

THE FUTURE OF CASH

Designing
for the
continued
support of
cash.

Igo Boerrigter
Master thesis
March 2019



COLOPHON

The future of cash: Designing for the continued support of cash

Graduation project Igo Boerrigter
March 2019

Design for Interaction
Faculty of Industrial Design Engineering
Delft University of Technology

Supervisory team:
Jasper van Kuijk (TU Delft)
Arnold Vermeeren (TU Delft)
Jelle Miedema (DNB)
Hans de Heij (DNB)

GLOSSARY

Pos

Point of sale

DNB

De Nederlandsche Bank

ECB

European Central Bank

eurozone

All countries using the Euro as their national currency

Denomination

A certain currency amount

Payment instrument

Products that are used to transfer value

Executive summary

This graduation report is an account of the graduation project of Igo Boerrigter for De Nederlandsche Bank (DNB) as a student of the Design for Interaction master at the Faculty of Industrial Design Engineering of the TU Delft.

The Netherlands is part of the eurozone where 19 countries use the Euro currency and accompanied Euro cash. Cash is a payment instrument which has been used for decades. With the emergence of digital payment instruments, the use of cash is changing. De Nederlandsche Bank has been a leading central bank on innovation and initiated a project to determine the future role and design of cash.

Within the Netherlands the use of cash has been steadily decreasing over the last 20 years to below 40% in 2019. With the cash use in the entire eurozone being around 80%, the Netherlands is one of the frontrunners in cash usage reduction. This reduction of use creates initial research questions:

- What is influencing payment behaviour change?
- What impact does the reduced use of cash have?
- What role does cash have in the future?

Using a payment behaviour model created by Van der Horst and van der Crujjsen(2016), it was found that there are multiple factors that influence payment behaviour but the crucial determinants of behaviour change are the usability aspects of payment instruments. If people have the luxury to choose not on safety, privacy or ability, but on usability, digital instruments are increasingly more preferred.

This results in a continued decline of using cash as a payment instrument. This creates challenges for the cash system to function properly. First, the reduced use of cash lowers the acceptance and availability infrastructure. This has a negative effect on the remaining cash users. As the adaptation of digital payment instruments is not evenly divided over society, cash is becoming

more of a niche product with a niche user base. This niche user base exists of people who are not able or willing to adapt to digital payment instruments. Although this group is declining over the next decades, the decline in cash usage is going much faster. To be able to facilitate the remaining cash users as long as possible, the cash cycle should become more efficient and less expensive to viably function on low use numbers until the remaining cash users have switched or gone extinct.

Secondly, the decline of cash usage will have its consequences for the backup role cash had in this digital area. If digital payment instruments experience some disturbance, cash has been the traditional choice which always functions. Within this project a distinction is made between low impact and high impact disturbances. Cash already does not function well in low impact disturbances such as a connection issue of a card company. People do not have cash on them, shops do not have enough change and payments take too much time and effort. This will only become worse when the use of cash drops further. In these low impact disturbances, it is advised to improve the robustness of the digital payment infrastructure and create parallel systems to which retailers can easily switch in case of a disturbance.

In high impact disturbances such as war, natural disasters or a collapse of the digital financial system, cash still has an important role. In such an event the trust and independence of cash are highly valued and there could be a quick reassurance in the use of cash. Such a scenario might not happen for decades, but society and central banks should be prepared for it. For such a scenario an emergency plan must be created to quickly deploy the required cash and supportive infrastructure.

A design goal was defined to support the reduction of cash use and improve the efficiency of the cash cycle. What was found in the cash cycle is the lack of circulation of coins. Coins are distributed through retailers to the general public.

These coins are often removed from wallets and stored at home limiting their circulation back to retailers. This is done because of the weight and space coins take up in a person's carry-on. This makes coins an expensive part of the cash infrastructure. The following design goal was formulated:

I want to redesign coins to make them easier to transport and use; by making them smaller, lighter and better fitting with the carry-ons people have with them.

A design process was performed that resulted in a redesign of the coins, Euro tokens, and a holder for these tokens. The Euro tokens are plastic, equally sized, flat tokens that replace the current Euro coins. The tokens are designed to fit into a holder which is sized according to the payment card ISO standard. This allows people to take up to 8 or 16 denomination tokens with them. These tokens are efficiently stored and weigh considerably less than current coins. The tokens have textures added to allow tactile recognition of the different denominations which is especially valuable for the visually impaired. The faces of tokens are designed to support the interface functions of cash. Each denomination has its own colour which mimics the colour pattern seen in Euro notes.

This design was detailed and evaluated based on a usability test performed with 8 participants. The design received positive feedback and was seen by many as an improvement on current coins. The usability issues that were communicated were improved upon.

Based on the findings in this project, four conclusions and recommendations were created for central banks in the eurozone and outside of it concerning the future of cash.

1. The use of cash as a payment instrument is reducing and its not going to stop. Central banks need to adapt to this change and prepare for its consequences.
2. Cash is becoming a niche product with a more defined user base who might have different user demands. Central banks need to be aware of these demands and facilitate them as best as possible
3. Hoarding of cash is becoming its main function and should be supported. The hoarded cash should have touch points to interact with the digital payment infrastructure
4. Becoming cashless does not mean cash will disappear. In times of crisis cash might be needed again. Even if cash is non existent as a payment instrument, cash and the infrastructure can be redistributed when it is needed again.

The change in cash usage is a fast and new process. It is a change which cannot be stopped and countries need to be prepared for it. The correct measures need to be taken and they need to be taken sooner than later because the longer we wait, the harder it becomes.

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Introduction

Challenges and relevance

This report covers an analysis and design process undertaken to design cash for future use with a use-centred approach.

Cash is and has been the main payment instrument in modern history. Due to developments in financial technology and digital payment instruments, the use of cash is reducing at points of sale (pos). As these changes in payment behaviour continue, the design of cash and its system should be updated to optimally support the future use.

The design of cash has been quite similar since its inception. Cash is a combination of coins and banknotes and developments in cash have mostly been technology driven and use(r) centred design has been applied to a limited end. Cash has an important role in society and should be optimally supported.

The challenges in this project lie in the complexity of the payment system and future payment behaviour of people. Cash has been the leading payment system for centuries and is now seeing rapid change in use due to digitalisation which has consequences for its use, support, reputation and system. The Netherlands has seen the biggest change in payment behaviour in the eurozone and should be prepared for the problems and opportunities that arise from this development.

Project context

This project was initiated by De Nederlandsche bank (DNB), the central bank of the Netherlands. DNB is part of the European system of central banks (ESCB) which regulates, distributes and monitors the Euro cash. DNB has always been an innovator in cash design and is looking at the future of cash and cash design. They want to apply use(r) centred design methods to cash design and therefore cooperated with the TU Delft to setup this project with a Design for Interaction student from the faculty of Industrial Design Engineering.

Societal mandate and responsibility

DNB as a central bank has a societal responsibility to ensure a stable financial system and a well-functioning payment system. As a designer it is important to realise whom this project is for. As a facilitating, non-commercial institution, the goal is to support people the best in what they want and need. This requires listening to users and following their behaviour instead of trying to change it or steer it. But sometimes some decisions have to be made on the basis of the responsibility to society as whole, which an individual might not notice or prioritize.

Goal and approach

The goal of this project is to analyse current payment behaviour and determine the drivers behind payment behaviour to make assessments of the future use of cash. Based on this projected future use, a design process is undertaken to (re) design cash and its system.

The process followed will be a combination of future design methods and use centred design to analyse current use and interactions of cash and other payment instruments, changes within this use, define future use scenarios and create a new design proposal for cash.

***The philosophy is to pro actively think
and plan for future developments
instead of being a passive victim of
change***

-Scenariothinking.org-



1 Payment and payment instruments in the eurozone

To make estimates about the future use of cash, it is important to understand the system in which it functions, what other options people have for payment and how these are used. This chapter gives an overview of the different payment instruments available (e.g. cash, credit card, debit card, mobile payments) their (dis)advantages and their use. Furthermore, a model explaining payment behaviour is discussed that shows the different factors influencing payment behaviour.

The goal of this part of the analysis is to gain an understanding of the context in which cash exists and the differences in use between different payment instruments and what factors influence payment behaviour. This covers payment instruments and payment behaviour in the eurozone with focus on the Netherlands.

The research questions that are leading in this analysis are:

- *What is a payment?*
- *Which payment instruments are used?*
- *How are these payment instruments used?*
- *What are the benefits and disadvantages of these payment instruments?*
- *What influences the use of payment instruments?*

Method

To answer these questions a combination of interviews, observations and desk research is performed.

1.1 Payment at points of sale

Payments are transfers of value often in exchange for a product or service. If these payments take place as a retail transaction where the buyer is physically at the point of sale the transaction is described as a point of sale(pos) transaction. In this report when payments or transactions are mentioned, they refer to a point of sale transaction. This excludes business to business transactions, online purchases and automatic deduction systems which are not conducted at a pos. At pos transactions the payment instrument is dependent on the buyer's and seller's available options, their preferences, habits and the context of payment.

1.2 Payment instruments

Within the eurozone a wide range of payment methods are used and the amount of payment options is continuously growing. The payment instruments can differ in use, technology, cost and support. For further reference, a categorisation is used proposed by Hans de Heij (2017) (Table 1.1).

The most common payment instruments are discussed below.

Cash

Cash is the most used payment system in the eurozone. Cash is the physical representation of money and is the only payment system independent of information technology. There are other payment instruments that are non-digital e.g. cheques, coupons and festival tokens but cheques are only used at the end of a digital process and tokens and coupons are always limited towards a specific context or use. Furthermore, cash is the only representation of money which is issued by central banks and is therefore commercially independent. All other payment systems are controlled by commercial institutions such as commercial banks, shops or other third parties. Currently, cash exists of different denominations of coins and banknotes. The properties of cash will be further analysed and discussed in chapter 2.

Debit cards

Debit cards are currently the second used payment instrument in the eurozone behind cash. Debit cards are issued by commercial banks and allow users to access their bank account. Debit cards can be used to transfer money to a receivers account at a pos or can be used to withdraw money in the form of cash, therefore payment cards are also an important part of the cash system.

Contactless payment cards

Contactless payment cards are most of the time debit cards with an NFC chip. They allow users to pay amounts up to a set limit without authorisation. Users can hold their card next to a payment terminal and the payment will be processed within seconds.

Mobile payment

Mobile payment is an instrument that uses the same NFC technology found in contactless payment systems (Apple pay, banking applications) or uses other technologies such as QR codes (Swish). In most modern smart phones these technologies are available and facilitate payments at similar speed and ease as contactless card payments.

Table 1.1 Payment instrument categorisation (de Heij, 2017)

Means of payment		
Payment systems	Payment channels	Payment instruments
Non-cash (Electronic, digital)	Bank account	Online banking
		Debit cards
		Credit cards
		Paper forms(Checks)
	Not-linked to bank account	Pre-paid cards
		Online purses
Virtual currencies		
Cash	Coins	Coin denominations
	Banknotes	Banknote denominations

Credit cards

Credit cards are not used much in the eurozone and are mainly used for specific payments such as online bookings (Plane tickets, hotels, venues). Credit cards are issued by commercial banks or other companies such as Visa and Mastercard. Credit cards allow users to make purchases on credit which are deducted at a later moment. Gift cards, other pre-paid cards and online purses can also be seen as credit cards but in this case the credit is deposited prior to use and these cards often have predefined limited use.

Cheques

Cheques are hardly used within the eurozone. In other areas, such as the US, they have higher use but this is also dropping. Cheques are a written authorization to your bank to transfer money. Cheques are issued by a commercial bank and require the owner to fill in the amount to transfer and the receiver to transfer to. The owner also needs to sign the cheque to validate it.

Virtual currency

Virtual currency, better known as crypto currency, is a digital currency which is based on block chain. Virtual currencies are relatively new and are currently not monitored or controlled by central banks and are therefore very volatile. Their value is constantly changing and their role in the current payment system is not clearly determined. It offers online anonymity and can potentially be used for fast transactions or as a independent store of value

Other payment instruments

Other payment instruments e.g. watches and rings with NFC chips are often an adaptation or addition to the payment instruments mentioned above and will not be discussed in detail.

1.3 Use statistics

By reviewing the statistics of payment behaviour, it is possible to indicate the current situation of the different payment instruments and the changes that have occurred to get to this situation. This will provide insights into what aspects influence payment behaviour and what should be researched further to gain input for future use scenarios. To gain insight into the current payment behaviour of people in the eurozone, the European Central Bank conducted a study: The use of cash by households in the Euro area (2017). Prior to this study, the central banks of the Netherlands and Germany already conducted similar studies for a few years.

1.3.1 Use of payment instruments

In figure 1.1, the amount of transactions, total value of these transactions and the average transaction value of payment instruments in the eurozone in 2016 can be seen. It shows that in 2016 80% of all payments were conducted with cash, 19% were conducted with cards such as debit and credit, and 2% with other instruments such as cheques and mobile payments. The total

value of these transactions differs from the number of transactions. The average value of card payments and other instruments is much higher than cash and therefore their total value of transactions is relatively higher. The total value of transactions is interesting as it indicates the type of payments and gives some information on the use. The amount of transactions gives a better insight into the relevance of cash and shows that it is still used in the large majority of the payments. Because of this high usage, it is incorrect to define cash as something that is outdated or which will definitely be replaced by an alternative in the near future. A deeper understanding of payment behaviour and behaviour changes is needed to provide input for the future of cash and its design.

The statistics mentioned above are the averages of the eurozone but differ greatly between countries. In figure 1.2, the percentages of cash transactions in each country can be seen. Some countries such as Greece, Italy, Malta and Cyprus have over 85% cash transactions while other countries such as the Netherlands and Estonia are below 50%. This shows that some countries

Number and value of payments in the Euro area in 2016

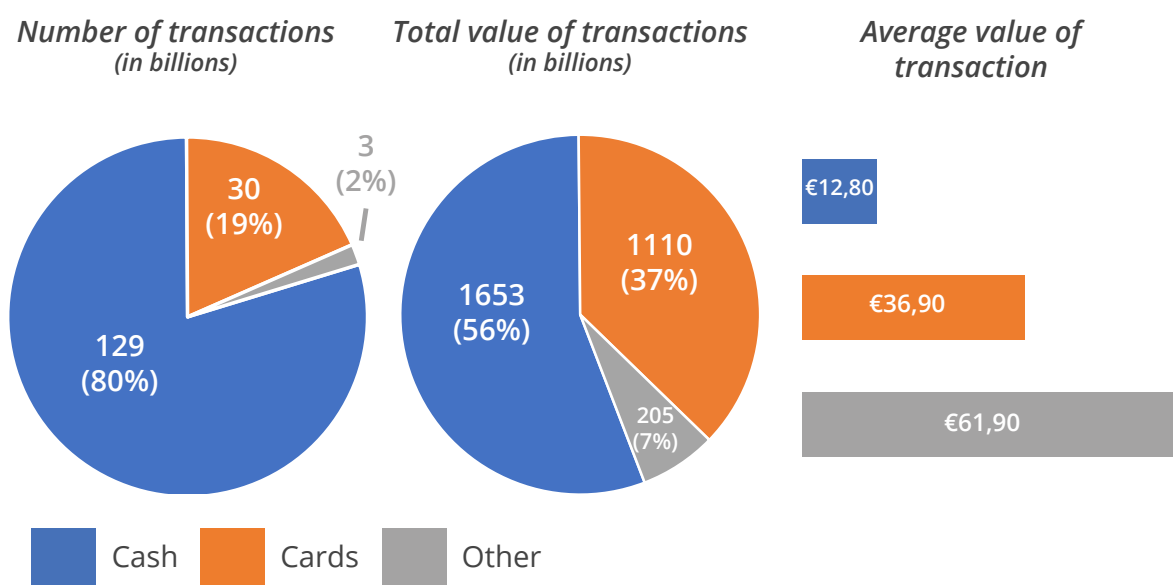


Figure 1.1. Number and value of payments in the Euro area in 2016

are greatly reducing their cash usage and are switching towards digital alternatives and some are not. This raises a couple of questions: What is the cause of these differences? Will other countries follow this reduction of cash usage? And how far will this reduction go?

These differences are likely influenced by culture, history, infrastructure, payment method acceptance, digital adaptation, trust in the financial system and much more. The research provided by the ECB does not supply data to support claims about the drivers behind these differences. To gain insight into these differences it is relevant to look at changes over time in the

eurozone. The ECB study is a snapshot of payment instrument usage and does not provide historical data about changes in use. Therefore the ECB research is compared to long term research done in the Netherlands from 2007 till 2016 (DNB occasional studies) and in Germany from 2008 till 2017 (Bundesbank). These two studies were performed with a comparable method as the ECB study and are thus considered suitable for a comparison. This comparison is also interesting because of the relative similarities between the Netherlands and Germany on a socio-economic level.

Share of cash transactions per country at points of sale 2016

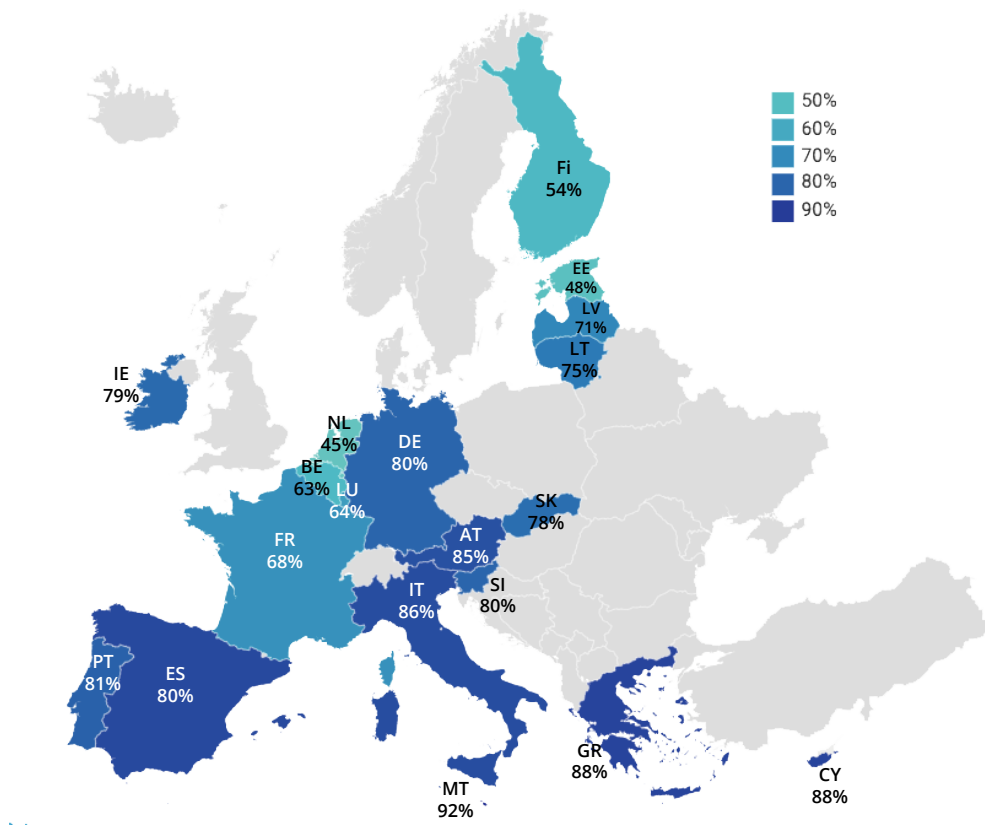


Figure 1.2 Share of cash transactions per country at points of sale in 2016

1.3.2 Changes in payment instrument usage in The Netherlands and Germany

Figure 1.3 and Figure 1.4 show the relative use of payment instruments in the Netherlands and Germany from 2008 till 2017. The Netherlands has yearly data from 2010 till 2016, Germany has data from 2008, 2011, 2014, 2017 and therefore the years in between are derived and plotted.

In the Netherlands, big changes can be observed. In just six years, cash went from the most used payment instrument, at 65% in 2010, to 45% in 2016. In 2015, debit cards overtook cash as the most used payment instrument and are used in 55% of transactions in 2016. This is a change of 20% in six years, which for an average total transactions of ±6,5 billion per year results in a reduction of ±1,3 billion cash payments in six year. Recent numbers of debit card payments in 2017 and the first months of 2018 show no

decline in the growth of debit card usage and therefore it can be determined that the decline of cash is continuing.

In Germany this change, although present, seems to be in a very early stage. In 2008 Germany had a relative cash usage of 82,5%. In 2011 and 2014 some decline can be seen with respectively 82,0% and 79,1%. In 2017 the decline started to increase with a relative cash share of 74.3% which is a difference of 4,8% over three years. Although the cash share is still much higher in Germany, a growing decrease of use can be observed. It is possible that Germany has just started switching to digital alternative payment instruments and in some years will follow the same developments seen in the Netherlands, but no certainty can be given. In following paragraphs a further analysis of possible reasons behind these differences in payment instrument use will be conducted.

Relative use of payment instruments in the Netherlands

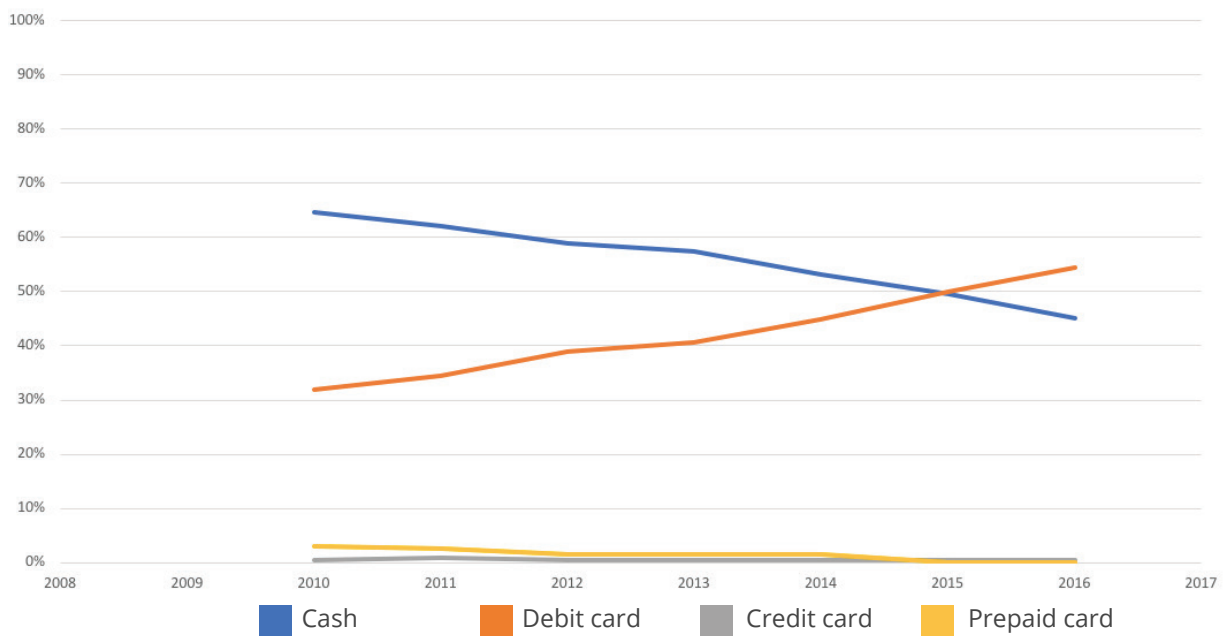


Figure 1.3 Relative use of payment instruments in the Netherlands 2010-2016

Relative use of payment instruments in Germany

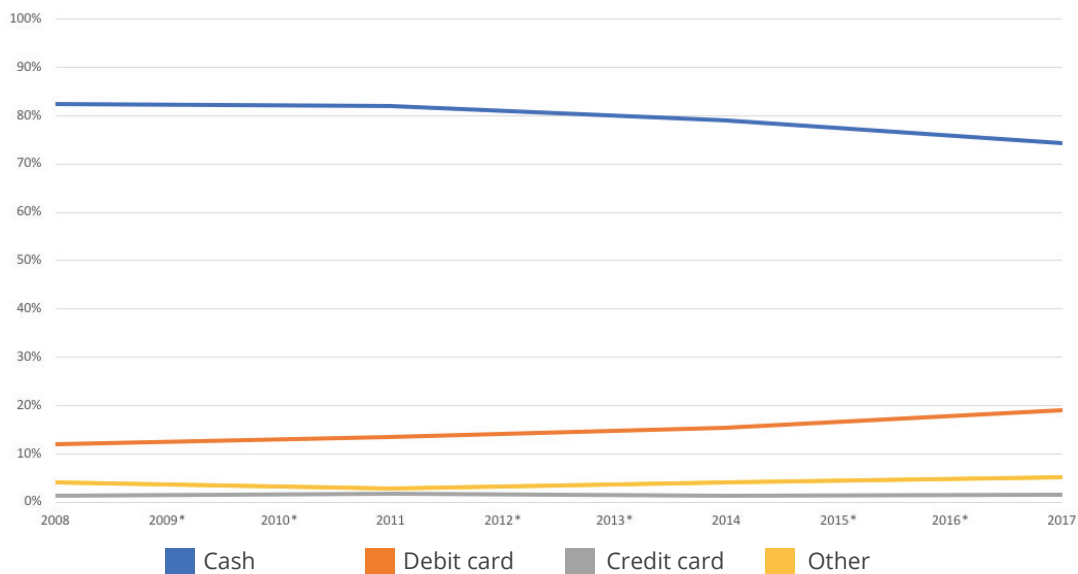


Figure 1.4 Relative use of payment instruments in Germany 2008-2017

One other development worth mentioning is the rapid growth of contactless payment cards. This technology was introduced in 2014 where it was used in 0,3% of debit card payments in the Netherlands. This percentage has grown exponentially which can be observed in figure 1.5. This growth has continued and the most recent data shows that in September 2018 54% of debit card payments were contactless and there are no indications that this growth is slowing down. This fast acceptance of contactless payment seems to indicate that usability and ease of

use are very influential on payment behaviour. Although, for users switching from normal debit card to contactless payment might not be that big of a step. It is supplied for free on an existing product that people already use. A valid question in this development of contactless payment is if contactless payments are also increasing the reduction of cash usage or if it is just causing a shift within the total amount of debit card payments. The data seems to indicate that it is the latter.

Debit card and contactless payments in the Netherlands

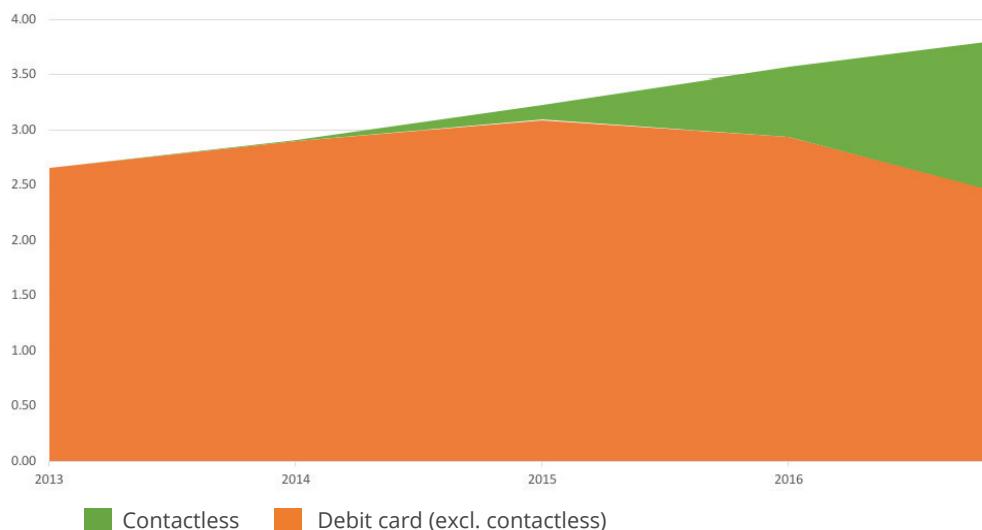


Figure 1.5 Share of contactless payments vs non contactless card payments, pin.nl (2018)

One aspect of contactless payments that could have an influence on reduced cash usage is the value range in which it functions. In the eurozone payments below €10, which are 53% of the transactions, are predominately paid using cash. Below €5, 93% of transactions are paid with cash and between €5 and €10 86% of transactions are paid with cash. The percentage drops as the value of transactions increases. Contactless payments are focussed on low value payments as they are currently limited to a maximum of €25. Therefore, contactless payments focus on the same value as cash is used most. The share of contactless payments is also higher the lower the value of payment is.

Currently there is no direct link between contactless payments and cash usage reduction but it could be an factor in further reduction of cash usage.

1.3.3 Demographics

A long side differences between countries, it is also valuable to analyse the differences in demographics. Which user groups have a preference for cash, and what are the reasons for their preference or their reluctance for change.

According to the ECB study a few differences between the payment behaviour of different demographic groups can be observed. The higher the education of a person the more daily payments he or she makes. Relative to other users, higher educated users use more card payments. Cash usage is similar among education level. Young people make fewer cash and card payments but this makes sense as this age group makes fewer payments overall.

As these statistics refer to the averages of the entire eurozone, changes and new innovation in some countries are not clearly visible in these statistics. More valuable insights can be obtained in countries where big changes are occurring. According to Rogers diffusion of innovation (2010), innovations are often adapted differently by various demographic groups. This results in user groups who adapt to innovation early, the slower adapting majority and user groups who lag behind (figure 1.6).

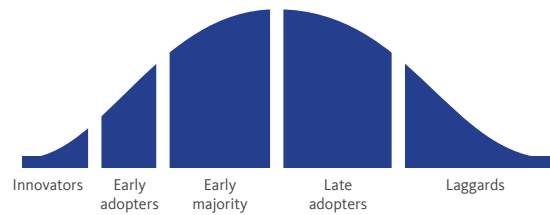


Figure 1.6. Innovation adoption curve.

In the Netherlands the cash usage reduction for ages below 55 was higher than for ages above although also in that age group big reductions can be seen. This difference can be explained by the relative lower degree of digital knowledge of older users. It can be more difficult for them to learn and adapt to digital payment alternatives. Furthermore a point of tradition or habit can be relevant. Older people are less inclined to adapt to new technology (Jia, Lu & Wajda, 2015). This higher degree of reduction in cash usage at lower ages indicated that the reduction of cash usage will continue as this group ages.

