifts (SecureIDNews 2012), offices (NFC Ready 2014) and amusement parks (PushCoin 2015). The possibilities are virtually endless, and therefore companies have started to make relevant applications for smart phones.

By adding programmable tags the user of the smart phone can acquire different kinds of items or services, and also by tapping the smart phone on a sticker the user can automatically change the settings of the smart phone. This way the user can turn the smart phone on silent mode, open up applications, pair Bluetooth devices, and disable Wi-Fi (CNET 2012). These small programmable chips are in fact small memory devices (like a USB memory stick) equipped with a small antenna enabling sending data wirelessly (Smart Card Alliance 2015). The encoding of the tag with the desired information or action, enables the use of the tag. The tag comes in the form of a postage stamp size sticker. It can also be embedded into car key, and business card. NFC tags do not hold lots of memory like USB sticks, in fact that only hold about 46 Bytes to 888 Bytes (GlobalSmart 2015). For reference a MP3 song is usually around 4,000,000 Bytes, a SMS message is around 68 Bytes and to turn of Wi-Fi on your phone with a task launcher takes around 60 Bytes.

3.2. Smart Phone

Mobile smartphones have come a long way in the past decade. The first iPhone was released in 2007, which marked the beginning of the first real smartphone with which the user could do multitasking in addition to the traditional phone calls and text messages. Today smartphones have large touchscreens on top of a modern computer. The potential of smartphones are stretched on an ongoing basis. Powerful applications, hardware, batteries and the introduction of integrated hardware like NFC only means that the smartphone is the only thing that the user has to carry around today at home and in the

office (Barkhuus & Polichar 2011; Nichols & Myers 2006), next to the traditional wallet of course.

Almost all smart phones have a digital camera, even the not so smart ones. Having a digital camera in the smartphone is an essential element of the smart wallet. Digital camera provides one way to transfer the data to the digital wallet. In this case the digital camera acts like a scanner of the different items like credit cards, debit cards, and bar codes in receipts, promotional coupons, and admission tickets (Rao 2012). In the next sections the potential of the technologies in the smart phones as regards to the smart wallet phones are discussed.

3.2.1 Bluetooth and BLE

Bluetooth is a technology that allows two devices to transfer data between each other. Since the invention of Bluetooth around 20 years ago there have been a number of improvements to the technology (TechRadar 2014). The newest version of Bluetooth is v4.1, which comes with faster transmission speeds, lower power consumption, improved pairing without a personal identification number (PIN) and support for NFC (Tyzzer 2014).

The traditional Bluetooth, v3.0 and older, was never a viable option for wireless payments because of the problem with power consumption (Nielsen 2012). The problem with Bluetooth has been that it works well with devices that are recharged on a regular basis like headsets, mice, and keyboards (Hoffman 2013), and thus Bluetooth has been not feasible for other interesting electronic devices and applications.

Consequently due to the relatively high power consumption the emphasis has been on the reduction of the power consumption. As an outcome of these efforts, a new version of Bluetooth with version 4.1. (Also called the Bluetooth Low Energy (BLE), or Bluetooth Smart), consumes much less power with similar speeds and range as traditional Bluetooth. Smaller devices, like heart rate monitors, have started to use BLE to transmit data to the smart phones in order to save battery life.

In terms of mobile payments there has been several attempts by companies like PayPal to introduce the technology into the mobile payment market. PayPal Beacon is a good example of this; it looks perfect on paper but for some reason Beacon has never got off the ground. Beacon is a Bluetooth Low Energy USB module for merchants designed to enable consumers to pay wirelessly (King 2013). The device sets up communication between point-of-sale (POS) and mobile devices with the PayPal application. This means that no GPS, wireless or mobile networks are required. In other words the customer sets up their phone in the settings section of their smartphone for automatic check-in for the payment of services, goods and for example restaurant bills. The advantage of this is that the customer does not have to wave the waiter down and run their credit card and wait for your signature or pin code. The customer can simple use PayPal Beacon to pay for the bill automatically and skip all the additional steps. The possible negative aspects of this technology include security and privacy, customers being checked in and charged incorrectly (King, 2013). The software has privacy features built into the application, however. Customers can for example choose where they want to check in, and accept payment with a pin code.

In the end both BLE and NFC both have their advantages and disadvantages. BLE appears to give a more streamlined experience because of the range, and thus users do not have to swipe their phone on a device in order to pay for something like with NFC. On the other hand NFC should be more secure because every transaction is somewhat physical. The user has to physically take their smartphone, swipe it on the receiving device and also input a code. This also gives the cash register security when completing a transaction.

3.2.2 QR Codes

Quick Response Code, better known today simply as QR Code, is a matrix code that can store data or can be used as an extension (Korhan 2011). QR codes are basically used like normal one dimensional bar codes expect for how they look and are scanned. QR codes are two dimensional square matrix patterns which are scanned, for instance, with the camera on a mobile phone (SGB Webdesign 2015). There are many uses for QR codes today but in terms of mobile payments it has been somewhat of a hit and miss, mainly because of security issues. The use of QR code is pretty easy and the technology

is very accessible because the user only needs a smartphone with an internet connection and a camera. The following figure shows an example of QR code.

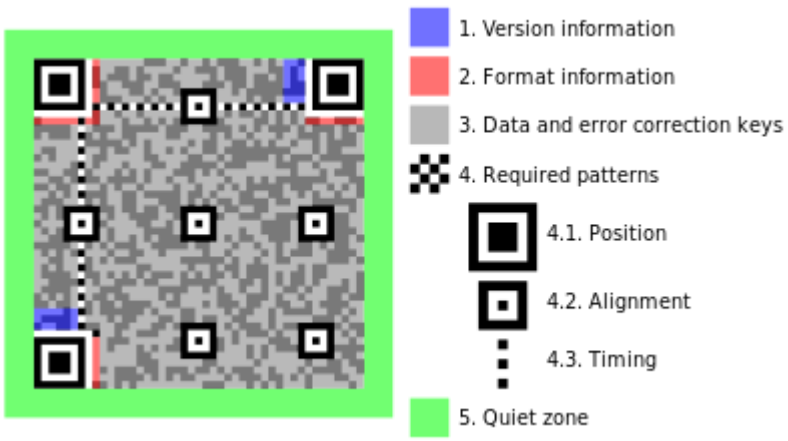

FIGURE 11. Sample QR code

3.2.3 Finger print scanner

Finger print scanner is an automated biometric method for recognizing a person based on a physiological characteristic, i.e. the fingerprint. Other biometric identification methods can use face, hand geometry, handwriting, iris, retinal, vein, and voice as the source of identification. The advantage of using biometric data in identification is that it is separate and distinct from personal information. Thus the identification is based on two unique dimensions, i.e. biometrics and personal identification. It is noteworthy that biometric ids cannot be reproduced or reverse-engineered to recreate personal information and thus they cannot be stolen and used to access personal information (Bioelectronix 2015). Thus using biometric data in conjunction with the digital wallet would be a great advantage from the security point of view to enable electronic mobile payments. The disadvantage of the use of biometric data together with a NFC enabled smartphone is that it slows down the payment process, which might not be feasible in transactions requiring speed (Bisson 2014). That being said the technology is only just starting to see its way into mobile devices. Both Apple and Samsung have already started implementing this technology into their smartphones.

Samsung's first attempt at the finger print scanner was "notoriously famous for being generally slow and unreliable". The user has to swipe their finger on the home button of the device which did not always work. The new version of the scanner which can be

seen on the new Samsung Galaxy S6 and Galaxy S6 Edge is taking notes from Apple's scanner. The user only has to hold his/her finger on the home button for the phones to register the scan, which is more accurate and takes less time. (PhoneArena 2015) As the technology advances the speed and reliability of these scanners will only become better. The finger print scanner at this point may not be as fast as inputting a PIN code to accept payments but they are more secure.

3.3. The Cloud

Cloud computing dates back to the late 1950s but has started to become a more general technology today. Cloud computing is mostly an evolution and a combination of existing technologies. It can be defined as "for the delivery of hosted services over the Internet" (Search Cloud Computing 2015). This means that users can use all of these technologies, without the deep knowledge of each and every one of them. A key point when discussing about "Cloud computing" is virtualization. It basically refers to computing being done somewhere else than in the user's computing device.

A key idea for the use of the digital wallet existing in the cloud is security and convenience. Security in the sense that the smart wallet can never be lost like the traditional wallet. If your traditional wallet gets stolen, the person who stole it can use the credit cards in it, use the cash or even use the personal identification. With a smart wallet this information is always in the cloud, not on the actual device, for instance in the smart phone. The phone only acts as an access point into the critical information. Security is always a very important topic when talking about personal information and this will be looked at more closely later in the thesis.

In terms of convenience it comes down to the fact that everything is always with the user. Personal identification cards, credit cards, club cards, and coupons could all exist in the cloud, which could be accessed with the smart phone or any other device for that matter. This would give way to the future of accessing the vital information by other methods with for example the finger print, retina (i.e. the innermost coat of the back part of the eyeball) or even on the most basic form of account name and password. In some cases there could even be the possibility of accessing the information from a family member's device.

3.4. Mobile Security Technologies

The issue of mobile security technologies is key to the introduction of the smart wallet. Government of Hong Kong (2011) summarizes some of the security weaknesses with mobile devices as follows:

1. Theft or loss of the device. Confidential messages or sensitive and personal data fall into the wrong hands if such data was stored on the device.
2. Disgruntled employees or unauthorized personnel can take advantage of the small size and powerful capabilities of mobile devices (e.g. storage space and camera functions) to steal sensitive data inside an organization.
3. Viruses spread across mobile devices. Mobile applications are susceptible to vulnerabilities and bugs just like any software.
4. The GSM/GPRS communication protocol does not have strong signal protection and it is relatively easy to intercept traffic on such networks.

As the above list indicates mobile security is indeed a multi-faceted issue, and cannot be dealt with in detail here. Instead the analysis of the relevant issues will be discussed only from the digital wallet point of view. Therefore the issues like viruses and GSM/GPRS communication protocol will not be discussed here.

