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### **Time Efficiency Of Point-Of-Sale Payment Methods: Preliminary Results**

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## **Abstract**

This article presents a wide range of different payment methods used at Point-Of-Sales from traditional cash and standard cards to contactless cards, RFID stickers and mobile payments (NFC and remote). All payment instruments are compared under the criterion of time efficiency that means the duration of a payment transaction. The measurement of payment transactions was undertaken with the help of a novel research technique based on a digital chronography of video material recorded by cameras installed in the biggest chain of convenient stores in Poland. More than 4,000 transactions were gauged.

It is empirically proven that cash is still the fastest means of executing transactions at the counter, although new innovative payment methods such as proximity cards and NFC mobile payments may be equally fast and sometimes even faster. There is a potential in accelerating the payment process of those latter. Standard cards together with a remote mobile payments method tested lag behind. Obtained results could be practically used by merchants who want to optimise its payment process at cash registers. Drawn conclusions may also have value for the developers of payment schemes in the world.

**Keywords: Retail payments, cash turnover, credit & debit cards, contactless cards, NFC, mobile payments**

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## **1. Introduction**

Payments at physical Points-Of-Sale are a daily activity of all consumers and may be executed with different types of payment instruments, such as: cash, cards, cheques or currently even mobile devices. The choice of a payment method is influenced by numerous factors which *inter alia* comprise its pecuniary cost of use, convenience, certainty of acceptance (Górka, 2009; Bolt *et al.*, 2009). Individuals must have compelling reasons to change their payment habits. Otherwise they keep using means of payment they are most familiar with (Borzekowski and Kiser, 2008).

Macroeconomically consumers payment pattern entails costs for other parties from the payment chain – like commercial banks and merchants. The problem of payment instruments' costs has already been analysed in a few countries – compare studies of central banks from Norway (Gresvik and Haare, 2009), Finland (Takala and Viren, 2008), Sweden (Bergman *et al.*, 2007), Portugal (Bank of Portugal, 2007), Belgium (Quaden, 2005), the Netherlands (Brits and Winder, 2005), Australia (Simes *et al.*, 2006) or the USA (Garcia-Swartz *et al.*, 2006). Retail sector – small shops, bigger supermarkets, other merchants pay much attention to their own cost calculations. On the other hand they strive for delivering maximum value to their customers which is vital for increasing sales. Consumer satisfaction from the purchase depends heavily on the time of queuing and the time of undertaking a transaction at the counter. As a consequence of strong competition in retail trade, aspects of payment costs, sales organisation and the length of queues have great impact on profitability of merchants business and their market success. Modelling the flow of customers and the time spent by them while paying may result in decreasing queues which is advantageous for both – merchants and consumers.

The main aim of the presented study was to measure the time efficiency of different payment instruments used at physical Points-Of-Sale in Poland. The time efficiency of payment methods understood as the speed of a transaction process has been evaluated on the basis of empirical research that was conducted in the biggest chain of convenient stores in Poland with a close cooperation of an international payment card organisation and one of Polish IT companies.

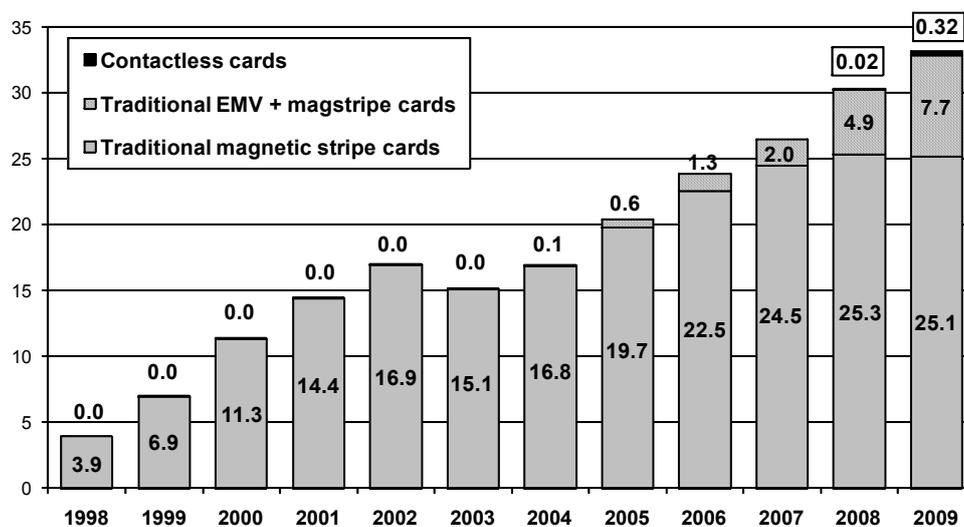
The authors were willing to verify whether new payment solutions like contactless (proximity) cards, RFID (Radio Frequency Identification) stickers or mobile payments – Polish mPay system, NFC (Near Field Communication) mobile phones were faster in a transaction process than traditional payment methods – cash and standard debit and credit cards (authorised by PIN, signature, equipped with a magnetic stripe or chip).