There are also other demographic groups that have a relative higher usage of cash caused by certain limitations they have. Stichting Lezen en Schrijven in the Netherlands mention that people who are illiterate have trouble using digital payment instruments and apps (Baay, Buisman & Houtkoop, 2015). Cash is an instrument that gives them overview on what they are paying as it has a high visual communication qualities such as colours, size, images and large numbers. Furthermore, for the vision impaired, cash is easier to see than small displays on payment terminals and they offer tactile feedback. It is important to realise that some user groups have to make a decision based on other factors than most people although also for these groups new solutions are being developed to aid them in using digital alternatives.

1.3.4 Use cases

Next to demographics different use cases can cause different payment behaviours. Identifying in which use cases cash is used more can give possible insights in the motivation behind payment choice and usability aspects of payment instruments.

The first relation between payment instrument and use can already be deduced from the relation between payment instrument and payment value. The lower the value the higher the use of cash, therefore use cases with an average payment value which is relatively low, will see higher cash usage. This can be also be observed in the ECB study and DNB study. Locations such as markets, bars, street vendors and small speciality shops see a higher cash usage. Locations with higher payment values such as hotels, clothing shops and petrol stations see a much lower amount of cash payments.

1.3.5 Hoarding

Alongside payment, cash is also used as a means of hoarding, storing money for a long period of time. No clear statistics are known about how much of the Euro cash is exactly used for hoarding but some conclusions can be made. Because coins are low value they are not efficient for storing and will likely not be used for hoarding. (High value) banknotes are probably used most for hoarding. The amount of banknotes in circulation (figure 1.7 & 1.8) has been steadily growing for the last 10 years around 7-8% annually. The €500 has been discontinued and is therefore slowly reducing until it disappears. €50 and €100 notes are growing the most while low value notes and €200 notes are very consistent and are increasing just slightly. Small growth can be explained by the growth of the economy, inflation and new countries adapting the Euro but the overall high growth of cash notes in circulation does not match the declining use of cash as a payment instrument.

According to estimations by the Bundesbank (2018), Germany's central bank that is responsible for 60% of eurozone banknotes, 90% of notes issued in Germany are never used for payments in Germany but are increasingly domestically hoarded or used outside Germany

(figure 1.9 & 1.10). Since the economic crisis, the Euro has acquired strong confidence as a global currency and is therefore also used as store of value outside the eurozone. Hoarding is also simulated by the almost non-existent or negative interest rates on bank accounts so there is no financial incentive to store money at a bank. This shows that cash has an important secondary function besides functioning as a payment instrument, it is a hoarding tool. Although cash has historically been more of a payment instrument, with its decline in payment transactions, cash is shifting more towards a hoarding tool which backup function becomes more relevant as we get more dependent on digital systems for our payments.

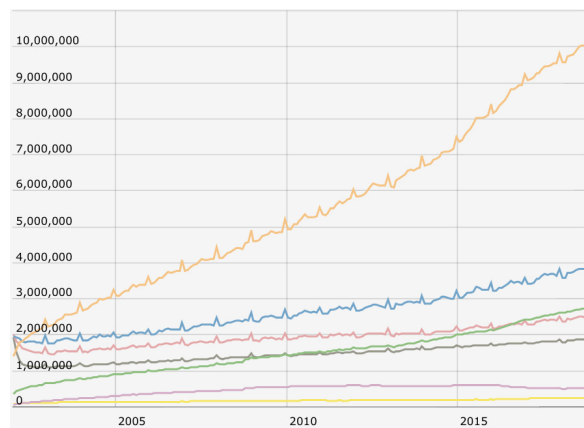
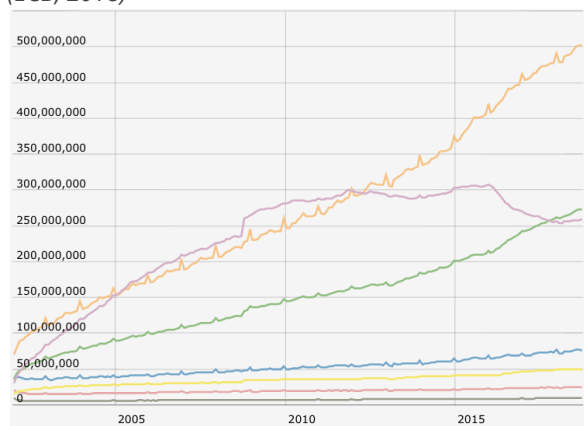


Figure 1.7 Number of Euro bank notes in circulation (ECB, 2018)



■ €5 ■ €10 ■ €20 ■ €50 ■ €100 ■ €200 ■ €500

Figure 1.8 Value of Euro bank notes in circulation (ECB, 2018)

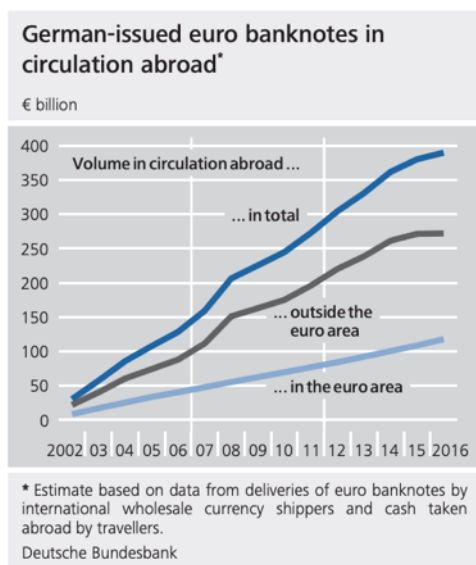


Figure 1.9 Banknotes in circulation abroad (Bundesbank)

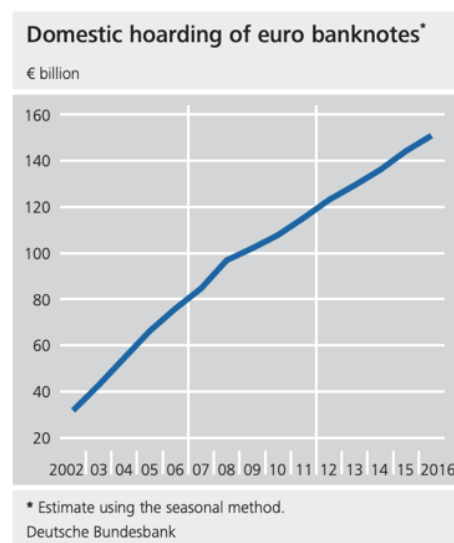


Figure 1.10 Domestic hoarding of Euro banknotes (Bundesbank)

1.3.6 First conclusions

The use of cash is declining in all countries which offer data on payment behaviour. Although overall cash usage in the eurozone is still high at around 80% some countries such as the Netherlands are quickly moving away from cash. Even in countries with high cash usage such as Germany a decline in cash can be observed and this decline is speeding up. It is important to realise that cash usage in these countries is not declining for everyone at the same rate. Certain demographic groups such as the elderly, visually impaired and illiterate still have a relative high cash usage because of the benefits it offers to these groups.

Although cash usage as a payment instrument is declining the total amount of cash notes issued is still growing each year. A large part of cash issued is being used as a hoarding tool inside or outside the eurozone. As we get more dependent on digital payment systems, cash is gaining more importance as a backup tool and a way to keep control of your own money. This effect is further supported by the reduction of interest rates on saving accounts since the economic crisis of 2008. So it is important to realize that cash as a payment instrument is reducing but cash as store of value is growing and therefore cash is not going away anytime soon.

1.4 Influences on payment behaviour

Based on quantitative usage data, changes in payment behaviour can be observed. Payment behaviour is changing rapidly which prompts the question what factors influence the payment behaviour of people. A payment behaviour model, developed by the Van der Cruisen and Van der Horst(2016) in commission of DNB, was used and adapted to explain the current behaviour change and make assumptions about future changes.(figure 1.11)

This model combines macro, culture and economic factors, product features, design aspects and psychological aspects to explain payment behaviour. First, the model and all its components will be explained. Following this, insight into the model and the relation with payment data will be explained.

1.4.1 Payment behaviour model explanation

Different factors can have an influence on how payments are conducted and can give some insight into the reasons behind the changes in use of payment instruments and possible input for future use. This model was adapted(figure 1.12) by adding the specific context as a fourth input for payment behaviour. Furthermore, certain groupings are made which combines multiple inputs into a single category.

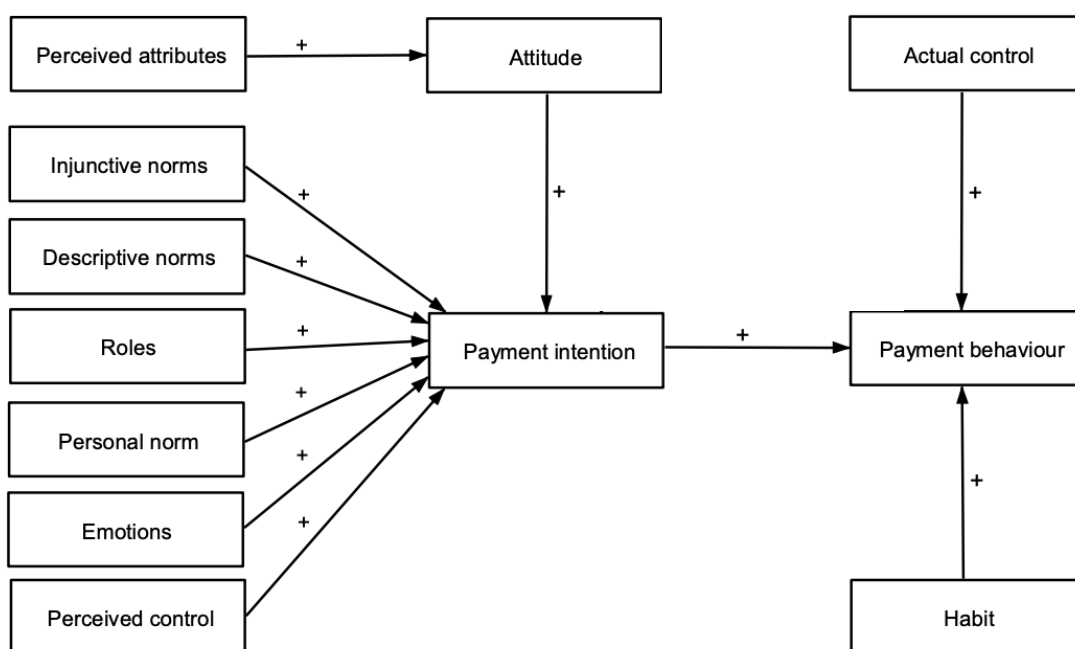


Figure 1.11. Socio-psychological model of payment behaviour: hypothesised effects.

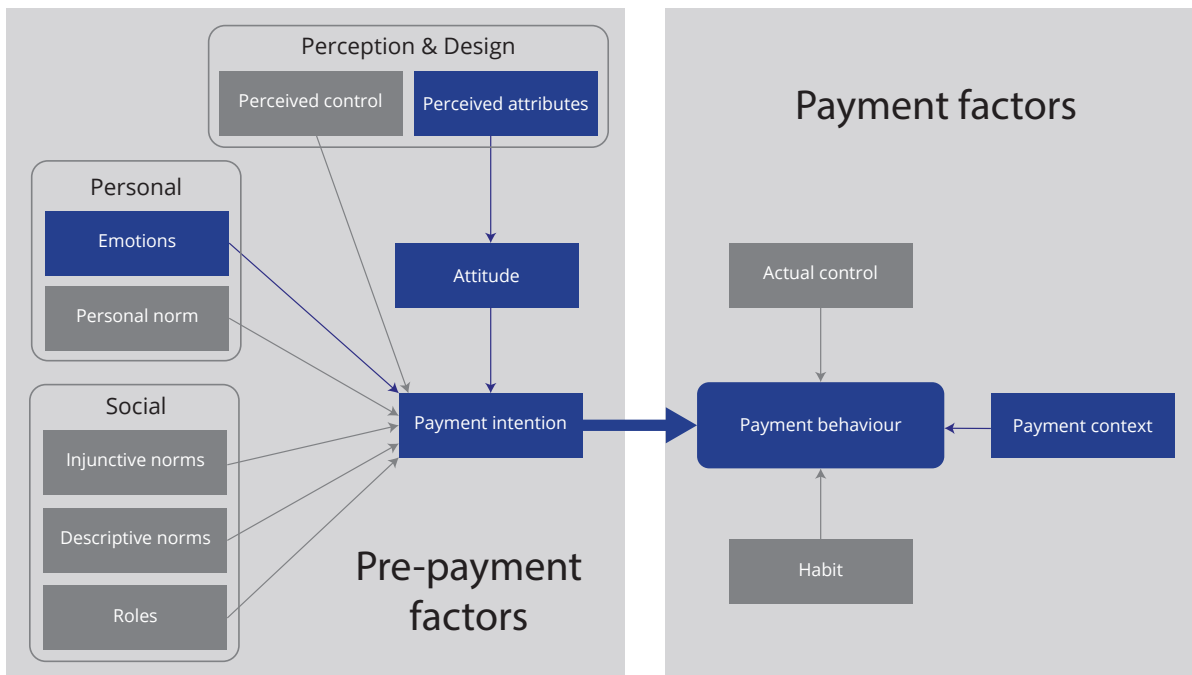


Figure 1.12. Adapted by author: Socio-psychological model of payment behaviour:

According to Van der Cruijssen and Van der Horst payment behaviour (the way a person pays) is influenced by payment intention, actual control and habit.

Actual control

Actual control covers the choice people have when paying. If shops don't accept a certain payment instrument, your payment behaviour is not determined by your intention or preference, but by the actual control you have in the payment context. This actual control can be determined by acceptance and available infrastructure, but one important realisation is that actual control is also influenced by the abilities of a payer.

Habit

Habit states that people who are used to paying with cash more often are more likely to pay with cash than people who are used to paying with digital alternatives. Habits state that if people have the choice to pick what ever option they want, they will more likely go for the one that they are used to. Habit is a process which allows people to not have to make cognitive decisions all the time and act based on prior experience.

Payment intention

Payment intention states that prior to payment, people already have the intention to pay in a certain way. People have a preferred choice upfront, which for example for most young people is card payments. Although there is some discrepancy between intention and actual behaviour which can also be noted in the ECB study where the preferred payment choice did not always match the actual payment behaviour.

Payment context

Payment context was added as an additional factor that influences payment behaviour. This model describes payment behaviour in a general way, but does not fully take into account the micro interactions and decisions made based on the context of the payment and the unique design features of different payment instruments. A person can also base its payment instrument choice on specific context factors during a purchase. To cover these cases the payment context driver was added to the model. Examples of a payment context influences payment choice are:

- I have some spare change in my pocket which I want to get rid of.
- If I have to pay €20, I am fine with paying cash. If its €16,42 I rather use a card.

Payment intention is again influenced by multiple factors which will be discussed below.

Attitude

Payment intention is influenced by the attitude towards a payment instrument: the manner to which we positively or negatively view a payment instrument. This attitude is influenced by the perceived attributes of a payment instrument.

Perceived Attributes

Perceived attributes are the positive or negative attributes a person associates with a payment instrument. These attributes are not always unique to cash or digital alternatives. Attributes such as safety, speed, ease of use, price, budgeting, privacy and coverage can be associated to both cash and digital alternatives. These attributes are of course influenced by the design and features of a payment instrument, but also by the perception of users. This association or perception is not determined objectively, but subjectively and is subject to constant change.

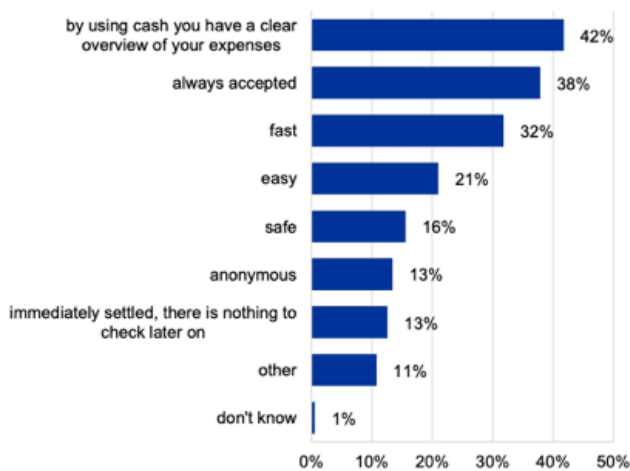
The same attributes associated to different payment instruments can be observed in the ECB study (figure 1.13 & 1.14).

Perceived control

Payment intention is also influenced by perceived control. The perceived amount of control they have on their payment instrument choice. If the perception is that debit cards are likely not accepted at many locations it influences the payment intention. This often happens when people are abroad, they have a perception of the acceptance of different payment instruments and adapt their payment intention.

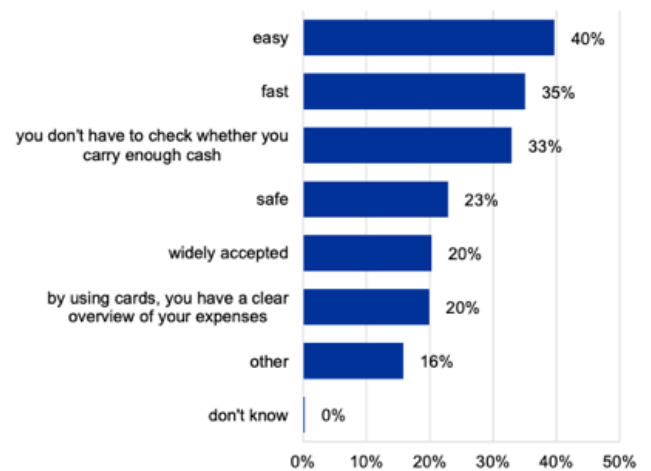
Emotions

Payment intention is also influenced by the emotions experienced during use. Emotions such as pain of payment or what people feel real money is. This is not based on features or usability, but more on experience and personal views.



Sources: ECB, Deutsche Bundesbank and De Nederlandsche Bank.

Figure 1.13. Attributes associated with cash



Sources: ECB, Deutsche Bundesbank and De Nederlandsche Bank.

Figure 1.14. Attributes associated with card payments

Personal norm, Injunctive norm, Descriptive norm & Roles

These factors influence payment intention based on the expectations from other people or expectations from people themselves. They are defined as: personal norms (a person's opinion if certain payment instruments should be possible to use), injunctive norms (what behaviour is expected), descriptive norms (how other people act) and roles (the appropriate behaviour determined by someone's position in a social group).

1.4.2 Change and limitation drivers

Within this model a distinction is made between change and limitation drivers.

- Limitation drivers (**Grey**): Drivers that have an influence on the speed of behaviour change:

Actual control, Habit, Perceived control, Personal norm, Injunctive norm, Descriptive norm, Roles.

- Change drivers (**Blue**): Drivers that are reasons for behaviour change.

Payment context, Payment intention, Attitude, Perceived control, Emotions.

Limitation drivers are not determinants for future use, but they determine how quickly or slow people change. Simply stated, if no change drivers existed, no change would happen. If no limitation drivers existed, change would happen constantly.

Habit is such a limiting driver on behaviour change. To change or divert from a habit, a certain balance between ability and motivation has to occur. According to Fogg's behaviour model (2009), behaviour change prompts only succeed if there is a balance between ability and motivation. (figure 1.15)



Figure 1.15 Behaviour model

So although the effort to use a different payment instrument might not be that high, there has to be a significant and noticeable benefit to create enough motivation to change behaviour. It works the same the other way around. The benefits from a different payment instrument might be very high, but if the effort to use it is also very high change will not happen.

Infrastructural facilities (actual control) and social norms have this same limiting factor. If the facilitation of other payment instruments are not well developed, change will not likely happen. If everybody around you pays with cash, you are not likely to switch to a digital payment method.

In the Netherlands, every person can choose his or hers preferred payment instrument almost anywhere and it's also socially acceptable to use either. These factors do not have a limiting factor anymore and therefore change has happened more easily. This change in behaviour happens slowly first, but speeds up after a while. This is because social norms and infrastructure follow and support behaviour change. Which means that if people start using cards more, the infrastructure for cards will improve and it will become more acceptable to use cards which will then gain causes more people to switch towards cards. Once change happens, it creates an effect which will speed up change.

In chapter 3 “Future role of cash” an analysis of the infrastructure and socio-economic developments in the eurozone will be conducted to evaluate how these developments in the eurozone are happening and what the time-line could be.

The limitation drivers are factors that make changing behaviour more difficult or slow it down. These drivers affect the ability aspect of Fogg’s behaviour model.

So why is behaviour change happening? This is caused by the change drivers. These drivers affect the motivation aspect of Fogg’s behaviour model. They create incentives for people to change and when these incentives are in balance with the required effort, change will happen.

This model shows that prior to the actual payment context the change drivers for payment behaviour are perceived attributes and emotion. Although these are different factors they are somewhat similar. They are about how people negatively or positively view a payment instrument. The word perception is important in this as it does not talk about the objective attributes a payment instrument has, but how these attributes are perceived by people. This can be observed in figure 1.13 and 1.14.

In the Netherlands the attitude towards card payments is constantly improving which explains the shift in payment behaviour. Note in figure 1.14 that the two attributes which are scored the lowest with card payments, acceptance and overview of expenses are determined by the infrastructure surrounding card payments. Acceptance is dependent on payment terminals being present at pos and overview of expenses is dependent on supportive services and applications. In the

Netherlands the infrastructure and supportive services are much further developed. According to Van der Cruisen and Van der Horst using data from CentERDATA the attributes overview of expenses and acceptance are more associated to card payments in the Netherlands compared to the eurozone (table 1.2). It is important to realise that perceived attributes are different than actual attributes. So although the infrastructure and functionality can improve in a short amount of time the perception of users might take longer to adapt. But there is a significant difference noticeable between the perceived score of payment instruments in the Netherlands and in the entire eurozone.

If these perceived attributes are improving for alternative payment instruments the motivation for change becomes large enough to overcome the effort to change.

Table 1.2. Perception of attributes, CentERpanel, September 2015

<i>Which payment method do you associate most with the attributes listed below?</i>							
	Fast	Safe	Easy	Cheap	Control of expenses	Provides privacy/anonymity	Well-accepted
paying cash	13%	15%	11%	26%	41%	58%	13%
no difference	31%	29%	29%	50%	29%	24%	56%
paying electronically	56%	56%	60%	25%	30%	18%	31%

1.4.3 Perceived attributes study.

To gain a better understanding of the perceived attributes associated with payment instruments a qualitative study was conducted. A qualitative setup aims to gain insights based on rich conversations with individuals where predefined questions are used but based on the answers given further explanation can be asked.

Table 1.3 Interview participants

Interview	Gender	Age	Primary payments instrument
1	Male	68	Cash
	Female	67	Cash
2	Male	24	Card
3	Male	48	Cash
4	Female	14	Card
	Female	15	Card
	Female	14	Card
5	Female	41	Card
6	Female	13	Card
	Female	14	Cash
7	Female	63	Cash
	Male	61	Cash
8	Male	50	Card
	Male	80	Card

8 interviews were conducted with a total of 14 persons (table 1.3). The interviews took place in the city centre of Delft. Participants were chosen at random with an intent to have an even distribution of age.

The goal of these interviews to evaluate the differences in perceived attributes associated towards payment instruments and see what emotions are linked towards these instruments. The question list can be found in appendix A.

In these interviews the differences in perception became apparent between cash users and card users. The findings from the interviews were grouped together to show the most important insights.

Card users almost exclusively mention practical reasons for their preference.

When card users are asked why they prefer card payments, factors such as ease of use, speed and safety are mentioned.

“The payment goes easier, quicker and safer”
Male, 50

Card users see a benefit for cash in specific use cases.

Although cards are preferred in general, examples are given when cash has its use. For example on small retail locations such as markets, for donations or tips and as a birthday present.

“I use cash for birthdays and if charities come collecting at the door”
Female, 41

Cash users mention emotional and privacy reasons for their preference.

Cash users are less likely to mention practical reasons for cash preference. Instead emotion, habit and privacy reasons are used. The feeling of holding cash, the money physically received as salary and a concern for sharing too much information

“When I was young I got paid for a holiday job. I received cash at the end of the week and they you really got a feeling of what you earned with the cash you have in your pocket.”
Male, 68

Some attributes are mentioned by both cash users and card users.

Both cash users and card users appreciate the overview of expenses they respectively give. It shows that all payment instruments have the same attributes. But people experience these attributes differently with different instruments.

Cash users see cash as the ‘real money’.

Card payments or other digital alternatives could be useful in some cases but cannot replace cash as cash is the real money.

“I want cash in my pocket”
Female, 67

The perceived attributes and emotion of payment instruments is not only influenced by its features but also by the overall perception of what money is and how to use money. Young people grew up during or after the digitalising of society and are better able to understand and work with digital products which can be more abstract. This creates the situation where young people view their bank account as their money and cash as an instrument to use it and older generations view cash as their money which is only stored by the bank. This big change and almost opposite view in perception shows the divide in society about cash and explains at one side the fast change and the other side the reluctance towards change.

How these perceived attributes have an influence on actual payment interactions is analysed in the next paragraph.

1.5 How payments are conducted

To gain an understanding of the interactions and use of different payment instruments observational research was conducted. These observations took place in three different locations:

- Coffee shop
- Supermarket
- Market

At each locations observations were made for 1,5 hours.

The aim was to identify clear differences in use between cash and alternative payment instruments and which design aspects of these payment instrument influence this use. These findings can support the process of determining future scenario's of cash usage and how design aspects can support this future use.

1.5.1 Aspects of a payment

Different factors can describe a payment. Which actors are part of a payment, what is used to complete the payment and how the payment is done.

User(s)

Each payment has a payer, the person making some sort of purchase. In most cases there is also a seller, the person to whom the payment is made. There are instances where the seller is not physically at the point of sale and no interaction between payer and seller takes place.

Payment instrument

A payment can only be done with a payment instrument, a means to transfer value in between two users. For this analysis we only take into account the most used instruments: cash, card payments and mobile payments.

Supportive products

Any payment instrument has a range of supportive products such as wallets, clips, phone cover, pin terminals and registers. Some are necessary to successfully complete a payment, others improve the usability or help in some other way but are not always needed.

Supportive systems

Each payment instrument is part of a bigger system which has to be in place for the instrument to function such as bank accounts, ATM and applications. These supportive systems and their functions can have an influence on the payment instrument choice of the payer.

On the following pages a visualisation of the different payment instrument use can be observed.

RETRIEVING

PAYMENT

CARD PAYMENTS

1. Retrieving card



Cards can be stored in different ways (e.g. wallet, alongside a mobile phone or solely in a pocket). Debit or credit cards are specified in ISO 7810 and ISO 7813 which determine its size and rounding corners.

2. Inserting card



In 2012 the magnet strip on cards was discontinued and replaced with the EMV chip to improve security. EMV chips were less vulnerable to skimming which was an easy way for criminals to access a persons payment info.

3. Typing in pin number



Card payments require authentication to transfer the money. A 4 digit code is used to authorize the payment. This code is typed in on the card terminal.

CONTACTLESS CARD PAYMENTS

1. Retrieving card



Similar to normal card payments.

2. Holding the card against the terminal



Contactless payment does not require inserting the card. The card with NFC chip can be held along side the payment terminal for 1 -2 seconds and does not require any further authentication.

MOBILE PAYMENTS

1. Retrieving mobile phone



Retrieving the mobile phone from pocket or bag.

2. Activating the phone



Often only lighting up the screen using a home button or finger scanner is enough. Unlocking is not necessary.

3. Holding the phone against the terminal



The phone with NFC chip can be held along side the payment terminal and most of the time does not require any further authentication. The terminal gives feedback when the phone can be removed which is often only about 1 or 2 seconds.

PAYMENT

STORING

4. Confirmation payment



After the code is typed in the terminal a confirmation is needed from the payment service. This can take a few seconds. Once the payment is authorized the card can be retrieved.

5. Storing card



When the payment is completed the card is stored back with potentially a receipt of the payment.

3. Confirmation payment



After the card is recognized a confirmation is needed from the payment service. If the amount is higher than a set limit, which currently is 25 Euros in the EU or a cumulative amount is reached, the 4 digit code has to be entered.

4. Storing card



When the payment is completed the card is stored back with potentially a receipt of the payment.

4. Confirmation payment



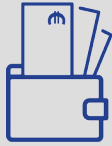
If the payment is successful a notification on the terminal is given to remove the phone. Sometimes an authentication is necessary in the form of a code or finger scan on the phone.

5. Storing phone



When the payment is completed the phone is stored back with potentially a receipt of the payment.

1. Retrieving cash



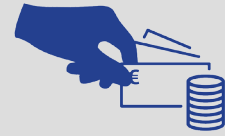
Cash is stored most often in a wallet, pocket, phone cover or money clip. Currently more of these storing options do not offer room for coins. Coins are often stored in a different place than the bank notes.

2. Assessing which cash you have



To decide on which denominations to use a user has to assess which notes and coins he or she has and what value of denomination they are. A user might know upfront which cash they have based on prior payments. Cash offers different design aspects to support value recognition both visual and tactile. In the Cash chapter further details of these design aspects will be given.

3. Determining which cash to use.



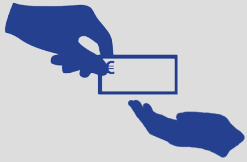
If a user knows which cash they have, they then have to decide which to use. This decision can be based on different reasons:

- What covers the amount to pay?
- What is the most efficient?
- What does the seller accept?
- Which cash do I want to get rid of?
- Which change will I receive?
- Which cash is the easiest to retrieve?
- What is the fastest way to pay?

These decisions are influenced by the design of cash. A payer can for example choose to pay a €16 bill with a €20 note although he or she also has a €10 and €5 note and a €1 coin. For this payer speed and easier to retrieve is more important than efficiency or change received. Another option is to pay with a €20 and a €1 to receive €5 as change. Then the payer wants to break the €20 note but wants notes instead of coins as change.



4. Handing over the cash



If the cash to use is chosen the payer hands it over to the seller. How this handling will take place is determined by the kind and amount of cash. Notes and single coins are often handed over using the index finger and thumb. Multiple coins are handed over using the palm of the hand or all fingers together. The cash is placed on a counter or other surface or in the hands of the seller. This can be done all at once or in multiple steps, for example first the notes then the coins.

