Towards A Holistic Analysis of Mobile Payments: A Multiple Perspectives Approach

Jan Ondrus *, Yves Pigneur

Departement of Information Systems, HEC School of Management and Economics, University of Lausanne, 1015 Lausanne, Switzerland

Abstract

As the mobile technologies and services are in constant evolution, many speculate on whether or not mobile payments will be a killer application for mobile commerce. To have a better understanding of the market, there is a need to analyze not only the technology but also the different actors that are involved. For this purpose, we propose to conduct two disruption analyses to draw the disruptiveness profile of mobile payment solutions compared to other payment instruments. Then, we try to discover what factors have hindered the technical and commercial development by using a DSS based on a multi-criteria decision making method called Electre I.

Key words: Mobile Payments, Disruption Analysis, Multi-criteria, Decision Support Systems

1 Introduction

For electronic commerce, the payment issue has already been a shared concerned between the different stakeholders involved in the financial transactions market. As the success of electronic commerce grew, many tried to improve the payment process in terms of security, reliability, and convenience. However, it seems the challenge of finding a perfect solution was underestimated. In fact, only few survived in the digitalization payment processes. Nowadays, even if the solutions we have are not the most efficient ones, the common payment instruments in e-commerce are credit cards, debit cards and Paypal electronic transactions.

* Corresponding author.
Email addresses: jan.ondrus@unil.ch (Jan Ondrus), yves.pigneur@unil.ch (Yves Pigneur).

With the widespread use of mobile devices, a new type of channel, called mobile commerce, is emerging. Furthermore, the pervasiveness of wireless networks is creating new opportunities to offer innovative mobile services. However, the payment process raises not only technological problems but also shows deficiencies in finding profitable business models [1]. In fact, mobile network operators want to generate substantial revenues rapidly since they are heavily in debt due to massive investments in 3G licenses. Therefore, they need to find a killer application to recoupe their endowment. As mobile commerce is likely to require real-time cashless wireless payments to buy physical and digital goods anywhere at anytime, mobile payments could become an important part of their business. Some already predicted that mobile payment will become a successful mobile service itself [2][3].

As already implied, the trend towards a cashless means of payment can be observed in the virtual realm as well as in the real world. The extensive use of credit and debit cards for proximity purchases has already demonstrated the possibility of considerably reducing the volume of cash-based transactions. This conversion from physical to virtual payments has already brought significant benefits to consumers and merchants alike [4].

Mobile payment systems are suitable for proximity and micro-payments. This relies on the great opportunity for mobile payments to reduce the number of small purchases paid with cash. Several successful mobile payments systems have already been launched in order to enhance the convenience of micro-payments for local daily expenditures. These solutions have been principally adopted by various quick-service oriented industries [5] such as public transportation (e.g. Octopus), toll booths (e.g. EZPay, FasTrak), gas stations (e.g. ExxonMobils Speedpass), fast-food restaurants (e.g. McDonalds), retail vending machines (e.g. Sonera Mobilepay) and ski resort ticketing (e.g. Skidata).

In South Korea, for example, MNOs have successfully offered mobile payment schemes (Moneta, K-merce, and ZOOP) that compete with classic payment instruments supported by financial institutions. With a market penetration near 70 percent of the seven million Hong Kong's citizens in mid-2001, Octopus cards can be considered as one of the most successful electronic payment schemes. This independent payment system has even succeed in a market where e-cash systems launched by credit cards issuers (Mastercard Mondex and Visa Cash) [6] have failed.

Even if some solutions were successfully implemented for specific purposes, there is still uncertainty as to whether the adoption and use of mobile payments will prevail; this uncertainty is primarily due to the lack of standards and the immaturity of the market. Nowadays, most common payment systems are based on cards (e.g. magnetic cards, smart cards, contactless cards). While magnetic cards have security issues, they are the most widely used ones. Fi-

nancial institutions decided on this particular cheap and simple standard to be able to quickly reach a critical consumer base. Indeed, there are few crucial requirements in order to be a success payment instrument provider: a large customer base and a high volume of transactions.

Mobile payments have the potential to revolutionize methods of paying products and services. However, the situation today in Europe is not very clear whether or not mobile payments are on their way to becoming a standard payment service. Without conducting a structured field analysis involving practitioners of different industries active in mobile payments, it is very difficult to get a good picture of the reality.

The objective of this paper is to propose an approach for analyzing the mobile payment context. The proposed methodology combines a multi-criteria analysis of technologies and considers the viewpoint of the different stakeholders involved. For illustration and analysis purposes, we collected relevant information by conducting interviews with a selection of representative experts in Switzerland. By using different perspectives, we expect to obtain a broader knowledge of the state of the market.

The paper is organized as following. In section 2, we first define a two-by-two matrix classification framework. It will help further investigations of two possible disruptions presented in section 3. For this analysis, we will use the Rafii and Kampas framework [7] in order to draw the disruptiveness profile of mobile payments using a technology and an actor perspective. In section 4, we present a multi-stakeholder and multi-criteria model which is implemented in a decision support system (DSS) based on Electre I. Finally, we draw some conclusions in section 5.

2 A Classification Framework for Mobile Payment Solutions

In order to classify the different solutions as to have a clearer overview of the market, we propose a classification framework based on a two-by-two matrix. This approach will help us conduct more structured further analyses using the different categories identified. In fact, the payment market can be examined in terms of payment service providers and technology. Payment service providers are typically financial institutions, such as banks and card issuers. In a mobile payment context, mobile network operators (MNOs) are considered natural candidates to offer payment services. They form the dominant actors present on the mobile payment market. They can choose to collaborate and cooperate, but also compete (Cell I and II). Other actors such as newcomers and intermediaries can also be serious competitors. They usually offer payment solutions for niche markets with specific needs. However, if they reach a

large customer base, they could become a real threat for the dominant actors (Cell III and IV). In this framework, we also separate solutions based on the different physical support such as card (Cell I and III) and phone (Cell II and IV).