Security is an issue with all current payment methods. In the case of cash for example, if cash is stolen there is usually not very much that can be done. Recovering the cash back is an unsurmountable task. In case of the other payment methods it is not the consumer who suffers (except in the case of gross negligence), but rather the financial institution. The following figure illustrates the growth of credit cards losses in Europe in 2008-14. As can be seen from the figure the total value of card fraud amounted to €1.33 billion in 2012 issued in SEPA. When looking at the extent of frauds as regards to the value of fraud as a share of transactions, the situation appears not be that bad due to the fact that there is fraud only in about 0.04% of the cases. The absolute amount, however, is quite significant.

As regards to mobile security the main options as far as storing critical data in the storage of the data either inside or outside (in the Cloud) of the smart wallet perhaps in encrypted format. The security of the device can be maintained by various kinds of access

codes or biometric identification, e.g. with fingerprint identification in Apple Pay. Therefore if the smart wallet gets stolen it cannot be used due to the lack of biometric identification.

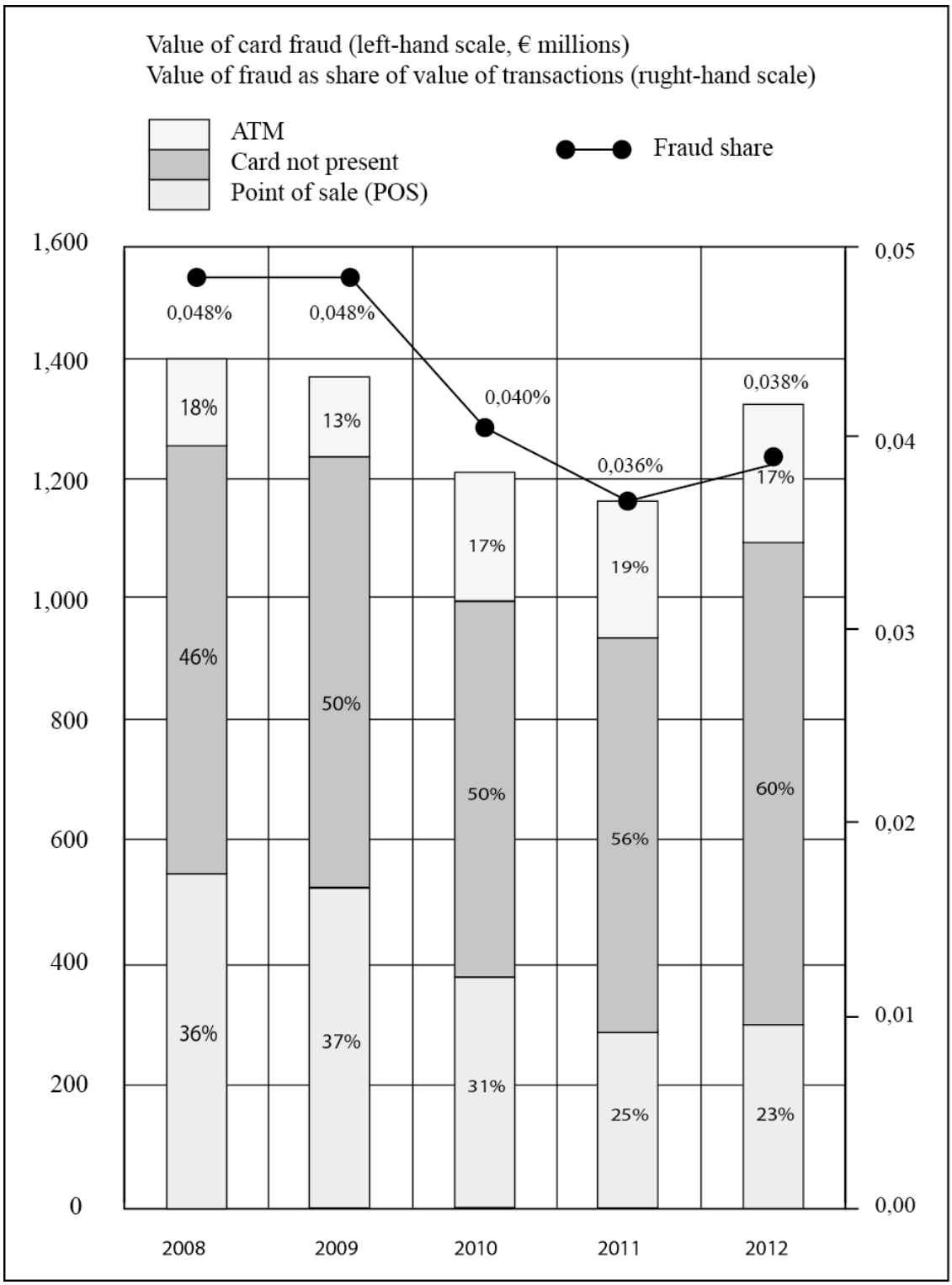

FIGURE 12. Credit card fraud losses in Europe in 2008-14 (ECB, 2014)

When reviewing the existing mobile security technologies it appears that many companies are becoming active in the area. Electronic Communication and Research Institute (ETRI 2015) for example indicates the following initiatives in relation to research on smart wallet technology:

1. Personal Information (ID, authentication information, transaction information) distribution security technology.
2. On/offline anti-phishing technology.
3. Personal information risk analysis technology.

The personal information identification related securities include many options like SmartSign technology, web electronic signatures without plug-ins on the internet browser, NFC (Near-Field Communication) based interaction technology for payment/authentication, TouchSign technology through NFC communication to protect against leakage of digital certificates from memory hacking attack on electronic signature, and finally security SMS technology, wearable security guide technology to protect against transaction modulation on wearable devices such as smart watch (ETRI 2015). In conclusion it is apparent that the mobile security issues are complicated, and have to be resolved before a major breakthrough in the mobile wallet technology can be expected.

3.5. Contactless bank cards

A new technology in credit cards is a way to pay without ever needing to put your card in a machine or typing your personal PIN code. The user simply swipes his/her card close to the receiving payment machine, and the transaction is done. Thus the question is how is this different to a phone with NFC? There is no difference in fact. The user still has to, however, carry the plastic cards. Most new Barclaycard, American Express, MasterCard PayPass and Visa Europe cards have NFC contactless technology in them, and with 30 million contactless cards already in circulation in the UK (look for the Wi-Fi like logo on the back) this is where the 'digital wallet' exists for now; i.e. in your wallet. Such cards can be used to make small purchases (typically under £15) in shops – and, on London buses." (Carter & Faulkner 2013). The following figure demonstrates the operation of the contactless card.

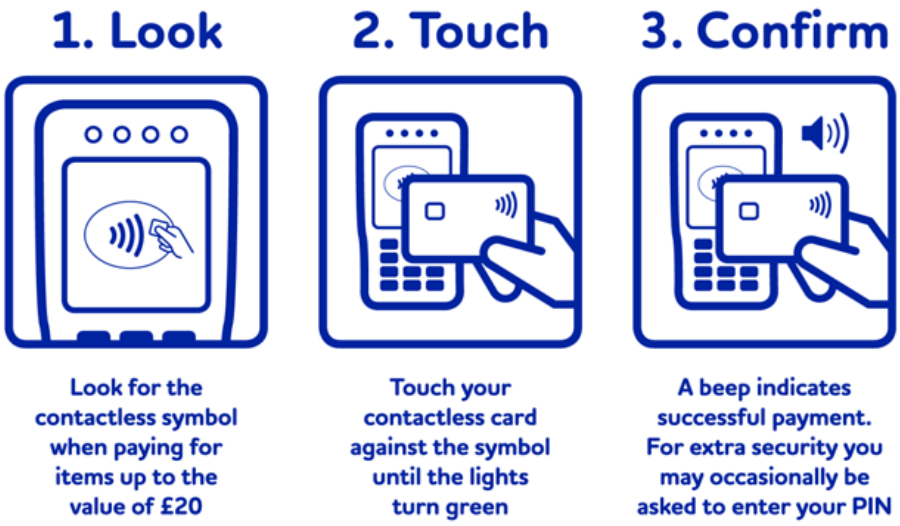

FIGURE 13. The operation of the contactless card (https://www.visa.co.uk/media/images/ContactlessHowTo10-2789.png)

4 COMPETITIVE SERVICES

Several technologies enabling the smart wallet have emerged during the past decades but none of them has made a breakthrough. In this section I will review the current and emerging competitive services, which appear to have significant potential.

4.1. Apple Pay

Apple Inc. entered the mobile payment industry just recently in 2014 with the introduction of Apple Pay. Apple Pay has the same basic principles as any of the other mobile payment services. This is due to the fact that Apple Pay does not replace the need for physical card since the cards will act as the underlying framework for the for the Apple Pay software (Payments Leader 2015) and thus the four party network as described in Figure 1 does not go anywhere. Apple has had a great launch with Apple Pay, grocery stores have seen a large increase in mobile payments since the launch of Apple Pay back in October 2014 buy around 400% (Macworld 2015).

From the consumer side the only setbacks with Apple Pay are mainly with its proprietary licenses. Apple Pay only works on Apple iPhone devices, more specifically the just released iPhone 6 and iPhone 6 Plus with the right version of iOS. In the end this is a huge drawback considering how great the reception of the service has been. Apple Pay has had a tremendous impact on the mobile payment experience. Apple now has around 100 banks on board with Apple Pay, some including Visa, MasterCard, Wells Fargo, and Western Union and so on. This is also a trend with retailers that are coming on board, hundreds have already accepted the platform as a means of payment and more are constantly being added. (Macworld 2015)

One feature of Apple Pay that stands out is the Touch ID security sensor incorporated into new iPhones. When paying in-store the user simply places their phone next to the wireless payment terminal while placing their finger on the Touch ID sensor on the phone. The Touch ID sensor scans the user’s finger print and tells the phone that the payment can be authorized. Touch ID basically takes the place of using a PIN code. (Macworld 2015) The following figure describes the way Apple Pay works. From the

security point of view it is important to note that Apple is not involved in the process, and does not receive any information that identifies the customer and his/her purchases (Mondato 2015).