5. Receiver assesses the cash



Assessing the cash is important for a receiver to check both the amount which is handed over and the validity of the cash. Checking the amount which is handed over can be done during the transfer and after receiving it. If only a single note is handed over a receiver can already assess the value of this note while handing over the cash. If multiple notes and or coins are handed over the cashier has to check the amount after receiving the cash. This is made easier by the value recognition design aspects found in banknotes and coins. The validity of the notes is also checked by the receiver although most of the time this is not done consciously. Users often evaluate based on experience, "Does it look or feel different than I'm used to"

6. Receiving the change



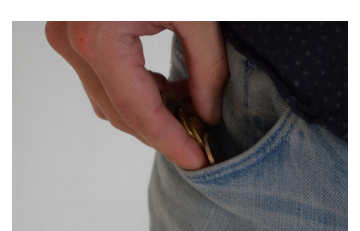
Based on the cash received an exact change is given back to the payer. The denominations of change are mostly chosen based on the most efficient way to reach the correct amount. Sometimes the denominations chosen are influenced by:
The available denominations.
Preference of the seller or payer.

The cash is handed back to the payer often in their hands. Sometimes notes first with the coins on top in the palm of the hand but payers prefer the coins in their palm and the notes given to be grabbed between their fingers.

7. Storing cash



Once the change is received the payer will store it. This is often done in the same way it was retrieved from storage but sometimes this can differ based on the denominations. If only notes are stored in a wallet, coins get put in pockets or bags.



1.6 Use cases

The payment interactions shown in paragraph 1.5 are also dependent on the use case of the payment. Some instruments are more suited and therefore also more used in certain use cases. Five distinct payment flows are described that have a different context of use. Each payment flow is described, locations are mentioned where they can be seen and cash and digital instruments are evaluated within this flow.

The five use cases are:

- **Optimized payment**
- **Seller payment**
- **Walking register payment**
- **Personal payment**
- **Metal box payment**

The optimized

An optimized payment flow (figure 1.16 & 1.17) is about high throughput, getting the most people to pay as fast as possible. These registers are solely setup for finalising payment, any shopping has been done beforehand. This can be seen in supermarkets, big box stores and other stores with a high amount of customers. Although cash and digital instruments are used both there is a preference for digital instruments.

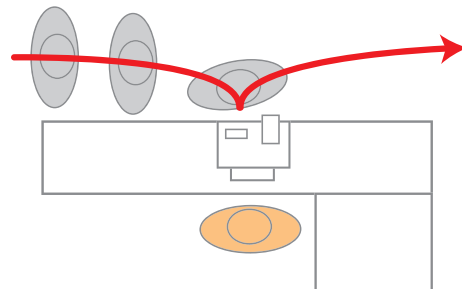


Figure 1.16 Optimized payment flow: register

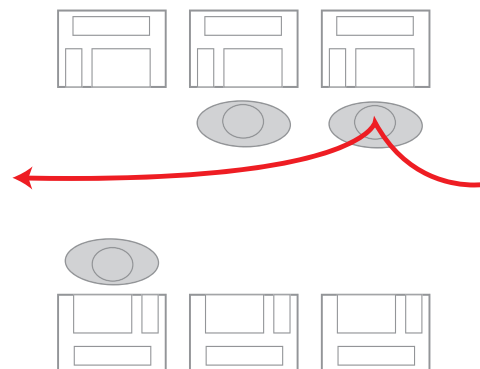


Figure 1.17 Optimized payment flow: register

The seller

A seller payment flow (figure 1.18) is one where the primary function is not only payment but also supplying a service for which the payment will be conducted, such as handing over products. This can be seen in smaller specialty shops such as bakers, butchers or ice cream shops. In this context registers and therefore pin terminals are not always located at the spot a customer is being helped or their are not enough register for each customer line. In this situation cash is not always slower then a card payment if, for example the pin terminal is already in use.

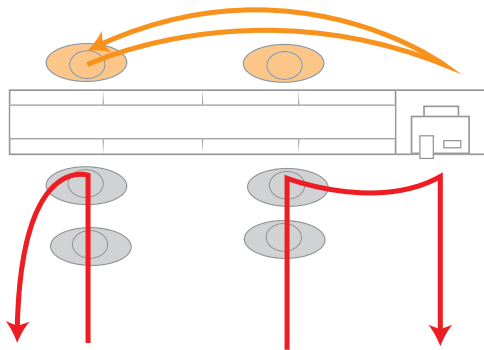


Figure 1.18 Seller payment flow

The walking register

A walking register (figure 1.19) is seen mostly in the restaurant business. There is no set location where a customer has to pay. Employees carry a wallet or small pin terminal towards the customers where the payment will be conducted. Speed of payment is not as important as the ease of use in this payment flow. Because no register is used and all supportive products need to be carried, cash has always been used the most. Until the recent development of small hand-held card terminals customers had to go inside towards the register if they wanted to pay with card.

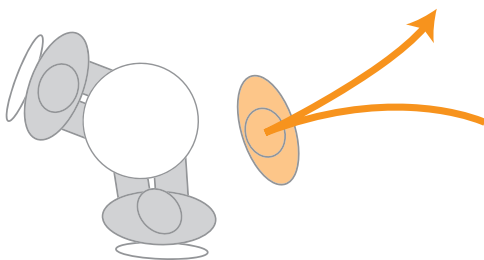


Figure 1.19 The walking register payment flow

The personal payment

A personal payment is payment which is not commercial but between individuals (figure 1.20). A gift to friend or relative or selling something second hand. Non of the actors have a register or payment system and in this payment flow cash is most often used. A card payment is often not an option. Bank transfers are possible but have not sufficiently been designed for ease of use. In recent times there are developments such as the Tikkie app from ABN-AMRO to improve digital payments between the general public. It is also noteworthy that trust can be off influence in these transactions. If a transaction is done with a stranger, cash is often preferred due to its direct transfer of funds.

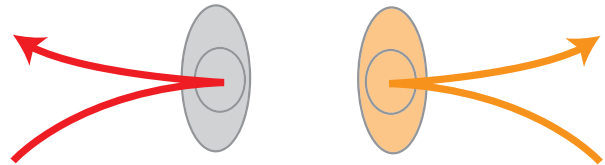


Figure 1.20 The personal payment flow

The metal box payment

The payment flow where you are just interacting with a machine such as parking meters, vending machines or ticket machines (figure 1.21). These where classically operated using coins and in a lot of countries still are but are seeing fast modernisation where they are switched to digital payment only. With a digital system the machines do not need to be emptied or refilled which greatly reduced the cost of use. It is highly unlikely that new machines will be deployed which still offer cash payment and most current machines will be replaced in the near future.

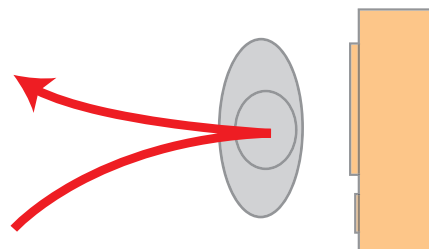


Figure 1.21 The metal box payment flow

1.7 Benefits and limitations of payment instruments

After seeing all forms of payment, how they are conducted, where they are conducted and how people make decisions a list of benefits and limitations is created for the different instruments. In general payment instrument can be evaluated on many factors and every situation is dependent on its context but some conclusions can be determined. As normal card payments are being replaced by contactless but are in essential the same product they are grouped together as card payments.

Card Payments

- + ARE SEEN AS THE FASTEST WAY TO PAY.
- + ARE A SAFE WAY TO PAY FOR THE CUSTOMER AND THE RETAILER.
- + USE A DIGITAL PLATFORM WHERE ADDITIONAL FUNCTIONALITY IS CONTINUOUSLY ADDED TO.
- + IF USER IS DIGITALLY CAPABLE, CARD PAYMENTS ARE EASY.
- ARE DEPENDENT ON THIRD PARTY ORGANISATIONS
- ARE DEPENDENT ON AN DIGITAL INFORMATION SYSTEM WHICH CAN GO DOWN.
- CAN CAUSE OVERSPENDING MORE EASILY. PAIN OF PAYMENT IS EXPERIENCED LESS

Mobile Payments

- + INTEGRATES PAYMENT WITH YOUR MOBILE DEVICES.
- + CAN FUNCTION USING THE MOBILE NETWORK AND CAN THEREFORE ALMOST WORK ANYWHERE.
- + CAN BE AN EASY WAY TO FACILITATE DIGITAL PERSONAL PAYMENTS.
- CAN HAVE AN EMPTY BATTERY
- CAN FEEL LESS SECURE
- CURRENTLY REQUIRES MORE EFFORT TO USE COMPARED TO CARD PAYMENTS.

Cash Payments

- + OFFERS PRIVACY IN PAYMENT AND STORAGE.
- + INDEPENDENT OF INFORMATION SYSTEMS OR OTHER THIRD PARTIES.
- + OFFERS BENEFITS FOR CERTAIN USER GROUPS SUCH AS THE ELDERLY, VISUALLY IMPAIRED AND ILLITERATE
- + OFFERS DIRECT FEEDBACK ON YOUR EXPENSES AND ALLOWS FOR BETTER BUDGETING.
- + IS WAY TO DIRECTLY SETTLE A TRANSACTION, THE VALUE IS INSTANTLY TRANSFERRED TO THE RECEIVER.
- REQUIRES MORE EXPENSIVE INFRASTRUCTURE TO FUNCTION PROPERLY.
- TAKE MORE TIME AND EFFORT.
- LESS SAFE THEN DIGITAL INSTRUMENTS BECAUSE CASH CAN BE STOLEN MORE EASILY.
- TAKES UP MORE SPACE AND IS HEAVIER THEN THE ALTERNATIVES

1.8 Conclusion: Digital alternatives are preferred if we have the luxury of choosing based on usability

This analysis shows that emotion but more importantly the perceived attributes of a payment instrument have an important influence on the payment behaviour of people. The usability benefits of digital payment alternatives are becoming more noticeable as supportive products and services are developed. But usability is not the most important factor for people when deciding on a payment instrument. Safety and trust are more important. But if cash and digital payments both are safe and trustworthy, which is currently the case, people will choose based on usability and habit. When the limiting factors such as infrastructure and social norms are becoming less of an issue, people are able to change their payment habits if there is a positive balance between the effort and benefits related to such a change. And the effort to use a digital payment instrument is becoming lower and the benefits of using them are becoming better. If people have the luxury to choose based on usability, digital payment instruments are the preferred choice. And as more people change their behaviour, the system supporting this behaviour becomes better which creates a snowballing effect. Only people for whom the effort of using a digital instrument is too high or the benefits of these instruments are not noticeable, will stick with cash. Besides those people, cash is preferred only in specific use cases and as a contingency tool.



2 Cash

From the first chapter a change in payment behaviour can be observed and a growing decline of cash is the result. For the future of cash and its design, it is important to know what cash specifically is, how it developed and which role it fulfils in society. Furthermore the interactions with cash and its systems will be analysed to gain an understanding of the problems cash experiences currently or will in the future.

The definition of cash according to the Oxford dictionary is:

“Money in coins or notes, as distinct from cheques, money orders, or credit.”

This definition is mostly an explanation of the design we associate cash with the most, coins and notes. For this project a new definition is proposed which suggests design is not what defines cash but is a result of its role and unique functions within the payment system. This offers a starting point with more freedom for design and only states what is fixed. To achieve such a definition research was done regarding the history of cash, its design and its characteristics.

2.1 History of cash

To gain insight in the reasons behind the current design of cash and its use, a historical analysis is conducted. Cash has been around since modern history and has been used in many different forms. The history of cash can be full research report on itself, so in this report only a brief summary of the most important developments and changes regarding cash will be discussed. For each development step the underlying motivation and design features is stated to show the important aspects of cash design. A more extensive time line of the history of cash is displayed in appendix B.

As stated above cash is representation of money or more abstractly: value. It is a mean to transfer goods and this is also how cash started.

Bartering - The need to trade

Bartering is the trading of goods with other people and is the simplest form of value transfer. Person A gives object x to person B for object y. This requires you to know the exchange rate between objects, find a person who is willing to trade specific items and practically, transport the objects. This is the primary use of cash, a means to trade.

Standardized trade - Common value system

The barter system had its impracticalities and resulted in the first instance of a standardized trade system where a commodity useful for most people was the preferred trade object. In early times this where items such as grain, livestock or plants. There was some form of agreed value of these commodities and could therefore be traded more easily. This shows the need for a common value system which currencies will full fill later on. The first practical implementation of such a system is the Shekel. The Shekel was introduced in Mesopotamia and represented a weight of barley or the equivalent value in silver, bronze or copper etc. It created a direct link between a commodity and an amount of metal . The term shekel was also used as a unit of weight in general and created a standardized system of value.

These first developments in trade show the basic necessities of a monetary system. An agreed upon standard which can be used to trade goods between people.

The first cash - A dedicated and trusted product

The metal representing a shekel was not dedicated as a trade instrument only. Metals had their own use in crafting and were valuable for their use. Although coins or badges were already in existence they were created for religious or ceremonial uses and were too valuable in normal commerce. The first coins dedicated for commerce came around the sixth century BC in Greece, India and China (figure 2.1 & 2.2). They had different designs as the Indian coins were punched, Chinese coins were cast with a hole in them and Greek coins were stamped. The Greek coin had one image on both sides were one was often a head of person, something still seen in coins today. This stamping also added a form of authorization which resulted in some form of trust in the currency alongside its intrinsic value. Alongside stamping, assaying became a technique to authenticate coins. Assaying is the chemical analysis of the composition of metals. Touchstones were invented that are still used today and helped to determine the purity of metal. This is an important part of trading with intrinsic value as it allows people to check the currency. Checking validity is one of the key aspects of cash and can still be seen in the authentication features of current banknotes.



Figure 2.1 Greek ancient coins



Figure 2.2 Indian ancient coins

From this point on developments within cash focus more on the usability and practicality of the products. The first major development is the introduction of paper currency.



Figure 2.3 Jiaozui, first Chinese credit notes

First bank notes - Easier transport and stored value

The first paper currency is seen in the Tang dynasty in China in the 7th century in the form of credit notes (figure 2.3). As stated above, Chinese coins were heavy forged iron objects and were impractical in large quantities. Therefore traders would leave their coins with a trusted keeper and receive a credit note which they could trade but was only valid for limited time and had a lowered value. This can be seen as the first face value currency. A currency that has no intrinsic value but represents a stored value somewhere else.



Figure 2.4 First European banknote, Sveriges Riksbank

Gold storage - Trust in the system

Goldsmiths, mainly in England, started to act as storage of gold for traders while supplying them with receipts of repayment. These receipts were not assigned and therefore could be traded. By law these deposits were a loan towards the goldsmiths and therefore allowed them to use the gold to for example forward it to lenders. This created the first issues of fractional reserve banking where not all outstanding credit is covered by value in holding. The gold deposits were relatively stable because receipts would be used as a safe and practical form of currency. As long as there was public trust in the goldsmiths ability to cover for the debts the system would not default. This is the start of cash as a representation of value which is more linked towards trust in the system than towards directly redeemable gold or value.

Government control - Acceptance

Seeing the success of goldsmiths, banks started issuing their own paper notes termed banknotes. The first European bank was Stockholm's Banco in 1661 (figure 2.4). As the amount of financial institutions grew, the amount of different issues banknotes grew with it. Only the largest and most creditworthy banks had banknotes which were accepted everywhere. The smaller banks had notes that could only be used in a small area or at a discounted rate. This wide range of different notes have been gradually replaced by banknotes issued and controlled by the national governments and today there are some private currencies left but have a very limited use. Because governments created a monopoly on cash the imagery and symbolism on cash started representing nationalistic messages.

Fiat currency - Disconnect from value

As the economy grew in the 20th century governments required more control. Fiat currency was introduced by the Nixon government in 1971 which decoupled the US dollar from gold supplies. Fiat currency is a currency not linked to a physical store of value and does not have any intrinsic value. Its value is derived from the government who controls it. This allows governments to print additional money, control inflation, manage interest rates and in general

makes the currency more stable as it is not linked to a limited supply of gold. Following the US, national fiat currencies have been used globally with changing exchange rates between them.

Crypto currencies - Digitalization of cash

In the 21st century digital currencies known as crypto currencies were developed. In 2008 bitcoin was the first. Crypto currencies use cryptography to have a distributed ledger mostly known as blockchain. Crypto currencies facilitate a decentralized digital payment method which allows payment without third parties and offers some anonymity because of it. The future of crypto currency is still unsure but central banks are researching their use. Currently Sweden is developing the E krona, the first national regulated digital currency.

Conclusion

From this history of cash multiple developments can be observed that have shaped cash to the point we know it as now. Although the shape or design of cash has not changed that much for the amount of time it has existed, what it represents and how the system behind works has changed. All these developments were necessary at some point to continue the success of cash. Being aware of these developments is useful when redesigning cash because of the importance these developments had.

Based on its history the properties that cash gained throughout its developments are:

- A means to facilitate trade
- Standardized value system
- Store of value
- Trusted (national) symbol based on its authentication features
- Widely accepted
- Controlled by public institutions

2.2 Design

Currently cash design is quite similar in most parts of the world. Most countries have some combination of coins and notes. Differences are mostly in the graphical print, material and sizing. To understand current cash design different aspects of cash are discussed in this paragraph.

2.2.1 Denominations

Denominations are a method to facilitate exact payment with cash. Different countries have used different denomination sequences. The Dutch guilder used a system of 1 - 2,5 - 5. The current Euro has a system of 1 - 2 - 5. The Japanese Yen has a system of 1 - 5 and the former Soviet union had an inconsistent pattern going from 1 - 3 - 5 - 10 - 25 - 50 - 100. All these systems are based on the decimal system but other systems such as base 2 (1-2-4-8-16 etc.) could be more efficient but do not match with the public's preference and habit of the decimal system. Denominations are necessary to pay an exact amount but the choice of denomination system should be a balance between efficiency and usability. The more denominations, the harder it is to distinguish them. This is even more relevant for groups such as the vision impaired as they have more trouble when determining the value of a coin or note. Although denominations are in most cases the chosen method of facilitating exact payment there might be other methods of solving this. For example the old bus tickets in the Netherlands used card that are stamped based on how much you used.

2.2.2 Form factor

The shape or form factor of cash has not changed a lot since its first versions. This can already be observed in the fact that cash is still described as coins and banknotes. Although the design variables within coins and banknotes have changed over time the overall form factor has always stayed the same. Coins are round shaped discs ranging from 4mm in diameter(quarter silver tara of Vijayanagar) to 33 mm(French polynesia 50 franc coin) but most modern coins are somewhere in the middle of this range. The size of the coin has an important effect on the handling which will be discussed more in sub

paragraph 2.2.5 alongside the tactile features used in coin design. The shape of coins stems from the intrinsic value metal had and the production method of stamping as mentioned in the history of cash. Furthermore the round shape of a coin makes it able to withstand use and abuse very well as it has no weak points.

Early paper money was a bit bigger than we are used to today measuring around the size of an a4. The size was not as relevant for use in that time as it was only used by merchant and not as a daily payment instrument. Current banknotes are smaller to facilitate easier handling and are sized to fit in a billfold wallet type. This can be observed in the US dollar which is sized at 66mm height to fit in wallets and the recent changes of the €100 and €200 notes where the size was reduced to also fit better in wallets. The form factor of bank notes stems from first banknotes which were written receipts or promissory notes which were therefore on paper. The dimensions have been updated over time to improve the usability and currently most banknotes are rectangular shaped. The sizing of banknotes can vary between denominations for better recognition of the value a denomination represents.

2.2.3 Symbolism

In all cash money design symbolism plays an important role. Cash is seen as a representation of a nation and has an important communication function. This can be observed in countries like the U.S. where the founding fathers along with buildings are displayed to represent its history and therefore its values. Traditionally historical figures, events and buildings are represented (figure 2.5), although other symbols of a country have also been used such as the Oxenaar series of the Dutch Guilder with Dutch symbols such as the snip bird and the sunflower(figure 2.6). Current Euro cash differs in symbolism on its coins and notes. Coins, which are distributed by the countries themselves, have one side, the value number side, which is identical for every country. On the other side country specific imagery and symbolism is printed. The banknotes however are country independent and uniform in design. As the Euro represents multiple countries, its symbolism is challenging as it must communicate a message which transcends borders but does not favour one of its countries. For the Euro notes the history eras of European architecture are used for the different denominations (figure 2.7). To not over represent a country, fictional buildings and bridges were designed. The symbolism on cash can be a topic of discussion. Opinions range from **nostalgic**, valuing historical figures and events, to **progressive**, current icons such as human rights advocates, scientist and other role models. A different option is imagery that represents a country but is independent of figures, events or politics such as the before mentioned Oxenaar series of the Dutch Guilder.



Figure 2.5. Ancient coins

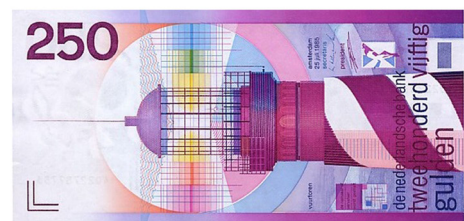


Figure 2.6. Oxenaar guilder series.



Figure 2.7. Euro bank note designs

2.2.4 Graphical design

The graphical design of cash has the most important communicative function. The other factors such as denomination and symbolism are represented through the graphical design of cash. The graphical design of cash has mostly been used for value recognition and the communication of symbolism. Coins have two sided, the obverse and reverse or the value and face side. The value side shows the denomination number it represents and the face side shows some symbolism as mentioned above. In the eurozone each country has a unique coin design on the face side but because coins are stamped and not printed the graphical options are limited. Graphical design is more relevant in banknote design as notes are printed. Graphics are used for creating a clear differentiation between denominations, creating authentication features and adding symbolism. These design elements will be explored for the current Euro series Euro banknote with the example of the 10 Euro note (figure 2.8).



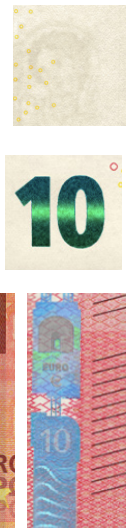
Figure 2.8. 10 Euro note, Europe series.

Safety features

Within the Euro notes multiple safety features are implemented. Some are visible for the general public and some are only readable by machines. The visible safety features are:

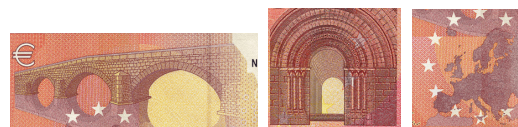
- The watermark
- The moving reflection within the number
- The dark security thread
- The holographic imagery in the silver field.
- The relief ink stripes at the side of the note.

These security features can be identified by feel, look or tilt.



Value recognition

The most important aspect of a banknote is identifying its value. Euro notes use different methods of communicating this. Multiple bold fonts are used that show the number the note represents. These numbers have different colours and background to make them readable in varying environments. The colour of the note also communicates the value it represents. Euro notes use a different colour for each denominations that are easy to distinguish. For the visual impaired the relief ink stripes also communicate the value based on touch by a pattern within the stripes



Symbolism

The symbolism and imagery in banknotes and coins are to communicate which currency it represents. Within the Euro different elements are used. The map or Europe and the flag of Europe are used in different places. For each denomination an architectural era in the history of Europe was chosen and a fictional bridge and gate were designed which are displayed on either side of the note.

2.2.5 Usability design - Upid model

Cash has different usability demands that need to be facilitated by its design features. In the previous paragraph some aspect of cash design are already discussed but in this paragraph the focus will lie on the usability and handling of cash. How do people interact with cash and which design elements support this. Hans de Heij created the User-centered Design of Payment Instruments model, in short the Upid-model (De Heij, 2017). This model shows the user interface and experience functions of payment instruments and advises on the best practices in designing for these functions.

De Heij proposes four user interface functions(UIF):

1. Recognising value
2. Handling
3. Checking authenticity
4. Receiving a communication message

And six user experience functions(UXF):

1. Recognising identity
2. Judging aesthetics
3. Retaining confidence
4. Connecting with main image
5. Expecting sustainability
6. Linking to information technology

In the previous paragraph three of the interface functions were discussed in regards to the graphical design elements. These functions are covered by individual design aspects. Handling is a term that describes all kinds of manipulations with cash such as retrieving, handing over, storing or feeding it into an automate. These interactions are covered in paragraph 1.5. The three other user interface functions are influenced by how cash is handled and therefore handling covers the size and placement of all these elements. From the interface functions, handling has received the least amount of attention in cash design and its importance is undervalued. Design elements that can be seen in current cash that assist the handling of cash are:

- Different orientations schemes
- Different sizes of denominations
- Adapting note sizes to efficient storing in wallets

When redesigning cash it is important to take along all UIFs and how they perform during different interactions with cash.

De Heij created designs based on assigning different locations on banknotes to each UIF:

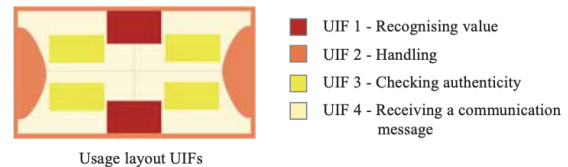


Figure 2.9. Layout of UIFs

This is one of the designs that followed from this process:



Figure 2.10. Conceptual note design, De Heij

The user experience functions although represented in this design will not be discussed in this report. In the further design processes during this project advises from this model will be used, namely:

- Use should steer the design of cash
- Be aware of the different usability or interface functions cash has.
- These interface functions should function during use. Which means that the design needs to be evaluated with multiple use cases.

2.3 Characteristics of cash

As can be seen in prior paragraphs cash has an extensive history and importance in society. But due to the recent changes in payment behaviour its role might change. To know what cash has to offer its characteristics have to be determined. The characteristics of cash have changed over time so it is important to evaluate the relevance in the current situation and the possible future situation.

According to the ECB official website cash has some unique features:

It is the most widely usable and fastest payment instrument for retail transactions and it is **the most important contingency payment instrument**

It is considered the cheapest instrument for small retail payments – the average overall cost per transaction for small payments is lower for cash than for comparable electronic payment instruments.

It is **“inclusive”**: people who have no bank accounts or limited access to them or who are unable to use electronic forms of payment can still make payments.

It enables people to keep a close check on their spending.

It is both a payment instrument and a store of value.

It has proved to be secure in terms of fraud/counterfeiting resistance.

These characteristics are part of what cash is but are subject to change. The characteristics are split between what is a direct feature of cash and likely will not change (**Bold**) and what are perceived benefits which alternative payments systems can also supply and in some cases already supply better. These differences in perception were observed in the research shown in chapter 1. Features such as speed of transaction, cost of transaction and budgeting are still associated

with cash payments but also increasingly with alternatives. Looking at developments in alternative payment instruments these perceived benefits are likely to change and at some point will be more associated with these alternatives.

Although contingency and store of value are less noticeable characteristics. This is because it is not a characteristic users experience in normal use. Contingency is a characteristic which only shows in time of crisis but is important from a system perspective and most people know cash more as a payment instrument than as a store of value. This also shows that the design of cash is dependent on characteristics experienced by users but should also cover situations less noticeable but which are important as a responsibility towards society.

2.4 Stakeholders

Cash as a product only functions if the production, infrastructure and regulatory institutions function well. And for a product used as much as cash the list of stakeholders associated with it is long. Making changes in such a web of dependencies, rules, work flows and agreements can be difficult. In this project working and adapting to all stakeholders would be out of the scope. Only the most important stakeholders will be discussed that have a direct touch point with the users of cash. A distinction is made between the main users and secondary stakeholders. The main users of cash are the general public and retailers. The secondary stakeholders are the production, regulation and facilitatory services of cash that support cash usage for the main users.

The general public for cash is defined as everybody from 6 years old and above. Figure 2.11 shows the overview of stakeholders and their relevant touch points.

The general public has access to cash through an ATM, counter withdrawal, cashback or in the form of change at a retailer. Between the general public cash is also handed over as personal payments, gifts or other uses. Retailers and ATM's are facilitated by cash distribution centres from which transport happens. Some cash will be returned to the central banks for checking the quality and authenticity. Cash distribution centres are supplied when necessary by central banks/production companies.

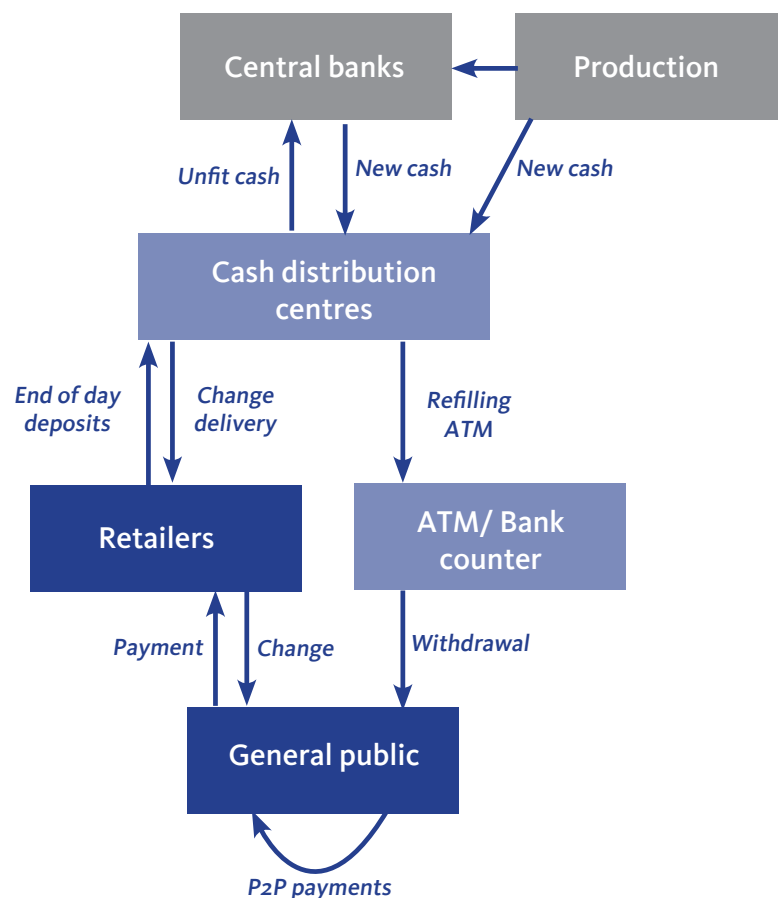


Figure 2.11 Stakeholders and their actions within the cash cycle.