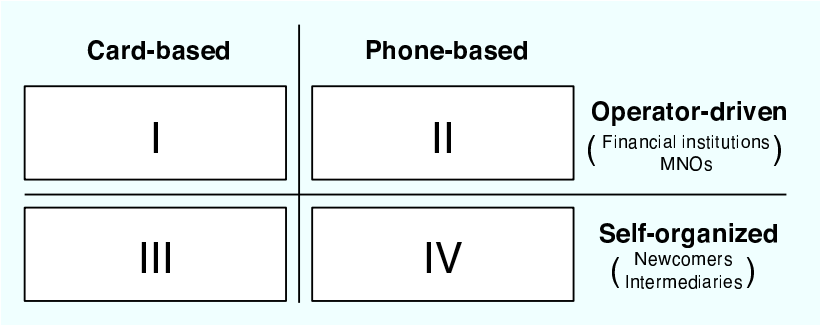

Fig. 1. Classification Matrix

As can be seen in Figure 1, we propose the use of a matrix to segment the payment market depending on the technology used and the service providers involved. These two axes of decomposition should provide a better overview of the market with its different initiatives.

2.1 A Selection of Mobile Payment Solutions

For the purpose of our research, we selected a set of payment solutions that are used for proximity micropayments. Theses payment systems illustrate each cell of the matrix introduced in the previous section. Most of the solutions are taken from the Swiss market. However, to provide sufficient illustration, we also describe several initiatives launched in other countries.

2.1.1 Cell I: Smart Card Payment Schemes Driven by Financial Institutions

In Cell I, we find schemes which use stored value cards as electronic purses. This technology is quite popular as it is used by many financial institutions. One of the first solution launched in the middle of the nineties was Proton, a Belgian nation-wide scale electronic purse based on smart card. This technology was exported in other countries. For our case study, we chose to depict the CASH card that was launched in Switzerland (see Table 1).

Despite the power of the financial institutions in Switzerland and the number of CASH cards issued, the scheme has not been as successful as anticipated by the card issuers. A few reasons can explain why CASH has not succeeded in Switzerland. When the financial institutions launched the scheme, they did not have a strong partnership with merchants. Therefore, the number of

Table 1
Cell I: Smart Card Payment Schemes Driven by Financial Institutions

Name	Description
CASH card	Introduced on the Swiss market in 1997, the CASH card was launched by the Swiss banks and the Swiss Post. The aim of this initiative was to offer a simple cashless micropayment scheme using a smart card. These cards can be reloaded in any ATM or postal banking machine in Switzerland. They are accepted at manned and unmanned point-of-sale (POS) such as public transports, parking, convenience stores and vending machines. The CASH chip is usually embedded in existing payment card (e.g. Maestro). Therefore, the number of cards on the Swiss market is relatively high.

points of acceptance was too low in order to successfully introduce the CASH card on the market. Since few merchants accept this card, consumers are not confortable loading and storing money on it as they do not know where they could use it. Moreover, Swiss consumers still seem to prefer cash as a payment instrument. Hence, when they go to an ATM, instead of reloading the card, they withdraw cash as the card would have to be inserted twice. Therefore, the process of reloading remains a serious issue that financial institutions have not yet been able to overcome.

2.1.2 Cell II: Phone-based Payment Systems Operated by MNOs

In Cell 2, we have payment solutions using mobile phones offered by MNOs either alone or with financial institutions. Different ways were imagined to enable mobile payment with phones such as (i) multi-application chip card (SIM and WIM (Wireless Identification Module) combined in a single chip card), (ii) Dual-SIM phone (two slots: one for SIM, one for WIM), (iii) Dual-slot phone (built-in smart card reader), (iv) external WIM card reader connected to the handset, and (v) a payment software installed on the phone. Most of these solutions require a special mobile phone. To avoid this issue, MNOs propose to overcharge SMS. This mechanism is called Premium SMS. The SMS cost is equal to the price of the good purchased plus the normal cost of an SMS. Another way is to use reverse-billed SMS. An SMS received costs the price of the good. Nowadays, MNOs are working on new payment platforms based on WAP.

Table 2
Cell II: Phone-based Payment Systems Operated by MNOs

Name	Description
Swisscom Mobile	In Switzerland, Swisscom Mobile introduced a mobile payment scheme to purchase beverages in vending machines in 2002. This service was available only for Swisscom Mobile users. A special USSD (Unstructured Supplementary Service Data) number was written on each vending machine. The consumer had only to dial this number and select the desired drink. The system used USSD instead of SMS because it has been considered simpler and faster. This solution was limited only to beverages. An attempt to sell CDs and DVDs in vending machines was launched without success. There were too many fraudulent transactions and Swisscom Mobile did not want to continue enduring the financial risks and the heavy losses. For now, Swisscom Mobile sells digital content (ring tones, news, and so on) over their Vodaphone Live platform. They also have implemented some other trials for public transport ticketing and parking.

In Europe, Simpay is an alliance between four major MNOs that includes Orange, Telefonica Moviles, Vodaphone and T-Mobile. These MNOs alone represent 280 million customers and there are already other MNOs interested in joining the alliance. The objective is to create a trusted brand for mobile payments in Europe. Simpay would allow consumers to pay for low priced purchases through their mobile phone bill. Moreover, they also plan to offer a mobile payment scheme using existing payment cards. As this scheme would be open and interoperable, this would probably contribute to the development of m-commerce in Europe.

