Mobile Ticketing: OV-Betalen

A user-centred design vision for mobile ticketing in Dutch public transport

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Expertise Centre for E-ticketing in Public Transport

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Design report
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List of definitions

App. An abbreviation for application: a computer program or piece of software designed for a particular purpose that you can download onto a mobile phone or other mobile devices.

Fare media. The collection of objects that travellers carry to show that a fare or admission fee has been paid. Paper tickets and the OV-chipkaart are fare media for example.

Interaction. Bi-directional information exchange between users and equipment (ISO, 2013). User input and machine response together form an interaction.

Journey & Trip. A journey refers to travelling from A to B, while a trip refers to a segment of the journey. A journey can consist of multiple trips. For example, when going from train station Delft to Beurs metro station in Rotterdam, the journey is from Delft to Beurs. The trips within this journey are from Delft to Rotterdam Centraal (trip 1) and from Rotterdam Centraal to Beurs (trip 2).

Mobile ticketing. Ticketing can be described as the process whereby travellers can order, pay for, manage, obtain and/or validate fare media (Reynolds, 2016). Mobile ticketing brings this process, or parts of it, to a mobile phone.

OV-chipkaart system. The collection of computer systems and hardware elements that are required to make travelling with the OV-chipkaart possible.

Smartphone. A mobile phone that performs many of the functions of a computer, typically having a touchscreen interface, Internet access, and an operating system capable of running downloaded apps.

Ticketing. The process whereby travellers can order, pay for, manage, obtain and/or validate fare media

Usability. The extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use (ISO, 2010).

User experience. A person's perceptions and responses that result from the use and/or anticipated use of a system, product or service (ISO, 2010).

User/traveller. This research focusses on the end-user or traveller. In most cases, the term 'user' refers to a person performing actions in public transport with a mobile ticketing solution.


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Executive summary

Mobile ticketing solutions are proposed as an alternative to the OV-chipkaart in a vision created by the Nationaal Openbaar Vervoer Beraad (NOVB), a council consisting of public transport companies, local governments and consumer organisations. By taking a user-centred approach in this project, a design vision was developed for mobile ticketing in Dutch public transport.

An in-depth field study was conducted of the solutions available in Oslo, London and Seoul, focussing on the factors influencing the adoption rate and traveller experience. These identified factors influencing adoption served as the foundation for the proposed guidelines for a successful implementation of mobile ticketing solutions in the Netherlands.

By conducting user and stakeholder interviews and evaluations, discussing working principles, developed ideas and concepts, the following design principles have been identified for a user-centred mobile ticketing solution in Dutch public transport.

Efficient onboarding process - Provide a set-up process that travellers are able to conduct on the go.

Accessible, immediate travel - Allow for immediate travel through a virtual mobile OV-chipkaart without high financial barriers.

Dynamic interface, adaptive per phase - Adapt to the traveller's journey by providing context dependent information, such as arrival times.

Provide the right information at the right time - Unburden travellers from uncertainty by pro-actively providing them with important contextual information.

Mix Matters - Provide clear distinguishable alternatives as travellers can have different preferences for fare media.

Independence from location-bound machines - Make sure that a mobile ticketing solution can operate independently from these location-bound machines. (e.g. mobile top up)

Using these design principles, a customer journey and proposed design was made and a first prototype of the OV-betalen app was created. In order to comply to the established design principles, this design vision steps away from card-stored data and proposes to store this data on a backend server.

Evaluating this prototype with users has revealed that this proposed design had an average rating of 'Best imaginable' on the System Usability Scale (Bangor et al., 2009). Participants also indicated that they hope that the evaluated app becomes reality. This report shows the process towards this proposed design vision and also elaborates on an implementation strategy for further development.

Contents

1

Personal OV-chipkaart

1. Introduction

1.1 INTRODUCTION

Since 2012 the entire Dutch public transportation system allows for travel throughout the country with one card, the OV-chipkaart. With the OV-chipkaart travellers no longer need separate tickets for different modes of transportation, instead, travellers can use a single OV-chipkaart to check in and out during their journeys. The Nationaal Openbaar Vervoer Beraad (NOVB), a council created by the government consisting of public transport companies, local governments and consumer organisations, indicates that although the OV-chipkaart has been widely adopted it still has its shortcomings. The NOVB states that the OV-chipkaart does not lower the barrier for occasional, international and disabled travellers, which can also be seen in the research of Joppien, Niermeijer and Niks (2013).

To improve travel experience and traveller satisfaction, the NOVB created a document called 'Visie OV-betalen' (2014), describing prospective ticketing and payment technologies for the Dutch public transportation system. In this document, the NOVB describes a vision where the bank card and mobile phone can be used as an alternative to the OV-chipkaart. The project described in this report focuses on improving the public transportation system in the Netherlands by creating a design vision for a mobile ticketing solution.

