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Acknowledgements

First of all, I would like to dedicate this thesis to my mother Rajani Vishwanath Naik for her love and continuous encouragement throughout my studies at MIT. I thank my parents and my family for always supporting me in my education and professional endeavors.

I also thank Patrick Hale, Director, System Design and Management, for providing his mentorship and advice while writing this thesis. I would like to thank the staff and my friends in the SDM program, especially to Pat Hale, Bill Foley and Amal Elalam, for making this a unique experience that I will cherish all of my life.

Finally, I would also like to thank and acknowledge contribution of my Digital Wallet teammates in Technology Strategy class. (Roar Eide, Vaibhav Naik, Kumar Abhinav Srivastava, Marit Rossnes and Kjersti Veum)
1. The Digital Wallet

The past couple of years, we have observed the rise of the Digital Wallet, a potentially game-changing technology application in the financial industry. Digital Wallets allow consumers to pay for purchases through digital devices, and the technology has created a battle among payment networks, banks and technology firms. In this paper, we analyse how the Digital Wallet is impacting the technology space, including the level of disruptiveness and future potential. We have two hypotheses regarding Digital Wallets:

\[ H1: \text{The Digital Wallet is disrupting the credit card network.} \]

\[ H2: \text{The Digital Wallet is disrupting the physical plastic card.} \]

In this thesis, we will use a range of research methodologies to test these hypotheses.

1.1 Definition of Digital Wallet

Before we delve into Digital Wallet, we need to clarify how we define Digital Wallet. We believe Digital Wallet is a composite product and a user experience. It has a higher value than engineering technology in itself. The definition of technology we will use in this paper is therefore based on Christensen’s definition:

The processes by which an organization transforms labour, capital, materials, and information into products and services of greater value (...) This concept of technology therefore extends beyond engineering and manufacturing to encompass a range of marketing, investment, and managerial processes. Innovation refers to a change in one of these (Christensen, 1997)

In light of this, we define Digital Wallet as a broader initiative that integrates loyalty cards, coupons, discounts, comparison shopping, tickets and other forms of contextual marketing...
including geolocation, eventually replacing the physical wallet in your pocket. Figure 1 shows the features of a Digital Wallet. Although all the features might drive adoption, for the context of this paper we have chosen to focus on the payment feature.

![Digital Wallet Diagram]

**2. The evolution of Digital Wallets**

**2.1 History**

In order to set the stage for our understanding of the Digital Wallet, we find it important to look at the formative years of this technology. In the mid-1990s, Digital Wallet technology established its first footprint by providing basic payment transactions using standalone clients.
The target market was the established financial and corporate enterprises. The major vendors were Microsoft, Verifone and IBM. Surprisingly, these companies are not leading the innovation in Digital Wallets today.

Towards end of the Twentieth century, the Digital Wallet redefined itself by providing automatic form filling and purchase information management capabilities over secure server-browser applications. By this time, a
standard was agreed upon, the ECML\textsuperscript{1} for electronic commerce. This time focus shifted toward merchants and consumers, often in the context of online transactions. A number of small entrants from a variety of internet related businesses. The billing business entered this wave fueled by rising internet usage until the dotcom bust. This synergy initiated many of today’s basic capabilities and nuances of remote payment, such as preferences and financial transactions in the mind of burgeoning internet users, creating stage for future web-based cross platform (PDA, Cell phone and PC) wallet. The development is illustrated in figure 2.\textsuperscript{2}

Partly because of the Electronic Signatures in Global & National Commerce Act 2000, signed by President Bill Clinton, the new technology had burst upon the world. “By making these digital signatures legally binding and secure, Web-based banking was expected to finally begin fulfilling its tremendous promise” (Digital Certificate, u.d.).

More importantly, the third generation Digital Wallet is marked by further rise of internet users as shown in Figure 3 (General Social Survey, u.d.).

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure4.png}
\caption{Smartphone sales in North America 2008 -2012 (million units)}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure5.png}
\caption{US Mobile Internet Users and Penetration 2008-2013 (millions and % of mobile phone subscribers)}
\end{figure}

\textsuperscript{1} ECML – Electronic Commerce Modeling Language, www.ietf.org

By the end of 2008 PayPal is an example of a Digital Wallet that had lived up to the promise of mobile/digital payments and showed seamless integration across the devices. Moreover, as shown in figures 4 and 5, early 2008 was also a turning point in terms of proliferation of smartphone sales and mobile Internet users in US region. We consider these as the signs of the beginning of the fourth generation, a rise of Digital Wallet, (as were Digital Certificate act, rise of broadband and server/web-based cross platform for third generation).

Payment online was now possible and widely in use, but still there was no mass adoption of the Digital Wallet. Maybe adoption of the Digital Wallet is about being able to deliver an experience of seamless integration among various accounts, sources of value and information across devices and channels.

2.2 Patents

Patent activity is relevant because it is a sign of technological innovation in a specific field.

Beyond being a sign of innovation and invention, it is also indicative of businesses and inventors believing that this technology might have commercial value and is thus worth protecting in order to capture that value.

In looking for patents protecting Digital Wallet inventions and technologies there are at least two different kinds of patents worth looking at for our purpose; the patents on underlying and enabling technologies and combinatory patents that protect devices, products, services and business methods.