To the best of authors' knowledge, this is the first study in the world in which there were gauged payment process time components of a wide range of payment methods used at Point-of-Sale. The article has been split into 5 parts – introduction, description of POS payment methods in Poland, explanation of research methodology and obtained data, demonstration of empirical results and conclusions.

## **2. Point-Of-Sale Payment Methods in Poland**

The modern retail payment market offers a significant number of payment methods which may be used at POS. Due to their physical features which are the most important for presented study, payment instruments can be divided into three groups: (a) paper instruments: cash (banknotes and coins) and cheques, (b) cards: debit, credit, pre-paid and e-purses (electronic money), and (c) mobile devices working in: remote schemes and proximity schemes. The usage of these instruments is very diversified in particular countries. However undoubtedly, cash is the oldest and it remains the dominant payment instrument despite the development of e-payments. Even in countries with several dozen years of experience in card use, cash still remains the main form of payment. According to McKinsey (2005), cash was used in 70-93% of the total of retail transactions concluded by households in the most important western economies in 2005.

The Polish market is also dominated by cash payments. The results of the survey study show that as much as 94.5% of all payments performed by retail customers at POS were made with cash, only 3.8% with debit cards and 1.7% with credit cards (Polasik and Maciejewski, 2009). These data are similar to those obtained by McKinsey (2009) in 2007 – 94% of payment transactions in Poland were made by cash. The payment card issuance in Poland accelerated since 1998, reaching the level of 33.2 million cards by the end of 2009 (Figure 2). However, two-thirds of them were debit cards and were used mainly for cash withdrawals (not for payments at POS). The Polish market is far from being saturated as there was an average of only 85 payment cards per 100 inhabitants, compared to the EU average of more than 160 cards (ECB, 2009).



**Figure 1:** Number of payment cards issued in Poland (in million)  
 Source: National Bank of Poland and own study based on data obtained from card issuers.

In terms of technology, the Polish payment cards market has seen considerable change. Firstly, the banking sector is monitoring the migration to EMV microprocessor card standard (Ward 2006) as part of implementation of the SEPA program. By the end of 2009 only 24% cards in Poland had EMV chips, the remainder used only magnetic strips (Figure 2), whereas 72% cards had them in the European Union as early as in 2008 (ECB, 2009). However, the delay in the EMV migration process seems to be advantageous for introducing the latest innovation in the card industry, i.e. contactless cards. Contactless payments are based on a RFID technology (Radio Frequency Identification) enabling remote reading of integrated circuits via radio waves (Hancke, 2008). In Poland this technology was pioneered by Bank Zachodni WBK SA in December 2007 and contactless cards became popular in 2009. By the end of 2009 there were 320,000 contactless cards in Poland. Statistics show that this market segment in Poland remains at a very early stage of development and that the penetration of contactless instruments is still low as contactless cards account for only 1% of all payment cards in Poland and are accepted by 3% of all POS terminals (data obtained from banks and acquirers). Today, apart from the UK and Turkey, Poland

constitutes the largest market for contactless cards in Europe and these cards are intensively promoted by MasterCard and Visa. A few Polish banks have already issued also a small number of RFID stickers for mobiles and some other contactless payment gadgets, like wristwatch and keyfob. These instruments are issued as payment cards and operate similarly to contactless cards, however they have different form factors and limited functionality. The more advanced proximity mobile payment technology, i.e. NFC (Near Field Communication is an expansion of RFID technology, complimentary to contactless card; see Hancke, 2008), which is very popular in Asia (Eastwood, 2008), has not been introduced in Poland so far.