A representation of mobile ticketing can be seen in Figure 1. Ticketing can be described as the process whereby travellers can order, pay for, manage, obtain and/or validate fare media (Reynolds, 2016). Fare media are the collection of objects that travellers carry to show that a fare or admission fee has been paid. Conventional fare media include smart cards and paper tickets. An OV-chipkaart (fare medium) with a season pass can be ordered online (ticket selection & payment) and topped up at ticket vending machines (ticket preparation) before checking in public transport (validation & fare payment). Mobile ticketing brings this process, or parts of it, to a mobile phone. Depending on the chosen implementation and solution validation can either take place on the phone or at validation equipment. A good implementation of a mobile ticketing solution could increase the simplicity and satisfaction of the Dutch public transport system by transforming the traveller's mobile phone into a fare medium.

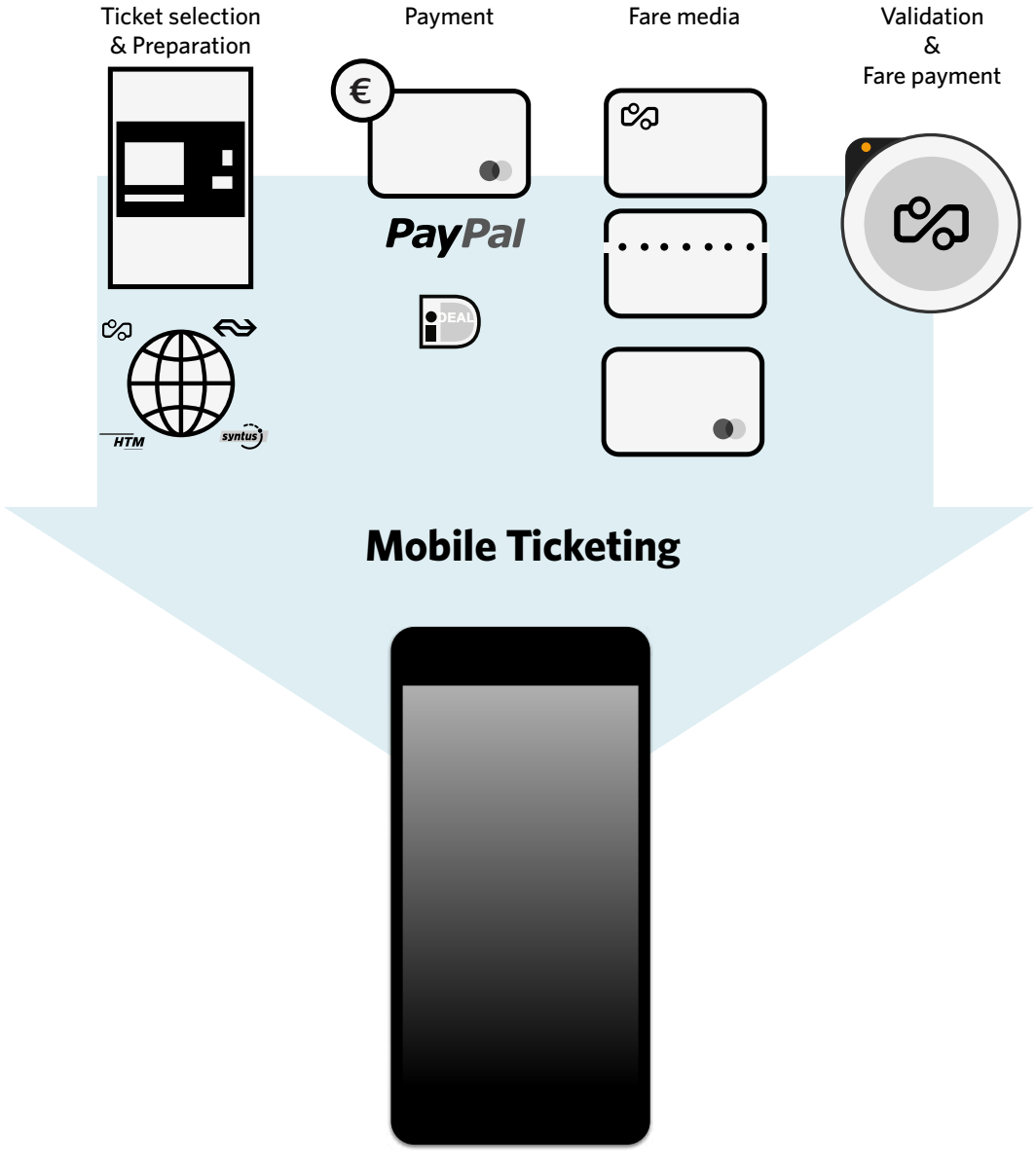


Figure 1. Representation of mobile ticketing

1.2 PROBLEM STATEMENT

As the development and introduction of the OV-chipkaart have shown, focusing on technological and business during the development of a new product service system can result in a suboptimal market introduction. A good implementation of a user-centred mobile ticketing solution could increase the simplicity of and satisfaction with the Dutch public transportation system. However, the stakeholders involved in the public transportation sector (governments, public transport operators, technology providers, consumer organisations and travellers) often have different requirements and ideas, making alignment complex. A mobile ticketing solution that does not meet user needs would add even more confusion to the already complex public transportation system in the Netherlands. This can already be seen in the variety of mobile ticketing solutions that are currently being developed (Figure 2). In order to develop a design vision for a mobile fare medium, it is essential to have a user-centred design approach throughout development and implementation.