We have searched for worldwide patents, not only US patents. This may lead to duplications, but the duplication will be consistent and thus not significant for our comparison and trend lines. We have consistently looked at patent applications, not publications. The fact that many of these
patents may never be published or awarded is not really relevant to what we are trying to establish.3

Most patents in this field seem to be classified by G06; Physics: computing; calculating; counting and H04; Electricity; electric communication technique. These are fluid classes and subclasses and for a layman the classification does not look very consistent across time and assignees. It is thinkable that some of these subclasses are even added during the relevant period. For these reasons, we have not used patent classification as a key parameter for our analyses.

Figure 6 is consistent with the third generation of Digital Wallet; the term Digital Wallet had a peak around the millennium, whereas our current generation Digital Wallet takes the form of a Mobile wallet, as that is currently the most ubiquitous digital device. Another thing the patent activity shows us, is that there is still plenty activity in this field, the game is not over and the cards may not be dealt yet. It's worth mentioning that patents from the first peak, if we take an average of 4 years from patent application to approval; there is still another 10 years before the patents start to expire.

Figure 6: Patent activity for the terms Mobile Wallet and Digital Wallet

3 Source Patsnap.com.
2.2.1 Top patent holders

The patent assignees seem to fall into four clear categories; the big technology companies, mobile carriers, banks and financial institutions and consumer electronics manufacturers. As we have seen also in the products and technologies on the market, the credit card companies and financial institutions are very strong in this field.

The top patent holders no doubt have high level of competence; resources and capabilities in and around this field and are also incumbents in the market.

There are some interesting outliers, though. These are smaller and newer firms that hold a rather large portfolio of patents. Blaze Mobile has around 60 patents regarding payment mobile solutions. They have been awarded several key patents regarding NFC and mobile payment the last years. They went to the market with an independent product, Blaze Mobile Wallet. To think in terms of the Gans and Stern (Gans & Stern, 2002) framework, it could be argued that Blaze underestimated the need for complementary assets in this industry, thinking that their strong IP was enough to secure them a place in the market.

Another interesting player is Bizmodeline Ltd. They have a total of 2700 patents related to finance, mobile, ubiquitous computing, RFID and NFC. 156 are “mobile payment”-titled patents, the majority are from 2007 to 2010. We cannot find that they themselves have launched any product, but they entered a MoU with Clavis Technologies (Global News Wire, 2011), a South Korean provider of RFID solutions. It may be the case that they are a research facility entering

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4 Source: Patsnap.com, the search is on worldwide Patents with the terms Digital, mobile, biometric, cloud or e-wallet, digital or mobile payment and ECML on Patsnap.com. Different divisions of the same company are merged.

55 MoU – Memorandum of Understanding
this market not as a product competitor, but as a licensor of IP. They are in the Market of Ideas, not in the product market (Gans & Stern, 2002).

The same goes for another big patent holder in this field, Qualcomm (ca 80 patents including patents from Firethorne). They are a big holder of IP in the cell phone industry and now probably also in the Digital Wallet segment.

Whether IP is really important to succeed in the Digital Wallet market is another question. Since there is not any one core technology that has won the market, there seems still possible to design around any one patent or patent thicket. And as we have seen, just having great patents in a specific NFC technology didn’t help Blaze Mobile very much. And the Blaze Mobile case may also be an illustration of that it in this industry or environment are large complementary assets, and that they play a bigger role than IP in and by itself (Gans & Stern, 2002). There is also a licence pool under development between the NFC Forum and Via Licencing (Via Licensing, 2011) as well as a GPL open patent library. From this we can conclude that there is little excludability based on formal IP in this sector.

2.3 Scientific research

One way of identifying the development of new technologies and technology dynamic is to look at scientific work conducted within a field. In order to understand the dynamics of Digital Wallets as a technology, we searched for scientific papers focusing on both Digital Wallets as well as enabling core technologies. Our hypothesis is that basic research on enabling technology has an effect on technology changes, and that this comes before or in parallel with patenting of that technology. We also believe that research on composite technologies and applications follow activity on enabling technologies. To test this, we searched for scientific papers in three categories:
- Basic research on core (enabling) technologies, such as “Near Field Communication”
- Basic research in a “commercial” context, such as “NFC” and “payment”
- Applied research on composite technologies, such as digital and mobile wallets

To identify the impact of scientific research on technology, we compared the findings with number of patents applied for in this field. As it was hard to find data on Digital Wallet production, we have not done any comparisons towards productions. However, an indicator of innovation activity is shown in figure 14. All searches for scientific papers are done in Web of Science\(^6\) or Engineering Village\(^7\). All papers included in the graphs are peer reviewed and scholarly.

### 2.3.1 Patent applications and scientific research on enabling technologies

A Digital Wallet is a composite of several enabling technologies. In our scientific search, we searched for the enabling technologies NFC and QR code.

In our research, we found “NFC and near field communication”\(^8\) to be the by far most researched technology. It is also the technology with most patent applications. This indicates that NFC has played a key role in the development of Digital Wallets.