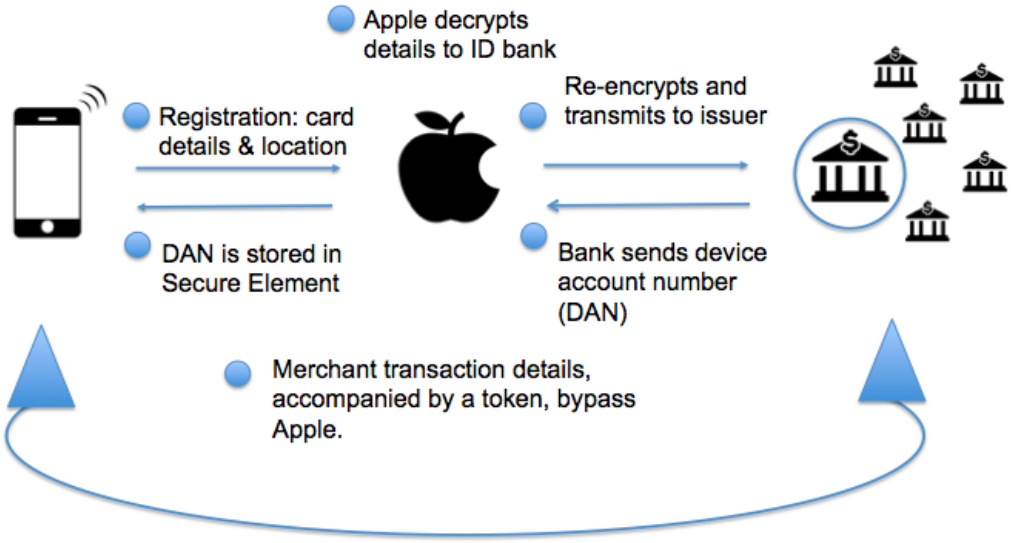

FIGURE 5. Apple Pay (Mondato 2015)

4.2. Google Wallet

Google Wallet is an application made for smartphones that acts as a digital wallet where the user can store credit cards, club cards, coupons and other information straight into the wallet. Users can pay for online goods straight from their account or pay in-store with a NFC enabled phone. The user can also opt for a Google wallet card that can store the user's credit cards. (Google Wallet 2015). The main downside to this is that the user still has to carry the credit card around.

Google Wallet was released in 2011 and has had a tough time penetrating the market. The service has been a hit with Google fans but has had trouble beyond that. With the introduction of other mobile payment services, like Apple Pay, Google Wallet also gains to benefit from this trend (TechRepublic 2015).

Google Wallet is at this point at a crossroads because there is a lot of competition and the market is at this point somewhat crowded. Crowded in the sense that services have to really stand out in order to make an impact. In Q4 of 2014 Android had a market

share of 83.6% in global smartphone usage (9TO5Mac 2014). Google's Android being the most popular operating system gives Google the edge in terms of devices for when the mobile payment ecosystems are in place throughout the world. "The Global NFC enabled handset market is forecast to grow at 55.8% CAGR during 2014-2019" (PR Newswire 2014). If these trend holds up then Android will have a huge market share in terms of devices with NFC.

The following figure describes the way Google Wallet works. It is important to note that Google Wallet is not integrated into the smartphone as a whole.

FIGURE 6. Google Wallet (NFC.CC 2015)

4.3. SEQR

SEQR works in a slightly different way to the other services described before. With SEQR the payment process is done with either using your phone's camera to read a QR code or using a smartphone with NFC to make the payment. Completing the transition will not charge the credit or debit card automatically but instead the user has 2 weeks to pay for the all the purchases made with SEQR. (NFC World+ 2013) Therefore SEQR is basically a type of credit system in itself. There is a credit limit for each user which has to be certified before the user can actually use the program. Once the user reaches the limit the service cannot be used anymore until the bill has been paid for. CEO Peter Fredell explains that they decided not to use Visa and MasterCard settlement system to avoid the associated transaction fees that these companies use (NFC World+ 2013).

The transaction part of SEQR is very simple to both the customer and the merchant. The customer simply scans the QR code at the register while at the same time the merchant presses the SEQR button on the cash register. The customer then received the payment

amount on their smart phone and then input their personal PIN code into the smartphone to accept the transaction. This same basic principle also applies when using NFC the only difference being that the customer does not take a picture of the QR code but instead swipes their smartphone on the payment terminal. The payment terminal in this case being an updated version of the SEQR IN sticker that includes an NFC tag as well as the existing QR code. Fredell explains that when they looked at the technology side communicating with a cashier point that not all phones have NFC built into them so they decided to start with a technology that's integrated into almost every smart phone, a camera. He also explains that with QR codes there is a slight security risk involved which is why they have also started using NFC which is more secure. (NFC World+ 2013). This will be explained in more detail later on in this thesis.

SEQR is likely the most used digital wallet in stores and online in Europe. SEQR enables the customer with a smartphone to pay in retail outlets as well as online. Customers can also transfer money at no charge, store receipts digitally and receive offers and promotions directly through one mobile application. Interestingly 3.1 billion transactions have been processed annually on behalf of leading mobile network operators, banks, retailers and distributors through virtually all kinds of access channels (SEQR 2015).

Figure 7 compares three options to mobile payments: the traditional payment card routing, card based mobile solution and finally the SEQR routing. On the basis of the figure it appears that SEQR offers a reasonable seamless, simple and fast payment process.

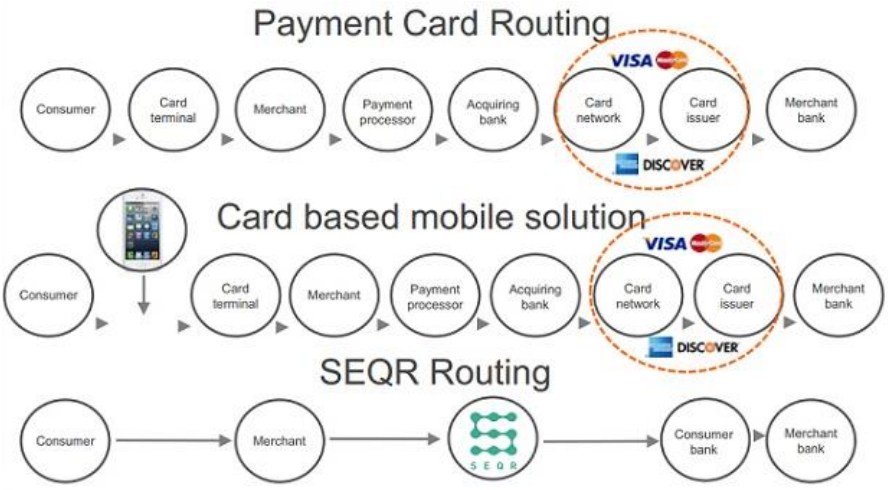

FIGURE 7. Comparison of the three alternative mobile payment methods (Nocash 2014)

4.4. Coin

Coin, a startup device out of San Francisco is another example of a credit card type that can hold up to 8 different cards. These cards can vary from credit cards to membership cards. The idea is basically the same as with Google Wallet, but the approach is simpler as Coin works using a patent-pending magnetic strip that changes on demand (The Verge 2013). The device has a small reader with which to scan cards into the Coin mobile application, which then syncs with the device itself over Bluetooth Low Energy (BLE). The same power usage protocol is used by many fitness trackers and smart watches. Coin has a battery life on around 2 years and thus requires charging only infrequently. The device also stays in contact with the user's smart phone with the Bluetooth technology. The implication of this is that if the user forgets the device somewhere the smart phone informs the user that he/she does not have the Coin card is use (The Verge 2013).

4.5. CurrentC

Instead of using the near field communication (NFC), CurrentC uses QR codes displayed on a cashier's screen and scanned by the consumer's phone or vice versa to initiate and verify the transaction. In addition CurrentC is designed to automatically apply discounts, use loyalty programs, and charge purchases to a variety of payment methods without passing sensitive financial data to the merchant. (Techcrunch 2014). The following figure illustrates the CurrentC payment method. The objective of the CurrentC initiative, which was started by major relailers like Walmart, Target and others, has been to completely replace the use of credit cards, which charge quite hefty fees for the transactions. This, according to TechCrunch, is also the reason why the probability of CurrentC succeeding is quite slim due to the fact that CurrentC does no make the payment easier, but rather somewhat more cumbersome. Furthermore CurrentC is not a replacement of the traditional wallet, but rather a more clumsy replacement of payment cards.