2.5 Current cash cycle

To see how the cash cycle will perform with the reduced usage of cash, the current cash cycle is analysed. The goal is to identify all major stakeholders and understand the role of each. In figure x an overview of the current cash cycle can be seen. The primary users of cash are the general public and the retailers. In the most ideal situation cash circulates between these two. But to get the required denominations to where they are needed some form of redistribution is needed. This is done by cash distribution centres, cash transport companies and DNB.

In the current system these stakeholders are crucial for a well function cash cycle, but with the continued reduced use the amount of supportive infrastructure becomes disproportionate. A cash user wants to be able to access and use cash where ever he is. This requires a minimal amount of locations where he can obtain cash and high percentage of retailers that accept cash. The number used for ATM coverage is therefore not the amount of ATMs per user, but the amount of ATM's per area. This means that although the amount of users in an area might be halved, the amount of ATM's cannot be halved but has to stay relatively the same. This is the main problem for the cash cycle. The current infrastructure can only be limited to a certain amount before it influences the normal use too much.

2.6 Denomination circulation

To gain further understanding of how cash circulates, the different denomination are compared. This will create a picture of which redistribution of cash is happening and why it is needed.

2.6.1 Banknotes

The first difference can be seen between denomination used for the initial payment and denominations used for change.

A visualisation of the different denomination flows can be observed in figure 2.12. This shows the different journeys denomination have within the cash cycle. The €50 notes circulate almost

exclusively in one direction. The public withdraws it from an ATM and spends it at a retailer. The retailer deposits it towards a cash centre from which it is delivered to an ATM again. The €50 notes are highly dependent on this infrastructure and spend minimal time circulating between the public and retailers. The lower denomination notes are also used partially as a change and therefore circulate longer between the public and retailers with the €5 note circulation the longest.

The €5 notes are not obtainable through an ATM an are less often deposited by retailers because they can be used as change. A relation can be seen between the value of a denomination and the amount of time it spends in circulation. The lower the note the longer it stays in circulation. This can also be observed by the fitness of the notes when the are evaluated. €5 notes are much more often found unfit because they are used more often and are not returned to cash centres as much.

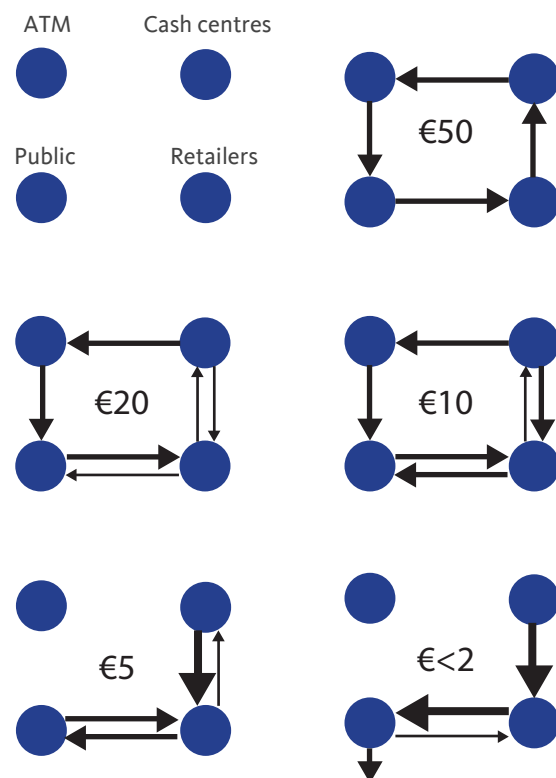


Figure 2.12 Denomination circulation

2.6.2 Coins

With coins a different pattern of circulation can be observed. Coins are only put in to circulation through retailers. Retailers need change to facilitate payments, therefore the public receives coins when making purchases. Although some of these coins are spend again by the public during other purchases a large amount of them are not re used but disappear in peoples homes or are thrown away.

The European commission send out a letter in 2019 stating that 61 billion 1 and 2 Euro cents are in circulation (Secretary-General of the European Commission, 2018). This would equate to each citizen owning 181 of them. This shows that coins, especially the lower denomination are not reused by the public but discarded. The Bundesbank (2014) came to similar conclusions stating: "Small denomination coins are used relatively infrequently to pay for goods and services. The majority are likely to be hoarded in order to lighten one's wallet, or are permanently lost." The metal design of coins allow for a much longer lifespan (around 30 years) than notes but although coins are kept for multiple years they see minimal actual use. This one-way distribution of coins create a constant request and flow of coins towards retailers which comes at a certain cost.

2.5 Conclusion: What defines cash?

The history of cash, its current design and the characteristics associated to cash by the ECB and the public should define the boundaries of cash. These boundaries are needed to identify where cash design can change and what core aspects should be kept. The new proposed definition of cash is:

Cash is a physical representation of money usable by everybody to own and store value independent of commercial institutions and information technology.

Functions

For cash three distinct functions can be described.

- Cash is a payment instrument
- Cash is store of value
- Cash is a backup tool

Values

Along side the definition, cash has certain unique selling points that are seen as important values cash has to those that use it.

- Cash is anonymous
- Cash requires no authentication for use
- The value of cash is guaranteed by the government
- Cash is trusted as counterfeit proof

Features

Cash is able to fulfil these functions because of several design features it has:

- The different denominations to allow exact payment
- The representation on value communicated on cash
- The authenticity features on cash
- The portability to take it in a carry on
- The durability to endure use

For cash to function properly it is also dependent on an extensive infrastructure that distributes cash and support the services associated with cash. This infrastructure is needed for cash to function well and the decreased use of cash can become an issue for this infrastructure to remain viable.

For cash to be able to continue fulfilling its functions, it is important that the values cash represent are kept and the design features that have caused the long term success of cash not to be changed without proper reasons.



3 Future role of Cash

What can be seen in the first two chapters is that there are significant changes happening in how people pay. This is caused by continuous developments in the digital payment field and cash has difficulty to compete with these innovations. The questions that arise are: Will this change continue? Which trends influence the future payment choice? And most importantly, which role will cash have?

This chapter will discuss the most relevant trends that will influence payments, it will evaluate other countries that are further in their cash reduction and lastly, future scenarios are created that show the potential developments, challenges and role of cash.

3.1 The changing landscape of payments

There are a few developments which are currently taking place or will in the foreseeable future that have an impact on payments and on payment behaviour. These developments will be discussed.

Digital infrastructure and education

Alongside payment there are numerous products, services and systems that are dependent on a well functioning digital infrastructure. This infrastructure is not available everywhere in the eurozone and not every country's citizens are fully able to work with them. But these developments are moving fast and a fully functional infrastructure for all countries will likely not take that long.

PSD2

This year PSD2, the new European payment service directive, will be launched (European commission, 2018). This directive allows third parties to access bank data if a person allows it. This will allow developments of more and likely better service application and integration. This can help support the secondary benefits of digital payment instruments. Furthermore custom solutions can be developed for specific user groups who experience problems when using digital instruments, such as specialized tools for the visually impaired.

Cyber crime

The increase of digital systems and our dependency on them have created vulnerabilities. Cyber crime or hacking is a new treat which consequences are getting bigger. Although institutions are preparing themselves better, the exponential speed of development in this field can make it difficult to keep everything safe. As we become more dependent on these systems and we start sharing more information through them it becomes crucial to keep the trust in these systems high.

3.2 Other countries that are going cashless

The future scenario's show a future of low cash usage and the possible issues related to it. Although the Netherlands has a relatively low cash usage in the eurozone, there are other countries such as Denmark and Sweden that have much lower percentages and could almost be described as cashless countries. Valuable lessons can be learned from the experiences of these countries and the problems they have encountered.

3.2.1 Sweden

According to the Riksbank of Sweden(2018), the use of cash has drastically declined in the last years. Currently the percentage of GDP in cash is 1,4% compared to around 10,7% in the eurozone and only 13% of transactions are done using cash. The reason why Sweden is almost cashless are similar to the developments we see in the Netherlands. A cooperation between government, regulatory institutions and commercial parties that pushed digital payment alternatives such as card payments and the Swish app. The Swish app allows people to link their phone number to their bank account and make almost instant payments using the app. The result was a fast decline in both the use and support of cash. With lower usage, more retailers no longer accept cash and even commercial banks are no longer offering cash withdrawals. Sweden is now experiencing the problems resulting from this fast decline in cash. Some groups are feeling left out as they prefer to use cash or are not able to use the digital products. In response, new regulation about mandatory cash withdrawal and acceptance are proposed but have not been successful. Alongside this there is a growing fear of dependency on digital infrastructure and the backup function cash used to offer. Because cash has declined so rapidly, the central bank is now developing the first national crypto currency E-krona. The e-krona would be a digital complement to cash which value is guaranteed by the state.

3.2.2 Denmark

In Denmark cash usage has also dropped to around 23%(Danish payments council, 2016). Denmark's central bank, National Bank decided in 2015 that it would discontinue the printing of new money and would outsource it. Different from Sweden, in Denmark cash acceptance is regulated and therefore mandatory by staffed shops. In recent time this regulation was changed a bit to allow shops to not accept cash during the night and currently there is discussion to abolish these rules completely. Although its acceptance is regulated, cash usage and services are continue to decline.

While these two countries are seeing a fast decline of cash usage and the majority of inhabitants see more benefits in digital payment instruments, a large percentage of these people feel that a cashless society would be problematic. What if the electricity goes down? What if the system is hacked? What if I need it? This describes the situation around cash the best. We do not want to use cash but we also do not want it to disappear.

3.3 Future scenario sketching

To be able to redesign cash and its system to make it suitable for long term continuation an understanding of possible future scenario's is needed. For this projects methods developed by the Deutsches Institute for development politics(2008) are used.

A future scenario is not a specific forecast of the future, but a plausible description of what might happen(Scenariothinking.org). A future scenario has no value if the path towards it cannot be explained. It's function is to allow designers, policy makers or commercial institutions to identify problems, challenges, opportunities and possible consequences which in the current time line are not yet apparent. It tries to avoid the pitfall of using the current situation to design a future solution while the current situation might drastically change when the solution will be implemented. The goal of a future scenario is to offer clear input to make strategic decision. Therefore it is important that prior to determining these scenario's it is clear which questions need to be answered. This will prevent creating an infinite amount of different scenario's were no direct conclusions can be derived from. Because of this, current existing future scenario's cannot be used in this project. A future scenario is a custom fit to the questions that need to be answered although trends and drivers of other scenario's can be translated.

Qualitative future scenarios are based not solely on quantitative data but also consider values, behaviour and motivations. It allows scenarios to be created which take into account effects for which no data is available. Therefore sudden changes such as a crisis or a quick change in political leadership can be taken into account, not by extrapolating current data, but by creating possible, but mainly plausible story lines about the development of society. Future scenario's offer a secondary benefit in design as it supports people in breaking away from their current believes and problem solving methods which therefore enables more creativity.

3.3.1 Method

Multiple methods have been used in futuristic design or future scenario creation. The first choice is between a explorative or normative scenario. Explorative scenarios pose the question, "what will happen if", whereas normative scenarios pose the question "what do we want the future to be like". Explorative scenarios help you prepare for new situations or changes and normative scenarios help you reach certain goals. In this project no clear future goal can yet be stated and therefore an explorative scenario process will be conducted.

A distinction is made between formal techniques and more intuitive creative driven techniques. Formal techniques such as impact analysis, consistency analysis and cross-impact analysis focus on defining multiple key factors. These factors are combined and compared in a systemic manner to create possible future scenarios. This does not take into account intuitive elements and often over-formalizes the process. For this project an intuitive creative technique is chosen, namely intuitive logics. The result of this technique is communicatively strong but condensed scenario which emphasises the important characteristics. This technique focusses on the decision-making processes that takes into account unpredictability and allows for the combination of data statistics but also estimates and the expertise of the people cooperating in the project. The scenario should be able to answer the questions: Which decisions must be made and what steps must be discussed?

This technique will take five phases:

1. Determining the scenario field. Create the scope, purpose and focus of the scenarios.
2. Identifying key factors that are crucial for making decisions
3. Evaluate these key factors on their unpredictability and degree of impact.
4. Create scenario logic. Factors with low uncertainty are used to create a consistent profile and factors with high uncertainty are used to create possible alternatives on these profiles.
5. Creating the scenarios. The scenarios should have highly descriptive titles, a compelling storyline and an overview of the different factors and their influence.

3.3.2 The scenario field

Prior to creating future scenarios it is crucial to define the goal of the scenarios as it determines how the scenario will be created.

Based on prior analysis some conclusions were drafted:

When limiting factors do not have a relevant effect on the payment instrument choice, emotion and perceived attributes become the leading drivers for this choice.

In general digital alternatives are increasingly more preferred because of their improved usability.

Cash is preferred more based on habit, emotion or because of its unique features such as privacy and independence.

Cash is a benefit for certain demographic groups because of their limitations of which some are shrinking.

New developments of digital alternatives will support groups such as the digital illiterate and visual impaired better.

Euro cash is being increasingly used for hoarding.

The remaining users of cash do not have as much issues with the product itself but with the reduced support of cash and the usability problems this creates.

This raises some question about cash in the future:

- Will cash disappear?
- Who are the future users of cash?
- What will cash be used for?
- How much will cash be used?
- Why will cash be used?
- How can we continue to support cash?
- How will crisis influence the use of cash?

Which can result in certain decisions that need to be made:

- Should the usability of cash improve to compete with digital alternatives?
- Should cash be designed as a niche payment product?
- Do we want cash as niche product?
- Should the infrastructure or cash cycle change?
- Should cash acceptance be regulated?
- Should cash be more focussed on hoarding?
- Should cash be split into a hoarding product and a payment product?
- Should we be able to facilitate higher use of cash in times of crisis?
- Will the reputation of cash change?

These questions need to be answered based on the future use scenario and the conclusions that come out of it. The scope of the scenarios will be the payment system in the eurozone with a focus on the Netherlands.

3.3.3 Drivers that influence future scenario's

A list of drivers which can have an potential influence on payment, cash or society in the future was drafted and can be found in Appendix C. This list was created in a brainstorm session based on prior analysis. From this list a subset was selected which would have the most influence on the questions posed above. These drivers clustered in general subjects. The final list of drivers is:



Digitalization

Digital capability:

The level on which people can properly use digital products.

PSD2:

Development of new integrated digital services.

Data usage:

The use of data by government or commercial parties that is created by citizens.

Secondary services

The automation of payments which do not require a primary action anymore.



Trust

Privacy:

The decrease in privacy and increase of awareness.

Financial system:

The trust in the financial system which can undermine payment systems.

Safety:

The trust in a continued safety and well being

Politics/ EU regulation:

Changes within the EU such as the brexit



Economy

Interest rates:

The interest rates impacts the benefits of hoarding

Growth:

The increase or decrease of the economy impacting spending.

Cost per instrument:

The cost of payment instruments based on supportive infrastructure

Hoarding:

The amount of cash which is stored privately and not used for payments



Infrastructure

Digital network:

The availability of digital connection

Acceptance:

The amount of places cash can be used

Cash availability:

The amount of places cash can be withdrawn



Demographics

Aging:

The change in demographic composition of countries.

Disabilities:

The people that are in some way impeded into using digital products.

Inclusion:

The effort to assist everybody within a community



Stability

Cyber security:

The robustness of digital systems.

Financial crisis

The sudden effects of a financial crisis

External

Politics happening outside of the EU

Sustainability

The need for an environmental friendly society.

3.3.4 Scenario logic

The drivers mentioned above are mapped based on the amount of impact they can have and the uncertainty they contain. This creates four categories of which two are used to develop scenarios.

Known and relevant - High impact and low uncertainty

This category is used to create probable futures and contains:

- *Digital capability*
- *PSD2*
- *Cost per instrument*
- *Hoarding*
- *Digital network*
- *Aging*

Not known and relevant - High impact and high uncertainty

This category is used to create a diversion on these futures and contains:

- *Interest rates*
- *Financial system*
- *Acceptance*
- *Availability*
- *All stability drivers*

Known and not relevant - Low impact and low uncertainty

Not known and Not relevant - Low impact and high uncertainty

These two categories are not used for the scenarios.

3.4 Future scenarios of cash

With these drivers as the most important influences on the future, three scenarios are described that show the potential development of society, cash usage and the problems we may encounter. The scenarios are:

- Steady digitalization
- Breach of trust
- Cashless

All three scenarios will be elaborated and the path towards it described.

Scenario 1: Steady digitalization



3.4.1 Scenario 1: Steady digitalization

The first scenario describes a continuation and acceleration of current developments in payment behaviour change without major disrupting effects. It shows a society that has continuously developed and adapted digital products to improve payment efficiency and usability. Digital safety has become an important point and many resources are used to keep the system safe. Cash usage and cash support is decreased and is only used by few people who value privacy or have a strong emotional connection to cash. The people who used to struggle with the use of digital alternatives have received custom solutions that cater better to their needs. Cash continues to exist but has to function as a niche product and acceptance had to be regulated.

The road towards it

The economy is continuing to improve and grow. Interest rates start to increase a bit which causes more financial incentives to store money on a bank account. The trust in the economy is back at levels from before the crisis. As more of society digitalizes, the people become more comfortable with digital products, services and abstract concepts. PSD2 allows third party developments to develop more supportive functions around money which enhances the benefits of digital payment instruments. The infrastructure continues to improve and becomes more flexible with mobile connections which makes it possible to pay digitally anywhere. New forms of cashierless shopping and the increase of subscription based and online shopping creates a bigger need for digital payment. Being able to pay with a digital instrument will become the social standard and using cash will become a burden for the seller. Cash becomes more difficult to get as the coverage of ATMs continues to drop because the cost of infrastructure increases as usage drops. Cash acceptance is regulated to make sure people can still use it. Cash will be mainly used as a hoarding tool or by the few who value privacy.

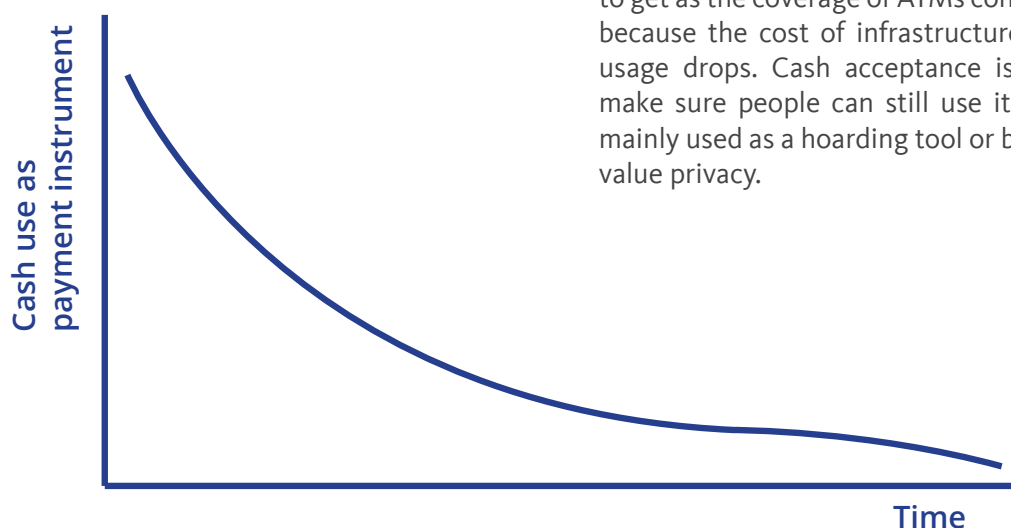


Figure 3.1 Cash usage over time in steady digitalization scenario

Scenario 2: Breach of trust



3.4.2 Scenario 2: Breach of trust

The second scenario describes a continuation of current developments where we become more dependent on digital products which creates vulnerability in our system. The fast innovation of digital alternatives has caused a lack of overview and digital safety. PSD2 has created an overwhelming amount of third parties using payment data. More of these systems become compromised and data leaks occur. The trust is fully lost when a large digital attack hits a major payment service. This combined with a new financial crisis that has emerged created a resurgence of cash but banks and ATMs have difficulty with living up to the demand. Data sharing by banks has been put on hold and only banks can facilitate digital payments. Cash has become the main payment instrument for people again until trust is restored. The cash system needs to expand quickly to facilitate this demand. Hoarded cash has started to circulate in payments and retailers have difficulty handling the large influx of cash.

The road towards it

The new PSD2 system is implemented. A growing amount of third party players enter the Fintech market. Bank data is shared to these services under control of the customers, but the proliferation causes a lack of overview and lowers the control of your own data. All these added payment services increase the usability and use of digital payment services. Regulatory organisations cannot keep up and the quality and safety of these services is not guaranteed. The first data leaks and malware occur and questions are asked about its safety. A long side this a new economic crisis is starting. The trust in the financial market has not fully recovered from the last crisis and people are quickly spooked. A large digital attack hits a major payment service, crippling its digital payments for an extended period of time. The data sharing of bank details is put in to question and multiple third party payment services are put on hold which creates an overall distrust in digital instruments and the safety and trustworthiness of cash become leading. Most people do not have cash anymore and the lower amount of ATMs have difficulty supplying the needed cash. Cash and its system need to scale up again to function as the main payments instrument until trust is restored.

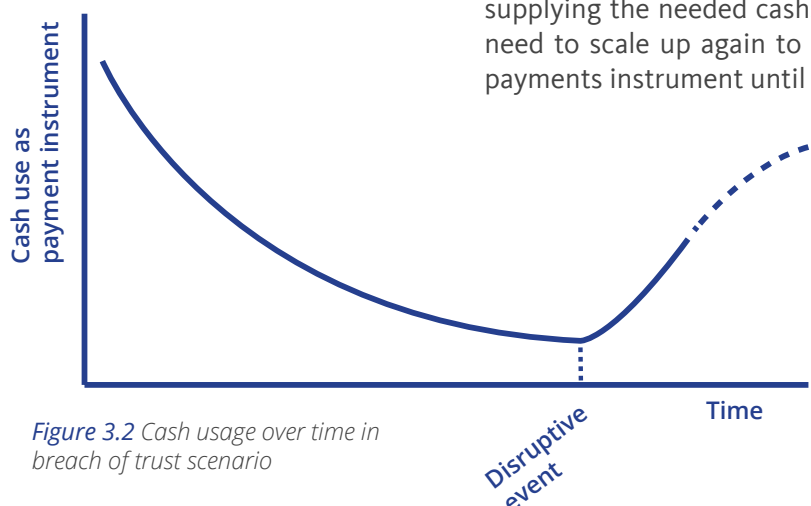


Figure 3.2 Cash usage over time in breach of trust scenario

Scenario 3: Cashless



3.4.3 Scenario 3: Cashless

This scenario describes a future where nothing is changed and cash is allowed to disappear. It follows the same development as the first scenario but cash is allowed to disappear. As cash usage reduced further, retailers and commercial banks see no benefit in supporting cash. More and more support for cash has disappeared until central banks could no longer facilitate the cash system and production is discontinued.

The road towards it

The economy is continuing to improve and grow. As more of society digitalizes, the people become more comfortable with digital products, services and abstract concepts. PSD2 allows third party developments to develop more supportive functions around money which enhances the benefits of digital payment instruments. The infrastructure continues to improve and becomes more flexible with mobile connections which makes it possible to pay digitally anywhere. New forms of cashier less shopping and the increase of subscription based and online shopping creates a bigger need for digital payment. Being able to pay with a digital instrument will become the social standard and using cash will become a burden for the seller. Cash becomes more difficult to get as the coverage of ATM's continues to drop because the cost of infrastructure increases as usage drops. At some points banks stop supplying cash and almost all retailers stop accepting it. Central banks can no longer facilitate the system and cash production is discontinued. Central banks shift towards digital currencies as a new way of supplying central bank money. Cash is still redeemable but only to exchange it for a digital alternative

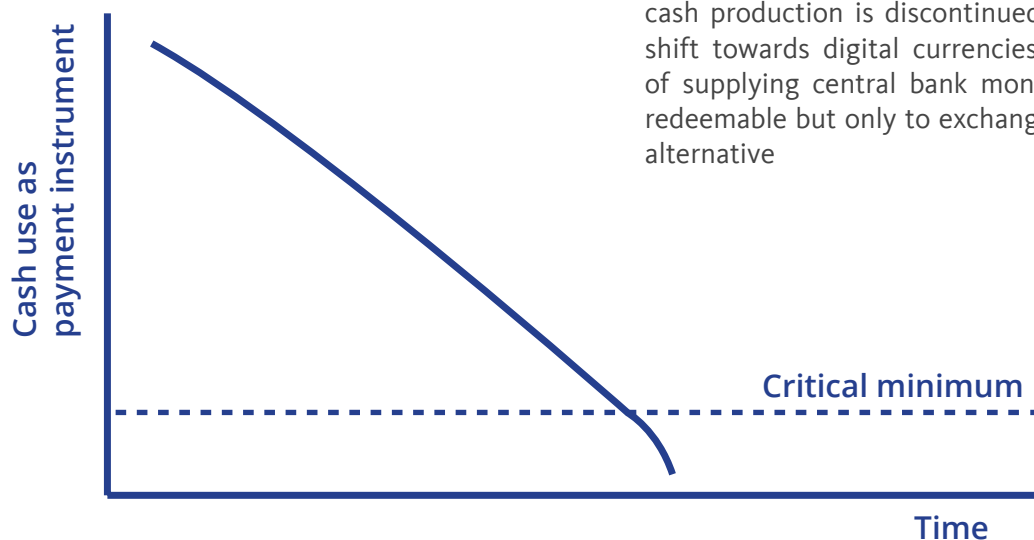


Figure 3.3 Cash usage over time in cashless scenario

3.5 Evaluation future scenarios

What can be concluded from these scenarios is that it is important that cash remains a part of our society even if it sees low usage numbers. In general digital payment instruments offer more benefits and habits will change. But cash as a backup tool and as an inclusive payment instruments has to continue to be supported. Furthermore the hoarding of cash is only increasing which makes the product still successful. The important question to ask is not if cash will disappear or how little will it be used but how to create a viable cash system that improves usability and removes the biggest disadvantages. It is important that this question is answered now because other countries who are further in their reduced use of cash already notice the problems that occur when nothing is changed.



4 Initial problem definitions

The future scenarios created initial problem definitions that will be discussed. The problem definitions are the crucial elements that need to be addressed. A design goal is formulated that defines what the resulting effect of the project should be.

4.1 Problem definition

As people, society and the infrastructure continue to adapt to the digitalization of payment, cash usage continues to decline in the Netherlands and the entire eurozone. The new developments and improvements of digital payment services, soon to be empowered by the introduction of PSD2, have caused an increase in digital payment instrument use.

The usage reduction of cash creates a new situation for cash to exist in as seen in figure 4.1. Cash is used less as a payment instrument and its hoarding and backup functions are becoming more relevant. Cash in its current form is already functional as a hoarding tool and will continue to be successful for it. The reduced payment usage and the importance of cash as a backup do create challenges which require changes within cash and its system.

This future situation creates problems for both the users and the system of cash. These problems are described using the integrated innovation model by van Kuijk (2015, See figure 4.2) which integrates the human, business, technology and society aspect of a product or service. For cash to continue to be successful it has to balance desirability, viability, feasibility and responsibility.

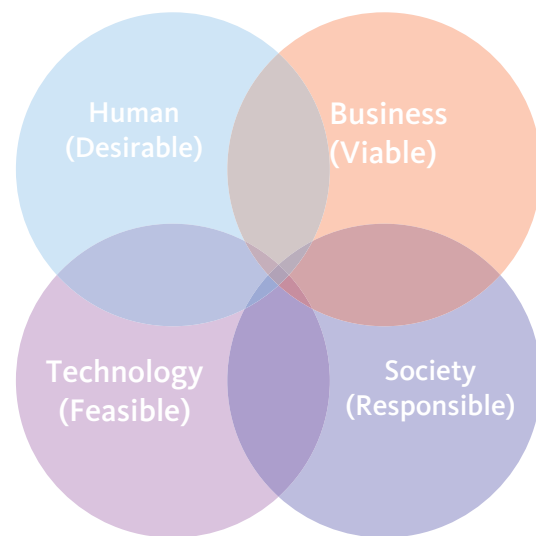


Figure 4.1. Integrated innovation model by van Kuijk (2015)

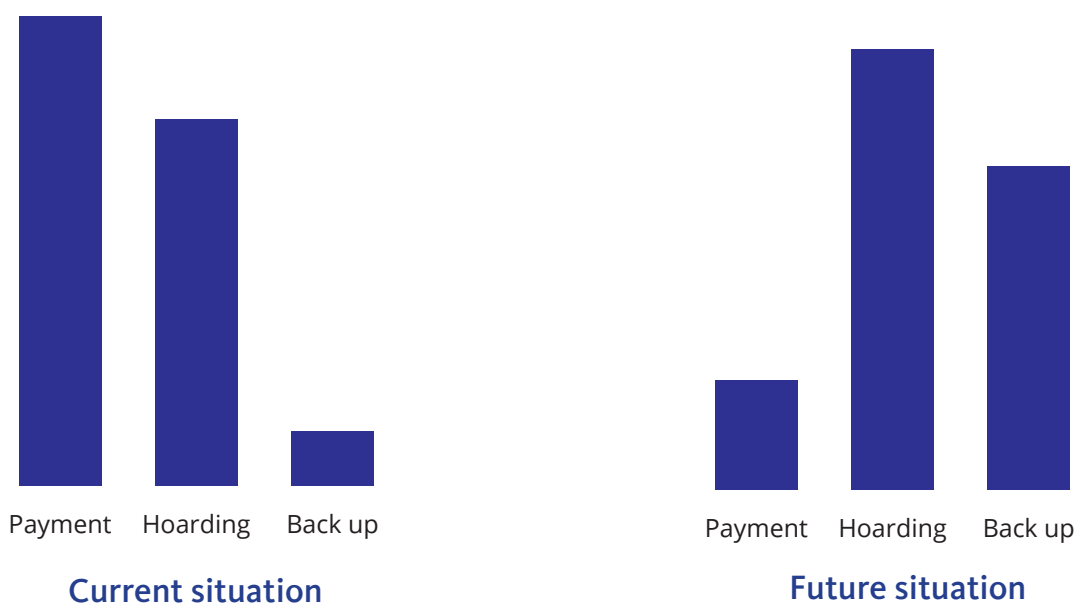


Figure 4.2 Current and future function profile of cash

Human

The handling of cash is not optimal due to the differences between note and coin interaction.