Figure 7: Patent- and scientific activity “NFC and Near Field Communication”

\(^8\) Source: Web of Science: [www.arps.webofknowledge.com](http://www.arps.webofknowledge.com/)

Note: The list includes all papers with specified topic «near field communication» from 1974-2013
The trajectories show how research is ahead of patent applications on NFC. This is in contrast to the composite technology, where science was a follower to patents.

The trajectories show how science and number of patents follow each other. One conclusion to draw from this is that many of the patents are applied for by the researchers themselves during the research phase.

The trajectories on QR codes do not tell much about the impact of science on patenting. However, the trajectories show an interesting trend on patent applications for core technology and the combination of “QR code AND Payment.” QR code patent application had its peak in 2006, whereas patent applications for QR payment had its peak in 2009, three years later. This indicates that patent applications for core technology are filed first. After identifying the “commercial potential” of the technology, patent applications are filed for in a commercial context.

2.3.2 Patent applications and scientific research on composite technology

The concept of Digital Wallet is the composite of many enabling technologies. In context of the evolution within online payments and new platforms, many terms are used to describe the same

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*Source: Engineering Village: [www.engineeringvillage.com](http://www.engineeringvillage.com/)

Note: The QR code e commerce list includes all papers with the term «QR code AND electronic commerce from 1997 - 2013"
composite technology. In order to track the total evolution of patents and scientific work within this field, we used the following search words: e-wallet, Digital Wallet and mobile wallet.

The trajectories for patents and scientific research on e-wallets indicate that patenting is ahead of scientific research. The patents have 3 major peaks, the first one in 2001, the second in 2007 and the third in 2010. All three peaks are followed by increased activity within scientific research, the first 2004, three years after the first patent application peak.

We find the same trend when searching for Digital Wallets. The trajectories show that patent applications for Digital Wallets have its main peak in 2001. Three years later, in 2004, science is following with a slight increase in research on the field.

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10 Source: Engineering Village: [www.engineeringvillage.com](http://www.engineeringvillage.com)

Note: The e-wallet list includes papers with the topic «electronic wallets» from 1974-2012

11 Source: Engineering Village: [www.engineeringvillage.com](http://www.engineeringvillage.com)

Note: The Digital Wallet list includes papers with the topic «Digital Wallets» from 1974-2013
Searches on the third term, the *mobile wallet*\(^3\), indicates the same as the two previous searches on composite technology. The patent applications for mobile wallets had its first peak in 2000, followed by an increased level of research from 2002 and up until a peak in 2005. Since then, number of patent applications has reached two peaks, one in 2007 and one in 2010. This trend is in line with the development of mobile technology and mobile market adaptation. Scientific research on mobile wallet has its peak in 2011. Our hypothesis is that this scientific peak is a response to the 2007 patent peak and that science has not yet responded to the 2010 peak.

Comparing number of scientific papers with patent applications has mainly given us the following indications:

- In terms of core *enabling technologies* such as NFC, science is ahead of patent applications and seems to play a key role for technology development. This is most likely a consequence of many researchers applying for patents themselves as part of their basic research on the core technology. Thus, our findings support our hypothesis.

- Science does not seem to have much impact on patent application for composite technologies, such as Digital Wallet. This is a sound result, as the commercial potential has to be identified, launched and experienced in the market before academic institutions can do research on it.

\(^3\) Source: Engineering Village: [www.engineeringvillage.com](http://www.engineeringvillage.com)

Note: The Mobile wallet list includes papers with the topic «mobile wallets» from 1974-2013
- The trajectories indicate that research on Digital Wallets and the enabling technologies follow the market adoption of technologies as the Internet and Smartphones, as the peaks come in 2000 (internet) and 2006 (smartphones). We find this to be an argument of how technologies depend on market adaption to be recognized as successful.

3. Mode of interaction between technologies

Through our research on Digital Wallet we have looked into the interaction between technologies: Would the interaction be a symbiosis where both technologies benefit from the relation, a predator – prey relation where either the incumbent or entrant benefit from the interaction or would there be a pure competition where both parties just creates harm to the other party (red ocean)?

The different technologies in the Digital Wallet business follow the different companies. Our research is therefor done on the companies in the industry and the interactions are traced through the payment solution utilised. The table below show a selection of Digital Wallet companies, their utilised technologies; whether it is an incumbent (I) or an entrant (E), what payment interaction which takes place and if there are any technology alliances between the interaction parties:

Table 2: Table of interaction between Digital Wallet companies

<table>
<thead>
<tr>
<th>Companies</th>
<th>Technologies</th>
<th>I/E</th>
<th>Payment interaction</th>
<th>Technology Alliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>PayPass (MasterCard)</td>
<td>NFC, Card Reader</td>
<td>I</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>V.me by Visa</td>
<td>NFC, App, Web</td>
<td>I</td>
<td>X, X</td>
<td>Google Wallet</td>
</tr>
<tr>
<td>Pay Pal</td>
<td>App, Web</td>
<td>E</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Isis</td>
<td>NFC</td>
<td>E</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Square</td>
<td>Card Reader</td>
<td>E</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Google wallet</td>
<td>App, Web</td>
<td>E</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Passbook</td>
<td>App, Web</td>
<td>E</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
The data from table 2 is transferred to the Multimode Framework (Pistorius, 1997) to show the interaction between the Digital Wallet companies. Through the framework we will more clearly identify the symbioses, predator-prey interaction and the pure competition between the Digital Wallet companies. We also define entrants as existing larger firms (example: Google) moving from their established market or technological base into a new product (Utterback & Afuah, 1991).