In the future, Swisscom Mobile would like to find a mobile payment solution to top up their prepaid card. In fact, convenience stores which sell reload scratch-cards take a ten percent margin on the price. Therefore, they want to find a cheaper solution. A project regrouping the Swiss MNOs and the Swiss banks was supposed to launch a mobile payment solution in 2004. This project called m-Maestro had the objective of extending the capabilities of the Maestro card (debit card). However, the Swiss banks decided that the market was not attractive enough. They claimed that the cost of staff training and marketing was too high for the low volume of transactions expected. Therefore, without the support of the banks, this solution has not been planned to be launched on the Swiss market.

2.1.3 Cell III: Independent Payment Schemes Using Cards

Independent solutions consist of all the payment cards that are not issued and directly operated by financial institutions. This type of scheme usually exists in industries which already have a fairly large customer base. Most popular initiatives are deployed in the public transports. As public transportation requires fast payment processing, contactless cards seem to be adapted. A very successful mobile payment scheme was launched by the Mass Transit Railway Corporation in Hong Kong. Octopus is an automated fare collection system using contactless cards. Nowadays, the Octopus chip can even be embedded in devices such as rings and watches. These devices can be recharged not only in the public transport stations but also in more than four hundred 7-Eleven convenience stores and in about two hundred Maxim's shops [6]. This shows that public transportations have a real interest in launching their own payment scheme. An explanation is that they need specific properties (e.g. speed, ease of use). Another is that they do not want to pay transaction fees to the financial institutions if they could avoid it.

Other initiatives are offered by newcomers such as SportAccess. They propose multi-purpose contactless cards for payments at particular locations such as temporary events (e.g. festivals, conferences and expositions), campuses, sport centers, hospitals and companies. They implement payment schemes using

corporate cards usable inside company buildings for access control and local purchases. These proprietary schemes are not implemented for the national market since they are limited to specific purposes. In other words, their solutions are attractive more specifically for communities needing their own payment system.

To illustrate Cell III, we selected a small-scale scheme that is offered by the Public Transports of Lausanne (see Table 3).

Table 3
Cell III: Independent Payment Schemes Using Cards

Name	Description
Galaxy	The TL (Public Transports of Lausanne) issued a smart card to pay for bus and metro tickets. This card called Galaxy was a prepaid card. The only incentive to adopt this scheme was a value bonus representing ten percent of the amount stored on the card. The problems encountered with this prepaid solution were that reloading was not planned and payment capabilities were limited to public transports and cinema tickets. Later, the TL introduced a contactless pass which can be revalidated using public terminals located at major stations and other public sites. This revalidation can be done using debit or credit cards. This public transport pass (Galilée) also offers some privileges such as a better rate at movie theaters, cultural events and even for car pooling.

For now, most of these solutions are limited since they are only implemented for specific markets. However, Octopus successfully extended its scheme for more generic purchases. Therefore, Octopus became a real threat for classic payment means as the number of consumers and the volume of transactions are great.

2.1.4 Cell IV: Independent Mobile Payment Solutions Using a Mobile Handset

MNOs and financial institutions are well position in the mobile payment value chain. However, there are still opportunities for newcomers and intermediaries to offer mobile payment schemes. They could bypass MNOs and financial institutions while using them as simple intermediaries. Usually, these types of solution have the advantages of being operator-independent. Thus, mobile phone users can register with this type of payment system independently of their MNO's membership.

In Switzerland, several mobile application service providers are offering independent mobile payment systems. Echovox propose SMS-based micro billing schemes (i.e. echoPAY and SmartPAY) primarily for purchases of digital contents. One serious issue they encounter is the weak margin they perceive for each transaction. In fact, MNOs take a confortable margin of forty to fifty percent for any digital good purchased with SMS. Moreover, Echovox has to give a fair part of the rest to the content provider while keeping only the small remnant. Therefore, the only way to be profitable is to process a large number of transactions. Another similar scheme for online content purchases

(e.g. News) is Quick&More, a partnership between Publicitas and Swisscom Mobile.

As the previously introduced solutions are not very popular, we decided to illustrate Cell IV with Paybox, which is a famous mobile payment scheme launched in various European countries (see Table 4).

Table 4
Cell IV: Independent Mobile Payment Solutions Using a Mobile Handset

Name	Description
Paybox	Paybox was a payment intermediary not tied to any particular network or bank account. Paybox only processed direct debits, which are cheaper than processing credit card payments. The consumer had to register to Paybox in order to use the service. Once the application was approved, the consumer could use Paybox for a range of transactions, including [8]: payments for e-commerce, Person-to-Person (P2P) transactions, payments to bank accounts, and payments in the mobile world (e.g. taxis). The customer's requirements for using Paybox are the possession of a mobile phone, a bank account and a Paybox registration. The advantage of such a system is that only the mobile phone number, not the bank account number or credit card details, are transmitted. Moreover, consumers can even request a Paybox alias phone number if they do not feel comfortable giving their mobile phone number to merchants.

In other countries such as Finland, SMS technology is also used for other purposes in mobile payment. Several public transportation companies, such as the Helsinki City Transport in Finland, provide SMS tickets that can be bought with mobile handsets. Apparently, this scheme was very successful as mobile ticket users are satisfied and the number of free riders reduced [9].

3 Drawing the Disruptiveness Profile of Mobile Payment Solutions

Nowadays, mobile payments are considered to a under-performing technology which does not satisfy the requirements of the customers in the mainstream market [10] [11]. Moreover, as mobile payments are mostly useful for niche markets, the incumbents (financial institutions) tend to underestimate the potential of such technology. These different elements are identified by Christensen as properties of disruptive innovations [12]. The idea is, that over time, investments in research and development will improve this technology and make it more attractive and more adapted for the mainstream market. Therefore, the sustaining technology might be replaced by the disruptive technology and by this, the incumbents would have a hard time competing with the new entrants.

Based on these thoughts, we identified two potential disruptions which could occur: (i) the physical device for payment could slide from card to phone; (ii) operator-driven solutions could be displaced by self-organized solutions driven by new entrants (see Figure 2).