Cash is not efficient as it can require many steps to complete a payment.

Certain user groups are not able to use digital alternatives and are therefore forced to use cash.

The hoarding function of cash becomes more important as cash usage in payment declines.

Retailers are moving away from cash as it poses safety issues.

Business

The cost of the cash infrastructure is becoming relatively more expensive as cash usage declines.

If the acceptance and availability of cash drops to a critical point, normal usage would become impractical.

If the cash usage is not sufficient anymore to support the current system, this system should change or adapt to the usage.

Technology

Due to size of the current cash system, implementing changes can be difficult across multiple countries.

The Euro is distributed throughout the world, If a change occurs, support for the 'old' Euro could be an issue.

Cash has its trustworthiness due to its safety against fraud. This is achieved by the authentication features within the design. New designs should be able to supply the same amount of safety.

Society

The backup function of cash is crucial. Although cash might see low cash usage in the future, it can increase rapidly during time of crisis.

Cash should be available to those who choose to use it which becomes more difficult when cash usage declines.

The reputation of cash can change if it becomes less visible in daily life. Cash could be seen increasingly as criminal or grey money.

When all these factors are combined two distinct problem statements are created:

Problem definition 1: Reduced use

Cash has an important role in society and everybody has a right and sometimes need to use it. For cash to continue to be a viable payment instrument, its usability should improve as much as possible but more importantly this should be compatible with a system that functions properly while having low or specific usage and also be able to facilitate a fast increase of demand in times of crisis.

Problem definition 2: Backup role of cash

If cash usage as a payment instrument and the acceptance of cash continues to decline, the payment system becomes more vulnerable when it is dependent on digital payment instruments. With this vulnerability comes the need for a well functioning backup instrument. Cash currently fulfils this backup role but with the declining support of cash a new or improved solution is needed.

4.2 Design goal

Based on these problem statements and the findings in the analysis two design goals are formulated:

Design goal 1: Adapt the cash cycle to the reduced use

I want to redesign cash to make it suitable for low usage by creating a system which requires less infrastructure, improves the availability of cash and reduces cost, risk and effort for retailers. In addition I want to improve the usability of cash for the user by simplifying the payment process and making it more efficient for transporting and handling.

Design goal 2: Backup payment instrument

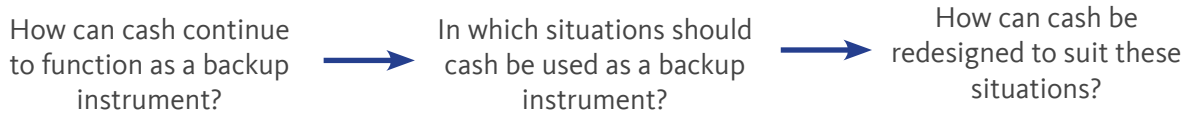
I want to design a backup payment instrument which replaces the role cash currently has. The new design should facilitate people and retailers in payments when digital alternatives are not functioning. The focus will be on short term interruptions of the digital payment system.

4.3 Approach

To fulfil these design goals several steps have to be taken. The design process is divided into two different parts. Designing for a viable system of cash with reduced use and designing for the backup function of cash. First the focus will lie on designing for the backup function of cash. Afterwards the design for reduced cash usage will be covered.

These parts will run partially parallel and might influence each-other. For each step defined in figure 4.3 ideas will be generated which will be combined into multiple concepts to be evaluated with users and experts.

Backup cash



Low usage system

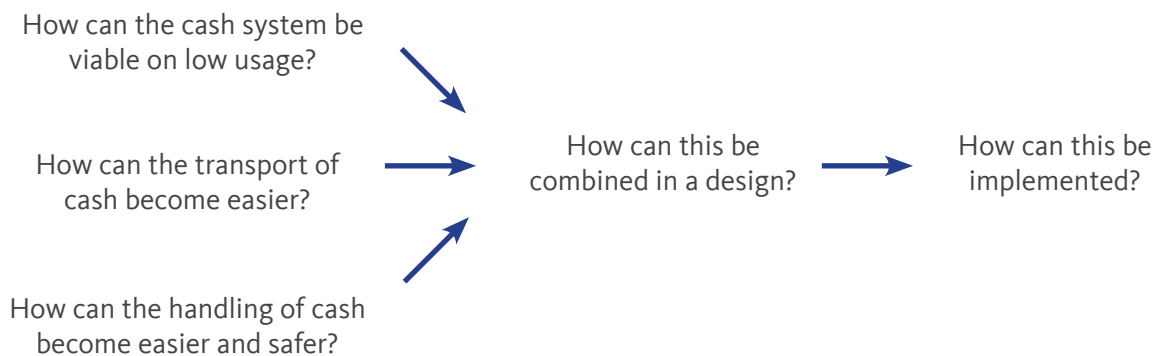


Figure 4.3 Approach



5 Cash as a backup instrument

Backup money is one of the core functions cash has been fulfilling since the introduction of digital payment alternatives. If there is a connection issue, software problem or empty battery, cash is used as the payment instrument that always works. This is an important role people often associate with cash.

The question arises if this role will become more important as the digitalization of the payments continues and if cash is able to keep fulfilling this role while cash usage continues to decline.

This chapter will discuss the current backup function of cash, possible scenarios which may require a backup instrument and how cash or an alternative could function in these scenarios.

5.1 Cash as a backup instrument

To gain an understanding of the potential role of cash as a backup instrument in the future its current performance as a backup instrument needs to be evaluated.

As mentioned before, cash is seen as the primary backup instrument if a disturbance takes place. Although cash is seen as the primary payment instrument, it is important to realize that it is not the only solution for a back up instrument. The goal of this chapter is to identify how we can reduce the vulnerability and improve the robustness of our payment system and if cash has a continued crucial role in this in its current or adapted form.

Why is cash seen as a backup payment instrument?

A backup instrument can be defined as *the best functioning alternative when the primary option has some issue*. Cash was for a long time the sole and primary payment instrument and because of its proven success and established infrastructure, it makes sense that it is seen as the best option when digital payments do not function. It is also an instrument everybody is familiar with, does not require other products to use and most importantly, is not dependant on digital systems. The disturbances of a digital system is what causes most of the problems with digital payments.

Therefore there exists the view that a backup instrument needs to be independent of digital infrastructure and cash fulfils this view.

To evaluate the backup function we need in the future a different view is proposed:

There should always be a well functioning alternative to the primary payment method. This does not mean that the alternative needs to be digital independent.

5.2 Scenarios that require a backup payment instrument

Different disturbances of digital payment can occur which can vary in severity, amount of people affected and the impact they have. It can range from a single shop that has connection issues to large scale disturbances on the back end of the payment infrastructure which will affect large groups of people. To gain an understanding of the possible scenarios, the amount of people affected by a disturbance and the downtime of the payment system are mapped as can be seen in figure 5.1. Within this mapping 4 different sizes of affected groups are identified:

- A single person.
- A small local group.
- Larger groups.
- Society wide.

These groups are compared to the amount of time digital communication systems will be down. This ranges from a short 1 hours disturbance to multiple days or weeks. The numbers within this figure represent different scenarios which will be discussed more elaborately on the next page. These scenarios show the variety of disturbances that can occur and the impact they can have. A distinction is made between “low” impact and “high” impact disturbances. The low impact disturbances are described as something that you need to overcome or bridge. It does not require a long term change in behaviour or product but something to overcome the current disturbance until normal functionality is continued. The high impact disturbances will have a lasting effect on the way people pay and some form of long term adaptation is required.

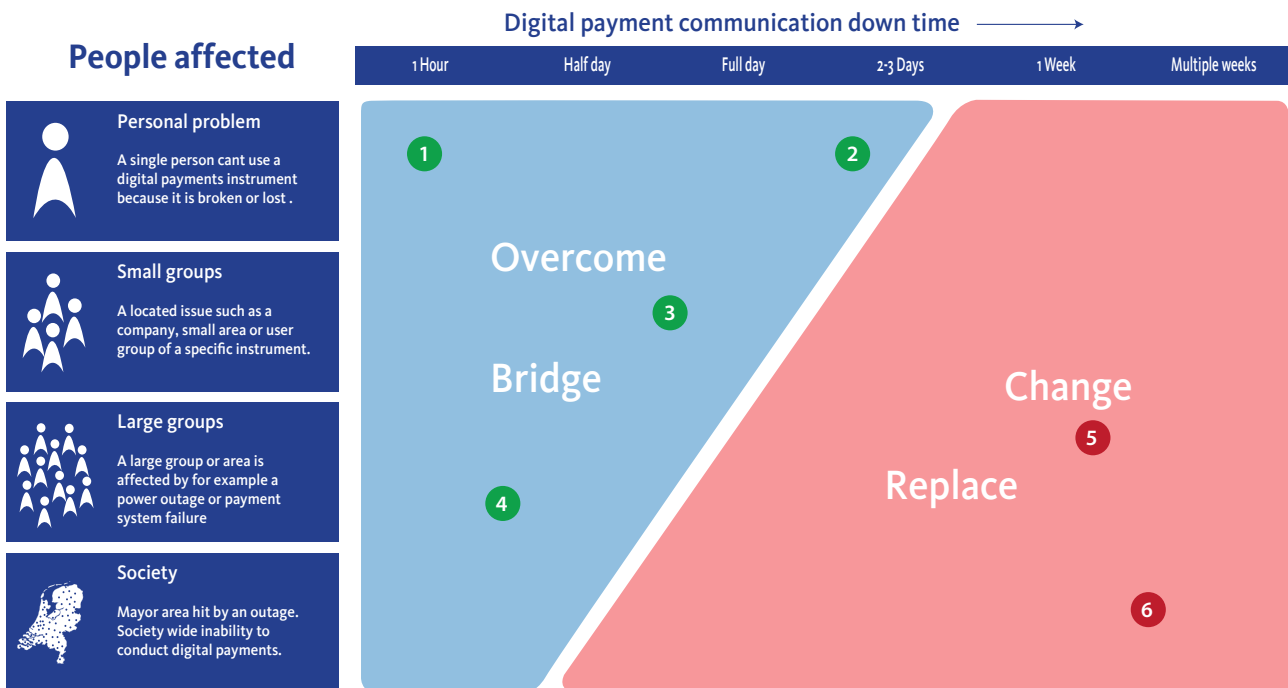


Figure 5.1. Mapping of the amount of people that will be affected due to a disturbance and the down time of the payment system.

Digital payment failure scenarios

1

Forgot my card

A small personal issue which only hinders payments for a short period of time. A person is not able to make 1 or 2 payments at a certain time and need a solution. Current solutions are using own or borrowed cash or asking someone else to pay. In some cases not making the purchases is also an option.

2

Broken or lost card

A medium personal issue which can hinder payments for one to multiple days. A person is not able to make any payment for a longer period. Current solutions are using cash or arranging some other digital payment instrument.

3

Store connection is down

An small located issue which targets a specific group. A certain shop that has no connection. In this case, digital payments cannot be made for a few hours to a day, although people might be able to use different shops. Current solutions are using cash or tallying expenses if customers are known. In this case retailers have a need for a backup tool to be able to continue doing business.

4

Power outage in an area

An issue which effects a large group or area. Multiple businesses and people cannot make digital payments for half a day till a day. Borrowing from other people, using different shops or not making payments are not an option. A functioning backup tool is needed. Current solution is cash.

5

Commercial bank going down

A major event targeting a specific group. This issue will not be solved in a few days. People are not able to use their issued cards or other services and need a new solution. They will have to switch to a different facilitator and for the transfer time need an alternative solution.

6

Natural disaster e.g. Tsunami hits Japan

A major disruptive event affecting a large part of society. People, businesses and infrastructure are affected. Digital payments are disrupted for a long, undetermined period of time and an alternative payment system is required for society to function. Current solution is cash but the withdrawal of cash is also disrupted.

For low impact disturbances, a personal backup system as visualized in figure 5.2 is a more suited solution. Something people have in their own possession and can use when needed. It requires no large scale deployment of a system. For high impact disturbances a large scale emergency system would be more suited. This system is coordinated by regulatory bodies and deployed when a high impact event takes place.

The focus will first lie on the low impact disturbances. These disturbances occur much more often and are the scenarios people are familiar with when talking about the backup function of cash. In these scenarios people would have to make around 1-5 payments in a different way they would normally make until normal functionality is restored. The value of payments that need to be covered also changes with the amount of time digital payment systems are disrupted. An estimation of the amount of money needed to cover payments during certain disturbances is shown in figure 5.3. The current advice from NIBUD is to have €50 cash in your possession for backup(NIBUD, 2013). This can support a person for one to a few days in their most crucial purchases and is a good focus point for this project also.

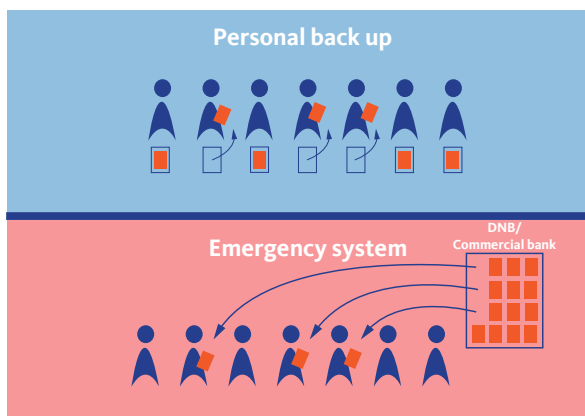


Figure 5.2. Personal back up system and emergency deployment system

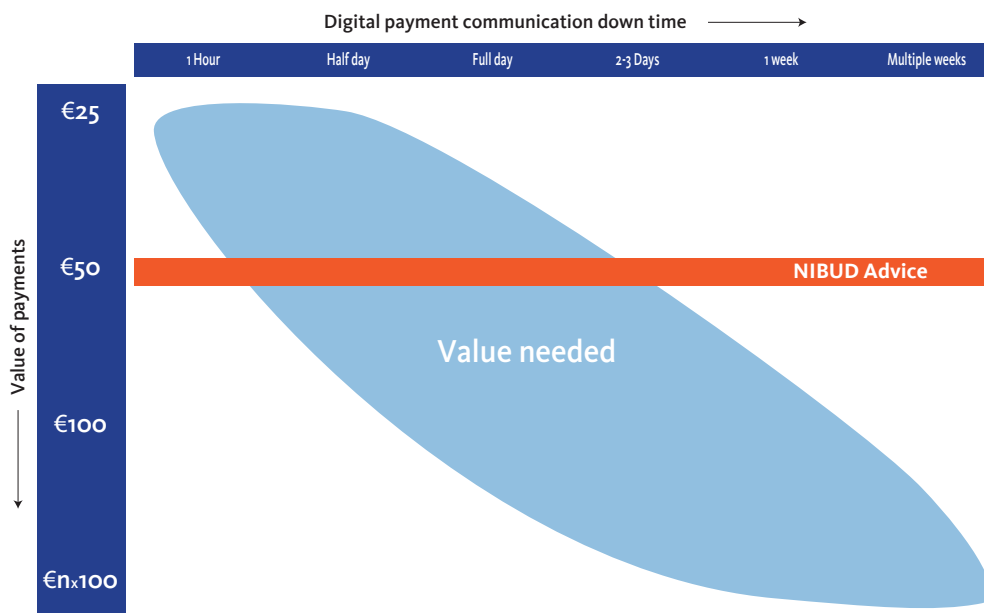


Figure 5.3. Value of payments needed during digital payment downtime

5.3 Low impact payment system disturbance

In the case of a low impact payment system disturbance multiple levels of goals can be stated:

Ideal goal: Smooth switching

A person is able to use a different payment method and does not have to change his/her shopping behaviour. Retailers experience no significant time or cost set back.

Compromise goal: Some effort

A person is able to use a different payment method but it does require more time and effort from the consumer and/or the retailer.

Minimal goal: Enough to function

A person is able to make essential payments but non essential purchases are postponed. These payments can come at an increased cost, effort and risk.

Cash currently functions somewhere between the ideal and compromise goal. Although in a lot of places cash is still accepted, the availability and number of people who carry cash is reducing. Therefore, in current digital payment disturbances cash is not always able to fully replace the digital payment methods. The question then arises if this inability to fully replace digital payment methods even for a short amount of time will continue to become worse and what actions should be taken to solve this.

If a low impact digital payment disturbance takes place, most consumers will notice this at the moment they try to make a purchase. Most people are not informed up front so no preparation is made by them. This can be observed in current disturbances where people do not have cash on them or shops run out of change. The ideal solution for a low impact disturbance should be something which requires limited preparation and therefore can easily be switched to when needed.

Recent cases of digital payment disturbances

Although the amount of digital payment disturbances are reducing, they still occur once in a while. In the recent year two major digital payment disturbances have occurred in the Netherlands. In the first case in July 2018 it was a disturbance of only 1,5 hours, but almost all users of Maestro cards were affected and it occurred at the end of the afternoon which had a major impact on purchases. The second case in December 2018 occurred in the early hours of the day when shops were still closed so mostly petrol stations were affected. In this case an error with a payment process system was to blame.

In both cases it became apparent that quite a lot of people were not able to pay with cash because they did not have it with them or it was not accepted. Therefore purchases could not be made. This resulted in a loss for retailers and an inconvenience for consumers. Because the second case affected mostly petrol stations and it is impossible to return fuel from a car if a payment cannot be made, the stations and costumers came up with different solutions to settle the payment. These solutions can also be seen in other disturbances and include using mobile payment methods such as Tikkie and leaving a deposit such as an ID or in one case even a wedding ring.

What can cause a payment system disturbance?

A digital payment disturbance can have different causes. A digital payment exists of multiple parties that work together to successfully facilitate a payment.

Every electronic payment system is dependent on power, so a power outage will have an effect on the ability to use these systems. While cash could function during a power outage, payment is not the primary problem during a power outage. Most shops closed down because other facilitatory systems also do not function. The doors can't open, lights do not work, cooling of food does not work and most importantly the register system does not work. So although the value settlement of a purchase could function all other aspects do not. Therefore a power outage is not a disruption that will be solved by a specific payment instrument. In that case purchases in general cannot happen.

Other disturbances of the digital payment system can be in the front end, back end or the communication between these as seen in figure 5.4.

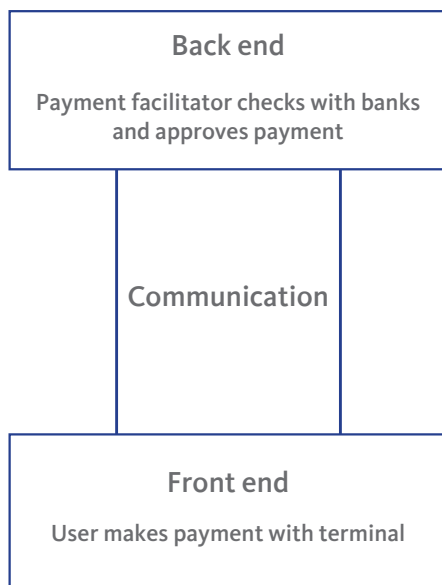


Figure 5.4. The front end, back end communication of digital payment systems.

The front end disturbances are problems with the payment terminal or another reason why the payment cannot be done at the PoS such as a broken card. These disturbances often only affect a small group of people.

The back end disturbances can affect larger groups of people. Back end disturbances are problems with the handling of a payment. This can be a facilitator that handles the payment or the banks associated with the accounts that are part of the payment. These disturbances affect all people who are dependent on payments facilitated by these parties.

The communication between the front and back end could also be the problem. In these cases both sides could function but no communication is possible between them. These disturbances can for example be caused by malfunctioning communication lines or problems at internet service providers.

What can be concluded is that the digital payment system is vulnerable at different points within the chain and until this system is robust enough, disturbances will occur.

Although cash has been the primary backup method when this happened it is dependent on change being present at the retailer. As more retailers are dropping their acceptance of cash it becomes difficult for cash to continue to fulfil this role and an alternative needs to be found.

5.4 Design goal

A design goal is defined to design a backup product when digital payment systems are disturbed:

I want to design a well functioning payment alternative that is available when current payment systems are disrupted. This alternative should require minimal extra effort, risk and cost when used.

5.4 Design directions

To fulfil this design goal some design directions were developed during a creative session with six DNB employees. The goal was to come up with a solution that functions when digital communication is down. The setup for this session can be found in appendix D. The leading question for this session was: How can you make an exact payment when digital solutions do not function?

The design directions that were identified are:

A payment queue that processes payments when the connection resumes.

This is from a user perspective the optimal solution. It requires no change in interaction or products and all changes during a disturbance will happen within the system

An “I owe you” (IOY) system, payments are made on a later moment.

This direction covers a solution some people already use themselves. A promise to settle the payment at a different time. This circumvents the disturbance but creates some trust issues. How can it be assured a payment will be made at a different time?

A physical exchange of value (cash or alternative), payment is settled directly.

This direction looks at an adaptation of cash. In the end, the most optimal solution is a direct settlement of payment.

5.5 Possible solutions

The design directions that were identified during the creative session are explored further to see how they could be implemented.

Payment queue

First the possibility of payment queue was explored. This solution functions if the disturbance occurs on the back end or on the communication connection. As this solution would be implemented in the front end, any disturbance in this front end would also influence this solution.

The role of the back end within a payment transaction is to approve the pending payment. This is done by checking the available funds on the payers account. If this check on the back end cannot occur, the payment cannot be guaranteed and opens possibilities of fraud. Retailers will not be willing to take on this risk so there has to be some other form of payment validation.

One possible solution can be found in the OV-chipcard used in Dutch public transport. This system has a built in queue system. This card stores the amount of available funds and can therefore allow a payment to be approved with a guarantee that the funds are able to be deducted. The problem that arises if this system would be implemented in debit card payments are the many touch points a bank account has. An OV-chipcard is the only way funds can be deducted from an OV account. Therefore the amount on the OV account will always be at least as much as the number stored on the card. Each time something is deducted the OV-chipcard will be updated. With bank accounts this is different. Withdrawals without a debit card are possible and will therefore not update the amount saved on the card. This creates an open system which cannot be secured and therefore no guarantee can be given.

So because a check on to the back end is required to give a retailer the guarantee of payment and this solution also does not function if there is a disturbance on the front-end, this solution does not seem to be viable as a backup system.

IOY system

An “I owe you” system is further explored. An IOY system builds on the idea that although a payment cannot take place at the moment of sale a prior or post payment could be possible.

If a prior payment has to occur, solutions come close to that of a credit card. This takes the risk away from the retailer and puts in on the credit card supplier. Most of the credit card payments are handled by the same system used in debit card systems and real offline credit card payments do not occur anymore. One solution that uses prepaid funds is the discontinued Chipknip system in the Netherlands. This system allowed you to store funds directly on a card and pay with it without requiring a connection to the back end. But this system had it's own limitations of not being able to see the amount stored on a card and it could only be topped up at specific terminals and was therefore in the end not a success with consumers.

Post paid solutions are dependant on the trust that can be established between the payer and the retailers. A retailer wants to be sure the payment will be settled at a later time and minimise his risk. This is already done sometimes using some form of deposit which is left behind. Such as leaving an ID card or some other valuable. Retailers will likely not mind if this happens once in while but it is not a solution if everybody does this. Creating a different kind of incentive for consumers to return for post payment is difficult. In the end it puts a lot of responsibility on a retailer to make sure he gets al his payments and is therefore unlikely to be used.

An already implemented system also works according to the IOY principle: debt collection slips(figure 5.5). It gives consumers the option to allow a single or period deduction from their bank account. And in the Netherlands the payment cooperation supplies SEPA one-time debt collection papers to be used at digital payment disruptions.

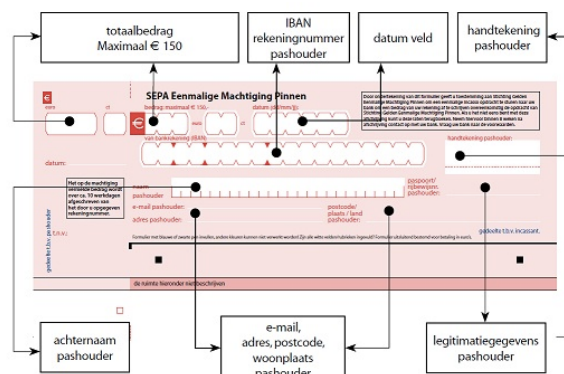


Figure 5.5 SEPA one-time payment authorisation

It is limited to only be used during a disruption and is limited to a maximum amount of €150. But although this option is offered to retailers and is a solution for digital payment disturbances it is used only minimal. It is not difficult to realise why it is used so little. Compared to the speed and ease of use of a digital payment this costs a lot of effort to fill in and send off. This does not fit with the fast paced buying experience users are used to.

What can be concluded is that different solutions that use a version of the IOY principle have been tried and tested and none have been successful so far. The issue is that it always lacks some form of guarantee for retailers that they will receive their payment. When such a guarantee is achieved, it often takes a lot of effort which consumer or retailer are not willing to do.

A physical exchange of money

Settling the payment at the time of sale is the most ideal solution and a physical exchange of money fulfils this. Cash offers this possibility of direct settlement but as stated above has its limitations and requires people to have it with them and retailers to support it. Changes to cash were explored to see if cash can be adapted to better suit a backup role. But any adaptation that was created had the same core issue cash has. It requires people to take it with them. A physical representation of money will always take relatively a lot of space in someone's carry on and people are not willing to do this anymore. Society is used more and more to fast and efficient digital payments and having to switch to a slower system which requires more effort does not seem like a viable long term solution.

5.6 Digital redundancy

It seems that non digital products that could be used as a backup tool in low impact disturbances require too much effort and change from the normal payment experience and are therefore unsuccessful and not used. It might be unrealistic to expect the cash infrastructure, which is consistently reducing, to be able to take over all the digital payment traffic. It can be visualised as a highway, in this case the digital payment system, that needs to be replaced by a small side road, cash, when a blockage occurs. Because traffic on this highway has increased so much, this small side road will never be able to properly facilitate the same service. The first efforts were made in improving or optimizing this side road but a likely better approach is to have multiple highways. When one is disrupted, people should almost effortlessly be able to switch to the other. This is called digital redundancy.

Currently our digital payments system is largely based on one infrastructural system and is therefore highly centralized. A centralized system is more vulnerable than a decentralized system. In some parts of the current infrastructure some redundancy has been implemented. Payments that can be handled by multiple payment facilitators on the back end or multiple communication lines connecting a business. This improved the robustness a bit but

for future reliability fully parallel systems should be implemented. This difference between partial redundancy and full parallel systems is visualised in figure 5.6.

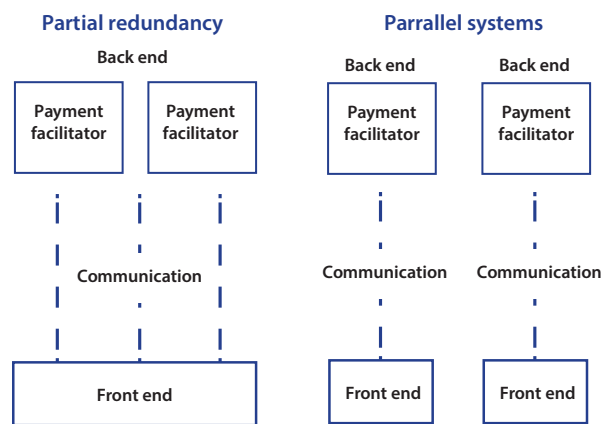


Figure 5.6 Visualisation of partial redundancy and parallel systems in digital payment infrastructure.

An example of a parallel system which is already used sometimes is the Tikkie application. Tikkie is an app created by ABN-AMRO that uses the IDEAL payment system to effectively make a bank transfer. This system uses a different front end, communication line and back end to facilitate a payment and is therefore still usable in most payment disruptions.

Mobile financial services

Mobile financial services are an example of an digital payment infrastructure which can potentially run parallel to a debit card system. These systems are highly successful in fast developing countries in Africa and Asia. These services used the often better established mobile infrastructure to facilitate digital payment. Most inhabitants of these countries do not have a bank account and the infrastructure needed for debit card payments was too expensive. Therefore the mobile phone network was used and Mobile network operators(MNO) have taken on the role of payment facilitators. These systems use a persons phone number as a money account and have created a well functioning payment experience for consumers. While MNOs in Europe will likely not take over as a payment facilitator as the European system is based on bank accounts, the infrastructure used shows how a parallel digital system can be implemented to improve robustness.

These kind of digital systems that can run parallel to debit card payments need to be developed, regulated and implemented in a way that creates minimal effort to use when the debit card system experiences a disturbance. If this is achieved a more decentralized digital payment system is created which is much more robust and the effects of a disturbance in one of these systems are minimized resulting in a better customer and retailer experience.

5.7 High impact disturbances

In high impact disturbances the primary goal is not to create the best customer and retailer experience, but to make sure some form of payment transaction can continue to occur. In this case cash can have a continued role as a backup tool. The reliability, familiarity and trust cash has gained throughout its history and its ability to function without the need of supportive products is crucial in these scenarios. Its downside of likely needing an emergency deployment of extra cash and temporary supportive infrastructure is justified by the severity of the situation. How such a deployment can occur in such a scenario needs to be evaluated continuously as normal cash support drops.

5.8 Conclusion

This chapter focussed on the role cash had and has as a backup payment instrument and if cash is still capable of fulfilling this role with its reduced use. What was found is that cash currently already has difficulty fulfilling this backup role in low impact disturbances. Alternative non-digital solutions are also not effective options as they are too different and disruptive from the payment experience people are used to. Furthermore they are not capable of handling the amount of transactions required.

The need for a backup tool is created by the vulnerability of the digital payment system which is highly centralized. A better approach would be to decentralize the digital payment system by creating parallel systems that function independently from each other. This will increase the robustness of the digital payment system and decrease the effects of a disturbance on retailers, consumers and the economy.