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<table>
<thead>
<tr>
<th>Effect of I on E’s growth rate</th>
<th>Positive</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Symbiosis</strong></td>
<td>PayPass</td>
<td>Google Wallet</td>
</tr>
<tr>
<td><strong>Predator (I) - Prey (E)</strong></td>
<td>PayPass (Master Card)</td>
<td>Square Google Wallet PassBook</td>
</tr>
<tr>
<td></td>
<td>V.me by Visa</td>
<td>Square Google Wallet PassBook</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Predator (E) - Prey (I)</th>
<th>Pure Competition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>V.me by Visa</strong></td>
<td>Isis PayPal</td>
</tr>
<tr>
<td><strong>PayPass (Master Card)</strong></td>
<td>Isis PayPal</td>
</tr>
</tbody>
</table>

Incumbent | Entrant | Incumbent | Entrant

Figure 12: Digital Wallets in the Multimode Framework

The Multimode Framework shows us that there is symbiosis between PayPass and Google Wallet because of their technology alliances. PayPass benefit from the alliance through access to customers via web and app technology possessed by their alliance partners. Google Wallet,
benefit from the ability to offer a payment solution technology to their customers by their alliance with PayPass.

In the pure competition quadrant of the framework V.me by Visa (NFC) and PayPass are in pure competition with PayPal and Isis. The pure competition quadrant shows us incumbents and entrants in interaction without any technology alliance or common payment solution.

The Multimode framework has identified two predators in the Digital Wallet industry. PayPass parent company MasterCard and V.me by Visa’s parent company Visa are predators through their possession of commonly accepted payment technology. Despite the fact that the Digital Wallet companies offer technologies that reduces that number of process-step for a transaction, they are the prey part in the interaction with the predators MasterCard and Visa.

From the framework we can draw a conclusion that the old giant will stay strong as long as the entrants are utilising their payment solution.

PayPal has seen the opportunity to bypass the large credit card companies by establishment of direct alliances with the banks and therefor gain its own blue-ocean of growth. Maybe possession of a payment solution technology is the source for success in the Digital Wallet industry?
4. Innovation activity

Since the beginning of the Digital Wallet industry in the early 1990’s a number of companies has entered and exited the industry. New entrants has seen their early mover opportunity, incumbents has seen the potential threat while others has been too ambitious and ended a short life in bankruptcy. The data in appendix 2 shows a list of major companies which were or are part of one or more of the technology trajectories in the Digital Wallet industry:

The list shows two waves of entrants to the industry. The first wave started in the early 1990’s and reached its upper plateau around 1998 to 2000. Around 2000 there were several companies that did not gain the required return to stay in business while other were acquired by larger profitable companies. The second wave started in 2006 and has been steady on-going until today. The graph below shows the companies that entered and exited the industry since early 1990’s until today. It also shows the total number companies in the industry: The graph above shows a steep growth during the 1990’s and then a slower decrease from around 2000 til 2006. Then we see a new wave of steep growth starting in 2006 until today. If the graph above is compared with
the Abernathy-Utterback model (Utterback, Mastering the Dynamics of Innovation, 1994) one could claim that there has been high innovation activity during two waves of the Digital Wallet industry history. We could assume that a high number of entrants would be proportional with the innovation activity in the industry. The major part of the entrants would enter the industry during the fluid phase of the industry that is characterized by high innovation activity with an intention to capture market dominance. When the industry enters the transition phase the dominant design will shake out several of the competitors and set the dominant technology before the entering the specific design and introduction of incremental innovation. Our analysis suggests that no dominant design has been reached for this current wave of Digital Wallet.

5. Dominant design

Christensen, Utterback and Suarez (Utterback, Suarez, & Christensen, 1998) hypotheses describes the dominant design in the CSU model, arguing with the following points:

- Firms that adopt the dominant design features will be less likely to exit from the industry.
- Firms that enter the industry during the “window of learning” just prior to the emergence of the dominant design will be less likely to exit.
- Firms that introduce architectural innovations into new markets will be less likely to exit.

When evaluating the first wave of the entry-exit-graph, we see that only three companies (VeriFone Wallet, Microsoft Passport Wallet and PayPal) seem to have survived the first peak of the Digital Wallet industry. The model indicates that these three are representing a dominant design. This is in line with the CSU model (Utterback, Suarez, & Christensen, 1998), arguing that the kind of plateau we see between 1998 and 2000 indicates a dominant design. We however, will argue that a dominant design has not yet emerged. Instead, we argue that the low number of technologies could be a result of bad timing and lack of market responsiveness.
The second wave started in 2006 and continues until today without reaching a plateau. PayPal is currently the largest player in the Digital Wallet industry, VeriFone was acquired and Microsoft has decided to change their concept and has therefore moved away from their Passport Wallet.