Apart from cash and payment cards (magnetic stripe, EMV or contactless technology) no other payment instrument plays a significant role in the retail POS payment market. Paper cheques (excluded from the study) were already withdrawn from the Polish market in 2005 and no system of hardware electronic money functions in Poland. However, one type of remote mobile payment system works commercially on the Polish market under the brand of mPay. The system was launched in 2007 and it is based on telecommunication connections in GSM standard – text USSD or voice IVR. It is a technology that allows using the system on any mobile phone without the need of installing additional software. mPay works as an electronic purse (e-purse) that has to be topped earlier by a customer. Payments can be made for merchants as well as for any mobile phones users, however it requires activity of a payer due to the need of entering payee’s number. Thus it supports both types of payments – C2B and C2C between individuals. This solution is characterized by flexibility and openness. mPay allows to make payments not only in POS, but also for the bills (bill payment), Internet shopping and in selected Polish cities it facilitates paying for public transportation and parking fees. By May 2010 mPay had gained 160,000 registered users in Poland, however the usage of the system is still very limited, in particular, besides certain exceptions, it is not accepted by merchants.

### 3. Research methodology and obtained data

In conjunction with the measurement of time efficiency we have carefully examined clients’ preferences towards various payment methods and other factors determining their usage including queuing. The empirical research was based on:

- Chronography of the purchase transaction process at cash registers with the help of video monitoring during regular work hours of shops and test transactions after shops closure.
- Survey of clients’ opinions (clients who conducted transactions and those who withdrew from the purchase).

In this work we will mainly focus on the basic results concerning duration of payment transactions performed with different instruments at the counter.

**Table 1: Payment instruments covered by the study**

Payment instrument	Type
Cash	-
Card (contact)	Magnetic stripe + PIN
	Magnetic stripe + signature
	EMV (Chip+PIN)
Contactless (proximity) card	-
RFID sticker on the mobile phone	-

NFC mobile payment	With PIN
	Without PIN
Remote mobile payment	mPay domestic Polish system
Additionally	
Cash back	Card
Bill payment	Cash

Terminal types (applies to cards only): integrated and non-integrated.

Type of a telecommunication connection (applies to cards only): DSL, Dial-up, GPRS.

Type of authorisation connection: yes (online), no (offline).

We have not only tested basic payment instruments such as cash and cards but also evaluated the rare innovative payment methods such as contactless cards, RFID stickers or NFC mobile payments which can gain on popularity and significance in the near future (Table 1). Besides we took into account different terminals and types of telecommunication connections. Terminals integrated with a cash register decrease the time of typing in the amount of a purchase on the terminal, while certain types of a telecommunication connection might lengthen the process of a transaction by many seconds. There are differences between broadband (DSL), through a telephone line (dial-up) and over-the-air wireless GPRS connections as well as between offline and online authorisation (see the table and the information below). As a consequence it is possible to obtain a full picture of time needed to complete a transaction including multiple dimensions (payment instruments, terminals, telecommunication connections). However such an extensive analysis is out of scope of this article with respect to its size.

In order to provide full complexity of the research we considered three modes of tests: (1) regular flow of customers; (2) mystery client tests (testers using given payment instruments among other clients queuing); (3) closed tests (testers only, after shop closure). In the process of a payment we investigated the time of queuing and the time of a purchase payment gauged from the moment of presenting merchandise by a client to a salesman until consummating the payment and handing out receipts. Every payment method has its own specific series of time components, although some of them may be the same – like for example scanning of items. Nevertheless the time components of payment methods vary considerably. In the case of cash we have: scanning of items, taking out and counting money by a client, taking money by a shop assistant, giving back the change with receipts, whereas in case of a payment card verified by PIN we can observe such stages: scanning of items, card preparation by a client, terminal activation and a card usage by a salesman, entering the PIN code on a PINpad by a client, slip printing and handing it out to a client. Every time a given stage had to be precisely defined and measured.