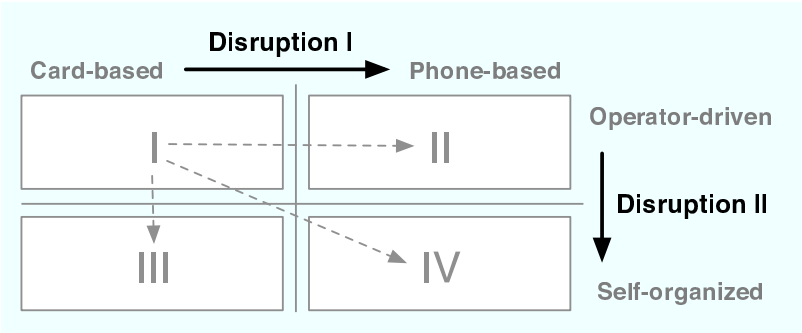

Fig. 2. The Two Potential Disruptions

Different methodologies, instruments and decision-support systems have been proposed to identify and forecast potential disruptive technologies [10] and other discontinuous innovations [13], using, among others, technology roadmaps [11], text mining [14], and multi-criteria decision-making [7].

For our analysis, we use a promising approach proposed by Rafii and Kampas [7]. They suggest that a disruption innovation process consists of six stages (see Table 5). For each stage, there are contributing factors which enable or disable the disruption. Moreover, a disruptive technology introduced by an insurgent can fail or seriously damage an incumbent at each stage. Rafii and Kampas propose a decision-making instrument for identifying, rating, and weighting the contributing factors that make the disruption more or less likely to succeed in each stage. This analytical methodology aims at scoring and graphing the disruptiveness profile with its disabling and enabling forces.

To evaluate the different contributing factors present at each stage, we conducted several exploratory interviews with Swiss mobile payment experts. We tried to involve practitioners who work for different industries such as financial institutions, MNOs, mobile application service providers (MASP) and contactless smartcard system providers. In respect to our classification framework, we selected companies offering mobile payments solutions located in each cell of the matrix. The objective was to have a multiple perspective analysis of the two potential disruption.

These practitioners work for different mobile payment service providers such as financial institutions, MNOs, mobile application service providers (MASP) and contactless smartcard system providers. Each of them was questioned about one of the possible disruptions on the mobile payment market. These interviews consisted in open and semi-open questions and took place between April and June 2004, each lasting on average two hours.

In the next subsections, we will describe the evaluations of the contributing factors for the two disruptions. These were collected during our exploratory interviews.

Table 5
Rafii and Kampas: Six Stages Framework [7]

Stage	Question
1. Foothold market entry	Can the insurgent gain a foothold (usually in the market below the main one)?
2. Main market entry	Does the insurgent face high barriers to entering the main market?
3. Customer attraction	How much value can the insurgent offer relative to the incumbent?
4. Customer switching	How easily can customers switch from the incumbent to the insurgent?
5. Incumbent retaliation	Does the incumbent have high barriers to retaliate against the insurgent?
6. Incumbent displacement	Does the innovation displace (as opposed to augment) incumbent products and revenues?

3.1 Disruption I: From Card-based to Phone-based Solutions

The assumption behind this hypothetical disruption is that mobile phones could become payment instruments as they offer more processing power capabilities than cards. Moreover, the acceptance number of mobile phones is very high. Therefore, we assume that there exists the eventuality that phones will replace the current cards in the future. This disruption does not necessarily mean that card issuers would totally disappear to leave MNOs as leading payment providers. The physical support of the payment instrument could be a phone with a special payment chipset inside. Another scenario where financial institutions could use mobile networks as a new channel is also possible. As already described, there are several technical options to combine current payment cards with mobile handsets.

The possible outcome of any of the proposed disruption scenarios is that mobile phones would become a device not only for communication but also for financial transactions. This means that magnetic cards would be replaced by small chipset, RFID, or even a software-based solution. A recent forum regrouping Nokia, Philips and Sony is working on NFC (Near Field Communication) technologies. This initiative may offer great benefits for the development of mobile payments as the mobile device would be able to act as a contactless card and a reader. Therefore, the user would be able to purchase a good and also get paid with the same device.

In Figure 3, we have summarized the different contributing factors and evaluations given by the interviewees for the first disruption. This give us a synthetic

overview and good insights of the current Swiss market.

As a conclusion for this evaluation, we can say that mobile phones might be a new channel for financial institutions. Moreover, the cards may disappear but MNOs might not displace the current payment service providers. However, they could gain a market share as they will probably propose a mobile micro-payment payment scheme without the banks in the near future. Most of the interviewees agree that mobile phones might be good physical supports for a future payment scheme. Thus, the market and the technology might not be ready for such evolution.

3.2 Disruption II: From Operator-driven to Self-organized Solutions

As MNOs and financial institutions take high commissions for financial transactions, merchants are motivated to find another solution. Therefore, a new demand for cheap and independent payment schemes exists. New entrants usually have fast reaction and personalization capabilities. This makes them very attractive for business for specific needs. A new payment scheme could also erode the market shares of the dominant actors even if it is not globally launched. This is even more dangerous when the merchant has a large customer base and a high volume of transactions. This new offering might have lower performance and less functionality, but at a much lower price. This might also generate great interests in other parties to form a consortium of merchants accepting this self-organized scheme as the consumer base is already large. This has been previously seen in Hong Kong with the Octopus card.

For all these reasons, we believe that a disruption generated by a self-organized scheme is possible. The evaluation of such a hypothesis is show in Figure 4.

This evaluation shows that there is a potential for self-organized solutions to succeed. However, there are big barriers in the main market entry to overcome. In fact, the most difficult activity is to bring together consumers and merchant to adopt the scheme. However, the performance of certain schemes as they are personalized make them very attractive. Moreover, the cost is usually lower than the current payment schemes. Success is essentially related to two key factors: the customers-merchants base and the volume of transactions. Yet, no independent payment schemes in Switzerland have really threaten the financial institutions.