6. Performance metrics of Digital Wallets

Finding performance data is hard for composite technologies such as Digital Wallet. Therefore, we have not measured the performance in line with the Adler and Clark methodology (Clark & Adler, 1991). We considered using number of customers or transactions, but we find this to be more of a market adoption indicator than a performance indicator. Therefore, we have chosen to count the number of set up steps and transaction steps in the context of “ease of use” for the customer. The highest number of steps in second generation and lowest number of steps in the first generation has clear implications. The first one tells us that number of steps is not the most important criteria driving adoption. The second one tells us that even though Microsoft made it easy for the customer, the customer did not see much value in Digital Wallets at that point of time.

Digital Wallets started with a different proposition – some were helpful to consumers while shopping by automatically filling up forms during online shopping and some were started as a white label product for different merchants or banks. To compare the different generations of Digital Wallets, we hypothesized that ease of use for the end consumer would be a decisive factor for adoption of Digital Wallets. We decided to break up the ease of use in two different stages:

- Number of steps required for setup
- Number of steps required for transaction
We believe the first parameter would be useful for initial adoption and a large value here could hinder adoption. The second parameter is more focused towards the day to day use of the wallet.

We also checked the overall total number of steps required for setup and transaction.

The setup steps for Digital Wallet providers that we considered in the first generation were as follows:

- Download Application
- Create Password
- Obtain Certificate
- Create Account

![Figure 16: The setup steps for Digital Wallets in the first generation](image)

The transaction steps for Digital Wallet providers that we considered in the first generation were as follows:

- Payment Processing
- Use Password/Certificate
- Shopping Comparison/Ads
- Fill Up Form

As we know, there was no clear winner in the first generation of Digital Wallet and even having common standards like ECML, which were supported by all major providers, did not help. It is however interesting to note that Microsoft did seem to realize the number

![Figure 17: Number of setup and transaction steps in the second generation](image)
of steps as an important parameter and did work to reduce this. Microsoft Passport was a single sign-on initiative for Digital Wallet and one could utilize the Hotmail/MSN account to store the Digital Wallet information and use the same while shopping. This was a remarkable improvement in user experience, which is one of the strengths of Microsoft.

The setup steps for Digital Wallet providers that we considered in the second generation were as follows:

- Download App
- Additional Setup
- Additional Hardware (Consumer)
- Additional Hardware (Merchant)
- Create Account

The transaction steps for Digital Wallet providers that we considered in the second generation were as follows:

- Payment Processing
- Operate Hardware Device
- Loyalty / Offers
- Enter PIN
- Select Credit Card/Account
- Identify Yourself

The NFC solution seems to be the most cumbersome in use requiring the maximum number of steps as well as specific hardware both for merchant and the user. However at the time of writing this report, NFC is one of the most popular solutions in the Digital Wallet space. One argument could be that in case of banking transactions, users see a trade-off between security and ease of use. Not so convenient option could also be perceived by some users as the more secure one. The future of NFC could have been promising if Apple decided to introduce NFC technology in iPhone 5, which it did not.
At the other end of spectrum is PayPal which is to be easiest to setup and use. It is the market leader in payments although it started as a Digital Wallet only to exchange money between strangers while shielding sensitive payment information. The ease of use for PayPal which only requires a customer to enter his or her mobile phone with a secure PIN to process transactions at a merchant site, is also perceived as less secure by many users. Another important aspect of PayPal is being hardware agnostic, which is one of the promising future paths of Digital Wallets. PayPal has a good start over other competitors even though it remains to be seen if PayPal can become a complete Digital Wallet.

The overall analysis does not seem to show a correlation between number of steps and popularity of Digital Wallets. Therefore, the data does not show any S-curve like trends. As there is no clear winner at this point, it remains to be seen what key parameter would tip the market in favour of one player. Possibly, parameters like network effects, partnerships, multi-device operability and security could prove to be more important than ease of use, in the evolution of a complete Digital Wallet.

**Figure 18: Cost base for Digital Wallets**

### 7. Cost base for Digital Wallets

In the previous chapter, we tried to find out if the number of process steps in relation to technology adoption (set-up steps) and transactions...
would be a performance measurement to detect the preferred technology. In the this chapter we
would do a cost breakdown of the different Digital Wallet solutions and try to identify what could
be a preferred technology over the others based on that.

Our assumption is that in a competitive and commoditized market the price of Digital Wallet
solution for both customers and merchants would be close to equal across the technologies. The
price is set by what the consumer is willing to pay and we assume that it would be at one level
independent of the type of technology utilized by the consumer. The price, as shown by the figure
above, will consist of point of sales (POS), credit card network fee, bank fee, transaction process
fee and profit. In addition, there is a cost related to acquiring and producing credit cards. The
price breakdown elements would presumably be equal across the technologies because they
utilize the same credit card networks, process suppliers, POS equipment and same bank relations.
Given the equal price across technologies and same cost elements across the technologies, the
difference would be the number of cost elements which are part of each price. The profit level
would then be opposite proportional with number of cost elements which are part of the price set-
up. With other word, cutting cost would give higher profit in a commoditized market. There is
also worth mentioning that this cost set-up would be independent of time and fluctuation because
the same elements are used across the set-ups.