The empirical data for the study were gathered between the 19<sup>th</sup> and the 21<sup>st</sup> of November 2009 in Torun, a Polish city, in a number of convenient stores. More than 30 people were directly engaged in the process (testers, pollsters, organisers and technical support). 4,000 different transactions and tens of thousands of particular time elements for all analysed payment instruments were observed and the survey covered almost 1,000 clients.

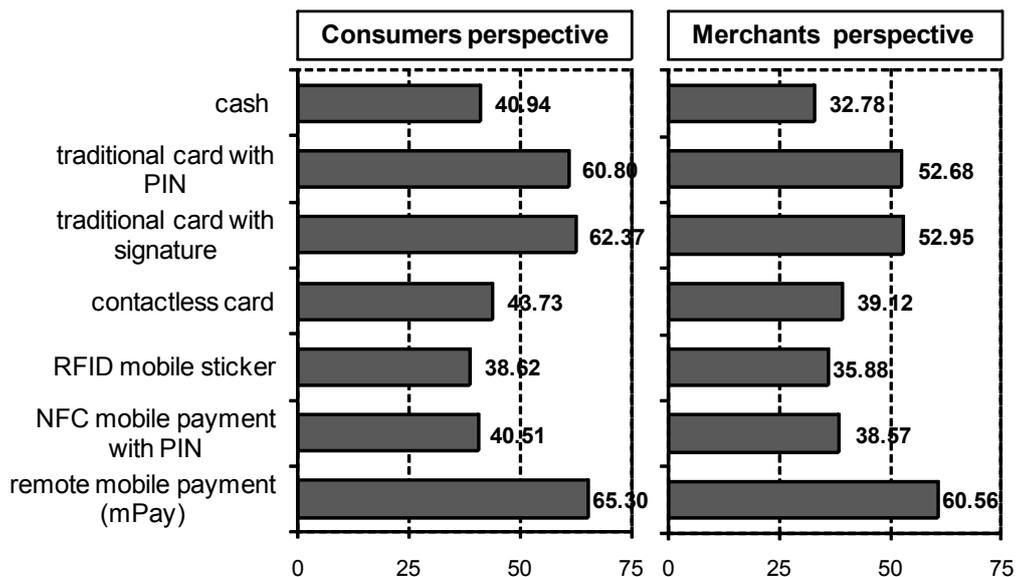
After the completion of the process of tests and recording the video a stage of chronography began. The team IT specialist developed a dedicated computer program Chrono-Metrics which facilitated measurement of all transactions and its time

components being combined with the recorded video material. 95 qualified trainees took part in gauges which lasted for more than 2 months. Each recorded transaction in every shop was on average measured by 5 people in order to eliminate errors. Eventually the set of raw data was collected and using mathematical algorithms average times of transactions of payment instrument were calculated.

#### 4. Empirical results

The survey results confirmed the prevalent share of cash in retail POS transactions in Poland. In the regular flow of customers 94.3% of transactions were made with cash and 5.7% with standard payment debit and credit cards. All the other payment methods could only be examined during mystery and closed clients' tests. Nevertheless it was confirmed that the structure of POS payments in convenient stores was roughly identical with the structure of payment estimated for all sorts of shops in Poland (compare McKinsey (2009) and Polasik and Maciejewski (2009).

The detailed empirical data gathered in the process of chronography allow to conduct an analysis of any time components of the purchase payment process using multiple variable dimensions. In this paper authors decided to concentrate on the comparison of the time process of payments using two approaches which probably have the biggest practical value. The first takes the perspective of a client, while the other – of the merchant. The first starts with the preparation of a payment instrument or with passing items by a consumer to the salesman and ends with the moment, when the consumer walks away from the counter. In the view of a client the whole time devoted by him to the execution of a payment is important. The chart below (on the left side) demonstrates the times of payment transactions for different payment methods. The second chart (on the right side) presents the merchants perspective – from the moment of a true beginning of clients servicing to handing out receipts to the client. For the merchant the time of a salesperson is important. There might be a slight difference between these two approaches, because for example the preparation of a payment instrument may start before the beginning of service.