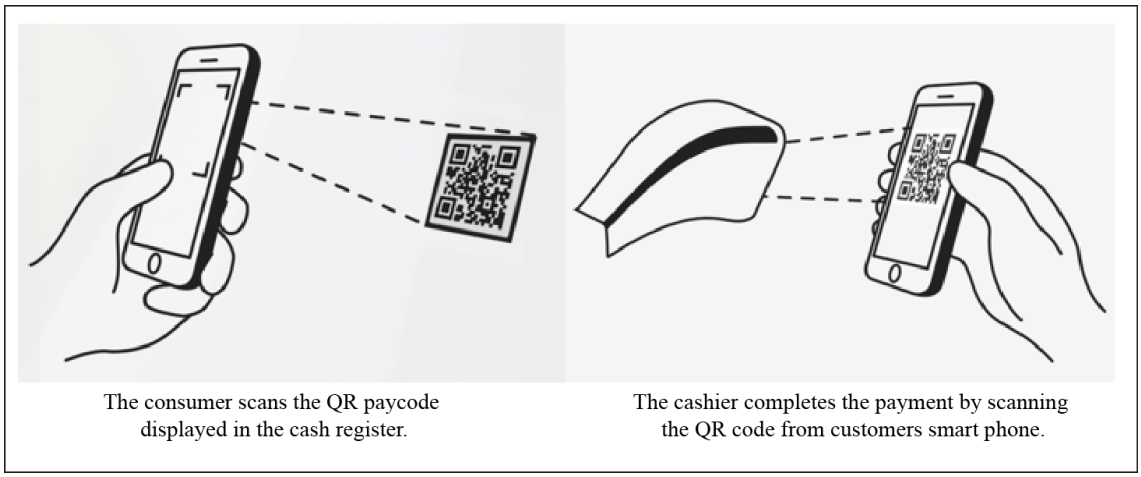

FIGURE 8. Illustration of the CurrentC payment method (Techcrunch 2014)

4.6. Pivo

Pivo is a digital wallet technology, which according to OP (a major Finnish banking organization) ”stores all your important banking information, payment and loyalty cards and favorite shops and their special offers” (OP 2015), and is available for both Android, iPhone and Windows platforms. When looking at the definition of the smart wallet in the Abbreviations and Terms section of this thesis, one can see that the PIVO smart wallet application is not even close to the definition used here. The PIVO application has been developed from the banking institution point of view and thus does not include the personal identification cards, driving licenses, membership cards, depository of digital receipts functionalities. More importantly the PIVO application does not allow cash, debit or credit card payments. In other words, the PIVO application does not match the definition of the smart wallet application presented in this thesis. Another disadvantage from the user’s point view is that the PIVO smartphone application is limited to the OP banking institution and related companies. In conclusion the PIVO smart wallet application is only a very basic illustration of what the smart wallet can actually be.

5 CONSUMER ADOPTION

One way to assess the adoption of the wallet is to use the framework provided by Everett M. Rogers. In his book ”Diffusion of Innovations” (1995) he indicates that there are five items which explain how various innovations ”diffuse” or are adopted by the customers. These items and their meaning are described in the following table.

TABLE 3. Items impacting the adoption of innovations

Item impacting adoption	Impact
1. Relative advantage	The degree to which an innovation is perceived as being better than the idea it supersedes.
2. Compatibility	The degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters.
3. Complexity	The degree to which an innovation is perceived relatively difficult to understand and use.
4. Trialability	The degree to which an innovation may be experimented with on a limited basis.
5. Observability	The degree to which the results of an innovation are visible to others.

The research regarding the adoption of wallet and other digital payment technologies is scarce, but the managing editor of The Wiglaf Journal, Mr. James T. Berger, has taken a stab at Apple Pay (2014). The results of his non-scientific approach can be seen in the following table.

TABLE 4. Assessment of items impacting the adoption of Apple Pay (Berger 2014)

Item impacting adoption	Conclusion	Impact
1. Relative advantage	No difference	±0
2. Compatibility	Compatible existing values, past experiences, and needs of potential adopters	+
3. Complexity	No constraints	±0
4. Trialability	Easy to try ouy	+
5. Observability	Yes	+

The shortcoming of the above approach provided by Rogers (1995) is that it does not allocate weights to the various items impacting adoption of various innovations. It probably has to be done separately in each situation, and maybe can be qualitative at best.

On the basis of the above table it is clear that the Apple Pay provides maybe only minor benefits for the consumer. Especially concerning point is the relative advantage which appears to be relatively small if anything at all in the case of Apple Pay.

The situation potentially changes, however, if the focus of the assessment is not just Apple Pay but rather a smart wallet, which as a concept is somewhat broader that Apple Pay or similar payment technologies like Google Wallet. As mentioned in the introduction section, "a smart wallet is a software application, usually for a smart phone, that serves as an electronic version of a physical wallet". The definition goes beyond the payment cards and includes all sorts of membership cards, and identification cards as well as the downloading and storing capability of promotional offers, digital receipts etc.

As discussed in the method section of this thesis in order to assess the adoption of the smart wallet technology lead users need to be identified. The objective in this regard was to create a list of 6-8 people who could be identified as lead users. As mentioned earlier the following criteria was used: First try to identify users who are at the leading edge of the identified trend in terms of related new product and process needs and second try to identify users who expect to obtain a relatively high net benefit from solutions to the identified need. It is obvious that this kind of selection of lead users suffers from validity and reliability issues, but has the advantage of providing insights of what is likely to happen in the future. In case the items affecting the adoption innovation are positive, then the attitudes of users in the adoption of the smart wallet technology, behavioral intentions to use the smart wallet technology and finally the actual use of the smart wallet technology will be positive as well (Chen & Adams 2005).

Table 5 includes the list of lead users and the reasons for their selection and table 6 includes the summary on the comments by the selected lead users, and table 6 describes the assessment of items impacting the adoption of a smart wallet by the selected lead users.

TABLE 5. List of lead users and the reasons for their selection

Lead user	**Reasons for selection**
Dr. Matti J. Haverila	• Intensive research in the area of New Product Development • Experience in managing high technology companies in Silicon Valley
Mr. Mika Lahtinen	• Intensive experience about launching digital payment technologies in a major commercial bank in Scandinavia
Mr. Tuomas Lecklin	• Digital media expert • A recent graduate of Tamk Media program • Knowledge of recent media technologies
Mr. Marko Nurmela	• Vice president of the Scandinavian operations of a global smart phone provider • Intensive knowledge and experience of smart phone related applications and technologies
Mr. Antti Lahtinen	• IT specialist • IT security specialist

On the basis of the results in table 6 it is obvious that the adoption of the smart wallet should be faster than of that of the Apple Pay, which has the main function of digital payments. In addition it is also clear that the enhancement of the digital payment system like Apple Pay with the features of the traditional wallet (e.g. payment cards, membership cards, promotional coupons, digital receipts etc.) should greatly enhance the adoption of the smart wallet.

TABLE 6. Assessment of items impacting the adoption of smart wallet[*)]

Item impacting adoption	Conclusion	Impact	Notes
1. Relative advantage	Major advantage	++	+ Physical size of the wallet decreases + Adding items to the wallet is not limited by their physical size + Adding promotional coupons to the wallet is easy + No cash + No need to fetch cash from ATM + Membership cards can be added digitally + Convenient transaction processing + No need to carry a physical wallet – Perceived security issues – Transaction processing might be lengthy – Unreliable network connection
2. Compatibility	Compatible existing values, past experiences, and needs of potential adopters	+	+ Compatible with current transaction processing systems + No need to change behavior with payment activities + Familiarity with smartphones – Perceived difficulty of use
3. Complexity	No constraints	-	+ Mobile payment service is not a complex innovation – More knowledge and instructions required – Technological learning curve and thus adoption takes time
4. Trialability	Easy to try out	+	+ Really easy to try + Low risks
5. Observability	Yes	++	+ Transaction processing easy and visible

[*)] ++ = Very positive impact on adoption, [*]+ = positive impact on adoption, ±0 = no impact on adoption, - = negative impact on adoption, -- = very negative impact on adoption

6 IMPLEMENTATION AND KEY ISSUES

In principle the data of the smart wallet is in the Cloud. It stores all critical data like account balances, identification, coupons etc. into the personal cloud. The smart phone acts as the bridge between the digital and analogue systems.

6.1. The Idea

The smart wallet is like PayPal, Google wallet and a traditional wallet all-in-one. For it to become a viable alternative to using the credit card these digital wallet enabled locations need to be in almost every place where we use money. In the following table a comparison is made between a smart wallet and traditional wallet (Digital Wallet 2015).

TABLE 2. Comparison of smart wallet and traditional wallet

Item	**Smart wallet**	**Traditional wallet**
1. Storage of digital data	Yes	No
2. Interface with electronic devices	Automatically using e.g. RFID or Bluetooth	Manually
3. Initial investment (time, money)	High	Low
4. System outages	Possible	Robust; outages unlikely.
5. Security issues	Possible	Possible
6. Cost of transaction for the customer	Low	Moderate
7. Cost of transaction for the retailer	Low due to simplified purchasing process	Moderate due to the need of Point-of-Sales (POS) system and personnel
8. Convenience	High	Moderate at best
9. Technology	Emerging	Legacy
10. Power supply	Smartphone yes, smart wallet no.	No
11. Promotions	Digitally	Manually; increases clutter
12. Management of personal issues (name cards etc.)	Digitally	Manually; increases clutter

“It is very important for the smart wallet to be able to handle all types of payments and it needs to be versatile about what technology it can use. Any mobile solution should

really try to accommodate both QR codes and NFC tags and be prepared to accept any technology that the client chooses to pay with." (NFC World+ 2013)

People use traditional wallets in many different ways. Some use it only to hold their identification cards, debit and credit card while others use it for everything from club cards, to storing notes and passwords for online accounts. The main idea of the smart wallet is to be an all-in-one application that lets the consumer choose how they want to use the application. One person may only use it to pay in stores with their NFC enabled smartphone. Another person may use it for storing login information and club cards, for instance if they don't have an NFC enabled smartphone but what to upgrade in the future. All information is stored on the cloud so the user does not have to worry about loss of data.

6.1.1 The Structure and Layout of the User Interface

Like with any other application that is run of a cloud based service the first thing that the user has to do is create a Smart Wallet account in order to be able to use any of the services of the application. Figure 9 illustrates a rudimentary login functionality into the smart wallet application.

The idea is that the user creates an official smart wallet account that has to be verified so that a single person has access to his/her smart wallet. E-Mail address and phone number are also typically added for additional security. This enables the user to get automatic updates and notifications whenever a certain feature of the application is used, for instance when money is being transferred or a payment is made.