The digital software solution has a clear benefit over the other technologies when it comes to
price and cost. This solution has a much lower cost base (less number of cost elements) than the
other technology solutions in the industry and could therefore cut profit down to the same level as
the others and offer a much lower price to the consumers. The potential for further reduction of
the cost base is dependent on bank relations and POS suppliers. We would believe that further
increase of scale would have an effect on the bank fees and POS supplier cost and the cost base
could be cut over time.
8. Digital Wallets as disruptive technologies

Starting this research, we had two hypotheses:

*H1: The Digital Wallet is disrupting the credit card network.*

*H2: The Digital Wallet is disrupting the physical plastic card.*

Based on the research done, we have found supporting arguments for why some of the Digital wallets are disruptive.

Table 3: Technologies disrupting the credit card network

<table>
<thead>
<tr>
<th>Game changing technology</th>
<th>Cost</th>
<th>Traditional performance (transaction security)</th>
<th>Ancillary performance (convenience)</th>
<th>Ancillary 2 (number of process steps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PayPal</td>
<td>Lower</td>
<td>Lower</td>
<td>Higher</td>
<td>Lower</td>
</tr>
</tbody>
</table>

One of the most important performance mechanisms that enable a Digital Wallet to be disruptive is the number of process steps being bypassed. One of the disadvantages of incumbent technologies is the number of players and steps in the value chain. The value chain of incumbent technology is showed in Exhibit 1; The Credit Card Value Chain and process flow. The number of process steps is driving cost. In order to disrupt the incumbent companies and their technologies, a success criterion is being able to bypass one or more of the process steps. This will first and foremost reduce transaction costs, but also reduce complexity and network disadvantages. As shown in Table 3, we have identified PayPal as the only technology leveraging this criterion.

Currently PayPal processes transactions using Credit Cards, Debit Cards and Bank accounts. In processing of these transactions, other banks as well as payment networks like VISA and Mastercard are involved. There are a few ways in which PayPal has the potential to disrupt some of the existing products and players. Firstly, if PayPal works with other payment networks like
Discover and tries to establish a new payment network equally wide as Visa or Mastercard, it could then disrupt these specific players in the market. It can work with lower transaction fees and avoid paying the Digital Wallet Fee which Visa and Mastercard are planning to impose. Many countries, like India, are actually in the process of establishing their own payment network to avoid the high transaction costs imposed by Mastercard and VISA. PayPal could partner with such local networks in different countries. Secondly, the current payment settlement networks like ACH do not work 24x7 and payments are settled in batches with some delay. Payment systems around the world are getting more and more advanced and they aspire to feature instant payment systems. If such a system develops, PayPal could benefit from it as people may avoid using Credit Card if they do not want to pay the high transaction fees. Thirdly, PayPal is already launching its own physical card and is thus following a model like American Express where it is bypassing the banks and thus eliminating one of the members in the current value chain. This is mostly beneficial for PayPal as it would again help eliminate a part of transaction fees and thus reduce its processing cost to increase its competitiveness. In fact, in a credit card transaction, the part of the transaction fee which goes to the bank is higher than the part which goes to the payment networks. PayPal thus has the potential to disrupt the current key players in transaction processing. With the given condition, we argue that Digital Wallets can disrupt the credit card network, as suggested in H1. One important fact to observe is also that physical credit cards are becoming less important as the use of PayPal and Digital Wallets is increasing. A time may come...
where you just need the information encoded in the physical credit card and an actual physical card is never issued. Or it may be possible that physical card is reduced to a chip in the mobile phone. Thus, we find this to support H2.

The way PayPal disrupts the credit card network is shown in the figure to the right.

9. The future of Digital Wallets

9.1 Biometric Wallets

Biometric technologies have evolved over the past decade and finding increasing applications in the government as well as the commercial space. Hitachi and Fujitsu are two companies which have invested significant time and money into Biometric Authentication products. While the initial products started with using one biometric data like fingerprint or iris scan, recent products are becoming increasingly sophisticated using multiple biometric data points for authentication. The table on the next page shows the comparisons between different Biometric Wallets.13

Table 4: Comparison of biometric technologies

<table>
<thead>
<tr>
<th>Biometric Data</th>
<th>Feature</th>
<th>Safety</th>
<th>Convenience</th>
<th>Acceptability</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fingerprint</td>
<td>Position, angle, pattern of fingerprint minutia</td>
<td>Good</td>
<td>Average</td>
<td>Poor</td>
<td>Medium</td>
</tr>
<tr>
<td>Face</td>
<td>Arrangement of contours, features, etc.</td>
<td>Average</td>
<td>Good</td>
<td>Good</td>
<td>Low</td>
</tr>
<tr>
<td>Iris</td>
<td>Iris pattern code</td>
<td>Good</td>
<td>Good</td>
<td>Average</td>
<td>High</td>
</tr>
<tr>
<td>Vein pattern</td>
<td>Pattern of blood vessels, veins in finger or hand</td>
<td>Good</td>
<td>Average</td>
<td>Average</td>
<td>Medium</td>
</tr>
<tr>
<td>Voice</td>
<td>Voice pattern time-sequence features</td>
<td>Average</td>
<td>Good</td>
<td>Good</td>
<td>Low</td>
</tr>
<tr>
<td>Signature</td>
<td>Pen manipulation, pressure, angle, etc.</td>
<td>Poor</td>
<td>Average</td>
<td>Good</td>
<td>Medium</td>
</tr>
<tr>
<td>Hand geometry</td>
<td>Hand or finger length, thickness, width</td>
<td>Average</td>
<td>Average</td>
<td>Average</td>
<td>Medium</td>
</tr>
</tbody>
</table>