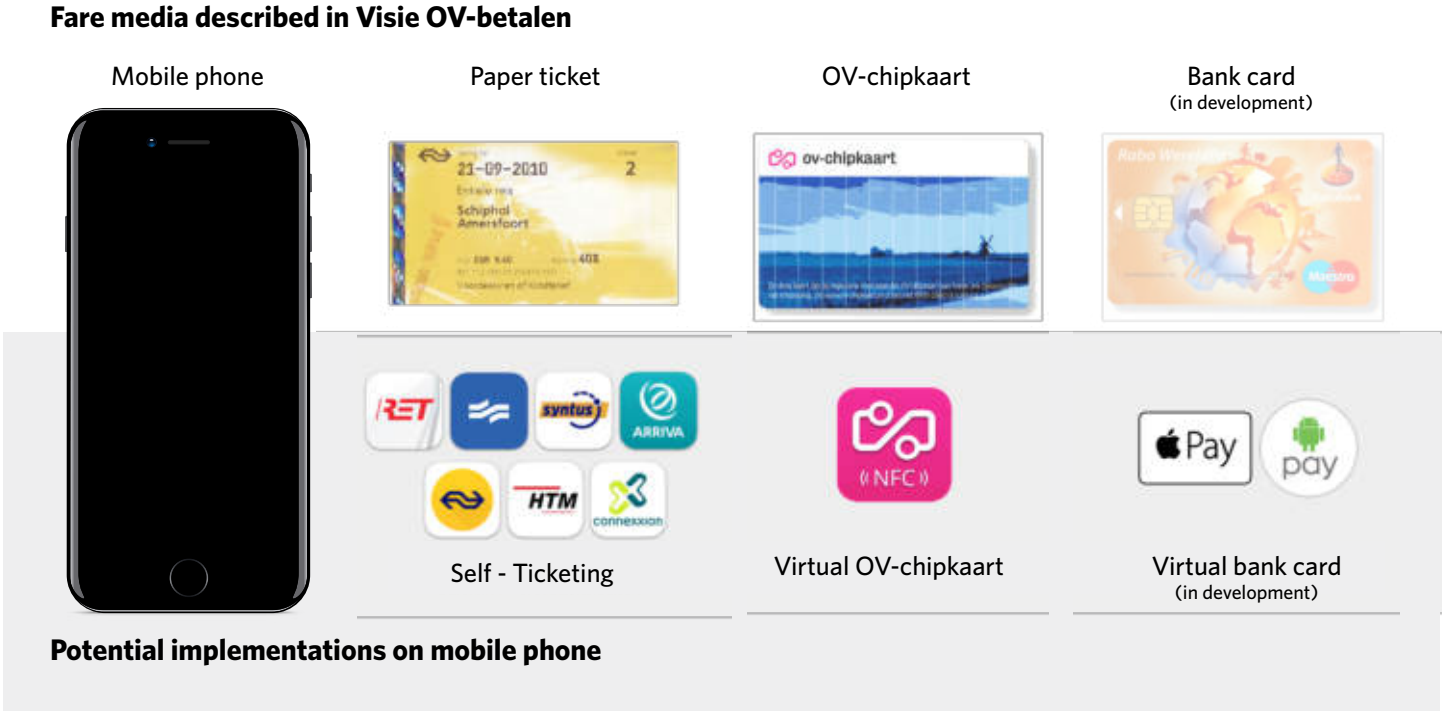


Figure 2. Mobile ticketing solutions that are in development for the Dutch public transportation system

1.3 PROJECT GOAL

The goal of this project is to develop user-centred solutions to improve travellers' experience in Dutch public transport. This is done by creating and depicting a future customer journey using a mobile ticketing solution in Dutch public transport. The design of this mobile ticketing solution would include several design solutions based on the guidelines proposed in the research report (Cheng, 2017) and newly gathered user insights.

Vision

A mobile ticketing solution that is easy to understand and helps the traveller with their journey. Travellers use their mobile phone to experience seamless travel in the Dutch public transportation system.

Mission

Create a mobile ticketing solution which draws people out of their cars and into public transport.