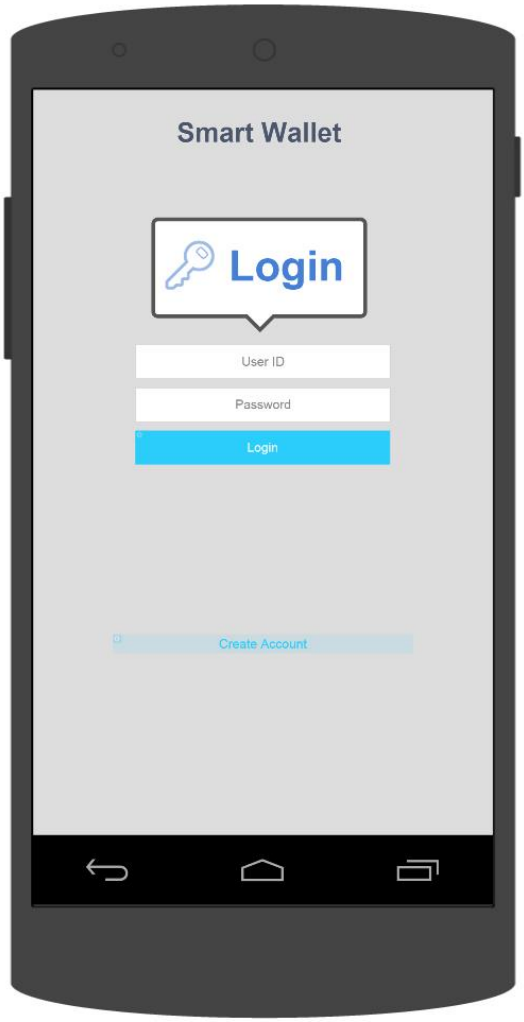

FIGURE 9. Illustration of the login functionality of the smart wallet application

After the user has created an smart wallet account and it has been verified, the account holder can start to use the smart wallet application. First the user goes through a simple tutorial and at the end they choose how they want to use their smart wallet and what features they want to enable. In the mock-up demonstration below one can see the basic layout of what the main menu looks like after the initial setup. As mentioned earlier everything from bank accounts to Facebook login information can be stored on the personal smart wallet.

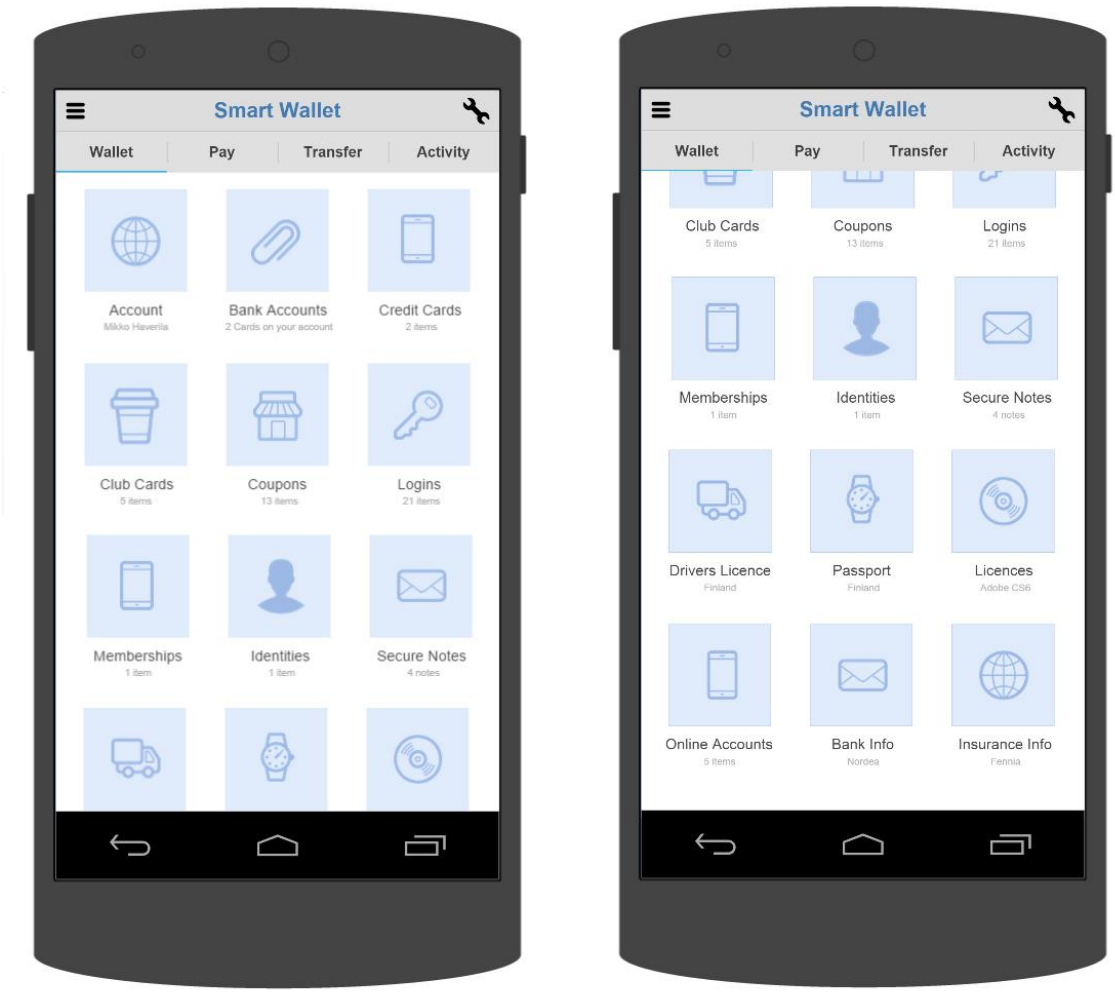

FIGURE 10. Illustration of the possible applications in a smart wallet

The applications are user friendly after the initial setup. The side bar can be customized regarding how the user wants to use the various applications and their smart wallet. The mock up below again illustrates the ease of use with the side bar. The sidebar consists of basic features like search, settings and a way to log out. The user can also opt for the use of a favorites tab in order to access certain places faster.

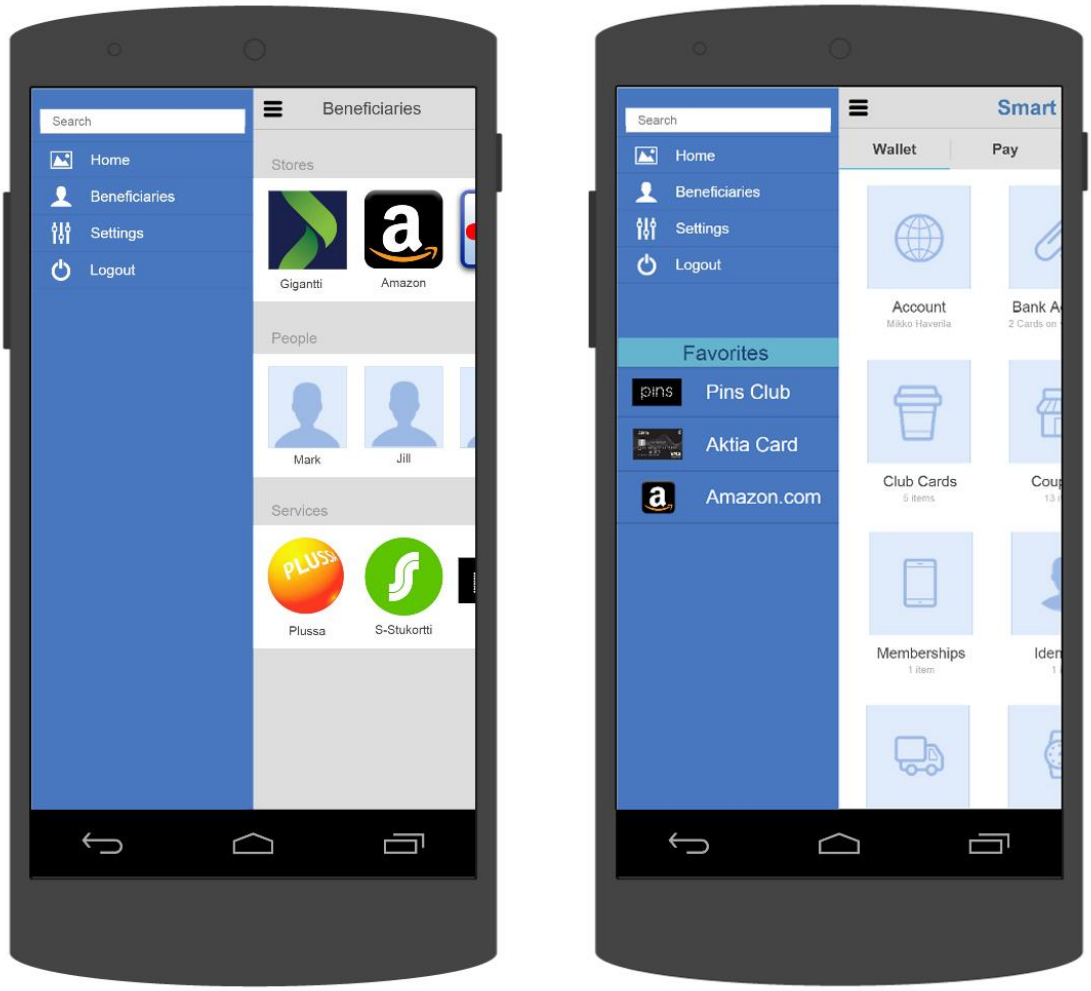

FIGURE 11. Illustration of the user interface of the smart wallet

6.1.2 Cards and Day-to-day Transactions

Through the introduction of the smart wallet the debit and credit, identification and club cards would be a thing of the past because all cards would be stored on the personal cloud and the user can access them at any given point via the smart wallet service enabled secure smart phone.

FIGURE 12. Illustration of the credit card functionality in the smart wallet

The debit and credit card side of the smart wallet application works in the same fashion as Apple Pay because at this point it is the most viable in terms on security and ease of use.

6.1.3 Memberships

Membership cards are usually the ones that fill the traditional wallet to its' physical limits. These are usually equipped with a magnetic strip, and thus do not require as stringent security requirements as the debit and credit cards. The main drawback of the membership cards is their requirement for physical space. Furthermore the membership cards also are a considerable cost for their providers. These costs include the material costs, printing costs as well as the human resources required to maintain the databases.