13 Hitatchi.com
The continued commitment of major companies and newer applications for biometric authentication systems is a proof that this technology is going to gain traction. In context of Digital Wallet, there is one of set of customers who are worried about the security aspect and being protected by personal PIN is not enough. Another set of customers do not like handling devices and are irritated with the glitches and the hassles associated with it. Biometric authentication for Digital Wallet has an answer to both these problems. The examples of use of biometrics for security are many, a school in Florida recently launched biometric authentication of students for quick processing for lunch lines. Decreasing cost of biometric systems would also help drive its adoption and thus use of biometrics in Digital Wallet is trend to be monitored. It could turn out to be as the only or additional authentication measure and could drive adoption.

9.2 Digital Currency & P2P transactions

Bitcoin\textsuperscript{14} is digital currency which can be used globally but is neither based on an actual commodity like gold nor regulated by any central authority. The value of Bitcoin is decided by the demand and supply rules of economics. Users need to choose among a software wallet, mobile wallet and Web wallet and they are then assigned unique Bitcoin address. The transactions are secured with the use of

\textsuperscript{14} :Bitcoin.org
sophisticated cryptographic algorithms. While there have been concerns around the value of BitCoin as well as the use of BitCoin for money laundering purposes, the market capitalization of BitCoin was estimated at over $1 billion in April 2013.

More legitimate example of digital currency in evolution is Mintchip, which has been backed by the Royal Canadian Mint. Unlike BitCoin, Mintchip is not virtual currency but a secure way to exchange Canadian Dollars and possibly other currencies in future. Also, instead of an assigned digital address like BitCoin, a physical chip issued by the Royal Canadian Mint is used for the purpose of identification. There was a contest held by the Royal Canadian Mint for developers to create apps for MintChip which started in April 2012 and concluded in October 2012 and had $50,000 as the prize money.

One of the greatest applications of digital currency is in peer to peer transactions and useful implementations could drive adoption of a Digital Wallet. BitCoin and MintChip may or may not succeed but there are useful lessons from their stories which could be refined in future to develop disruptive payment systems.

9.3 Low value Transactions and Text Messages

_M-Pesa_ is mobile based money payments and microfinance product, started in Kenya by a company called Safaricom in 2007. Over the past more than 5 years, it has become one of the most successful mobile payment products and has been launched in other developing countries like Tanzania, South Africa and India. With the backing of corporate giants like Vodafone and Citibank, the product certainly is a promising one.

American Express and WalMart launched _Bluebird_ as a product with no monthly, annual, or overdraft fees, no minimum balance requirements and still with the capabilities for direct deposit, for use at an ATM, and had a smartphone app that card holders could use to pay bills. The card
became FDIC insured in March 2013. And even before it became FDIC insured, 575,000 account holders had loaded $275 million onto the card. Most importantly, 85% of the customers were new to American Express.

Bluebird facilitates direct deposit by methods like payroll direct deposit, remote check capture via the Bluebird mobile app, using cash at any Walmart register, or by linking a checking, savings, or debit card to the account. Bluebird also offers the functionality of a Digital Wallet, including person to person (P2P) payments, mobile app functionality, and the ability to control subaccounts for friends and family right from a smartphone. Bluebird is built upon the digital payment capabilities of American Express’ Serve platform.

*Chase Liquid* is a similar card with very low costs and a huge network to avail. With companies like American Express and Chase Bank investing significant amount of money into micro payments, it is evident that there is a market for such products even in the most developed countries of the world.

As of now, mobile wallet offers little value to the customers at the bottom of pyramid. But if features like P2P (peer to peer transfer) attract these set of customers, products like M-Pesa and Bluebird are likely to gain importance as they can tip the market by the sheer volume and decide the winner in the Digital Wallet arena. Adding weight to this argument is the fact that products like M-Pesa could be used via text messages. One does not need a smartphone to use this product. And this is another factor that could drive adoption in lower end of the market.
9.4 The window of opportunity for the mobile carriers

What is interesting for our current generation of Digital Wallets is that the mobile carriers and smartphone manufacturers are very active in patenting Digital Wallet technology. As long as mobile phones are the preferred and ubiquitous means for Digital Wallet, the mobile “industry” has a window of opportunity. If digital payment and Digital Wallets moves on to other kinds of devices, the window might close for the smartphone manufacturers and the mobile carriers – if they don’t also become contenders in these new generations of devices or authentication solutions.

On the horizon we can see devices like the Pebble\textsuperscript{15} and quantified self-devices that can become richer with features. In this respect the current players in the consumer electronics industry could be major players also in this next wave.

\textsuperscript{15} Smart watch
9.5 The Digital Wallet Ecosystem

One way to look at the future Digital Wallet landscape is from the view of its different stakeholders and their expectations from each other. There are three key stakeholders – Wallet Providers, Merchants and Consumers, and thus three key relationships in the Digital Wallet Landscape.