A good product or service is designed through a user-centred and integral approach, which will also be used during this project. This integrates the needs of the users (desirability), the possibilities of technology (feasibility), the requirements for business success (viability) and the needs of society (responsibility) as can be seen in Figure 3. This model, as proposed by van Kuijk (2015), is adapted from IDEO's Human-centred design model (IDEO, 2009).

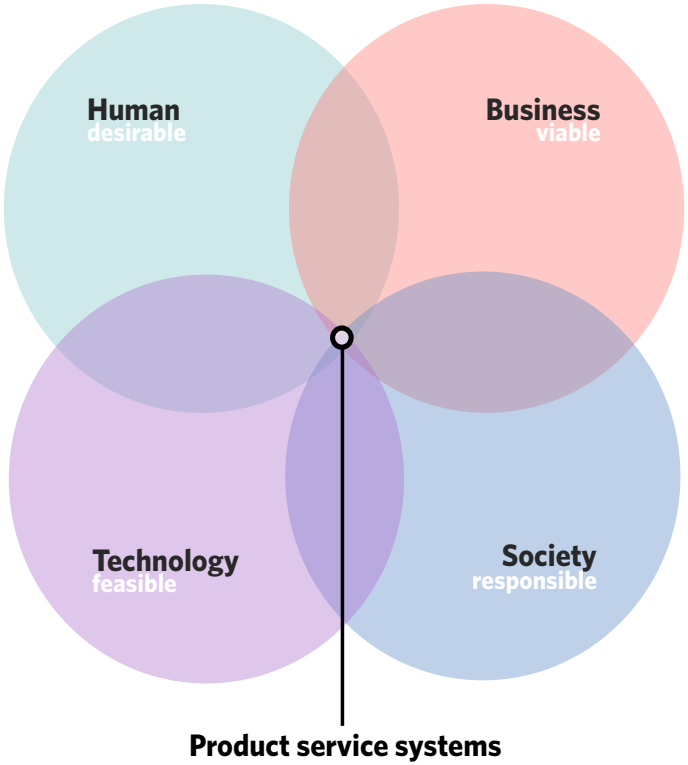


Figure 3. Integrated innovation model by van Kuijk (2015)

1.4 PROJECT SETUP

The TU Delft Expertise Centre for E-ticketing in Public Transport (X-CEPT) aims to develop integral future solutions for user-centred electronic ticketing and payment used in public transport in the Netherlands. In collaboration with Trans Link Systems, also known as Translink, this project focuses on improving the public transportation system in the Netherlands by creating a future vision for the mobile phone as a fare medium in public transport.

This project is divided into two phases: an analysis phase and a design phase. The first phase is documented in the analysis report 'Exploring Mobile Ticketing in Public Transport' (Cheng, 2017) and gives an overview of insights and proposes guidelines for the adoption of a mobile ticketing solution in the Netherlands. Chapter 2 of gives a brief overview of this analysis report.

Where the first phase focussed on getting insights for mobile ticketing in general, this phase aims at creating design solutions which improve travellers' experience in Dutch public transport. This report builds upon the insights from the analysis report and, through ideation and concept development, turns these into a new design proposal for a mobile ticketing solution in the Netherlands.

Stakeholders and project partners

Important stakeholder groups in the context of this project are *Translink* and public transport operators. A number of these stakeholders participate in this project as project partners by supporting this research. The project partners are the Amsterdam public transport operator (*GVB*), the Dutch Railways (*NS*) and the Rotterdam public transport operator (*RET*). Consumer organisations were consulted for their expertise in travellers' interests. Governmental institutions provided insights on governmental concerns, whereas market regulators provided information on how transport operators can compete fairly with one another, and it protects consumer interests.

1.5 DESIGN BRIEF

In order to improve travellers' experience in Dutch public transport, the goal of this design phase is to develop a new design vision for a mobile ticketing solution. Ideas and concepts generated during this phase will be evaluated and tested by both stakeholders and travellers. This ensures that wishes and concerns of the business, technology, and mainly the human aspects related to a mobile ticketing solutions are taken into account.

1.5.1 Aim

The aim of the design phase is to develop ideas, concepts and a design vision for a mobile ticketing solution in Dutch public transport, based on the gained insights during the research phase and additional user research.

1.5.2 Research questions

The following research questions were formulated for the design phase:

- How can a mobile ticketing solution improve travellers' experience in Dutch public transport?
- How can the proposed guidelines from the research phase be translated into design aspects?
- What human, business, technological and societal aspects are relevant for the design of a mobile ticketing solution?
- Which solutions can be found to enhance the public transport experience of travellers?