Embedding the membership card into the smart wallet will not remove these costs completely but will for sure make the life easier for the consumer as well as for the provider.

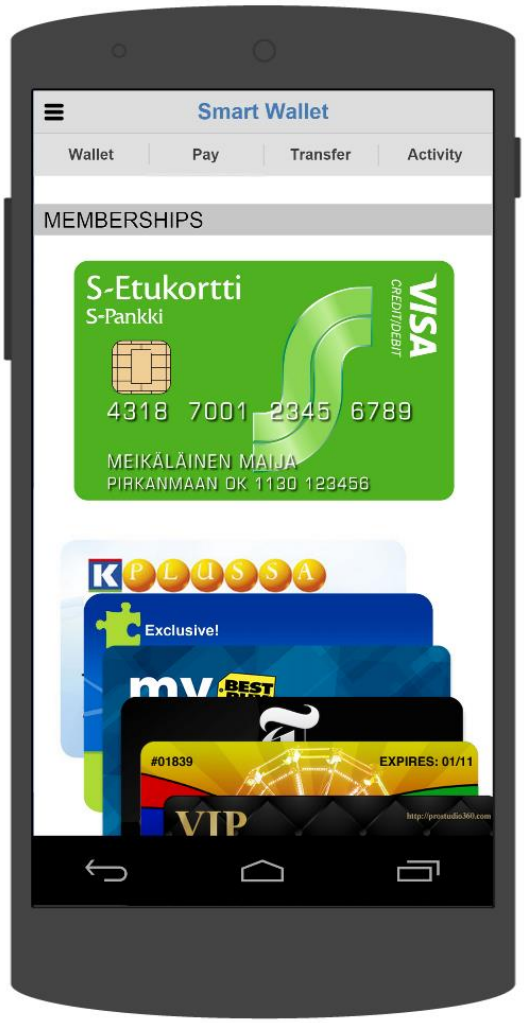

FIGURE 13. Illustration of the membership cards functionality in the smart wallet

The Smart Wallet application can hold an infinite amount of club and membership cards in various different formats. Magnetic, numeric, QR code, and also the "buy nine get one free" stamp cards can all be integrated to work with the software. All cards are placed in the membership application where the user has fast access to them.

6.1.4 Coupons and Promotions

Consumers keep coupons and other promotional items in their traditional wallets (and elsewhere) and like the membership cards they can take a lot of physical space. In addi-

tion it is difficult to keep track of them. In order to be able to keep those coupons in the smart wallet, and for the system to work on a larger scale the coupons that are provided to customers have to have some kind of identification number attached to them. This facility enables the digital storing of the coupons into the smart wallet. Another method of using and storing coupons if to use QR Codes. QR codes can be stored on the phone and when a user wants to use a code all they have to do is show it at the register and the clerk can scan it right from your phone. Another example of a coupon would be a basic one time use coupon, like the once cut out of a newspaper. The consumer has to physically give the coupon to the clerk and it is then "used". The same practice can be done with the smart wallet.

The benefit of the smart wallet is the versatility in terms of keeping various kinds of promotional coupons in the smart wallet. These include for example cards which require a stamp when used. For example the consumer has to get 10 stamps in order to get something for "free". This is an interesting development area for many software developers.

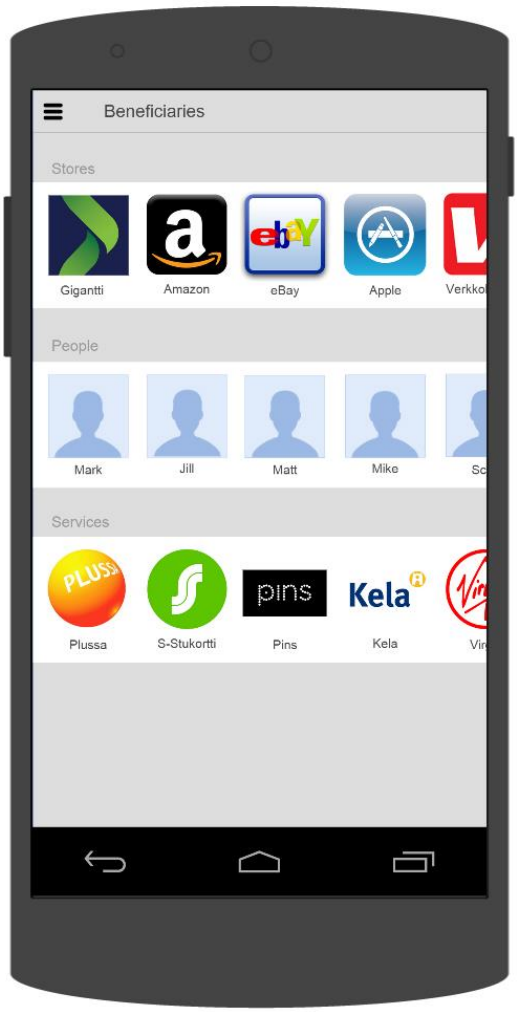

FIGURE 14. Illustration of the coupons and promotions functionality in the smart wallet

6.1.5 Official Identification

The question here is that “Can I use my passport embedded into my smart wallet in a smart phone”? This is not a possibility yet, but the obvious benefit of this is that it is likely to streamline traveling. The traditional passports appear to be pervasive especially in international travelling, but the expectation is that the travelers will be able to pass through an airport without physical boarding passes very soon (Carter & Faulkner 2014). This has been successfully trialed with NFC secure boarding passes in BlackBerry devices, which acted as their security pass for a dedicated, priority path through the airport. Boarding passes based on QR codes have been around for some time, but NFC passes should be far more popular with airport operators. Unlike QR codes, NFC codes loaded in a SIM card can even be used when the device is switched off. NFC passes are also far more secure than QR codes which can be easily duplicated, forwarded or altered. (Carter & Faulkner 2014)

6.1.6 Notes and Information

People use their traditional wallets, computers, mobile phones to store all kinds of information from basic notes to delicate information like passwords. The Smart Wallet application would store all such information on the cloud in one place. The user could add, for example, the “Logins” application, which could be used to store all accounts and passwords that they use on the internet.

6.2. Smart Wallet Application and the Role of the Cloud

The idea of the smart wallet application is to be as simple as possible while having lots of features which become available to the user if they wish to use them. As said when the application is launched for the first time the user will go through a process where they create an account and then verify that account. After the account has been created the next step is to choose how exactly he/she wants to use the service and what features they want to use and not to use.

As stated earlier the user can choose exactly how they want to use smart wallet. All information stored on the cloud can be accessed from one place after they have entered the correct credentials, in most cases the user name and password. Users can also add information to the program that does not require a log in. For example if a user decided that all coupons that are in the program do not have to be behind the login credentials they can choose that option. The next time they open the program all coupons are available without logging in, however to access any other information they have to log in. The basic idea is convenience. It takes a long time to access something that is behind a user name and a password. All smartphones have some kind of security to access the phone so basic information like quick notes and coupons can be access easily without having to login to the application with personal credentials. Account transactions and payment info can also be accessed right from the application if the user decides to opt for the feature.

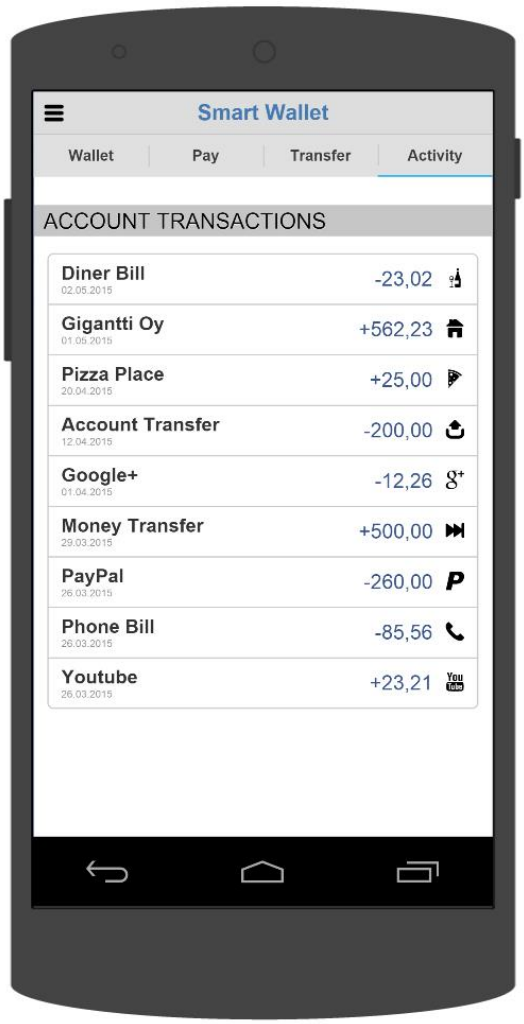

FIGURE 15. Illustration of the administration functionality of the smart wallet

Due to the security reasons it is fundamental that basically everything will be stored on the cloud. For example when the user wants to upgrade their smartphone, all they need to do is download the smartphone application on their new phone, log in, verify the new device and the necessary information is usable with the smart wallet application in the smartphone.

6.3. Migration from Traditional Wallet to Smart Wallet

Migrating from a traditional wallet into a smart wallet is not something the user can and should be able to do automatically. To start with the user has to choose exactly how and which features they want to use in the smart wallet application. If for example the user lives in a part of the world where stores have started to use wireless payment terminals in conjunction with their cash registers then they can use the application to pay for products with their smart phone. If on the other hand the wireless payment terminals are not an option, then the user can use the application for things like online payments, Club Cards, coupons, membership cards etc. while having the possibility to start using other features later on.

7 CONCLUSION/RESULTS

The purpose of this thesis was to investigate the challenges and roadblocks for the so-called smart wallet service. In the background section the characteristics of the traditional wallet as well as the traditional payment methods were reviewed. Some of the existing payment methods like smart cards are still in the adoption stages of their life cycle.