Card-based Solutions ⟶ **Disruption I** ⟶ **Phone-based Solutions**

Stage	Forces disabling disruption	Evaluation	Forces enabling disruption
1. Foothold market entry	- Large scale and high volume of transaction needed to be rapidly profitable	→	+ Already generates extra-revenue through the carrier channel (e.g. SMS, WAP) + Presently enables new mobile services (e.g. ring tones, games, news) + Potential alliance between MNOs (global coverage: cross-operator & cross-border) + Existing large customer base (3 national MNOs with 70% penetration rate in Switzerland against 150 banks)
2. Main market entry	- Small margins compared to fraud risks - Strong position of the banks on the Swiss market - Difficulty to reach a large base of physical merchants	↔	+ No real legal issues + Offer a new channel for financial institutions (MNOs as payment intermediaries or telco carrier)
3. Customer attraction	- Education of the user (temporary) - Mobile payments procedures are too complicated (need to be simplified) - Requirement to register to the service (not always)	↔	+ Better performance in certain industries (e.g. m-commerce) + Digitalized wallet (no need to carry wallet and phone)
4. Customer switching	- Behavioral issues (Swiss still like cash-based transactions) - Need marketing effort and time - Unsuccess of previous electronic purses (e.g. CASH card) - Unfriendliness of current phone interfaces	←	+ Payment of new digital content mainly adopted by youths
5. Incumbent retaliation	- Financial institution's strong brand name and image - Loyalty and trust in banks for financial services	←	+ MNOs have fast reaction time to new technologies
6. Incumbent displacement	- MNOs' strong dependance on banks and classic payment means - MNOs' preference to partner with financial institutions to bring a standard to the market	←	+ Market segment not efficiently covered (micro vs macro)

Fig. 3. From Card-based to Phone-based Solutions

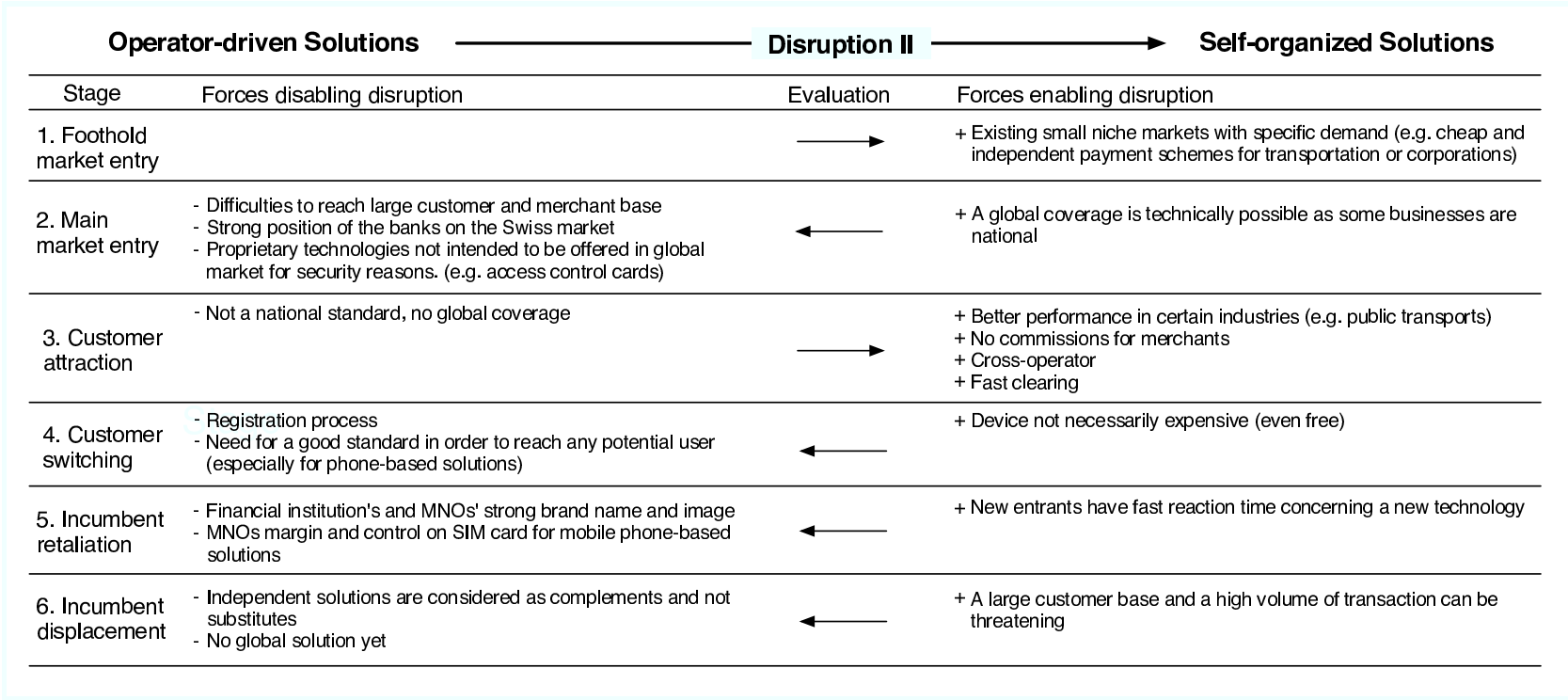

Fig. 4. From Operator-driven to Self-organized Solutions

3.3 A Brief Conclusion on the Disruption Analysis

A statement on which all the different interviewees agree is that mobile payments are still predicted to be a natural evolution in the payment industry. However, there are still some business and technological issues to overcome before mobile payments could really take off. As MNOs are more likely to collaborate than compete with financial institutions, the success of mobile payments are in the hands of the banks. They should not wait too long as other independents could offer better solutions to specific market segments. Needless to say that for now, the threat is still weak as the implementation of a payment scheme and the behavioral change is not done overnight. However, independent and phone-based solutions are already entering the market as complementary payment instruments. Therefore, the switch from complement to substitute is not excluded if the adoption and use rate is high enough.