1.5.3 Method

As stated earlier, a user-centred design approach was used to develop an integrated design solution. In the analysis phase, several qualitative research methods were used, including observing travellers in their natural behaviour, conducting semi-structured interviews (Patton, 2002) with stakeholders and travellers, and using the researcher's own experience. Whereas quantitative research aims at collecting a lot of data and create statistics, qualitative research aims at collecting rich insights about the studied interaction (Kvale 1983). The insights gained though these methods gave the opportunity to generate and develop ideas and concepts, which led to a design vision for a mobile ticketing solution. More than in the analysis phase, stakeholders were consulted in order to address the business and technology aspects in order to come to a viable, feasible, desirable and responsible design proposal

The precise qualitative research methods used are described in each chapter's respective method section.

2

OV-chip mobiel

2. Analysis report recap

2.1 INTRODUCTION

As can be seen with the development and introduction of the OV-chipkaart, introducing a new product service system while mainly focusing on technological and business factors can result in a suboptimal market response. The goal of this project is to improve travellers' experience in Dutch public transport, by developing user-centred mobile ticketing solutions.

An understanding was gained of potential usage problems and concerns, the potential solution space, and factors influencing the adoption of a mobile ticketing solution. This was done by looking at the Dutch public transportation context, trends and developments, and the implementation of mobile ticketing solutions in public transport systems abroad. An in-depth field study was conducted of the solutions available in Oslo, London and Seoul, focusing on the factors influencing the adoption rate and traveller experience. A detailed documentation of this research phase can be found in the analysis report 'Exploring Mobile Ticketing in Public Transport' (Cheng, 2017).

This chapter presents the overall conclusions of this research phase, the identified factors influencing adoption and guidelines for a successful implementation of mobile ticketing solutions in the Netherlands.

2.2 MAIN FINDINGS

The mobile ticketing solutions in Oslo (RuterBillett, Self-ticketing), London (Apple Pay, mobile bank card) and Seoul (Mobile T-money, SIM-based emulation) have been researched and analysed in order to identify what worked well and which usability issues travellers encounter when using these solutions. From this analysis, the following conclusions can be drawn related to the implementation and adoption of a mobile ticketing solution for public transport. This includes incentives and positive experiences, which enhanced the adoption, and the barriers and negative experiences, which discouraged the adoption of the mobile ticketing solutions. A brief overview of the differences between these public transport systems is given below.

2.2.1 Factors enhancing adoption

Phone is never forgotten

In contrary to a card, which can occasionally be forgotten, interviewees consider it less likely to forget a mobile phone. The convenience of always carrying your phone and knowing where you have put it seem to be beneficial for users.

Self-service

In all of the examined cases, the convenience of not having to go to a ticket machine was considered as one of the main benefits of using a mobile phone as a fare medium. In Oslo, the ability to be able to buy a ticket on the spot and see the remaining validity solved a few pain

points that were related to the other ticketing alternatives. Being able to see the remaining balance and top-up through the Mobile T-money app were incentives for people in Seoul to use the app.

Novelty

Users of Apple Pay in London have shown that novelty plays a role in their decision to use Apple Pay. Even though travellers have their issues with Apple Pay, and even stating that there doesn't seem to be a noticeable benefit using it, the novelty of using it has been experienced as fun or cool. Embracing and being open to new technology is thus a characteristic that travellers had when using their mobile phone as fare medium.

2.2.2 Factors discouraging adoption

Discomfort of using and relying on a mobile phone

Non-users of mobile ticketing solutions in all contexts have indicated to feel uncomfortable using their phone as a fare medium. People have stated to have more trust in a physical ticket than using a mobile phone and rather present this to a ticket inspector. This discomfort is also reflected by taking out something valuable to check-in/out.

Privacy & security

Especially in London and Seoul, lack of trust and the fear of cyber fraud have discouraged people from using the available mobile ticketing solutions. Concerns about the insecurity of the software, theft of personal details and money have been raised amongst travellers.

Benefit vs effort

As most travellers are already in possession of a fare medium, they need to be convinced to switch to the mobile phone. This done by creating and communicating clear benefits, also in comparison with existing ticketing solutions. As could be seen in both London and Seoul this seems to play a role in the low adoption rate, as people were generally satisfied with the Oyster card and T-Money enabled credit card. This means there is almost no incentive for these people to go through the effort of requesting a new SIM card or setting up their phone to act as a fare medium.

Check-in/out performance can be discouraging

In both London and Seoul, using a mobile phone to check-in/out is less reliable than using a card alternative. In London, the reading speed is consistently and noticeably slower than that of an Oyster card. In Seoul, checking in or out is unpredictable as errors and failed check-ins/outs randomly occur. In both of these contexts, the underperformance of checking in and out with a mobile phone has created negative experiences amongst users and discouraged them from further usage.

Figure 4. Mobile T-money is not working for a traveller. After multiple check-in attempts resorts to his card.