The existing competitive services field were also reviewed in the thesis. These services included cash and traditional wallet, credit and debit cards, Apple Pay, Google Wallet, SEQR, Coin, CurrentC and PIVO. Cash, traditional wallet, credit and debit cards of course have been around for varying lengths of times and gone through some changes. Apple Pay, Google Wallet, SEQR, Coin, CurrentC and PIVO on the other hand are representatives of more modern times. None of these modern services are however full replacements of the traditional wallet even though they might use the name “smart wallet” of themselves. PIVO for example does allow payments at all but acts rather as a access and storage facility for financial information.

The various relevant technologies including digital wallet, Near Field Communication (NFC), smart phone, Bluetooth and BLE, QR code, digital camera, finger print scanner, Cloud, mobile security technologies, and contactless bank cards potentially necessary for the smart wallet were discussed next in the thesis. In the words of Ranger (2013): Smart wallet with NFC in itself won't make the physical traditional wallet disappear, even if it makes it a bit thinner — which isn't a compelling reason unless the user is obsessed with the fit of your jeans or suit. It is crucial to understand however that many disruptive technologies (expression used by Clayton Christensen, 2015) require multiple technologies to be operational at the same time in order to achieve a real breakthrough in the marketplace.

In order to achieve the breakthrough consumer adoption issues have to be addressed. These issues include the following items: Relative advantage (what kind of advantage does the new service/product/technology give to the consumer in relation to the existing one), Compatibility (how compatible is the new service/product/technology with the existing values of the customer), Complexity (how complex is the new ser-

vice/product/technology in relation to the existing one), Trial ability (how easy it is to try the new service/product/technology) and Observability (how easy it is to observe the benefits of new service/product/technology. The interviews with selected lead users indicated that the smart wallet likely has a good chance in the market place but it likely that this will take some time.

The main problem with the smart wallet is that the infrastructure is just not there. Even if the cloud and mobile side would be ready, there is simply not enough support in the real world. Even if the user wants to use the smart wallet to pay for a sandwich, there are very few places the user can use the smart wallet because the deals between banks, credit card companies and handset manufacturers still haven't been done." (Ranger 2013)

The smart wallet service in itself is a simple concept to understand, basically combine features to make an all-in-one applications that works in conjunction with other services that are already in place. The trend these days seems to be that every business, corporation or bank has to have their own card or membership service, which is closed off from other services. If a business decides to make a digital version of their membership services then the end product should be a digital mobile application of their service. The clutter from the wallet is moved to the smartphone where in the end the user will have lots of applications on the phone taking up large amounts of (visual) space.

Likewise consumers aren't going to readily embrace a payment method that are known not to be accepted by all retailers. There has to be significant benefits for both users and the providers. For example Starbucks started to utilize the QR readers when it implemented its mobile payment system due to the fact that Starbucks already had the scanners to handle QR and there wasn't the cost associated with accepting NFC payments (TechRepublic 2015).

It appears however that the foundations of the NFC ecosystem and thus for the smart wallet appear to be largely in place. The introduction of large scale initiatives like Visa's PayWave and MasterCard's PayPass mean that NFC terminals are appearing in thousands of UK (Carter & Faulkner 2013).

On the manufacturers' side, nine out of ten manufactures have incorporated NFC into their products. The iPhone 5 did not include NFC, which means that retailers or banks were less willing to invest in NFC enabled payment systems (Ranger 2013.) It is noteworthy, however, that the new iPhone 6 is already NFC enabled.

In conclusion it appears that the smart wallet will be a common thing of the future. The benefits both for the user and the technology and service providers will outweigh the disadvantages, but this will still take some time.

REFERENCES

9to5Mac. 31.10.2014. iOS and Android combine to capture 96% global market share in Q3. Read 03.02.2015. http://9to5mac.com/2014/10/31/android-vs-ios-market-share-3q-2014/

Geuss, M. 2014. How Apple Pay and Google Wallet actually work. Read 16.03.2015. http://arstechnica.com/gadgets/2014/10/how-mobile-payments-really-work/

Android Authority. 2015. What is NFC & how does it work? Read 02.03.2015. http://www.androidauthority.com/what-is-nfc-270730/

Balaban, D. 2013. The year ahead for NFC: Commercial launches at hand. NFC-TIMES. Read 11.12.2013. http://nfctimes.com/report/year-ahead-nfc-entering-commercialization-phase

Barkhuus, L. & Polichar, V.E. 2011. Empowerment through seamfulness: smart phones in everyday life. Journal Personal and Ubiquitous Computing 15(6) 629-639.

Bennett, B., Conover, D., O'Brien, S. & Ross Advincula. 2014. Cash continues to play a key role in consumer spending: Evidence from the diary of consumer payment choice. Read 01.03.2015. http://www.frbsf.org/cash/files/FedNotes_Evidence_from_DCPC.pdf

Berger, J.T. 2014. Will the marketplace adopt Apple Pay? Reda 16.03.2015. http://www.wiglafjournal.com/product/2014/11/will-the-marketplace-adopt-apple-pay/

BigSkinny. 2015. The history of the wallet: From coins to paper to plastic. Read 15.03.2015. http://www.bigskinny.net/the-history-of-the-wallet.html

Bisson. S. 2014. Apple Pay: Too complicated for the real world? ZDNet. Read 03.03.2015. http://www.zdnet.com/article/apple-pay-too-complicated-for-the-real-world/

BMW Group. 2010. Near Field Communication: Organizing everyday life intuitively. Read 02.03.2015. http://www.bmwgroup.com/e/0_0_www_bmwgroup_com/forschung_entwicklung/science_club/veroeffentlichte_artikel/2010/NFC_White_Paper_en.pdf

Bohn, D. 2014. Apple Pay was this week's most revolutionary product. Read 11.01.2015. http://www.theverge.com/2014/9/10/6132153/apple-pay-was-this-weeks-most-revolutionary-product

Campbell, A.Y. 1931. The boy, the grapes, and the foxes. The Classical Quarterly 25 (2) 90-102.

Carter, J. & Faulkner, C. 2014. What is NFC and why is it in your phone? Read 02.03.2015. http://www.techradar.com/news/phone-and-communications/what-is-nfc-and-why-is-it-in-your-phone-948410/2

Chen, J.J. & Carl Adams, C. 2005. User acceptance of mobile payments: A theoretical model for mobile payments. Proceedings of the Fifth International Conference on Elec-

tronic Business. 5-9.12. 2005. Hong Kong. Read 18.03.2016. http://iceb.nccu.edu.tw/proceedings/2005/619-624.pdf

Christensen, C. 2015. Disruptive innovations. Read 17.03.2015. http://www.claytonchristensen.com/key-concepts/

CNET. 2012. The most practical, creative ways to use NFC with your Android device. Read 02.03.2015. http://www.cnet.com/how-to/the-most-practical-creative-ways-to-use-nfc-with-your-android-device/

Comscore. 2015. ComScore Reports July 2014 U.S. Smart Phone Subscriber Market Share. Read 01.03.2015. http://www.comscore.com/Insights/Market-Rankings/comScore-Reports-July-2014-US-Smartphone-Subscriber-Market-Share

Daggar, R.N. 1994. Multimedia electronic wallet with generic card. U.S. Patent US5748737 A. Read 12.03.2015. https://www.google.com/patents/US5748737

DeGennaro, R.P. 2006. Merchant acquirers and payment card processors: A look inside the black box. Economic Review 91(1), 27-42.

Digital Wallet. (2015). Advantages and disadvantages. Read 02.03.2015. http://digitalwallet.weebly.com/advantages--disadvantages.html

Ebringer, T., Thorne, P. & Zheng , Y. Parasitic authentication to protect your e-wallet. Computer 33(10), 54 – 60.

Ekekwe, N. 2012. Disruptive technologies, innovation and global redesign: emerging implications: Emerging implications (Google eBook). IGI Global.

Electronics and Telecommunications Reseach Insitute (ETRI). 2015. Introduction of Research. Read 23.03.2015. https://www.etri.re.kr/eng/sub6/sub6_01020102.etri;jsessionid=959F120238FC24A3964F838C11488A42?departCode=11&departInfoCode=63

European Central Bank (ECB). 2014. Third report on card fraud. Read 23.03.2015. http://www.ecb.europa.eu/pub/pdf/other/cardfraudreport201402en.pdf?e50b929264594aabb07bba92a0a26b3f

Fashion-kid.net. 2015. Fashion For (Wallet For Women Open). Read 15.03.2015. http://fashion-kid.net/wallet-for-women-open.html

Federal Reserve System. 2011. The 2010 Federal Reserve Payments Study Noncash Payment Trends in the United States: 2006 – 2009. Read 01.03.2015. https://www.frbservices.org/files/communications/pdf/press/2010_payments_study.pdf

Gartner. 2015. Gartner says sales of smart phones grew 20 percent in third quarter of 2014. Read 01.03.2015. http://www.gartner.com/newsroom/id/2944819

GlobalSmart. 2015. NFC & Mobile card solutions. Read 02.03.2015. http://www.globalsmart.com/graphics/pdf/2014NFC-PUBLICATION.pdf

Google Wallet. 2015. Google wallet, Frequently asked questions. Read 15.03.2015. https://www.google.com/wallet/faq.html#

Government of Hong Kong. 2011. MOBILE TECHNOLOGIES SECURITY. Read 23.03.2015. http://www.infosec.gov.hk/english/technical/files/mobilets.pdf

Hoffman, C. 2013. Bluetooth low energy explained: How new types of wireless gadgets are now possible. How-to Geek. Read 02.03.2015. http://www.howtogeek.com/176437/bluetooth-low-energy-explained-how-new-types-of-wireless-gadgets-are-now-possible/

How-to Geek. 2015. How to easily transfer files between nearby smart phones. Read 15.03.2015. http://www.howtogeek.com/167344/how-to-easily-transfer-files-between-nearby-smartphones/