In high impact disturbances, events that can affect multiple different systems, have a much longer duration and are highly disruptive to society, cash can still be the most viable option. Although these events are rare and have not been seen in the Netherlands, yet it is important to be prepared for such a scenario. In this scenario a smooth customer experience is subordinate to making sure payment transaction can take place. These events likely require an emergency deployment of cash by regulatory bodies and central banks have to be prepared for this. As Dennis Waitly said: "Hope for the best but plan for the worst".



6 How to handle changes in cash usage

This chapter will discuss the challenges of a further transition towards a cashless society. The future scenarios described in the problem description show a continued decline of cash usage. Cash was a system which used to facilitate almost 100% of payments, but has reduced in a relative short amount of time towards a percentage below 40% and likely will continue to drop. Which consequences will this have for the stakeholders involved and how should cash adapt to these changes?

6.1 Transition from a cash society to a digital society

The OECD(2017) stated that: “The ongoing digitalization of our economies and societies will only expand and deepen. Digitalization does not only contribute to productivity and efficiency, but also to broader socio-economic development.” It is clear that the digitalization of society will continue and payment systems will follow this development. So how will this change happen? In figure 1.3 in chapter 1 the transition from cash to digital payments has been visualised. In the Netherlands, the amount of cash payments has dropped below 40% and there are no signs of this change slowing down. If statistics from the Digital Economy and Society Index (DESI) on the connectivity and human capital of eurozone countries are compared with the cash usage, a clear relation can be observed (figure 6.1).

Once a society becomes more digitalized, cash usage declines. This digitalization of payments has and will have a major influence on the cash system and on the people who have to make this transition. Both of these will be discussed.

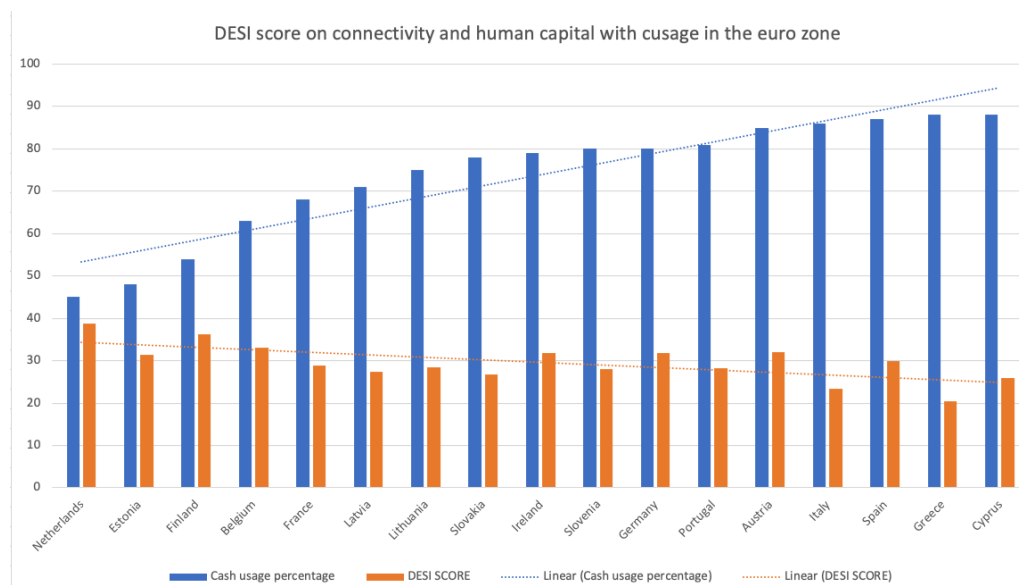


Figure 6.1. Cash usage compared to connectivity and human capital of countries in the eurozone

6.2 User groups affected by the change towards digital payments

First the change from a user-centred perspective will be discussed. The diffusion of innovation model from Rogers(2009) shows that innovation adaptation is not evenly divided over all different user groups. Although this model is often used for marketing purposes, it also holds merit within payment behaviour change. Within society, four distinct user groups were identified that have a different adaptation process towards digital payments. These groups are:

The cashless user

This user uses almost no cash. He or she sees no great benefits in using cash and has no emotional link with it. If this user has cash, he or she will not use it or get rid of it quickly. This group has been responsible for the majority of the cash usage reduction. This user is more than often of a younger age and has grown up alongside the digitalization of society.

The hybrid user

This user has no distinct preference, but uses what he or she deems better in each situation. This user has embraced digital payments in some cases but also sees the benefit of cash. Although he or she used to have a habit of paying with cash, he or she is now used to digital payments and is using it increasingly more. This user needs some more time to fully change his or her payment behaviour. This user is more than often in the medium age range. Although they have not grown up during the digitalization, they have adapted to it.

The cash lover

This user has always used cash and has no intention to stop doing so. This group has a strong emotional connection with cash and somewhat detests the digitalization of society and payments. More than often this user is a bit older and his long term habit of cash usage will not change anymore. This user is sometimes also a cashlover because of the privacy it provides instead of the emotional connection, although these often overlap.

The digital incapable

This user does not have the option to choose or adapt to digital payments because they are not capable. This user can be vision impaired, digital illiterate or have some other limitation. This user is dependent on cash and the reduction of cash will create problems for him or her. Only if custom solutions are created that solve the pains of this user, will they be able to change towards digital payments. This user often has some overlap with the cash lover and is more than often an elderly.

Cash reduction of different user groups

The reduction of cash usage differs among these different user groups. From a user perspective the ideal cash usage reduction graph is shown in figure 6.2. The ideal scenario means that users can change their behaviour based on their own experience and choice. Not because they are forced to do so. This scenario should be a goal for central banks to realise.

The cashless user has already moved away from cash and only uses cash in very specific cases. The hybrid user will be the next major group that will slowly lower their cash usage which will mostly leave the cash lover and digital incapable user as the primary cash user. Although the cash lover and digital incapable user groups will shrink over time, they will remain a substantial group and are dependent on the continuity of cash.

The reduction of use creates a niche role for cash. Cash used to be a product/service used by everyone and no distinct user base could be determined. If the reduction of cash usage continues, cash will get a much more defined user base which can have an influence on how cash and its system should function.

6.3 Consequences of this change

The ideal cash usage reduction from a user perspective as seen in figure 6.2 poses the question for central banks and other stakeholders: how to realize this controlled reduction and how to make sure the availability and acceptance remains high enough?

It is important that action is taken. If no action will take place, which has happened in Denmark and Sweden, cash will not experience this controlled reduction but more likely the system will implode as it will not be able to function anymore. The graph in figure x will then not level out at the end, but continue to drop to the bottom. Although this view is somewhat pessimistic, the first signs of this are already showing. In January 2019 the biggest cash distributor in the Netherlands, SecurCash, filed for bankruptcy (Burenlegel, 2019). This was a result of the reduced cash distribution market. If these problems are already appearing at a usage percentage of around 40%, it is likely more of these issues will occur for stakeholders in the cash cycle when this percentage drops.

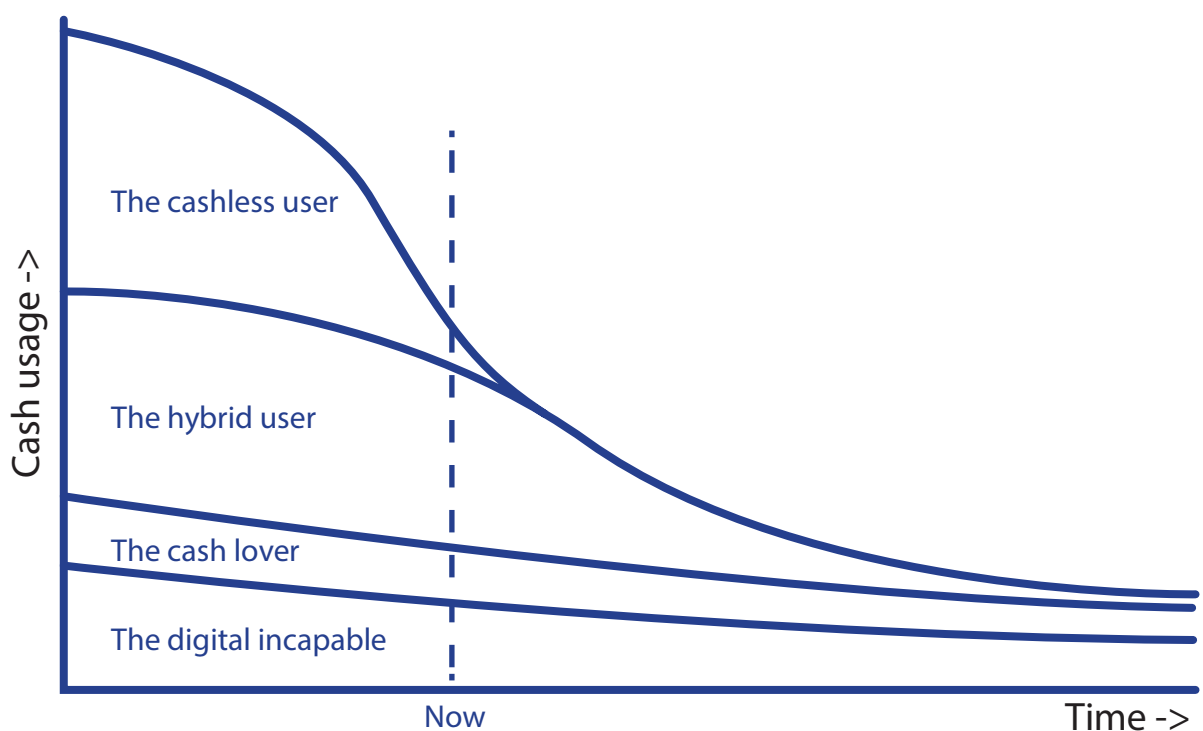


Figure 6.2 Ideal cash usage reduction from a user perspective.

Within the cash usage graph in figure 6.3, some critical minimum line can be drawn. The exact location of this line is difficult to determine. This critical minimum is defined as the minimal amount of cash usage that needs to occur to keep the cash system viable from a business, technological and human perspective. As to say, at what point is the infrastructure to support cash too expensive and at what level of availability and acceptance does cash still offer enough functionality towards its users?

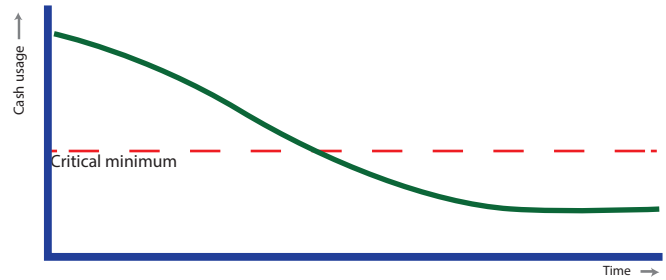


Figure 6.3 Critical minimum sketched in usage decline graph

Commercial banks are already experiencing difficulties with keeping the availability of cash high. In 2019 the Geldmaat was introduced (figure 6.4) (Geldmaat, 2018). This is a collaboration between commercial banks to optimize the ATM network in the Netherlands because independent ATM networks of each commercial bank were not viable anymore. The Dutch central bank together with the government are lobbying to keep the amount of ATMs as high as possible but their coverage continues to decline. These are likely only the first steps in the reduction of the cash supportive infrastructure.



Figure 6.4. The Geldmaat: an initiative to optimize the ATM network in the Netherlands

What the bankruptcy of SecurCash and also the creation of the Geldmaat show is that stakeholders within the cash system are already experiencing the consequences of the cash usage reduction and it is important that actions are taken to ensure a continued well functioning cash system. We seem to already be approaching this critical minimum line and will definitely pass this line if nothing is done.

Within politics there has also become more awareness of these developments and their potential negative consequences. In January 2019 the Dutch parliament unanimously supported the effort to keep cash available for those who need it and make sure that cash is accepted at locations where a person is forced to use its services, such as municipalities (Tweede kamer, 2019). The awareness that cash is of great importance to certain people is becoming more clear which is an important step in the continuation of cash.

6.4 Challenges going forward

The main challenges going forward for the cash system and all its stakeholders are as follows:

Creating a system that is viable on low usage

If the use of a product or system changes, the product and system should adapt to this change. Until now, mostly optimizations of the current system have been undertaken but for cash to be supported on the long term, the entire system might need to be adapted.

Keeping acceptance and availability high enough for remaining cash users.

The infrastructure cannot reduce evenly with the reduction of users without impacting the functionality of cash for the remaining users.

Plan ahead for the backup role of cash in major disruptions.

If the cash system is adapted to reduced use, it may interfere with the ability of cash to function during high impact disruptions.

6.5 Improving the cash cycle

The main problem for the cash cycle is the balance between functionality provided and cost of the infrastructure. Although the amount of users continues to drop, the supportive infrastructure can only drop to a certain minimal limit. This means that the cost per cash user increases when usage declines. It is acceptable if the increase in cost of cash happens a bit. If the total cost of payment facilitation is seen as a lump sum, the profit created by more people paying with digital payment instruments (these are cheaper per payment than cash), can be used to compensate the increased cost of cash payments. But this imbalance can only be stretched to a certain limit and the question is how these funds are properly distributed. If retailers pay the price for the increased cost of cash, keeping acceptance high will be difficult.

Improvements in the cash cycle for current and future cash use will therefore be a combination of:

- A more efficient cash distribution
- Regulation
- Possible subsidies

Based on the analysis performed on the cash cycle in chapter 2, two different challenges can be defined in regards to the improvement of cash circulation:

1. The circulation of notes should happen as much between the public and retailers relieving the burden and cost of supportive infrastructure and therefore creating a more viable cash system.
2. Coins need to circulate more instead of being stored or discarded after limited use. This will relieve retailers of consistent delivery cost lowering the cost of supporting cash.

6.6 Conclusion

The reduction of cash usage is not evenly distributed among all people. The user dependent on cash will become the primary user group of cash creating a niche role for cash. This reduction of overall usage creates challenges for the cash system to continue to facilitate the users. The first effects of this cash reduction on the supportive infrastructure are already affecting stakeholders within the cash cycle. For cash to continue its existence, the cash cycle needs to be evaluated and adjustments have to be made. The distribution of cash has to become more efficient while remaining functional for its remaining users. This can be achieved by optimizing the circulation of notes or supporting the circulation of coins better. The circulation problems of coins are caused by the design of these coins and therefore this challenge was chosen to further develop.



7 Design brief: Creating a circular coin system

Based on the prior design goals stated in chapter 4, further exploration was done into both the backup function of cash and the reduced use of cash. Based on these explorations, it became clear that cash will have a limited role as a backup tool and that the consequences of the reduced use of cash are more important issues to tackle. This design brief will describe the specific problems that were defined in this reduced use, the design goal and the process towards fulfilling this goal.

This design brief is a further detailing of the previous problem statements and design goals described in chapter 4 with a focus on the problems associated with the reduced use of cash. It was found that for the cash cycle to be viable and able to function well, the circulation of denominations has to be more efficient and less dependant on infrastructure. Especially with coins, problems within this circulation were found. Based on this analysis, the following problem statement was defined:

Problem statement

Coins are not being reused by the general public as much as needed, but are being discarded or stored because the effort of transporting and using coins is too high.

This led to the following design goal:

Design goal

I want to redesign coins to make them easier to transport and use; by making them smaller, lighter and better fitting with the carry-ons people have with them.

It is important to realize that these improvements of coins will have the biggest effect on the hybrid user group. These are the users that do still use cash but are also used to the faster and lighter payment interactions of digital payments. The primary cash users are currently already more likely to re-use the coins. By improving the cash experience of hybrid users the decline of cash could somewhat slowdown which will have a positive effect on the acceptance and availability of cash which will then benefit the cash users. Furthermore, it would lower cost for retailers which again will have a positive effect on acceptance. For the cash users it is important that a redesign of cash does not change too much of the way they use it. This user group is satisfied by cash although changes to cash can also improve their experience. Solutions that for example remove the need for change, such as receiving change digitally are therefore not feasible as this will create issues for the main cash users.

A list of design requirements and limitations is created to give guidance in the design process. This list can be found on the next page.

Design requirements

A list of design requirements is defined which state the minimal requirements a design has to fulfil in order to be approved.

1. Functions

- 1.1 Payments can be made anonymous.
- 1.2. The payment can be directly settled.
- 1.3. Exact payments rounded to 5 cents are possible.

2. Safety

- 2.1 The new design is resistant against counterfeiting.
- 2.2 People and retailers are able to assess the validity of the new design.

3. System

- 3.1 The design keeps the current denomination pattern.
- 3.2 The new design is cheaper and more efficient to transport than the current coins.

4. Users

- 4.1 The new design should be usable by everybody.
- 4.2 The new design is not more difficult to use for the current cash users.
- 4.3 The new design should assist the visually impaired in identifying the different denominations.

5. Use

- 5.1 The new design makes transportation easier for the general public.
- 5.2 The new design can be used in most carry-ons used by the public.
- 5.3 The new design does not slow down a cash payment.
- 5.4 The new design is easy to hand over as 1 denomination, multiple denominations and in combination with notes.
- 5.5 The new design is durable to endure long term use (5+ years) .
- 5.6 Different denominations can be clearly identified.
- 5.7 The new design clearly communicates that it are Euro denominations.



8

Redesigning cash used as change

To fulfil the design goal stated in the design brief, a design process was performed. Different design directions were tested to see what would result in the best improvement of coins. This chapter discusses the process that was followed, the ideas and concepts that resulted from this, the chosen concept and its further development.

8.1 Design process

The design process that was performed consisted of different phases. In figure 8.1 an overview of the process can be seen. The first part was about identifying potential design directions. For every identified design direction an ideation process took place which resulted in concepts. These concepts were evaluated based on the requirements stated in the design brief and on general feasibility in cooperation with DNB. Finally, one concept is chosen which is further developed.

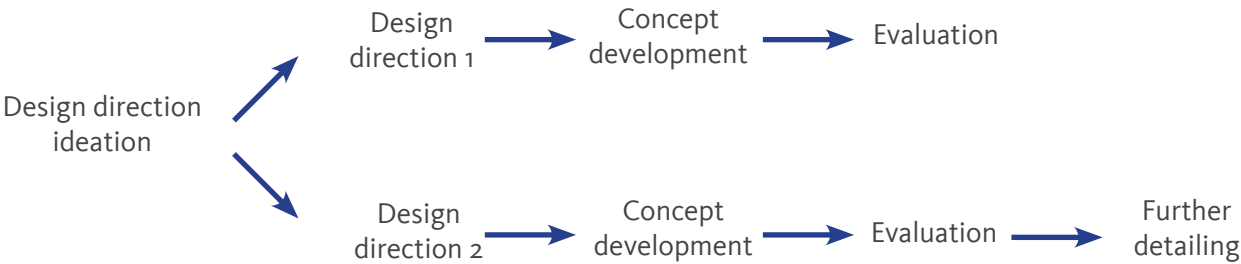


Figure 8.1. An overview of the design process

8.2 Design directions

The design process started with multiple How-tos that were formulated for the design goal. These are small problem statements formulated as a question to stimulate idea generation. The How-tos used in this process were:

- How to create incentives for people to use coins more?
- How to combine change in larger denominations?
- How to transport change?
- How to retrieve and store change?

An individual brainstorm was performed on these How-to questions which led to several design directions. These design directions will be individually discussed on their viability.

8.2.1 Incentives

Looking back at the behaviour model of Fogg described in chapter 1, behaviour change can be realised by improving the motivation of people or lowering the effort required.

Improving the motivation of people to reuse coins can be done by offering more incentives to do so. Incentives are ways to encourage people to reuse coins and redistribute them to retailers. From the brainstorm different incentives were created. An incentive used often in motivating behaviour is a monetary one, some form of monetary reward to support desirable behaviour. This can be realised by discounts when paying with coins or selling coins to retailers. Although a monetary incentive can be quite successful in changing people's behaviour, it is not possible in the context of cash. Because cash is already a monetary tool, adding a secondary value, which has to be higher than the face value, is unwanted. This would create a situation where cash has two different values which is unmanageable and creates possibilities of fraud. Therefore a monetary incentive was discarded as a possible solution.

Other incentives that were considered ran into

the same issue of adding a secondary value to cash. Adding some sort of benefit to the use of coins might push more people towards using coins they would normally discard. But these benefits have to also be given to the people who already reuse their coins. This will always be a limiting factor of adding incentives to coin usage which makes this solution infeasible.

A different strategy to motivate other behaviour is punishing negative behaviour, in this case the hoarding of coins. This can be done by limiting the fitness of coins or limiting the time of validity. This solution will have too much of an impact on the cost of coins and will likely create backlash. Punishing negative behaviour was therefore discarded a possible solution.

It seems that increasing the motivation of coin usage is not realistic. The motivation of using coins is already defined by the face value it represents.

8.2.2 Lowering effort

A different strategy would be to lower the effort required to use coins. This strategy would focus on improving the usability of coins. This is likely a more feasible design direction because usability was also described as the reason for the hoarding of coins. As mentioned in chapter 7, the Bundesbank stated that:

“Small denomination coins are used relatively infrequently to pay for goods and services. The majority are likely to be hoarded in order to lighten one's wallet, or are permanently lost.”

This shows that the effort of carrying and keeping track of coins is too much compared to the value they represent. Because the value they offer to people cannot be changed, coins should be improved to lower the effort required to transport them and keep track of them.

Based on this insight different factors were identified that have an impact on the effort or usability of coins.

Weight

Relative to banknotes, coins represent a lot of weight. A coin can weigh between 3 and 9 grams depending on the value. This is quite heavy compared to banknotes that weigh around 1 gram. Because coins are used as changed you are likely to have a number of them on you.

Size & transport

Coins are also much thicker compared to notes and cards. Coins thickness varies between 1,7mm and 2,4 mm. Although they are smaller in diameter, they are often stored clumped together as seen in figure 8.2.



Figure 8.2. Coins are often stored clumped together.

There size does not allow efficient storing which create bulges in a wallet. Because people want thinner carry-ons (slimmer phones, slimmer wallets) coins are often a significant part of the thickness of a wallet.

Retrievability

Even if coins are carried by people, using them can be difficult. Banknotes and cards can be retrieved quite easily from a wallet or phone case because they can be stored in a organized way. Cards are all aligned together and notes are often stacked in a predetermined space and order. Coins are much more free moving and do not support a person to create some sort of organisation. This means that every time coins are needed, a person has to determine which they have and where they are. If you have a coin purse, storing coins is somewhat easier than cards and notes. Because there is no predetermined location for each coin, they can be tossed in and do not need to be stored individually.

These factors should be improved to lower the effort of using coins.

8.2.3 Flexible denominations

This direction was defined from an insight within the cash flow. If we simplify the cash cycle to only the retailer and the public, we see that notes predominantly move from the public towards the retailer and coins move from the retailer towards the public (figure 8.3).

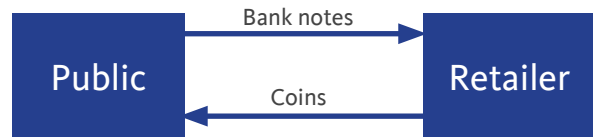


Figure 8.3. Simplified representation of the cash cycle between the public and retailer.

This can also be described as large denominations move towards the retailer and small denominations move towards the public. If smaller denominations could be combined to bigger denominations and vice versa, a circulation could be realised that is less dependent on infrastructure. This design direction will likely also have an effect on the Euro banknotes if further developed.

This combining of denominations could also be limited to only the coin denominations. If 5 cent, 10 cent, 20 cent and 50 cent denominations could be combined into 1 and 2 Euro coins it can already have a positive effect on the ease of use of coins.

8.2.4 Chosen directions

From this first analysis two design directions were chosen to further develop. One is more focused on improving the design aspect and stays relatively close to the current form:

Lowering the effort of transporting and using coins

The second direction is more drastic and much different from the current situation:

Creating denominations that can be combined and split up

Based on the two design directions described above, an ideation process was performed which can be seen in appendix E. The resulting concept will be discussed and evaluated.

8.4 Concept Token holder

8.2 Concept Flexible denomination

In figure 8.4 the concept 'Flexible denominations' is illustrated. The flexible denomination concept are individual denominations that can be combined together for easier transport and represent a larger denomination. A grid is created to allow the individual denominations to be combined in any way. The lower denominations can be attached to themselves or onto the back of bigger denominations.

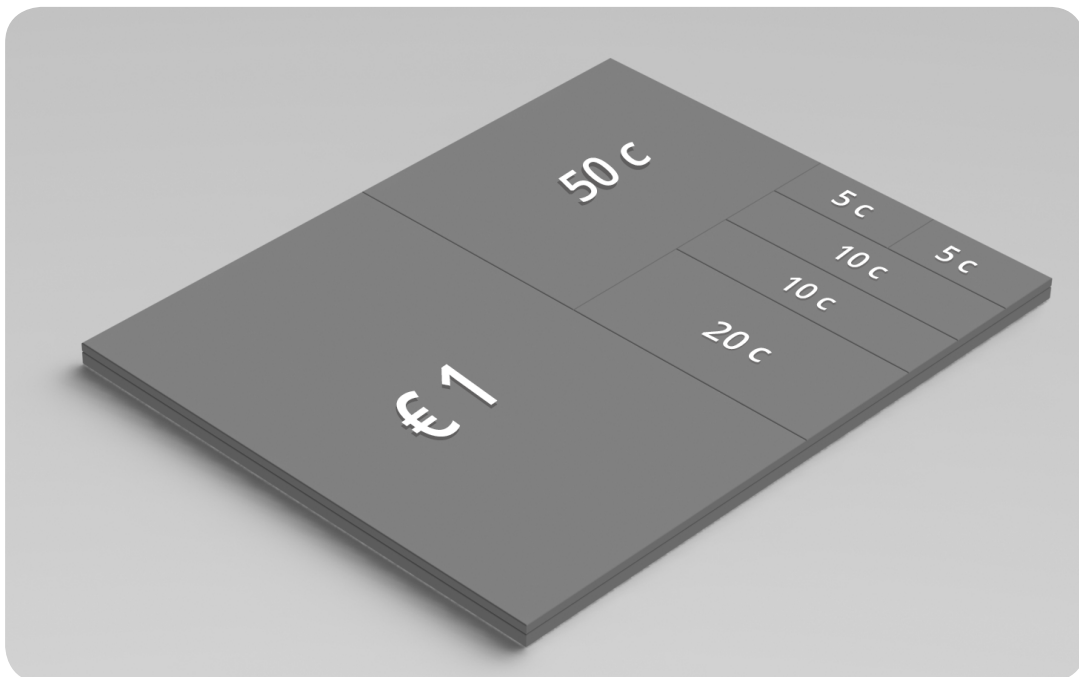


Figure 8.4 Concept flexible denominations

In figure 8.5 the magnet system can be seen. By adding small magnets in all denominations a system is created which allows any combination of individual denominations to be combined. The area a denomination represents is standardized across all values, meaning a 10 cent denomination is twice the size of a 5 cent denomination. This allows for the most possible combinations while remaining easy to handle.

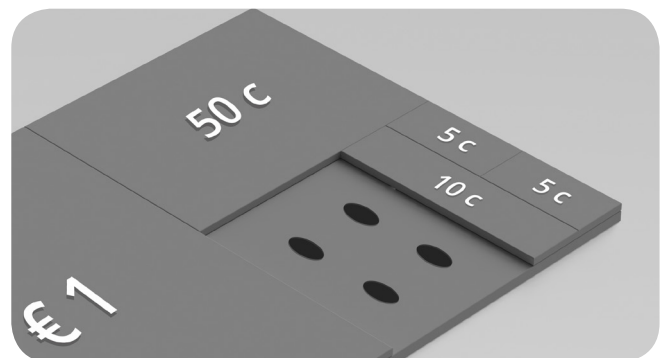


Figure 8.5 The denominations can be attached to each other by magnets.

In figure 8.6 the concept 'token holder' is illustrated. The token holder is combination of an payment card sided holder which can hold up to eight flat plastic tokens that replace the current coins. This concept was developed to allow people to organize their coins while fitting within the carry-ons they have. This shape was chosen because almost every person has storage for payment cards an they are easy to retrieve and store.

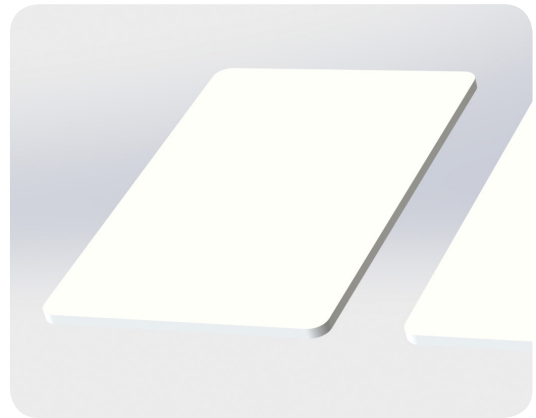


Figure 8.7 A token

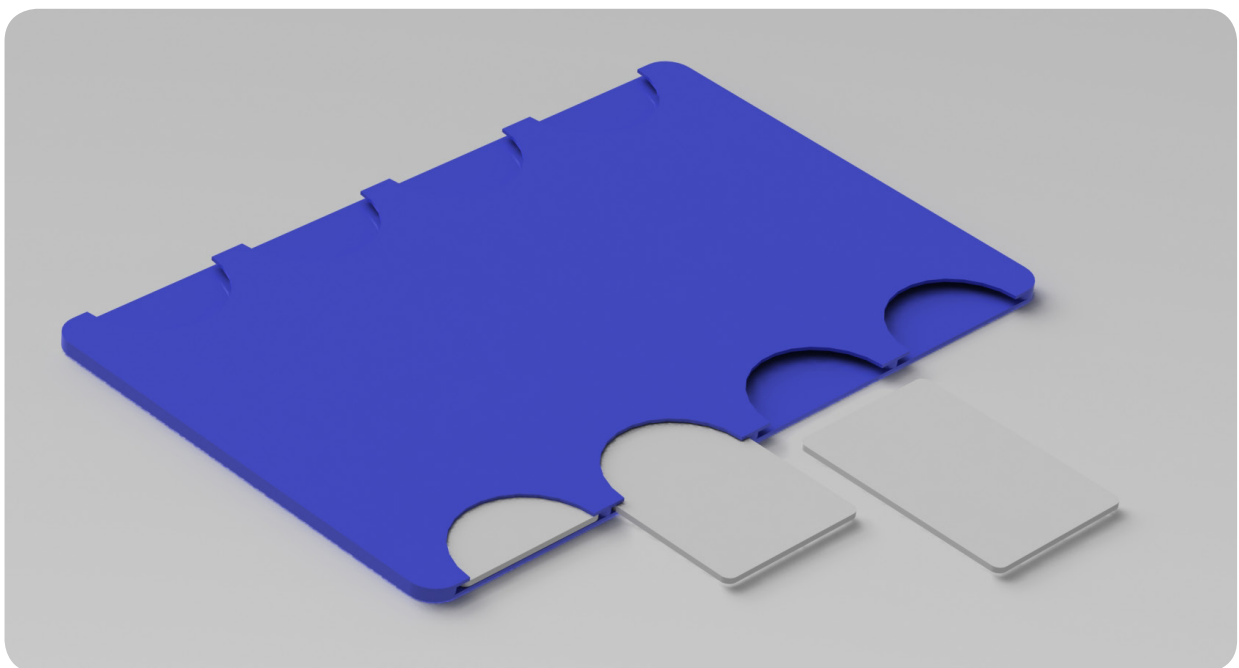


Figure 8.6 Concept token holder

The holder is sized according to the ISOID1 card standard of 85.60 x 53.98 mm(ISO, 2003). It has a thickness of 1,56 mm which takes up the room of two standard payment cards.