Battery concerns

Running out of battery seems to be a concern in all contexts. To lessen this concern, Ruter has equipped ticket inspectors with battery packs (Figure 5). In London, users carried a backup option with them next to their mobile phone, either a contactless bank card or Oyster card. When it was not sure if the phone would still have enough battery for the whole journey, a user would use the card alternative instead. In Seoul, it was common for travellers to carry a battery pack in response to this concern.

Level of adjustment

The needed change in traveller's behaviour, is also of influence on the adoption rate of the mobile phone as a fare medium. In Oslo, little to no change was needed as all of the ticket interactions take place on the app's interface presented on the phone itself. In London and Seoul, a bigger change was needed as the mobile phone, a valuable and personal object is held against readers to check in and out instead of a card. In order for this check-in/out to properly function, users also have to consider making changes in their phone accessories. Using card cases to carry other cards, such as a company employee card, will result in card clash, while other cases might block the phone's NFC signal. Using wired earphones while checking in or out will also be uncomfortable as it is harder to reach the validator.

Figure 5. Power bank carried by ticket inspectors

Figure 6. Traveller showing his phone case with a card slot

2.2.3 Potential usage funnel

A potential usage funnel (Figure 7) has been created based on the previously mentioned enhancing and discouraging factors of adoption. This funnel illustrates how system requirements, how users acquire the service, and user experience is of influence on the potential, initial and retained user base.

System Requirements

The potential user base is dependent on the set system requirements, such as supported operating systems and payment methods. Ruter, for example, has chosen to optimise mobile ticket sales by initially developing RuterBillett for three mobile operating systems, iOS, Android and Windows phone. Foreign credit cards, however, are not supported and exclude potential users such as expats and tourists from using RuterBillett. In London, travellers indicated to travel with monthly or yearly travel passes, making Apple Pay, and any other mobile contactless alternative, not suitable for them. Mobile T-money has excluded iOS users as it only supports Android devices.

Acquiring the service

Oslo and London have shown that high awareness can be created through extensive marketing campaigns in the public transport context. London, however, has shown that a lack of value, especially when comparing to a contactless bank card, has led to a relatively low amount of mobile contactless users. Lack of awareness and a difficult onboarding process, has not worked in Mobile T-money's favour.

User Experience

A retained user base can be established by providing a pleasant experience when using the mobile ticketing solution. Ruter has done this by extensive user involvement during the development of RuterBillett. This resulted in users being able to repurchase a ticket with two taps. An inferior check-in/out experience using Apple Pay and Mobile T-money, when compared to a card, has discouraged user from continued usage. By providing a good user experience, the appeal can be raised to a level where more users install and try the product. High enough appeal can result in people who are willing to adjust towards the system requirements, e.g. the iPhone being exclusively available at T-Mobile during the introduction in the Netherlands.