ITU. (2015). The world in 2014: ICT facts and figures. Read 01.03.2015. http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2014-e.pdf

IDC. 2015. Smart Phone OS Market Share, Q3 2014. Read 01.03.2015. http://www.idc.com/prodserv/smartphone-os-market-share.jsp

ImgArcade. 2015. Gallery Images For (Ancient Leather Money). Read 15.03.2015. http://imgarcade.com/1/ancient-leather-money/

Indetive NFC. (2015). What is NFC? Read 02.03.2015. http://www.identivenfc.com/en/what-is-nfc

Investopedia. 2015a. Digital wallet. Read 16.03.2015. http://www.investopedia.com/terms/d/digital-wallet.asp

Investopedia. 2015b. Credit card tutorial. Read 01.03.2015. http://www.investopedia.com/university/credit-cards/

Jordon Cooper. 2015. Joseph Abboud brown elastic front pocket wallet. Reda 16.03.2015. http://www.jordoncooper.com/2013/06/joseph-abboud-brown-elastic-front-pocket-wallet/

King, R. 2013. PayPal Beacon promises hands-free mobile payments via Bluetooth LE. Read 14.01.2015. http://www.zdnet.com/article/paypal-beacon-promises-hands-free-mobile-payments-via-bluetooth-le

Korhan, J. 2011. How QR codes can grow your business. Social Media Examiner. Read 03.03.2015. http://www.socialmediaexaminer.com/how-qr-codes-can-grow-your-business/

Life Hacker. 2013. What Is NFC and How Can I Use It? Read 02.03.2015. http://lifehacker.com/5943006/what-is-nfc-and-how-can-i-use-it

Macworld (2015). The ultimate guide to how and where to use Apple Pay. Read 01.03.2015. http://www.macworld.com/article/2834669/the-ultimate-guide-on-how-and-where-to-use-apple-pay.html

Mondato (2015). Under the hood of Apple Pay. Read 01.03.2015. http://mondato.com/blog/apple-pay-security/

Moore's Law. 2015. How overall processig power for computers will double every two years. Read 01.03.2015. http://www.mooreslaw.org/

Near Field Communication. 2015. History of Near Field Communication. Read 01.03.2015. http://www.nearfieldcommunication.org/history-nfc.html

New York Fed. 2013. How currency gets into circulation. Read 01.03.2015. http://www.newyorkfed.org/aboutthefed/fedpoint/fed01.html

NFC.CC. 2015. Google Wallet 2.0: Any credit/debit card on an Android. Read 01.03.2015. http://www.nfc.cc/2012/08/03/google-wallet-2-0-any-creditdebit-card-on-an-android/

NFC Forum. 2015. Our mission & goals. Read 01.03.2015. http://nfc-forum.org/about-us/the-nfc-forum/

NFC Ready. 2014. Replacing your keys and Smart Cards with your NFC smart phone. Read 02.03.2015. http://www.nfc-ready.eu/20141012914/914-replacing-your-keys-and-smart-cards-with-your-nfc-smartphone.html

NFC World+. 11.04.2015. Seamless adds NFC to QR payments platform. Read 08.02.2015. http://www.nfcworld.com/2013/04/11/323448/seamless-adds-nfc-to-qr-payments-platform/

Nichols, J. & Myers, B.A. 2006. Controlling home and office appliances with smart phones. Pervasive Computing, IEEE 5(3), 60-67.

Nielsen, S.-E. 2012. Bluetooth v4.0's Smart start. Electronic News. Read 02.03.2015. http://www.electronicsnews.com.au/technical-articles/bluetooth-v4-0-s-smart-start
Nocash. 2015. Seamless Romania. Read 01.03.2015. http://www.nocash.info.ro/seamless-romania-vom-oferi-preturi-mai-bune-indiferent-de-oferta-bancilor/

OP. 2015. Get more out of your wallet. Read 05.05.2015. https://www.op.fi/op/private-customers/pivo?id=11090&kielikoodi=en&srcpl=4

Payments Cards and Mobile. 2015. Security breaches help drive EMV migration in the US. Read 03.03.2015. http://www.paymentscardsandmobile.com/security-breaches-help-drive-emv-migration-us/

Payments Leader. 2015. Does Apple Pay replace the plastic in your wallet? Read 16.03.2015. http://www.paymentsleader.com/does-apple-pay-replace-the-plastic-in-your-wallet/

Payyourway. 2015. Payments glossary. Read 03.03.2015. http://www.payyourway.org.uk/glossary/

Pininterest. 2015. Wallet, stamped leather Eastern Iran or Afghanistan; end of 12th-beginning of 13th century. Read 15.03. 2015. https://www.pinterest.com/pin/514184482432350121/

Pixel Ballads. 2013. Quick NFC update…. Read 03.03.2015. https://pixelballads.wordpress.com/2013/11/06/quick-nfc-update/

PhoneArena.com. 04.03.2015. Samsung Galaxy S6 fingerprint scanner vs Apple iPhone 6 TouchID. Read. 07.03.2015. http://www.phonearena.com/news/Samsung-Galaxy-S6-fingerprint-scanner-vs-Apple-iPhone-6-TouchID_id66820

PushCoin. 2015. A solution to long lines. Read 02.03.2015. http://parks.pushcoin.com/#section=services

PR Newswire. 12.12.2014. NFC Transaction Market (47%) and NFC Enabled Handsets (55%) 2019 Growth Forecasts in New Global Research Reports. Read. 02.03.2015. http://www.prnewswire.com/news-releases/nfc-transaction-market-47-and-nfc-enabled-handsets-55-2019-growth-forecasts-in-new-global-research-reports-285591571.html

Qfuse. 2013. NFC used to improve parking payment system in San Francisco. Read 02.03.2015. http://qfuse.com/blog/nfc-used-to-improve-parking-payment-system-in-san-francisco/

Ortiz, C.E. 2008. An introduction to near-field communication and the contactless communication API. Read 16.03.2015. http://www.oracle.com/technetwork/articles/javame/nfc-140183.html

Ranger, S. 2013. Smart phone payments via NFC? Don't ditch your wallet just yet. ZDNet. Read 21.06.2014. http://www.zdnet.com/smartphone-payments-via-nfc-dont-ditch-your-wallet-just-yet-7000011846/

Rao, R. 2012. System and method for providing smart electronic wallet and reconfigurable transaction card thereof. US Patents US 20140006277 A1. Read 24.03.2015. http://www.google.com/patents/US20140006277

Rapid NFC. 2015. What is NFC - A beginners guide. Read 02.03.2015. http://rapidnfc.com/what_is_nfc

Rogers, E. M. (1995). Diffusion of innovations (4th ed.). New York, Free Press.

Search Cloud Computing. 2015. Cloud computing. Read 16.03.2015. http://searchcloudcomputing.techtarget.com/definition/cloud-computing

Search Manfacturing ERP. 2015. RFID (radio frequency identification). Reda 16.03.2015. http://searchmanufacturingerp.techtarget.com/definition/RFID

SecureIDNews. 2012. Australian ski resort adopts NFC. Read 02.03.2015. http://www.secureidnews.com/news-item/australian-ski-resort-adopts-nfc/

SEQR. 2015. SEQR the mobile wallet. Read 01.03.2015. http://seamless.se/products/seqr/

SGB Web Design. 2015. What is QR Code? Read 03.03.2015. http://www.sgbwebdesign.com/services/what-is-qr-code/

Smart Card Alliance. 2015. Smart Card FAQ. Read 02.03.2015. http://www.smartcardalliance.org/smart-cards-faq/

SoftNuke. 2015. NFC Demystified: Just a matter of touch? Read 02.03.2015. http://www.softnuke.com/nfc-demystified-just-a-matter-of-touch/

Strategic Business Insights. 2013. MacroMonitor Market Trends. Read 16.03.2015. http://www.strategicbusinessinsights.com/cfd/newsletter/2013/2013-06.shtml#.VQm1whDF_fY

Techcrunch. 2014. Currentc is the big retailers' clunky attempt to kill Apple Pay and credit card fees. Read 19.03.2015. http://techcrunch.com/2014/10/25/currentc/

Techopedia. 2015. Convergence. Read 15.03.2015. http://www.techopedia.com/definition/769/convergence

TechRadar. 2014. Bluetooth: What does it really do and will it be replaced? Read 02.03.2015. http://www.techradar.com/news/phone-and-communications/mobile-phones/what-is-bluetooth-how-it-works-and-how-you-can-use-it-1141428

The Verge. 2013. Wallet hack: Can Coin replace your credit cards? Read 01.03.2015. http://www.theverge.com/2013/11/14/5103820/coin-electronic-card-to-hold-all-your-credit-cards

Tyzzer, J. 2014. Bluetooth v4.1: What developers need to know. Read 02.03.2015. http://www.edn.com/design/wireless-networking/4433313/Bluetooth-v4-1--What-developers-need-to-know

Hippel, E. 1986. Lead users: A source of novel product concepts. Management Science 32(7), 791-805.

WhatIs.com (2015). Digital wallet. Read 15.03.2015. whatis.techtarget.com/definition/digital-wallet

Whatley, S. 2015. Mobile payment users on the rise says Gartner. Read 02.03.2015. www.simonwhatley.co.uk/mobile-payment-users-on-the-rise-says-gartner

Why Apple Pay won't be the death of Google Wallet. 12.01.2015. Read 12.02.2015 http://www.techrepublic.com/article/why-apple-pay-wont-be-the-death-of-google-wallet/

Wolman, D. 2009. Time to cash out: Why paper money hurts the economy. Wired Magazine. Read 11.01.2014. http://www.wired.com/culture/culturereviews/magazine/17-06/st_essay

Zhejiang New Century Luggage Company Ltd. 2015. Product List. Men's wallets. Read 15.03.2015. http://walletrend.manufacturer.globalsources.com/si/6008842287180/pdtl/Mens-wallet/1047219552/Mens-Bi-fold-Wallet.htm