The tokens are equally sized for all denominations and have a size of 18 x 25,99 mm with a thickness of 0,76mm which equals the thickness of payment cards. A token is presented in figure 8.7.

The tokens can be slid in and out of the slots located at both sides of the holder and they are held in by friction. The holder has rounded in-cuts at the top to allow access to the tokens (figure 8.8). The tokens can also be used without the holder when needed or if preferred.

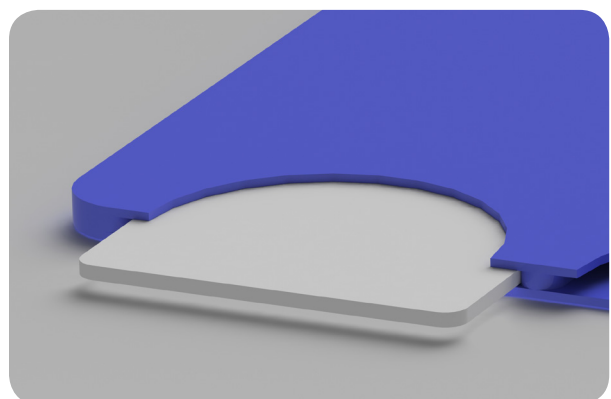


Figure 8.8 Tokens can be placed in slots in the holder

8.5 Evaluation

The concepts are evaluated based on the design requirements that were set and on overall feasibility. The evaluation will also discuss the most crucial problems.

8.5.1 Dividable cash

Although the underlying idea of this design direction could optimize the current cash cycle it was quite a drastic change and some issues were discovered in the concept that was created for it.

Firstly, the combining of denominations is a benefit because it could replace impractical small coins with a lighter weight, easier to transport note. But this was the critical problem with such a design. A combination of the smaller coins may not be harder to use than the notes we are used to. Because in the combined form, its shape and weight is never less than the sum of the individual coins there is not enough of a benefit or incentive to combine the tokens together. It is impossible to transform 10 Euros that are easy to handle individually into a 10 Euro note that is also light and easy to handle.

Secondly, combining all different combinations of coin denomination together will often not result into the correct amount (one of the larger denominations). This would require people to hoard the smaller denominations until they have the correct combination. This is the opposite of the effect to be achieved.

If an amount of, for example 5 Euro is achieved it is not interchangeable with a 5 Euro note. If people have the choice they prefer a note over a combination of the lower denominations.

These problems show that transferring a note to smaller change and vice versa is impossible or at least impractical. Concluding, the dividable cash direction is not feasible and is therefore discarded as a possible solution.

8.5.2 Token holder

The token holder concept was evaluated with employees of the cash department at DNB. A prototype was created and shown to the employees. This concept was received with enthusiasm. It was seen as an improvement on the transportation aspect and also had opportunities of improving the usability of coins. Furthermore, the addition of a holder was not seen as a problem. The use of the ISO standardized size of payment cards was a positive point which fits with carry ons people use now, and in the future. Based on this evaluation, a list of elements that are valued and elements that could be improved are created.

Valued elements:

- + Addition of a holder.
- + Slim size of the holder and tokens.
- + The same size for all denominations, this allows you to put each token in each slot.
- + The organisation you can create with the holder. Have a good overview of all the tokens you have.
- + The tokens can also be used without a holder.
- + The tokens allow for more graphical design possibilities which can lead to better recognition.

Points of improvement:

- It was difficult to retrieve the tokens as they were hard to grab.
- It was difficult to put tokens in the small slots within the holder.
- The amount of tokens in the holder needs to be verified with user testing. 8 could be enough but more might be better.
- How will security features be incorporated with the tokens?

8.6 Further detailing of the tokens

and the holder

The token concept was further developed based on the issues and possible improvements that were found in the first evaluation.

8.6.1 Detailing the holder

The holder was further detailed to improve the retrievability and storing of tokens (figure 8.9).

The opening on the individual token slots

To improve the storing of the tokens in the holder, the openings were adjusted. From a prototype model it was noticed that putting the tokens into the holder was difficult. The token had to be placed exactly on the opening to slide it in correctly. The in-cuts in the holder were moved further back creating room to put the token on the correct place before sliding it in (figure 8.10 & 8.11).

The number of token slots

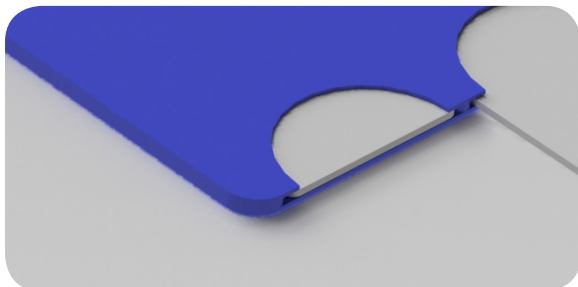


Figure 8.10. The in-cuts as they were presented in the first concept.

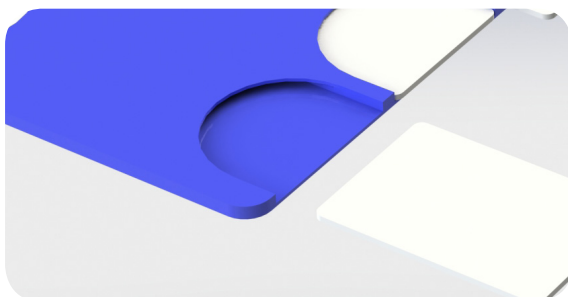


Figure 8.11. The in-cuts moved further back and widened.

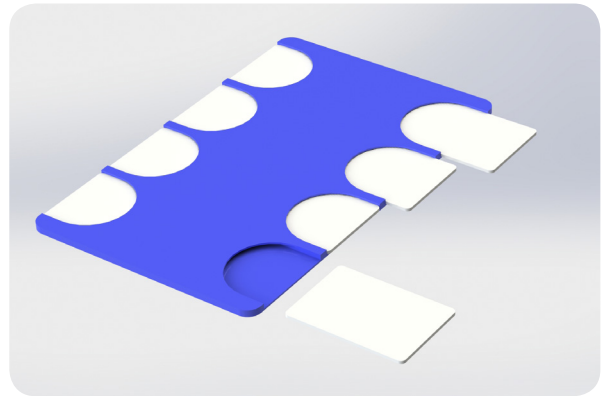


Figure 8.9. The improved version of the token holder concept.

A second version was created that can contain ten tokens instead of eight. Both can be seen in figure 8.12.

The tokens had to be made smaller because

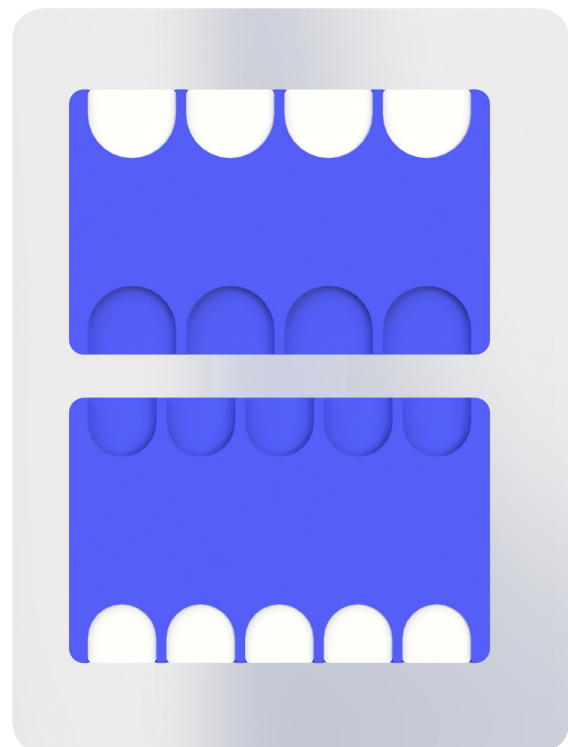


Figure 8.12 Two versions of the token holders: with 8 tokens and 10 tokens.

of the limitation of size in the holder. The ten version holder uses tokens sized 14 x 25,99mm, so they are 4 mm narrower than the 8 token version (figure 8.13). It is not yet clear what the best option is. The smaller tokens do allow more of them to be stored in a holder but they are also more difficult to hold. With the user evaluation both options will be tested.

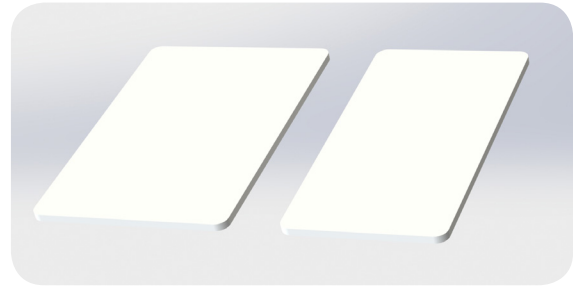


Figure 8.13 The bigger token (part of the 8 token version) and the smaller token (part of the 10 token version).

A second variation that allows more storing is a double sided holder which can be seen in figure 8.14. This holder has a double row of slots allowing people to store up to 16 tokens (or 20 with the smaller tokens). The back side of the standard holder can be used for both token slot rows, therefore only increasing the thickness by $\frac{2}{3}$ resulting in 2,66 mm. This is the thickness of about three to four payment cards. This option could be offered to people who use coins more often and require extra slots.

8.6.2 Detailing the tokens.

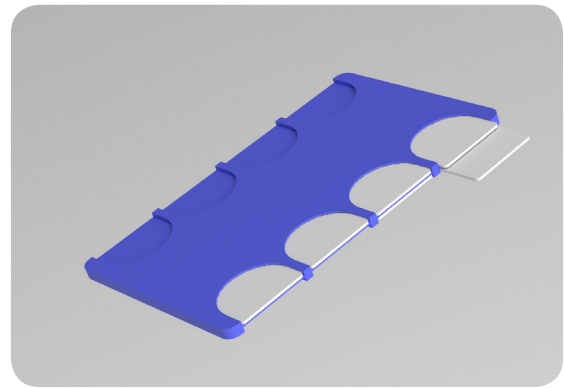


Figure 8.14 The double sided holder in which 16 tokens can be stored.

The tokens were further developed by designing the graphical layout and texture

Graphical design

As stated in chapter two, cash has to communicate its value and denominations should be distinguishable. Because the tokens are made of a plastic, a lot more graphical design freedom is possible in comparison to metal coins. To design the graphical layout the Upid-model from Hans de Heij was used(2017). This model was developed for the graphical design of banknotes but is transferable to these smaller tokens. The tokens will be made symmetrical to allow users to insert the tokens in each possible orientation.

The graphical design should clearly communicate the different denominations. Because these tokens are all the same size they lack the ability to be recognized based on their size or shape as current coins can. This needs to be compensated and possible improved by the graphical design of the token.

The user interface functions a token must support are:

- *Recognising value*
- *Handling*
- *Checking authenticity*
- *Receiving communication message*

For the first design, authenticity is not taken into account and will be discussed in chapter 10. First the colour of the tokens was determined. According to De Heij(2017), colours are a powerful tool and one of the most recognizable features of denominations. Because the Euro notes already have a colour scheme which people know, it was chosen to replicate the same colours within the tokens by matching the value of the Euros notes on the tokens in cents as can be seen in figure 8.15. Alongside the colour, the numerals on the token are important for recognising the value.

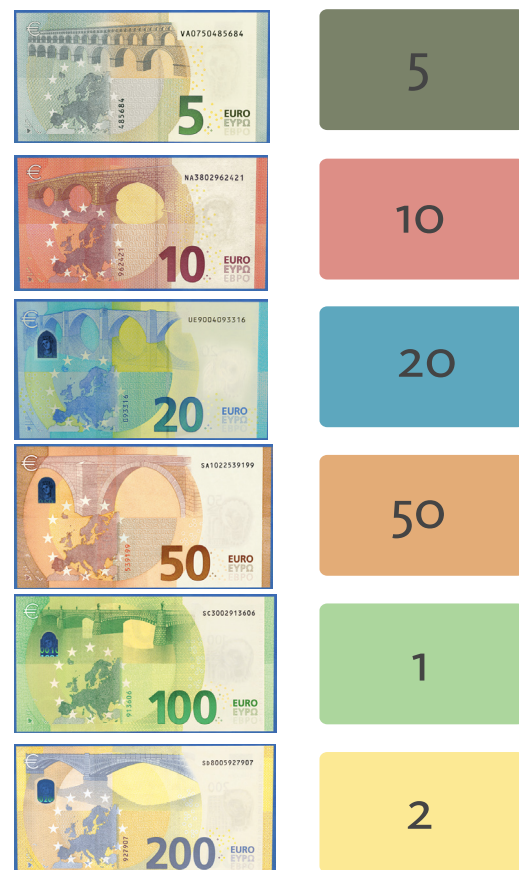


Figure 8.15 Matching the colour pattern of the tokens with the Euro Notes.

For sizing and placement of the numerals, it is important to realize how the tokens will be handled. When retrieving the tokens only the area within the in-cut of the holder will be visible (figure 8.16). Furthermore when tokens are handed over, a finger will cover part of the token at on side. Therefore numerals are placed at both sides of the token mirrored vertically (figure 8.17).

For visibility the numerals can be printed either positively (dark numerals on light background) or negatively (Light numerals on dark background). The positive numerals are more readable with high levels of light and the negative numerals with low levels of light. (De Heij, 2017). De Heij advises to put both negative and positive numerals on bank notes at different locations. For the tokens this is unwanted as it removes the symmetry which was intended. A compromise was tried which gave the negative numerals a dark outline combining a negative numeral with a positive one (figure 8.18).

In figure 8.18 the added units can also be seen. For the cent tokens, the letter c is added after the numbers. For the 1 and 2 Euro tokens the Euro sign is added before the numeral.

To add the communicative message of European cash, design elements used in the current coins are added to the tokens. In the 10 cent, 20 cent, 50 cent, 1 Euro and 2 Euro coins an illustration of the Euro countries is shown (figure 8.19). This illustration is reused for the new tokens, creating some recognizable element. These elements combined create the complete series of the new Euro tokens (figure 8.20).

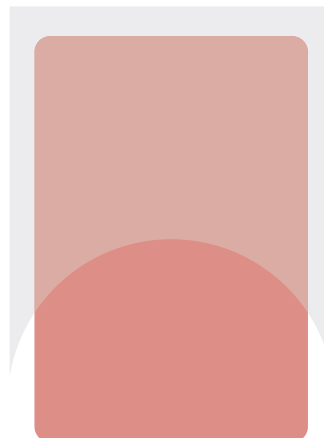


Figure 8.16 Visualisation of visible part of token when inserted in the holder

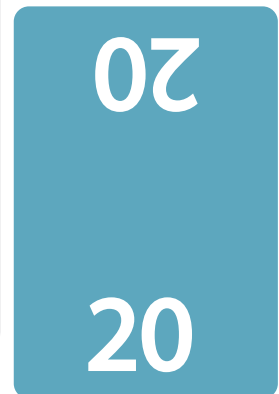


Figure 8.17 Numbers are placed on both sides of the token mirrored vertically.

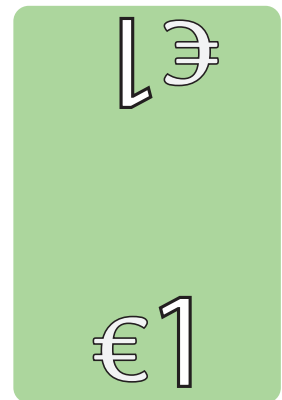
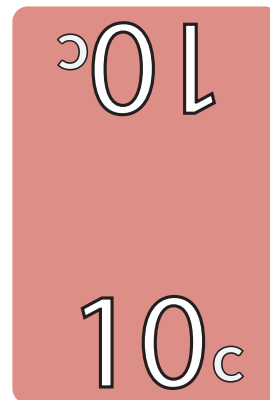


Figure 8.18 The design of the numerals and units.



Figure 8.19 The illustration of the Euro countries on the current coins is used on the tokens.

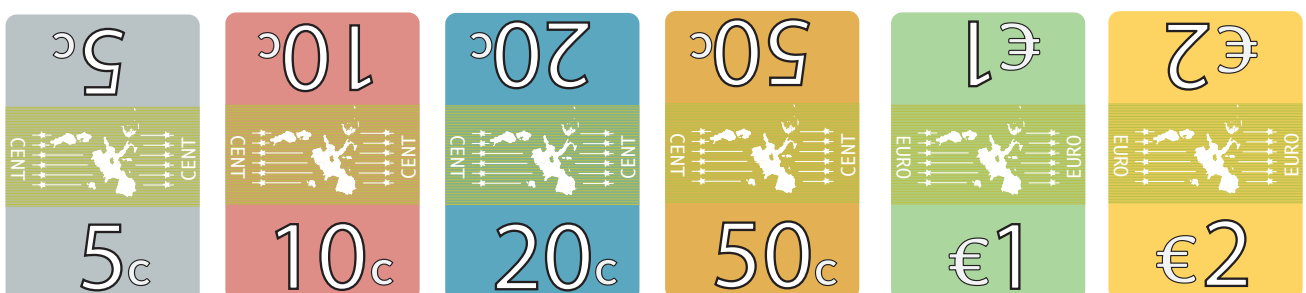


Figure 8.20 The complete series of the new Euro tokens.



9 Evaluation of the design

To further develop the concept and evaluate usability issues, prototypes are created that are tested with participants in a usability study. The findings will be summarized and the issues found will be addressed.

9.1 Test plan

The token holder concept was evaluated with a usability study. The research questions to be answered by this study are:

9.1.1 Research questions

How do people use it?

- How do people store the holder and tokens?
- Are the tokens experienced differently with and without the holder?
- How is the holder used during a payment?

Which usage issues are experienced with the product and what causes these?

- How well are the tokens distinguishable?
- Are the tokens easy to hand over?
- How is the retrieval and storing process experienced?

What are the preferences?

- Is there a difference between cash users and card users?
- Which size is preferred and why?
- Are these tokens preferred over the current coins and why?

9.1.2 Participants

For this study 8 participants are selected. 4 participants are selected based on their preference for cash payment and 4 are selected based on their preference for card payments. Of these participants at least two have to be above 60 years old. Other selection criteria are not defined. In table 9.1 an overview of the participants is displayed.

Table 9.1. Overview of the participants for the usability study.

Participant	Cash / card preference	Age	m/v	Special remarks
1	Cash	72	v	Retired
2	Cash	72	m	Retired
3	Cash	33	v	Low income
4	Cash	63	v	
5	Card	26	m	
6	Card	46	m	
7	Card	29	v	
8	Card	31	m	Shop manager

9.1.3 Method

The study will consist of a set of payment tasks followed by an interview.

Each participant will conduct a total of 16 payments in four different compositions.

- 4 payments with the normal tokens and the holder.
- 4 payments with the normal tokens and without the holder.
- 4 payments with the small tokens and the holder.
- 4 payments with the small tokens and without the holder.

The sequence in which these tasks occur are randomized to prevent a learning curve from impacting the test results.

The amount to be settled in the payments are consistent for each participant, but are also randomized in sequence. These amounts are determined based on the number of tokens needed for such a payment. The intention is to vary between combinations of notes and tokens in both payments and the change they receive.

In tables 9.2 and 9.3 the setup of the test for each participant is displayed.

The interview is a semi-structured interview which allows for further questioning based on the answers given. The setup of the interview can be seen in appendix F.

Table 9.2 Payment task options for participants.

Payment #	Kind of payment	Round 1	Round 2	Round 3	Round 4
1	Pay with 2 tokens	€0,55	€0,30	€1,20	€2,10
2	Pay with a note and 2 tokens	€11,20	€10,25	€13,00	€10,70
3	Receive 2 tokens as change	€9,60	€7,00	€19,40	€18,80
4	Receive 2 tokens and a note as change	€8,80	€9,60	€7,00	€9,40

Table 9.3 Test procedure for each participant.

Test sequence	Participant #	Cash preferred	Card preferred	Normal holder and tokens	Normal tokens only	Small holder and tokens	Small tokens only	Payment sequence(see table 9.2)
2	1	x		1	2	4	3	1234
3	2	x		2	1	3	4	2341
4	3	x		4	3	1	2	3412
5	4	x		3	4	2	1	4123
1	5		x	1	2	4	3	4123
6	6		x	2	1	3	4	3412
7	7		x	4	3	1	2	2341
8	8		x	3	4	2	1	1234

9.1.4 Procedure

For each participant 45 minutes are scheduled.

First the participant will be introduced on the test and what will be expected of him or her. He or she is asked to use their own wallet or any other product they use for payment in combination with the concept product. The participant has a short time to get acquainted with the product. This way the initial learning curve of using the product is not as influential on the test results.

Following this, the participant will start conducting the payments. The payment will take place in front of a counter imitating a normal retail payment. They are asked to store the tokens (and holder) and have to retrieve them to make the payment. The amount is communicated to them after which they will make the payment and store the eventual change. This is repeated for each of the 12 payments.

Following this the interview will take place asking about their experiences with the product and issues they came across.

9.1.4 Prototypes

For the test two prototypes of the holder and 36 tokens (18 normal/ 18 small) were created. With 18 tokens there are three tokens for each denomination. The prototypes can be seen in figure 9.1 and 9.2. The tokens are the correct size but do not have any texture yet because of the limitations of the prototype production method. The holder is approximately 0,4 mm thicker than the intended 1,56, again due to limitation of the production method.



Figure 9.1 Prototype with 8 tokens



Figure 9.2 Prototype with 10 tokens

9.2 Results

The results found in the usability study will be discussed. In this paragraph a summary of the feedback and identified issues will be given.

The tasks were performed successfully by all participants. Some participants preferred the addition of holder with the tokens, some did not see the holder as an improvement with the tokens.

The larger tokens were preferred over the smaller tokens as the smaller tokens were too difficult to handle.

It was observed that retrieving the tokens prior to a payment occurred faster and easier when using the holder as it allowed fast overview of the available denominations. Storing the tokens after payment took more time when using the holder compared to without or compared to the current coins.

The token holder was used in combination with large wallets, card holders or in a pocket. In all cases it could be used but provided the most benefit when used in card holders or in a pocket.

It was also observed that in some cases the token holder did not have to be retrieved from the wallet completely as the necessary denominations were already visible and retrievable at one side of the holder.

9.2.1 Points of improvement

Based on the performance of the participants and the feedback provided afterwards, points of improvements are listed.

Retrievability

- It is difficult to retrieve the tokens because they cannot be grabbed onto when in the holder.
- The tokens offered minimal grip because the prototypes were smooth which made it more difficult to slide them out the holder or pick them up from a surface.

Value recognition

- Denominations can be difficult to recognize when the tokens are stored in a pouch or pocket because they cannot be distinguished based on size or weight.
- It was difficult for people to distinguish between cents and Euros because the cent(c) and Euro(€) symbols are difficult to perceive
- The numbers were not easy to read due to the dark outline which reduced the contrast with the background
- Although the colours were seen as a good way to distinguish the denominations, they were perceived as not bright enough.

Storing

- It was sometimes difficult to put the tokens back into the holder because the placements had to be exact.
- It was sometimes difficult to put the holder into a card slot as it had sharp edges which could get stuck behind edges or fabric.

9.2.2 Further remarks

The current weight difference was mentioned as a benefit to the current coins as it made it easier to distinguish the higher value Euro coins compared to the cent coins. Some form of weight difference could be beneficial to make the tokens easier to distinguish.

The shop manager mentioned that the similarities between cents and Euros could cause more mistakes when handing of change.

9.3 Evaluating texture designs

Based on the findings from this study and the importance of inclusion when designing cash, new prototypes were created to evaluate different textures that could be added to the tokens. The textures would assist people when sliding the tokens in and out by the added grip causes by the texture. Adding texture has a secondary benefit for the vision impaired. By creating a texture which is unique for each denomination, people can determine its value based on tactility. To protect the texture and allow the tokens to be slid in and out easily, a positive border is created along the sides of the texture. The textures should allow the vision impaired but also the general public to distinguish and identify the different denominations. To create the textures, research of Maarten Wijntjes (2009) was used. In this research the hypothesis from Lederman and Hamilton is mentioned that single (relief) symbols are not suitable for banknote denomination since the shape of a symbol is not accurately perceived. Optimal tactile recognition can be achieved by clear spatial recognition of certain textures. It focusses on finding the location of a texture and being able of identifying the denomination with the help of this. Another option is to add sharp edges which are easy to recognize and based on the number of these edges, identify the denomination.

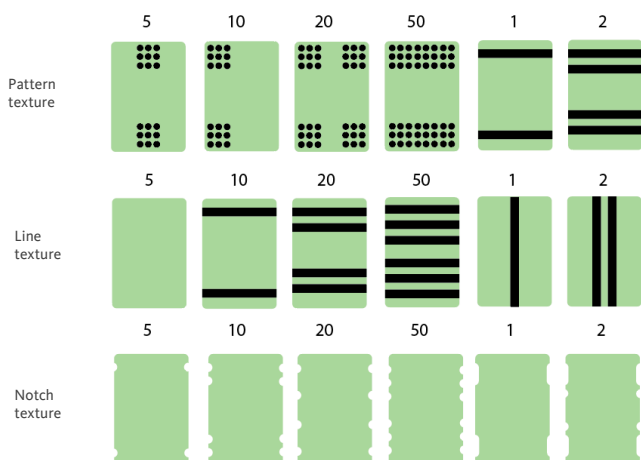


Figure 9.3 Three series of texture design for the tokens

9.3.1 Design and prototypes

Three series of texture designs are created which will be evaluated with two blind persons. The three designs can be seen in figure 9.3. One is based on the ability to recognize texture patterns and to identify the locations of these patterns. One is based on the ability to count the amount of edges based on touch. The last one uses a system of long and short indents located at the sides of the tokens. Of these series, prototypes were created which can be seen in figure 9.4. These prototypes were evaluated during a table session. No full usability study was performed, but relevant recommendations for the further development of texture patterns is provided.

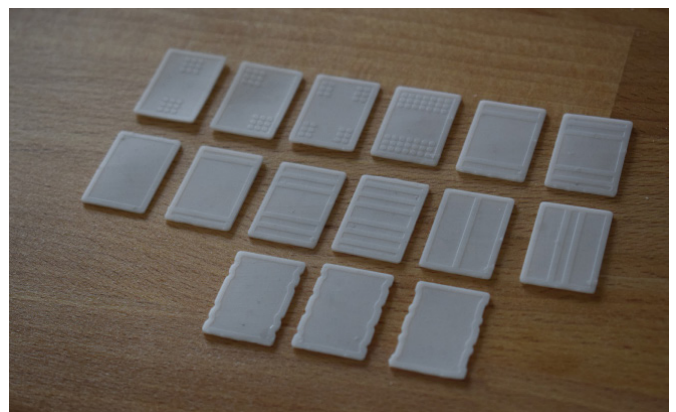


Figure 9.4 Prototypes created to test the texture designs

9.3.2 Feedback

The pattern texture was difficult to feel. Although they were able to identify the denominations, it required much effort and they would not recommend using such a system. The two persons highly preferred the line texture tokens as they were better to feel and easier to identify. The notches were difficult to identify the denominations but they did mention that such notches could help them distinguish the Euros from the cents.

They also mentioned that a contrast between the cents and Euros is important to allow a first filtering and this could be achieved by for adding only notches to the Euros or having some form of weight difference between the Euro and cent tokens.

9.3.3 Recommendations

A list of recommendations is created for the further development of haptic elements in the tokens.

- A line texture is the easiest to feel and identify.
- The higher the texture the easier it is to feel.
- Euros and cents should have a different pattern.
- Weight difference can provide a first filtering of Euros and cents.
- The material should feel and be identifiable as money. It should not be confused with other small plastic objects.



10 Final design: Euro tokens

Based on the findings from the usability study improvements were made to the design of both the holder and the tokens. The resulting design and its features will be described in this chapter. Furthermore some recommendations on the material and safety features will be given.

The final design is a combination of new Euro tokens which can be used in combination with a holder (figure 10.1). The design replaces the six denominations of the current Euro coins excluding the 1 and 2 Euro cent coins.