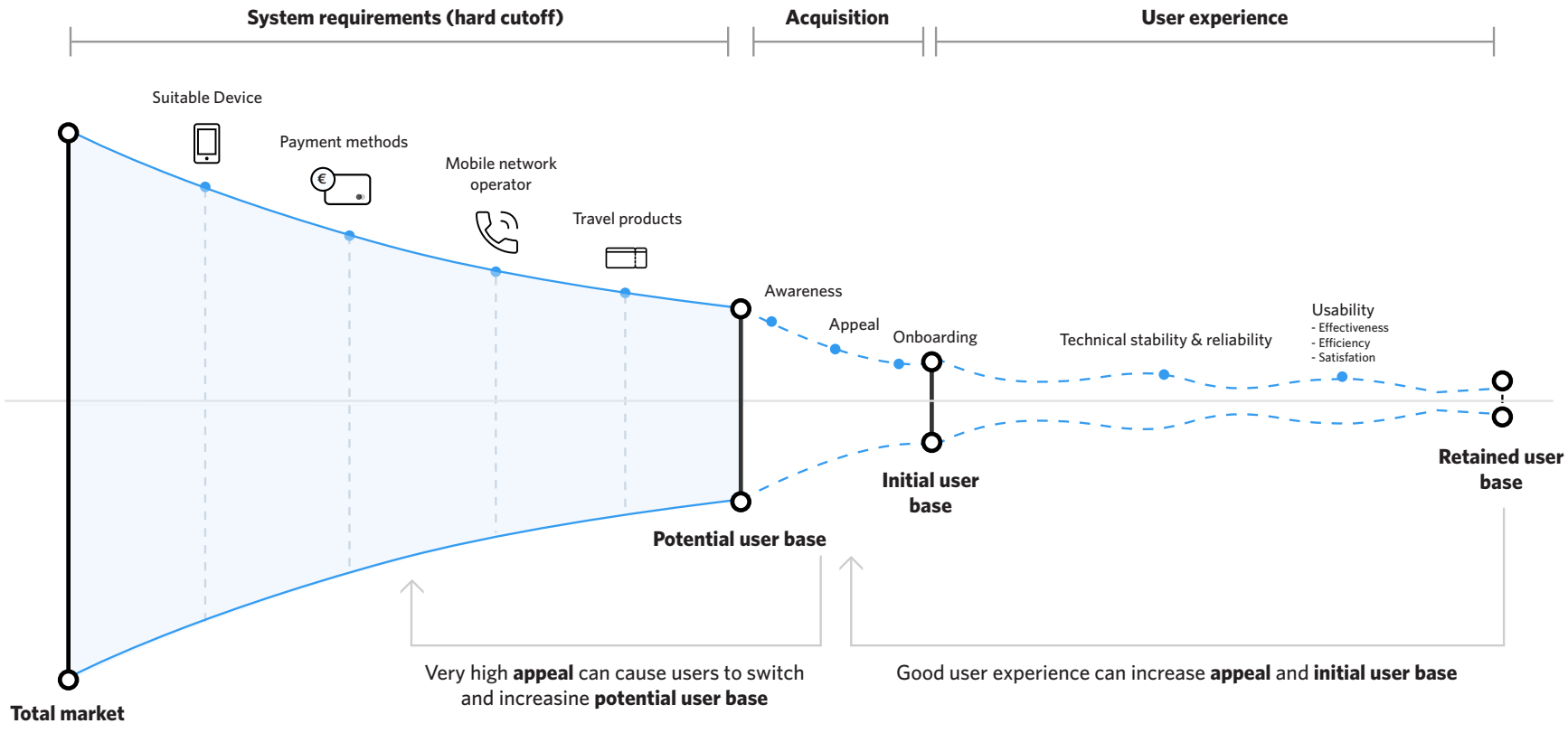


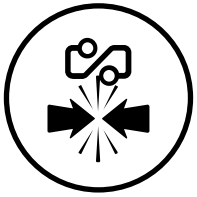
Figure 7. Potential usage funnel

2.2.4 Guidelines for a user-centred mobile ticketing solution

This section proposes guidelines for the development of a user-centred design vision for a mobile ticketing solution in the Netherlands based on the conducted research. These guidelines and the insights from this analysis phase will be used in the design phase as a starting point. During this design phase, these guidelines might change as new insights and information become available. Following these guidelines will be helpful for a successful implementation and adoption of a mobile ticketing solution.

Create clear value and benefit in proposition

In order for the mobile phone to be considered as a traveller's main fare medium, there needs to be clear and significant value and benefit over the other options, mainly the OV-chipkaart and soon the contactless bank card. Value can be created by solving existing pain points of current travellers in the Netherlands and unburdening them from these issues. As shown in London and Seoul, the proposition of being able to use the phone to check-in/out does not seem strong enough for travellers to switch. Even travellers that are interested in using their mobile phone as fare medium have indicated that they couldn't be bothered as they're satisfied with what they currently have. The shift towards an account-based system and the developments related to mobility, payment and self-service offer opportunities to create value and benefit. This includes, not having to wait for an OV-chipkaart to be delivered, lower purchase costs than an OV-chipkaart.

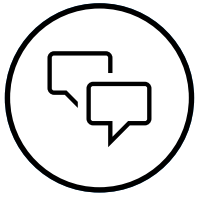


Benchmark against the familiar

The traveller's experience of their current fare medium, which is the OV-chipkaart in most cases, is leading. If the satisfaction is high, travellers will be less inclined to make a switch. In order for a new fare medium, be it a mobile phone or contactless bank card, to be considered as a valid alternative by travellers, it needs to be benchmarked with the standard, the OV-chipkaart. As London and Seoul have shown, slower or unreliable check-ins/outs of the mobile phone as fare medium will be detrimental and discourage potential users. RuterBillett offers the same tickets and passes that are compatible with the Reisekort. A mobile ticketing solution in the Netherlands needs to take a similar approach and offer similar pricing and travel products as the current OV-chipkaart.

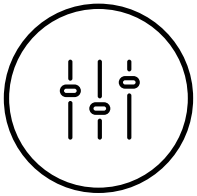
Ease and comfort of installation and use

Potential users can be discouraged by negative experiences during the set-up and use of their mobile phone as fare medium when the required effort exceeds the benefits. Complex requirements and sign-up process, as seen in Seoul, can deter travellers from further use. Especially when travellers are satisfied with what they currently have, a complicated set-up process will easily be seen as a hassle. As stated earlier, a complex, slower and more unreliable interaction at the validator gates have made users switch to another ticket medium. A mobile ticketing solution in the Netherlands should make it easier (e.g. Oslo) to travel in public transport and not make the process more complex (e.g. London, Seoul).