1. Wallet Providers and Consumers: This is a technology led relationship where customers expect easy to use yet secure wallet solutions. The solutions should be not limited to one or two platforms and should be of minimal cost, ideally zero cost to the consumers.

2. Wallet Providers and Merchants: This is a technology led relationship where merchants do not want too many different solutions but solutions with lesser dependence on specific hardware as an additional investment. Merchants want to accept as many forms of payments as they could do and they want to pay lowest transaction margin fees.

3. Consumers and Merchants: This is a business led relationship where the parties would not care too much about specific technology. Merchants want increased loyalty and sales. Consumers want relevant coupons, offers and would not even mind at look at advertisements if they help them to use a wallet with zero fees.

Our view is the personal data based advertising would be at the centre of a solution which would win in this market as this has something for all the stakeholders to be interested in. Wallet providers gain revenue from aggregated data and target advertising. Merchants benefit from customized placements and would be willing to pay for the same. Customers would be willing to look at ads and offers that are relevant to their choices and as long as they do not pay for the wallet. This is potentially a win-win solution.
Disruptions, however, could come from the different sources that we have listed earlier like Biometric Wallet, Digital Currency, P2P transfer and Low Margin Networks. All of these have strong reasons to tip the market as they materialize and could be game changing solutions.

10. Beyond the value net
There are two different macro trends we believe can influence the development and adoption of Digital Wallets. Emerging markets are already leapfrogging steps in technological evolution, going directly to mobile computing without the middle step of stationary or even laptop computers. This is changing how banking is done in some emerging markets. There are also plenty of initiatives to push for more effective and fair money transactions in developing countries, ways of transferring funds that don’t offer such a big cut to corporate players. These changes can hasten the adaption of the Digital Wallet.

Legal and regulatory changes may influence the development of Digital Wallets by changing the rules on transaction security, the handling of private information and privacy. This would probably be to the advantage of the large incumbents, both because they have a high level of information and transaction security already and they have the capital to make changes to their infrastructure, products and processes.

11. Conclusion
Based on our research, we have gained a broad perspective of the development of the Digital Wallet industry. Data illustrates that over the past decade, there have been congruent actions across technologies in the industry.
The first wave of the Digital Wallet technology started a few years after the internet was released for public use. The activities of the first movers within patent filing, research and commercial appearance peaked around year 2000. However, as argued in chapter 4, we do not believe that a dominant design has emerged.

The linkage to the development of internet and smartphones is a key finding in our research. Evidently, from our research we can see that the activity level on patent filing and publishing of scientific articles did gain new momentum around the launch of the smartphone. This link is also illustrated through the entry-exit curve. Our conclusion is therefore that the internet and smartphones have been enabling technologies for the two waves of Digital Wallets, as they enabled companies to establish new payment solutions.

Industry players such as MasterCard and Visa are predators in the Digital Wallet industry. For almost every new Digital Wallet innovation, their credit card network would be used, allowing them to strengthen their market position.

Our research has showed that technologies such as PayPal can disrupt players like MasterCard and Visa, allowing them to reduce transaction fees and processing costs. If carrying out these actions, PayPal is a disruptive technology. Thus, this supports our H1; Digital Wallets disrupt the credit card network.

Our research also showed that the physical credit card is getting less important. At the same time, usage of Digital Wallets is increasing. This indicates support to our second hypothesis (H2): The Digital Wallet disrupts the plastic card.

However, since a dominant design has not emerged, a highly relevant question is whether today’s Digital Wallets have been a success and or not. Based on our research, we believe that the
potential of Digital Wallets are huge, and that the technology can be a future game changer in the financial industry.
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Exhibit 1

The Credit Card Value Chain and process

Cardholder initiates purchase

Merchant completes or declines transaction

Issuer processes request, sends authorization/decline

Network sends authorization to Issuer

Processor

Network sends authorization request to Issuer

Acquirer sends approve/decline code to Merchant

Network sends authorization to Acquirer

Acquirer

ISO's (Independent Sales Organizations) may step in as resellers

## Exhibit 2: Entries and exits

<table>
<thead>
<tr>
<th>Company</th>
<th>Entry</th>
<th>Exit</th>
<th>Reason</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>CyberCash</td>
<td>1994</td>
<td>2001</td>
<td>bankruptcy</td>
<td>Gartner</td>
</tr>
<tr>
<td>IBM Consumer Wallet</td>
<td>1996</td>
<td>2001</td>
<td>closed down</td>
<td>homepage</td>
</tr>
<tr>
<td>Trintech NetWallet</td>
<td>1996</td>
<td>2006</td>
<td>acquired</td>
<td>verifone.com</td>
</tr>
<tr>
<td>VeriFone vWallet</td>
<td>1996</td>
<td>2012</td>
<td>acquired</td>
<td>verifone.com</td>
</tr>
<tr>
<td>Brodia.com</td>
<td>1997</td>
<td>2002</td>
<td>bankruptcy</td>
<td>Gartner</td>
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<tr>
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<td>2001</td>
<td>acquired</td>
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<td>PayPal</td>
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<td>active</td>
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<td>active</td>
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<td>Google wallet</td>
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<td>iPhone Passbook</td>
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<td>Mastercard PayPass</td>
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<td>V.me by Visa</td>
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