This analysis helped to draw the disruptive profile of mobile payments. Therefore, it gave a good perspective to observe the market in a structured way. There are still facets of the market that have not been seen through our first exploratory study. For this purpose, we propose in the next section to use a multi-stakeholder, multi-criteria framework to assess the different preferences of the market and therefore explain the factors that have hindered the development of mobile payment schemes.

4 A Multi-stakeholder and Multi-criteria Market Analysis

In this section, we propose a multiple-stakeholder, multiple-criteria model to assess various aspects related to the adoption of mobile payments from a market perspective. Using this framework, we try to find a technological consensus that is satisfactory to all players in the mobile payment market. We believe that this approach takes into account various facets that could explain the success or failure of mobile payment solutions. In fact, a payment solution could only prevail if all the participants on the market agree on a technology.

4.1 The Stakeholders and the Technologies of the Mobile Payment Market

For our model, we identified three groups of stakeholders that represent the mobile payment market; the providers, the merchants, and the consumers. We assume that each individual actor in these groups has homogeneous evaluations on the different issues.

As briefly discussed above, there are various wireless technologies which could enable mobile payments services. These technologies differ not only in their technical capabilities but also in the impact of the value they could have. We selected three technologies that are good candidates for mobile payments. The first alternative is the contactless card embedded with a RFID (Radio Frequency Identification) tag. These cards tend to become very popular for many reasons. They are cheap, reliable, and very easy to use. They are mainly used in the transport industry and other quick-services oriented industries. Then, we chose mobile phones using proximity networks such as Bluetooth, RFID, and Infrared. This type of solution is good for proximity payments in the real world. Finally, we included mobile phone using remote networks (e.g. GSM, GPRS, UTMS, EDGE, WLAN,). These devices are suitable for remote payments such as e/m-commerce transactions. We also included two very popular payment technologies such as magnetic cards (e.g. VISA, Mastercard) and smart cards (e.g. Proton).

Table 6
The Five Selected Technologies

Type	Example
Contactless card (RFID tag)	Octopus
Mobile phone "proximity" (Bluetooth, RFID, Infrared)	Moneta
Mobile phone "remote" (GSM, GPRS, ...)	Paybox
Magnetic card	Visa, MasterCard
Smart card	CASH, Proton, Galaxy

Each of the introduced technologies has its advantages and drawbacks. Some have limitations that others do not have. For that reason, a mobile payment service provider should consider all these options before launching a scheme. Running an analysis with all these different technology should not only help us to compare the performance of mobile and existing technologies but also give us good insights about the current situation on the market.

4.2 The Stakeholders and Their Criteria

We assume that each stakeholder should evaluate the different technologies using its own criteria. As not every criteria is relevant for each group, we decided to look into the literature to build a framework containing a set of important criteria for each actor.

4.2.1 The Provider Group

Table 7 illustrates some relevant criteria for the providers (Financial institutions, MNOs, Independents). These criteria will be used to evaluate the five technologies presented in Table 6.

Table 7
The Provider Group Criteria

Criteria	Description	References
Cost	Two types of costs: the fixed cost, referring to the infrastructure, and the variable costs that are the transaction costs.	[15]; [16]
Organizational change	Internal changes to provide a new payment scheme. Impact of introducing a new product could be important. Hire new employees or consultants. Manage new partnerships.	[16]
Security	Level and mechanisms of security of the technology.	[15]; [17]
Standard	Standard accepted by most of the players. Important for schemes launched in global market.	[17]

4.2.2 The Consumer Group

This group represents the potential consumers that would use a mobile payment scheme. Most of the criteria presented in Table 8 are derive from the Technology Acceptance Model (TAM) [18] and an extension of the model for mobile payment proposed by [19].

Table 8
The Consumer Group Criteria

Criteria	Description	References
Cost	Investment for the device. Cost of each transaction.	[15]; [20]; [19]
Ease of use	Ease of use for an average consumer. Number of human interventions in the process.	[17]; [20]; [19]
Expressiveness	Possibility for the consumer to express him/herself by using the system. Personalization could be a factor. Enhancement the social status. Differentiation between individuals.	[19]
Trust	A high level of trust in a payment solution is more of a basic requirement than a competitive advantage. When fraudulent activities are frequent and financial risks are high, trust becomes more important.	[21]; [19]
Universality	Able to use the payment scheme almost anywhere. Universality is crucial if the system is launched on a national or international market.	[17]
Usefulness	Use a system for certain reasons. Respond to certain consumers needs.	[17]; [19]

4.2.3 The Merchant Group

The merchants need to be convinced just as much as the consumers to adopt a new payment scheme. This is due to the fact that the implementation of a new payment infrastructure is not always seamless. In addition, a payment scheme is very important for merchants, as they need to replace cash transactions that are very expensive to manage.

Table 9
The Merchant Group Criteria

Criteria	Description	References
Cost	Fixed cost of the payment infrastructure. Transaction fees asked from the acquirer.	[15]; [16]
Customer base	Number of existing and potential consumers.	[15]
Ease of use	Ease of use of a payment system on the merchant side.	[17]
Reliability	Transactions always done successfully.	[15]
Security	Security to prevent fraud.	[15]
Value proposition improvement	Not only for the mobile capabilities but also for the differentiation factor. Improvement of the shopping and the purchase experience.	[22]

4.3 Introduction to the Analysis Using Electre I

Electre I is a robust MCDM method coming from the French school [23]. This method was inspired by a very old democratic rule of Condorcet, a French Enlightenment Philosopher. When an action A is better than an action B in relation to most decision criteria and there are no criteria on which A is much worse than B, then we can state without too many risks that A is preferred to B. In other words, A outranks B. Using the output, we can observe the individual preference of each actor. Finally, we combine the preferences to obtain a consensus that will represent the market preference.