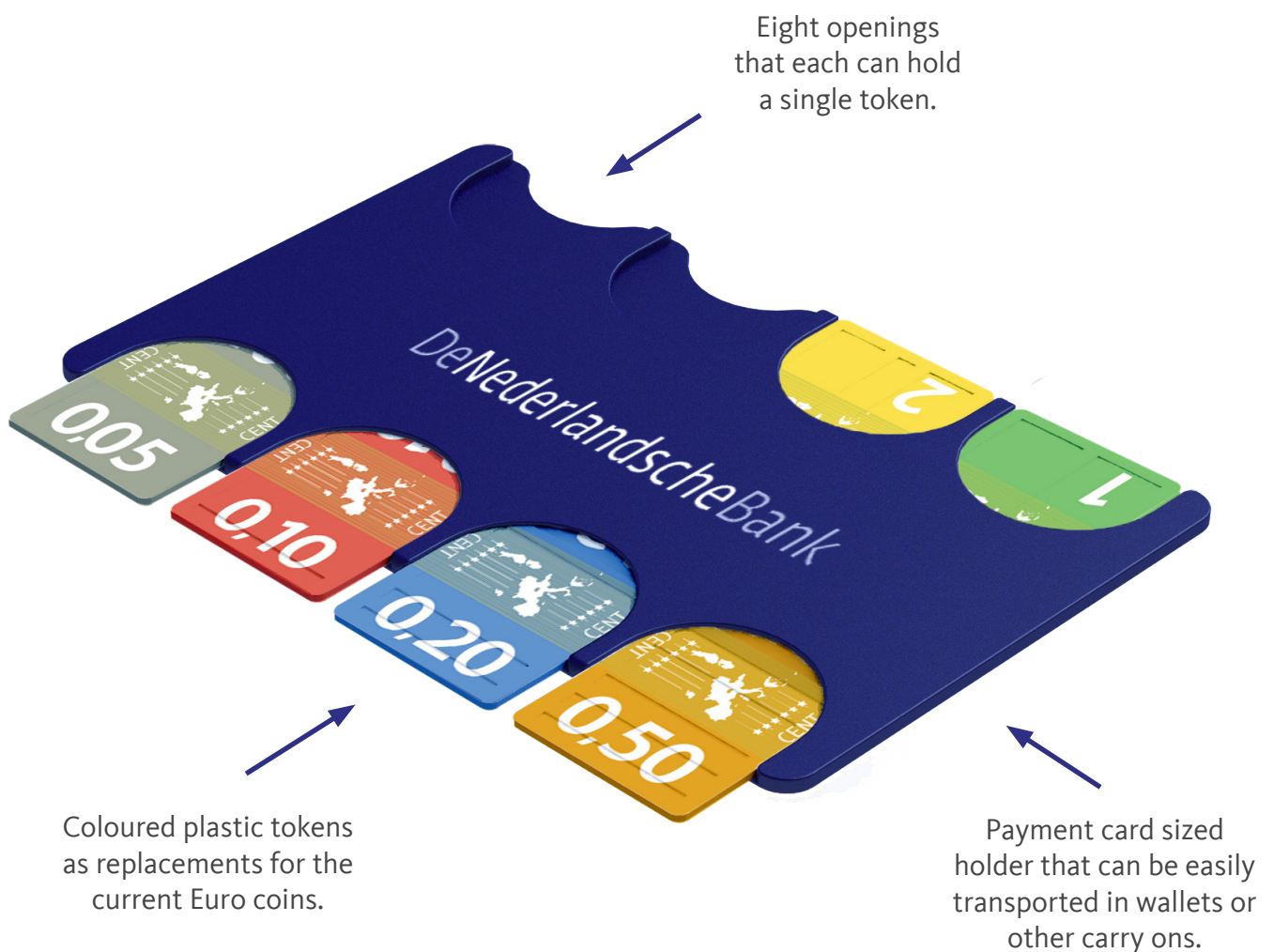


Figure 10.1 The final design: the holder including the Euro tokens for all six denominations

10.1 The tokens

The denominations are six evenly sized plastic tokens which differ in colour (figure 10.2). The tokens are sized 18 x 25,99 mm with a thickness of 0,37mm. All design aspects of the tokens will be individually discussed.

Shape

The shape and the size of the tokens are based on the holder for which it is used. With this design 8 tokens fit within the holder which is sized according to payment card dimensions. The tokens are small enough to transport multiple of them easily but are large enough for people to handle them comfortably. The thickness of the tokens are similar to payment cards which allows the holder + tokens to fit within the space of two cards stacked. All the tokens are made of plastics, additionally the €1 and €2 tokens have an added metal layer in the middle to increase their weight a bit compared to the cent tokens. This allows for easier recognition of the higher value tokens.

Graphics

The graphical design on the tokens is based on the usability functions of the product. Each token is symmetrical on rotation and on both sides to allow users to insert the token in each direction. On the face of the token, two areas are defined:

- The value area that holds the numbers representing the denomination
- The communication area that holds the currency information and symbolism.

The value area is always visible when inserted in to the holder or when a token is held between two fingers. The value numbers are based on Euro units with the cent tokens represented as decimals. This allows for easier recognition between Euros and cents. The 1 and 2 Euro numerals are placed of centre again to allow for easier recognition. For the communication area a design is proposed which is partially based on the current coin design. Other options are also possible and open for further development.

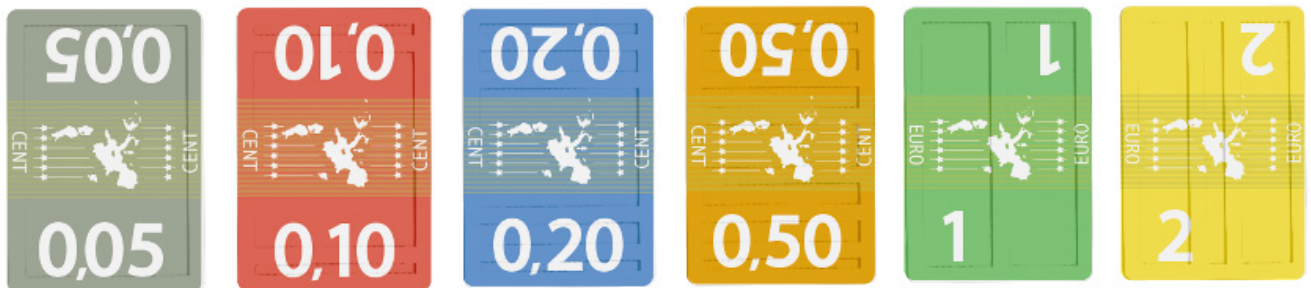


Figure 10.2 Euro tokens

Texture

The tokens have a texture added to allow for easier retrieval and is an identification tool for the visually impaired. The textures are created using protruding edges. Based on the number of edges and orientation of these edges the denomination can be identified. The cent tokens have horizontal edges varying from 0 to 3 edges for 5 to 50 cent respectively. For the 1 and 2 Euro tokens, 1 and 2 vertical edges are used to allow for easier recognition between cent tokens and Euro tokens. To protect the protruding edges from wear, a protruding border is placed around the face of the tokens.

Colour

Each denomination has its own colour which is based on the colour pattern seen in Euro notes. Colour difference is the most important tool in distinguishing denominations and these colours were chosen based on the contrast between sequential denominations.

10.2 The holder

The holder (figure 10.3) is designed to allow easy and efficient storing of the tokens. The holder is sized using the dimensions of payment cards: 85.60 mm x 53.98 mm. The thickness is equal to two payment cards at 1,52 mm.

Slots

Each holder has 8 slots to allow tokens to be stored (figure 10.4). Each slot has a rounded opening at the top which allows users to position the token correctly before inserting (figure 10.5). At the bottom of the slots a smaller indent is placed. This indent allows a user to pinch a token when it is inserted to allow easy retrieval.

Each slot holds a single token. Because the sizes of the tokens and slots are all similar, each token can be placed in any open slot.

Alternative versions

Different versions of the holder can be created based on different demands. For example a double sided version is created to allow up to 16 tokens to be stored for people that require more than 8 tokens (figure 10.6).

The holder also opens options for commercial marketing with different colours and logos that can be added. Commercial banks can create their own versions to supply to their customer base.

Furthermore completely different design can be possible as long as they have the right sized slots to hold tokens. Such slots can be integrated with phone cases, cards clips or other products.



Figure 10.3 The holder

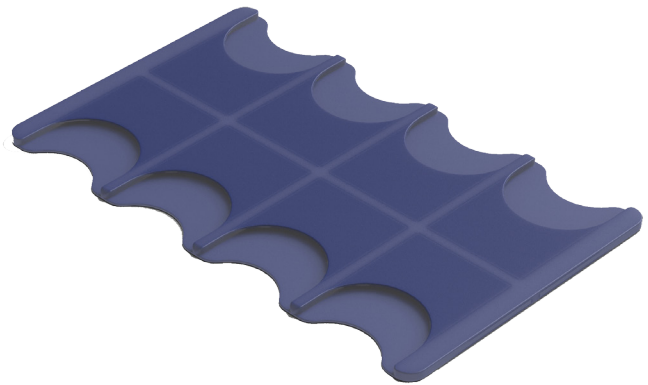


Figure 10.4 The holder has 8 slots to store tokens



Figure 10.5. Rounded openings and incuts allow the user to insert the token correctly before inserting.

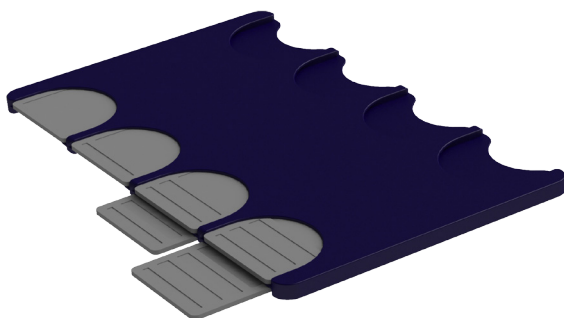


Figure 10.6. The double sided version of the token holder with 16 slots

10.3 Further recommendations for the design

10.3.1 Security

Cash money has to be secure from counterfeiting and should therefore facilitate authentication by users. No security features are completely resistant to copying but the goal is to create features which are too difficult to copy to make it worth while counterfeiting them. The safety features are less crucial with coins compared to notes as the value they represent is lower. Developing security features in this design was out of scope for this project but some recommendations of possible features are given.

Holographic images

Similar to banknote design, using complex holographic imagery (Which can be seen in 2.2.4) on the communication area of the tokens can create a difficult to copy and easy to validate product.

Perforation techniques

Because of the plastics used in the tokens some form of perforation technique can be used. This technique is currently seen in some identification documents. It creates an image by micro perforations in the material which is difficult to copy

Passive electronic chips

Adding passive electronic chips such as NFC chips would allow electronic validation of cash. This feature would be an addition to other visible safety features. This feature would also create a way to add machine readability to the tokens.

Security fibres

Used in most paper based products, adding small fibres distributed through a material makes it harder to imitate the material in production.

10.3.2 Material

Fully defining the material for such a product is a long process of testing and evaluating based on use, cost and the implementation of security features. For this project this was out of scope but some recommendations can be provided.

Tokens

The advice for the primary material of the tokens is a plastic or composite plastic. The goal of this is to greatly reduce the weight compared to the current metal coins. Furthermore plastics allow more graphical freedom in design of the faces. To allow some weight difference between the higher and lower denominations it is proposed to add a thin layer of metal inside of the €1 and €2 tokens. The plastic used will be dependent on the fabrication cost, detailing freedom and durability of use.

Holder

For the holder different options are available which can also result in different material versions. Soft silicon versions could be an option for flexible storing, stiff plastics can be chosen for use in card holders and to minimize weight. Metal versions are also possible from an aesthetic point of view or due to integration with existing card clips.



11

Conclusion and Recommendations for the future of cash

The findings and problems described in this report show the challenges cash and the payment system as a whole face in the short and long term. These challenges will require effort from all participants and stakeholders within this system, but the central banks within the eurozone should have a leading role in this. This chapter provides the conclusion and final recommendations for the future strategic steps of the cash system.

1 The use of cash as a payment instrument is reducing and its not going to stop

The reduction of cash usage is not something which is limited to certain countries, cultures or economies. There are context factors which have an influence on this reduction, but in general the same conclusion can be drawn: if people have the luxury to choose on usability, digital payment instruments are preferred over cash. Although this speed of change is not occurring at the same rate everywhere yet, it is going to happen and its crucial that central banks are prepared and take steps to deal with a low usage of cash and its infrastructure. An example is the proposed redesign of the Euro coins.

2 Cash is becoming a niche product with a more defined user base who have different user demands

One of the first consequences of the reduction of cash usage is the change in user base. When cash usage is high, there is no defined user base. It is used by everybody. Cash usage starts dropping when certain demographic groups stop using it all together or only use it on rare occasions. This usage reduction of cash is not evenly divided among all users. This means that if cash is used in 30% of payments, a large portion of these payments is done by a small group. In countries where cash usage has dropped significantly, a niche group of users is left who still use cash in most of their payments. Central banks need to be aware of the reasons and motivations of these remaining user groups and identify the specific demands they can have on the product or the cash system. A product should adapt to the users it has.

3

Hoarding of cash is becoming its main function and should be supported

Although cash used in payments is reducing, the overall amount of cash in circulation in the eurozone is increasing. It is important to realise cash has multiple functions and one of those is a store of value. Multiple statistics show that the amount of cash that is hoarded is increasing. This means that cash is being used less in transactions and more as a way to store value independently of banks or digital systems. While the infrastructure and support for cash as a day to day payment tool is dropping, it is important to realize what effect this would have on cash as a hoarding tool. If this stored cash cannot be used as easily in normal payments, the importance of other touch points increases. If cash should function properly as a store of value, it should have ways to interact and be interchangeable with digital payment tools. This means that withdrawing or depositing large amounts of cash at commercial or central banks is something that needs to be available. If people are not able to use their stored cash in payments and they are not able to deposit it; the trust in cash, the currency and the government that controls it will be at risk.

4

Becoming cashless does not mean cash will disappear

Cash has long been seen as the backup tool for digital payments. Because of the reduction in use, and the drop in infrastructure and support, cash will not be able to facilitate the payments during short term disturbances in the digital payment system. The backup role cash should have is when high impact long term disturbances take place. Society disturbing events such as: natural disasters, (cyber)war or events that disrupt the confidence in the digital financial system. Although these events do not happen often, a government or central bank has to be prepared for this. This does not mean that cash has to continually be supported and used to be ready for such an event. While a society is stable, cash usage as a payment instrument might drop to 0% and a cash cycle will be non existent. When it is needed, there has to be an emergency plan to quickly redistribute cash and setup a functional cash cycle again. In other words: cashless is a result of the societal context. If this context changes, cash might need to return and central banks need to be prepared for such a situation.

Discussion

Within this report multiple findings and recommendations are communicated regarding the future of cash. The challenge in designing for the future are the assumptions you create and how well these hold up over time. It is therefore crucial that the conclusions that are stated within this report are consistently evaluated and revised if necessary. Within the creation of the future scenarios, disruptive events are taken into account but new events can always happen which can have drastic impact on the way cash and the cash system might need to function.

Furthermore there is much to achieve in improving the available data on payment behaviour and especially the cash cycle. With better knowledge of what happens within each step of the cash cycle and how cash is exactly used, better insight can be gained. This will allow central banks to prepare for changes.

For the proposed design further developments steps are required. The design shows how cash as a product can still be changed, but further research is required to evaluate if such a change is possible and if it will fulfill the goals for which it was created. The major aspects that need further development are: the production of the tokens, the material properties for wear, the safety features that need to be added and the implementation of the design in combination with the existing coins.

Reflection

This project marks the end of my time as a student. This project has provided valuable lessons and experiences I will be using throughout my further career. In this paragraph I will reflect on the lessons I learned during this project.

At the start of this project the size and complexity of the subject was already apparent. Most projects I have worked on had a defined context and often an already visible problem. This project only gave the broadest context of cash and the future it might have. This was a challenging task as it required me to first discover all aspects of this context and find all the factors that can have an influence on it. This resulted in a full system analyse and redesign of cash as a service, where the coins and notes are a product of. Tackling such a service system was challenging, but also really interesting and I think it was a valuable lesson for me. Within this system the complexity of all the different stakeholders became clear, which required me to take along their needs and communicate with them throughout the project.

Designing for the long term future was also something which was new for me. It required me to learn new methodologies about future scenario sketching. To not only look at the current world, but extrapolate trends and take along disruptive events. These methodologies were really valuable for me and I think it should also get a place within the curriculum of Industrial Design Engineering as the developments in society come much faster.

Lastly, this project gave me the opportunity to work with experts in the field of cash and payment systems. Although I have worked with experts before, in this project I could constantly discuss and evaluate thoughts, ideas and insights. It showed me the value of surrounding yourself with people who are knowledgeable on specific topics to assist you in tackling large scale issues.

In the end, I thoroughly enjoyed the project and discovered my passion for large public service systems and the fascinating challenges these hold.

WORD OF THANKS

I want to conclude this report with thanking the people that helped me during this project.

First of all, I want to thank my chair Jasper van Kuijk and mentor Arnold Vermeeren for the support and coaching I received during this project. I especially want to thank Jasper for all the interesting discussions we had about this project and many other interesting subjects.

I also want to thank Jelle Miedema and Hans de Heij of DNB for their guidance, expertise and the pleasant collaboration we had during the project. I also want to thank all the other employees of the CBS department for their input and hospitality.

Lastly I want to thank Marije, my number one spell checker and the person I could always share my thoughts and ideas with.

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Icons

flaticon.com



12 Appendix

Appendix A: Interview question list

1. Do you still use cash?
Why do you (not) pay with cash?
2. Do you have cash with you?
3. Do you also use payment cards?
4. Which do you use more often?
Why?
5. In which situations do you use cash?
Why?
6. What is the benefit of cash over payment cards?
7. What are the benefits of payment cards?
8. Have you encountered digital payment disturbances?
How did you deal with this?
9. Do you think cash is going to disappear?
Why(not)?
10. Should cash disappear?
Why (not)?

Appendix B: History of cash

3000 BCE: The first steps

Bartering

Bartering is the trading of goods with other people and is the simplest form of value transfer. Person A gives object x to person B for object y. This requires you to know the exchange rate between objects, find a person who is willing to trade specific items and practically, transport the objects.

Standardized trade

The barter system had its impracticalities and resulted in the first instance of a standardized trade system where a commodity useful for most people was the preferred trade object. In early times this were items such as grain, livestock or plants. There was some form of agreed value of these commodities and could therefore be traded more easily.

Shekel

The shekel was introduced in Mesopotamia and represented a weight of barley or the equivalent value in silver, bronze or copper etc. It created a direct link between a commodity and an amount of metal. The term shekel was also used as a unit of weight in general and created a standardized system of value.

1000 BCE: Coinage & metals

Dedicated coins (Standardisation & Trust & Symbolism)

The metal representing a shekel was not dedicated as a trade instrument only. Metals had their own use in crafting and were valuable for their use. Although coins or badges were already in existence they were created for religious or ceremonial uses and were too valuable in normal commerce. The first coins used for commerce came around the sixth century BC in Greece, India and China. They had different designs as the Indian coins were punched, Chinese coins were cast with a hole in them and Greek coins were stamped. The Greek coin had one image on both sides were one was often a head of person, something still seen in coins today. This stamping also added a form of authorization which resulted in some form of trust in the currency alongside its intrinsic value.



Greek ancient coins



Indian ancient coins

Assaying (Authentication)

Assaying is the chemical analysis of the composition of metals. Touchstones were invented that are still used today and helped to determine the purity of metal. This is an important part of trading with intrinsic value as it allows people to check the currency. Checking validity is one of the key aspect of cash and can still be seen in the authentication features of current banknotes.

500 CE: Bank Notes

Bank notes (Usability)

The first paper currency is seen in the Tang dynasty in China in the 7th century in the form of credit notes. As stated above, Chinese coins were heavy forged iron objects and were impractical in large quantities. Therefore traders would leave their coins with a trusted keeper and receive a credit note which they could trade but was only valid for limited time and had a lowered value. This can be seen as the first face value currency. A currency that has no intrinsic value but represents a stored value somewhere else. In the 11th century the first real banknotes followed when the central government saw the benefits of paper currency and supplied monopoly rights to certain deposit shops. The idea of banknotes transferred to Europe through travellers where at first promissory notes were introduced, a written statement to pay money to a specific person or later to the person in possession of the note. These promissory notes can be seen as the predecessor of banknotes in Europe.



Jiaozi, first Chinese credit notes

1500 CE: Banking

Need for credit (Safety and store of value)

The growth of trade in Europe was partly dependent on credit. Goods could be supplied against a bill of exchange. This bill was a promise to pay the debt at some specific date. These bills, if trusted, could be exchanged with banker merchants for coins at a discounted price. Furthermore it allowed safer travel without coins where credit could be given in one town and paid of in another. These bills were not only a medium of exchange but also a store of value.



Later promissary note, 1774

Gold storage (Representation of stored value)

Goldsmiths, mainly in England, started to act as storage of gold for traders while supplying them with receipts of repayment. These receipts were not assigned and therefore could be traded. By law these deposits were a loan towards the goldsmiths and therefore allowed them to use the gold to for example forward it to lenders. This created the first issues of fractional reserve banking where not all outstanding credit is covered by value in holding. The gold deposits were relatively stable because receipts would be used as a safe and practical form of currency. As long as there was public trust in the goldsmiths ability to cover for the debts the system would not default. This is the start of cash as a representation of value which is more linked towards trust in the system than towards directly redeemable gold or value.

1600 CE: Government

Government control (Acceptance, authority, nationalistic symbolism)

Seeing the success of goldsmiths, banks started issuing their own paper notes termed banknotes. The first European bank was Stockholm's Banco in 1661. As the amount of financial institutions grew, the amount of different issues banknotes grew with it. Only the largest and most creditworthy banks had banknotes which were accepted everywhere. The smaller banks had notes that could only be used in a small area or at a discounted rate. This wide range of different notes have been gradually replaced by banknotes issued and controlled by the national governments and today there are some private currencies left but have a very limited use. Because governments created a monopoly on cash the imagery and symbolism on cash started representing nationalistic messages.

1900 CE: Decoupled from gold

Fiat currency (Disconnect from physical value)

As the economy grew in the 20th century governments required more control. Fiat currency was introduced by the Nixon government in 1971 which decoupled the US dollar from gold supplies. Fiat currency is a currency not linked to a physical store of value and does not have any intrinsic value. Its value is derived from the government who controls it. This allows governments to print additional money, control inflation, manage interest rates and in general makes the currency more stable as it is not linked to a limited supply of gold. Following the US, national fiat currencies have been used globally with changing exchange rates between them.

2000 CE: Crypto currency

Crypto currencies (Digitalization of cash)

In the 21st century digital currencies known as crypto currencies were developed. In 2008 bitcoin was the first. Crypto currencies use cryptography to have a distributed ledger mostly known as blockchain. Crypto currencies facilitate a decentralized digital payment method which allows payment without third parties and offers some anonymity because of it. The future of crypto currency is still unsure but central banks are researching their use. Currently Sweden is developing the E krona, the first national regulated digital currency.

Conclusion

From this history of cash multiple developments can be observed that have shaped cash to the point we know it as now. Although the shape or design of cash has not changed that much for the amount of time it has existed, what it represents and how the system behind works has changed. All these developments were necessary at some point to continue the success of cash. Being aware of these developments is useful when redesigning cash because of the importance these developments had.

Based on its history the properties that cash gained throughout its developments are:

- A means to facilitate trade
- Standardized value system
- Widely accepted
- Trusted (national) symbol based on its authentication features
- Store of value

Appendix C: Future scenario drivers

Driver	Uncertainty score	Impact score
Cashierless shopping	5	5
Circular economy	5	4
Climate goals	3	4
Comfort with digitalisation	3	5
Cost of Instrument	2	6
Crisis	7	7
Data use	4	5
Demographic changes	3	5
Digital currency(crypto's)	7	5
Digital infrastructure	2	6
Economical growth	6	6
Eu/ Nationalism	5	4
Global stability	6	6
Horizontal grouping	5	2
Independence	4	6
Migration	6	3
Online shopping etc.	5	5
Personalisation	4	3
Privacy	5	5
Safety	6	6
Services	6	3
Social care	2	5
Social gaps	6	3
Suscription models	6	2
Sustainable ethics	5	4
Sustainable materials	5	3
Trust in Authority	5	6
Urbanisation	3	4
Usability	2	6
Viability	3	5
Wearables	5	3

Appendix D: Setup of creative session

Thursday, December 6

Participants: 6

Time: 9:30 am - 11:00 am

Schedule:

9:30 - 9:40 A | Instruction

9:40 - 9:50 B | Creative exercise

9:50 - 10:05 C | 1st round

10:05 - 10:15 Closing 1st Round

10:15 - 10:30 D | 2nd round

10:30 - 10:45 E | Presenting / discussion / outflow

A | Instruction

How can you pay when there is a fault with digital payment instruments?

Cash is no longer used, so there is no change.

Short-term disruptions where people have to be able to make 1-3 payments in a different way.

Brainstorm rules

- All ideas are good
- Build on each other's ideas
- No criticism, yet.

B | Creative exercise - White a4

1. Do you think of something you do almost every day?

2. What would be different about this in 25 years? Think of a product that you would use for this?

C | 1st round: How can you pay exactly? Groups write on post-it's

Intervention options:

What if safety is not a problem?

What if there is no electricity?

What if there is no cashier?

Choose idea by putting dots.

Creating new groups to work out.

D | 2nd round: How would it work?

How does it look?

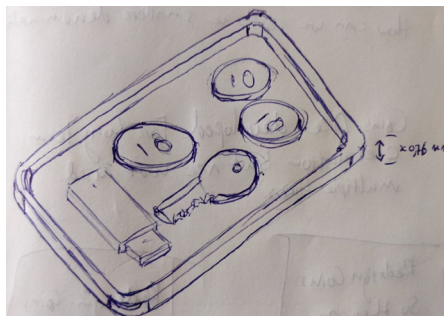
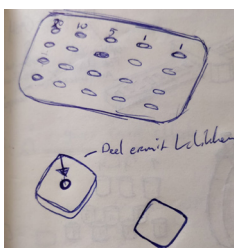
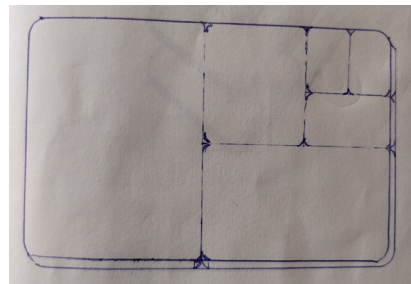
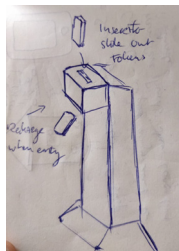
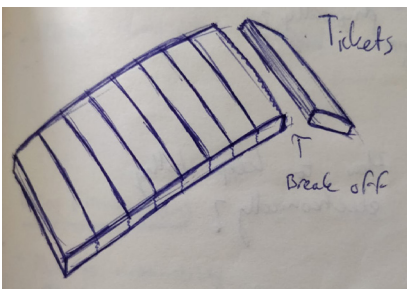
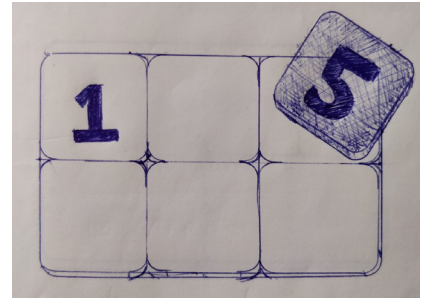
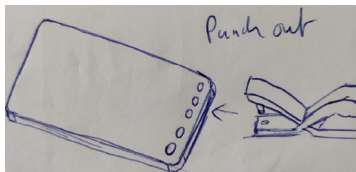
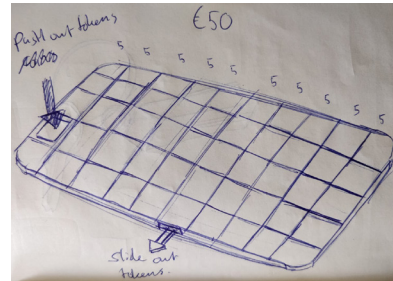
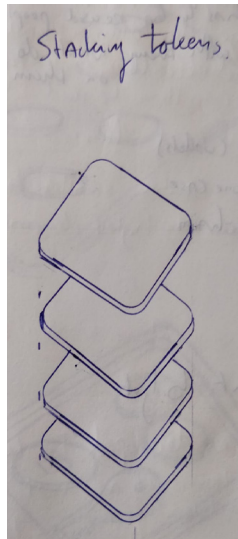
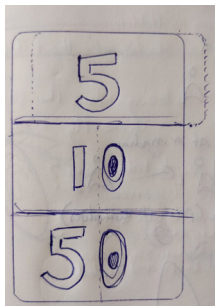
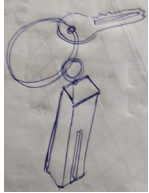
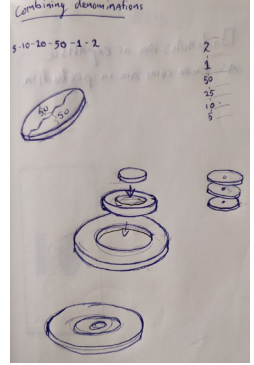
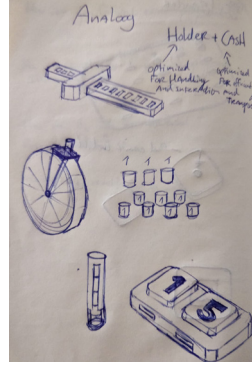
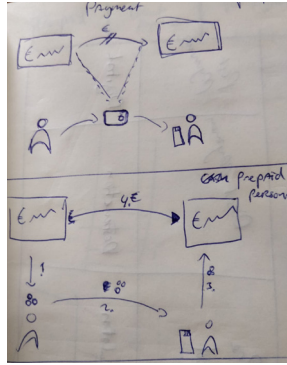
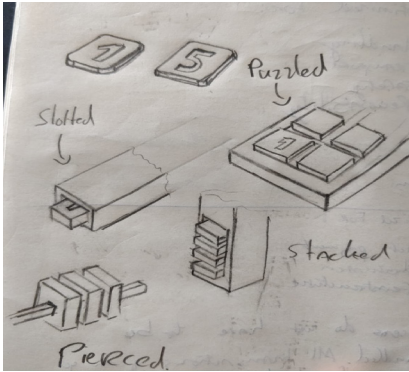
How do people get involved?

How does it work for shops?

Each group present their idea

E | Presentation and discussion

Appendix E: Ideation



Appendix F: Interview setup usability study

GENERAL

How did it go?

Follow up based on answers

How do you like the new tokens? (Room for own remarks without leading questions)

Follow up based on answers

USABILITY

How difficult were the tokens to retrieve?

Why?

How did the handing the tokens over and receiving the change go?

What was?

Are the tokens well distinguishable?

Why (not)?

Which difficulties did you encounter?

What made this difficult

How was it to use the tokens without the holder?

Why?

Based on observed behaviour during test question issues or behaviour

DIFFERENT SIZES

Which of the new tokens did you prefer?

Why?

PREFERENCE

Would you prefer these tokens over coins?

Why?

Would you keep these tokens in your carry on?

Why?

What would you want differently?

Why?