**Figure 2:** *The average duration of a purchase transaction by payment methods in seconds*

*Source: Based on authors' own study.*

The first empirical result is that in convenience stores cash still stands out as the statistically fastest payment method. The cash payment is especially short from the perspective of a merchant. However, what should be underlined, traditional cards with a magnetic stripe or chip are much slower than cash. Their usage transposes to lengthening of the time spent by a consumer at the counter by about 50%. Such a significant difference in the duration of a payment transaction (20 seconds) may have an effect on the queue when most clients decide to pay with their traditional cards.

On the other hand the results revealed that only payment instruments based on RFID technology – contactless cards, RFID stickers and mobile NFC payments may be competitive when considering times of completing transactions. These payment instruments may require sacrificing more time by merchants than cash but they are at the same moment much faster from traditional payment cards. Hence it seems that declarations of card issuers that the usage of contactless cards may shorten queues in shops, is true. Polish legal system regulations require printing two slips for card transactions. It appeared that printing them lasts on average 6 seconds. Consequently changes of law acts and cancellation of this requirement for low value payments might lead to shortening of contactless cards payments which would than easily surpass cash in time efficiency. Moreover it is always possible to cut down the time of a transaction execution in case of payments undertaken only in offline mode (currently in Poland most of contactless transactions are performed in online mode).

Interesting conclusions pertain to mobile payment such as RFID stickers or NFC which undoubtedly are time efficient. Some clients can even pay more quickly with their mobile phones than with contactless cards taken out of wallets. Contactless solutions are technologically mature, based on international standards. They gained quite a big popularity in some countries, especially in Japan and the USA (Eastwood, 2008). These factors increase the probability of their further development greatly.

It does not mean however that spreading out of remote type mobile payments is not possible. Such payments are characterized by a wider functionality than proximity type mobile payments because apart from POS payments they can be used for transactions on the Internet, for bill payments, parking meters or purchase of tickets in a mass transit communication system. A considerable number of remote mobile payment systems operate in the world, however they are not compatible with each other. This is one of the reasons why they have not become common. An additional barrier for their market success is a necessity for consumers to type some information on the phone and this might be time consuming. The Polish domestic mPay system proved to be the slowest payment method out of the analysed. Nevertheless it must be emphasised that mPay was only slightly slower than traditional payment cards and there are potential ways and procedures that – when properly implemented – may successfully accelerate the transaction process performed with remote mobile payment methods.

## **5. Summary and conclusions**

The obtained results provide an insight into the important problem of the time efficiency

of payment methods at physical Points-Of-Sale in Poland. The data enable not only to assess the average time of a purchase transaction but also to determine the influence of payment methods on the queuing time and costs borne by merchants. The comparison of many payment instruments gives valuable knowledge than can be used by decision bodies capable of promoting the most efficient payment methods.

Our research confirms the dominance of cash in retail transactions in Poland. It also reveals that cash is the fastest payment method available at Points-Of-Sale. Probably the time efficiency of cash is one of the reasons people use it so often. Traditional payment cards equipped with a magnetic stripe or EMV chip are much slower than banknote and coins at the counter. The time difference between cash and cards duration of a payment transaction is fairly large – about 20 seconds (a half of the entire duration of a cash payment transaction). It suggests that frequently the use of traditional cards by customers lengthen queues and may cause cost increases for merchants, which have to do additional work (cashiers) and risk losing sales.

The results may be especially important for the companies introducing new payment solutions to the market, like contactless cards and mobile payments. It turns out that thanks to the innovative contactless technology, in terms of transaction's speed, electronic payment instruments are likely to become true competitors of cash. Contactless cards and other variants of RFID payments devices – mobile stickers and NFC mobile payments – are almost as fast as cash, despite additional legal requirements for slip printing. The speed of contactless payments make them attractive for merchants and customers. It suggests that we can expect the development of these payment methods around the world. In contrast, remote mobile payment schemes are rather slow in POS purchases, however these innovations become rather more popular in other payment market segments (e.g. Internet) and may have additional functionality.

The article can be placed in the stream of researches on costs and revenues of payments. Its results might be interesting from a scientific as well as a business viewpoint. Moreover, the detailed timing study of a payment process will in the future allow to build an accurate model of the whole payment process covering customer and sales person activities and – at the same time – including other factors such as: the type of a payment instrument, terminal, connection used and a number of items purchased. We believe that our findings will be useful in preparing the strategy for promoting efficient payment instruments among consumers and merchants in Poland.

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