The data that are used as inputs in our model are derived from the exploratory interviews presented above, an extensive research in the literature, and some experts' opinions during several focus group sessions.

The outcome of Electre I are several matrix. In the concordance and the discordance matrix, we can compare how better or how worse a solution is from another. The discordance matrix is very interesting because it indicates whether there is a strong opposition on one or more criteria. Therefore, a solution which has good evaluations for most criteria but one or more very bad evaluations on other criteria could be detected and eliminated. The combinaison of these two matrix gives an outranking matrix that shows if a solution outranks another based on the evaluations. From there we can draw outranking graphs that improve the visualization of the outranking relations.

To find the a general consensus with the concordance and discordance matrix of each actor, we will use a group decision approach proposed by [24]. The idea is based on the min-max concept in game theory [25]. The values for the group concordance matrix are the lowest values found in any actor concordance matrix. For the group discordance, we take the highest value. Therefore, this process is very selective. However, if the values are not too extreme a consensus should be found.

4.4 Results with our DSS

For this analysis, we designed and used a DSS based on Electre I and the group decision feature presented above. This IT artefact is a good support for every step of the analysis as it facilitates the input of the data and automatically calculates the results. Moreover, during the design of the prototype, particular attention has been paid to the visualization module of the outcome in order to easily conduct sensitivity analysis. Once the different evaluations for each actor has been entered, the DSS can run the matrix comparisons in order to find the group consensus.

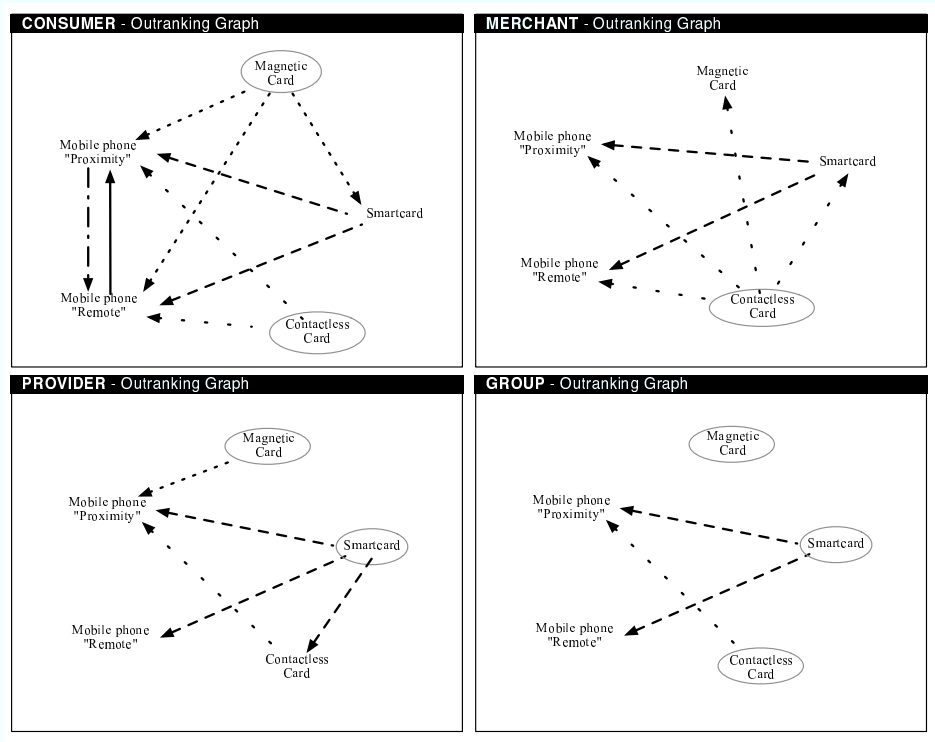

Fig. 5. The Outranking Graphs

In Figure 5, there are the four outranking graphs we obtained from our analysis. The consumer outranking graph shows the contactless card and the magnetic card as the preferred choice, as they are not outranked by any other solutions. The result is not very surprising as magnetic cards are the most popular technology on the market. Moreover, the contactless cards are becoming to be more and more used as transportation and access control cards. Phone-based solutions are not in a good position as they are outranked by every other solution. This is mainly due to the ease of use and a very low merchant acceptance rate are very low. For the merchant, the contactless card outranks all the other solutions. This can be explained by the fact that this technology is made very attractive by its low cost, the fast payment process, and strong reliability. Moreover, the evaluations also show that the value

proposition is increased by offering the customer such a technology. On the provider side, it is not a big surprise that magnetic cards and smartcards are the preferred solutions. Indeed, the cost of these technologies is low and they are already established standards in global markets.

The group consensus mostly illustrates the fact that phone-based solutions do not perform well in the market. For the card solutions, it is impossible to compare them to each other as they are not linked by any outranking relations. This means that they are in the group of the best solutions but we do not know which one is preferred.

4.5 Brief conclusion of our market analysis

This analysis shows common patterns with what we discovered in the first potential disruption (Figure 3). We can conclude that card-based solutions preform well on the current market. The phone-based solutions have too many flaws to displace the cards. However, with the sensitivity analysis, we could observe some dramatic changes if the evaluations of criteria such as cost, ease of use, and universality were improved. It might be just a question of time before the mobile phone solutions will become cheaper and easier to use. We have already noticed in Asian countries such as South Korea and Japan that these factors are no longer issues. In fact, mobile payments are well accepted and widely used in these countries.

The outcome of this analysis confirms the current state of the market we already draw in the disruptive analysis. Moreover, it shows the technological preference of each actor. The group consensus brings another set of information about the market preference. Therefore, if a technology has good evaluations for each actor's own criteria, it might be a commercial success.

5 Conclusion

In this paper, we tried to use a multiple perpective approach to analyze the mobile payment market. Firstly, we proposed a classification framework that was mostly illustrated with Swiss case studies. Secondly, we conducted a qualitative analysis of two potential disruptions using the categories derived from the classification framework. Thirdly, we presented a multiple-stakeholder, multiple-criteria model to assess various aspects related to the adoption of mobile payments from a market perspective. These different multi-perspective analyses allowed us to have a more completed view of market. Moreover, we obtained good insights about the current state of the Swiss market as practi-

tioners were involved in the analytical process.

The results of our analyses show that mobile payments are not yet ready to take over the market. However, the potential is there as the different stakeholders already agree that this could be the next big evolution in the payment market. Many consortiums are working on bringing a standard to the market so as to boost the development. So far, the technology remains flawed with many issues such as security. Moreover, the market does not seem to be quite ready to adopt mobile payments en masse. Thus, for specific services in various industries (e.g. public transportation), mobile payments seems to a very attractive alternative to classic payment instruments.

To continue further research in this domain, we need more empirical data from the market. With that data, we would be able to conduct more quantitative analysis and confirm our first insights obtained with the analysis described in the present paper.

Acknowledgement

The work presented in this paper was supported by the National Competence Center in Research on Mobile Information and Communication Systems (NCCR MICS), a center supported by the Swiss National Science Foundation under grant number 5005-67322.

References

[1] K. Wrona, M. Schuba, G. Zavagli, Mobile payments - state of the art and open problems, in: L. Fiege, G. Mühl, U. G. Wilhelm (Eds.), Electronic Commerce, Second International Workshop, WELCOM 2001 Heidelberg, Germany, November 16-17, 2001, Proceedings, Vol. 2232 of Lecture Notes in Computer Science, Springer, 2001, pp. 88–100.

[2] M. S. Ding, J. F. Hampe, Reconsidering the challenges of mpayments: A roadmap to plotting the potential of the future mcommerce market, in: 16th Bled eCommerce Conference. Bled, Slovenia, 2003.

[3] A. Herzberg, Payments and banking with mobile personal devices, Communications of the ACM 46 (5) (2003) 53–58.

[4] Mobile Payment Forum, Enabling secure, interoperable, and user-friendly mobile payments (White Paper 2002).

[5] A.-M. Moore, Replacing cash with convenience: The promise of RFID payments, Celent Communications.
URL http://www.banktech.com/showArticle.jhtml?articleID=14700510

[6] P. Y. K. Chau, S. Poon, Octopus: an e-cash payment system success story, Communications of the ACM 46 (9) (2003) 129–133.

[7] F. Rafii, P. Kampas, How to identify your enemies before they destroy you, Harvard Business Review 80 (11) (2002) 115–123.

[8] M-commerce payment war hots up, Card Technology Today 14 (3) (2002) 12–13.

[9] N. Mallat, M. Rossi, V. K. Tuunainen, Mobile banking services, Communication of the ACM 47 (5) (2004) 42–46.

[10] J. Bower, C. Christensen, Disruptive technologies: catching the wave, Harvard Business Review 73 (1) (1995) 43–53.

[11] S. Walsh, Roadmapping a disruptive technology: a case study. the emerging microsystems and top-down nanosystems industry, Technological Forecasting and Social Change 71 (2004) 161–185.

[12] C. Christensen, The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail, HBS Press Book, 1997.

[13] S. Kassicieh, S. Walsh, S. Cummings, J. McWhorter, P. Romig, D. Williams, Commercialization of disruptive technologies: moving discontinuous innovations into products, IEEE Transaction on Engineering Management (49 (4)) (2002) 375–387.

[14] R. Kostoff, R. Boylan, G. Simons, Disruptive technology roadmaps, Technological Forecasting and Social Change 71 (2004) 141–159.

[15] Y. Chou, C. Lee, J. Chung, Understanding m-commerce payment systems through the analytic hierarchy process, Journal of Business Research 57 (12) (2004) 1423–1430.

[16] I. Papaefstahiou, C. Manifavas, Evaluation of micropayment transaction costs, Journal of Electronic Commerce Research 5 (2).

[17] S. Karnouskos, Mobile payment: A jouney through existing procedures and standardization initiatives, IEEE Communications Surveys and Tutorials 6 (4) (2004) 44–66.

[18] F. D. Davis, Perceived usefulness, perceived ease of use, and user acceptance of information technology, MIS Quarterly 13 (3) (1989) 319–340.

[19] A. Zmijewska, E. Lawrence, R. Steele, Towards understanding of factors influencing user acceptance of mobile payment systems, IADIS WWW/Internet, Madrid.

[20] K. Poutsttchi, M. Zenker, Current mobile payment procedures on the german market from the view of customer requirements, 14th International Workshop on Database and Expert Systems Applications (DEXA'03), Prague, Czech Republic.

[21] T. Dahlberg, N. Mallat, A. Oorni, Trust enhanced technology acceptance model - consumer acceptance of mobile payment solutions, The Stockholm Mobility Roundtable 2003.

[22] J. Ondrus, Y. Pigneur, Coupling mobile payments and crm in the retail industry, IADIS International Conference e-Commerce.

[23] B. Roy, Classement et choix en presence de points de vue multiples: La methode electre, Revue Francaise d'Informatique et de Recherche operationelle 8 (1968) 57–75.

[24] T. Bui, M. Jarke, A dss for cooperative multiple criteria group decision making, International Conference on Information Systems (ICIS).

[25] J. Von Neumann, O. Morgenstern, Theory of games and economic behavior, 3rd Ed. Princeton University Press, Princeton, New Jersey, 1953.