Communicate effectively

Promotion, especially in the public transport context, is essential for creating awareness amongst travellers. Clear information about the costs and, more importantly, the benefits that the mobile ticketing solution offers needs to be addressed. Travellers need to be educated on how to get started and how to use the service, e.g. fare-free days during the introduction campaign. Measurements that have been taken in regards to perceived barriers such as privacy and security plays a role in the amount of trust travellers have. Providing clear feedback when transactions or check-ins/outs fail is necessary for the users in order to have an understanding of why the action has failed, and possibly which actions to take.



Keep level of adjustment at a minimum

The more adjustment is needed on the traveller's side, the less likely he will be to adopt the usage of a mobile fare medium. As London and Seoul have shown, the current state of technology makes the check-in/out performance of a mobile phone less reliable and predictable. It is expected that a similar solution in the Netherlands would need changes to accessories such as cases (NFC signal of a phone), carried cards (card clash) and for example wired earphones (comfort) in order to perform a successful check-in/out with a mobile phone. Ruter, on the other hand, has found a ticketing solution that exclusively takes place in the RuterBillett app, which does not need any adjustments. Making the change from holding a card, a less valuable object, to a mobile phone, a personal and valuable object, against a reader needs a certain level of adjustment for most people.

2.3 CONCLUSION

The research done in the analysis phase, and especially the field study in Oslo, London and Seoul has resulted in various insights regarding a mobile ticketing solution in public transport. Factors that influence the adoption rate have been identified and were translated into a potential usage funnel. This funnel illustrates how system requirements, how users acquire the service, and user experience is of influence on the potential, initial and retained user base. Furthermore, guidelines for a user-centred mobile ticketing solution were proposed. These insights will be used during the design phase of this project. In order to translate the findings to the Dutch context, insights in the Dutch travellers' wishes and expectations are needed. Chapter 3 describes the steps that have been taken to get to these insights.

3

Evaluation stimuli

3. Evaluating working principles and ideas for mobile ticketing

3.1 INTRODUCTION

In order to translate the findings to the Dutch context, insights in the Dutch travellers' wishes and expectations are needed. This chapter describes the steps that have been taken to get to these insights. Working principles and current developments and generated ideas based on the research phase regarding mobile ticketing in Dutch public transport have been evaluated with users to get insights into their wishes and expectations. These wishes and expectations will set the concept direction.

3.2 WORKING PRINCIPLES & CURRENT DEVELOPMENTS

To improve travel experience and traveller satisfaction, the NOVB created 'Visie OV-betalen' (2014), describing new ticketing and payment technologies for the Dutch public transportation system. This document also describes three mobile ticketing principles, which have also been identified by Gonzalez (2017), and Cheng (2017) in other public transport contexts: Self-ticketing, smart card emulation and travel with a mobile bank card. This section gives a brief of the current developments in Dutch public transport to implement these principles to realise the Visie OV-betalen. It is important to evaluate the execution of these mobile ticketing principles with users in order to check if these developments indeed align with the travellers' wishes and needs.

3.2.1 Self-Ticketing

With this mobile ticketing method, travellers need to be in possession of a valid mobile ticket before boarding a vehicle (Figure 9). A mobile ticket becomes available on the traveller's phone and can be shown when boarding a vehicle or on ticket inspection. Time-based tickets generally need to be activated before boarding the vehicle to be considered as valid. Self-ticketing solutions use visual validation methods to validate a ticket. This can be a daily animation, timer, QR-code or any combination of these options. The Dutch public transport operators NS, HTM (Figure 8) and Syntus already offer such a self-ticketing solution to their customers, whereas other public transport operators are still considering or developing a mobile self-ticketing solution. NS and Connexxion have started a trial with Tranzer, an app that allows travellers to buy mobile tickets from any train operator in the Netherlands.

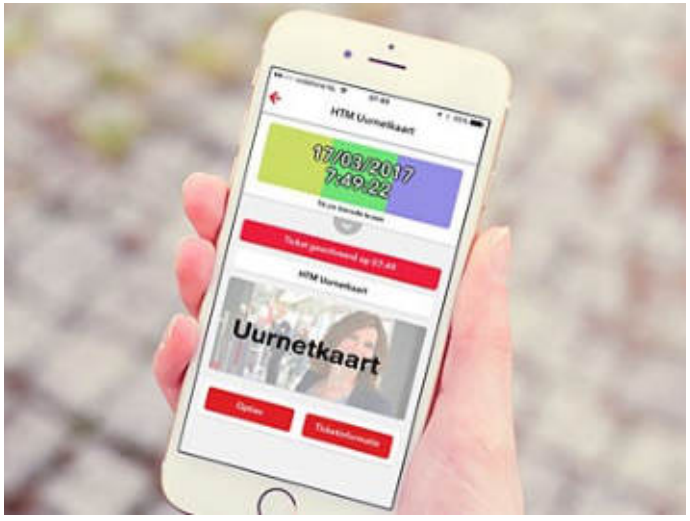


Figure 8. HTM self-ticketing app 'HTM Ticket'

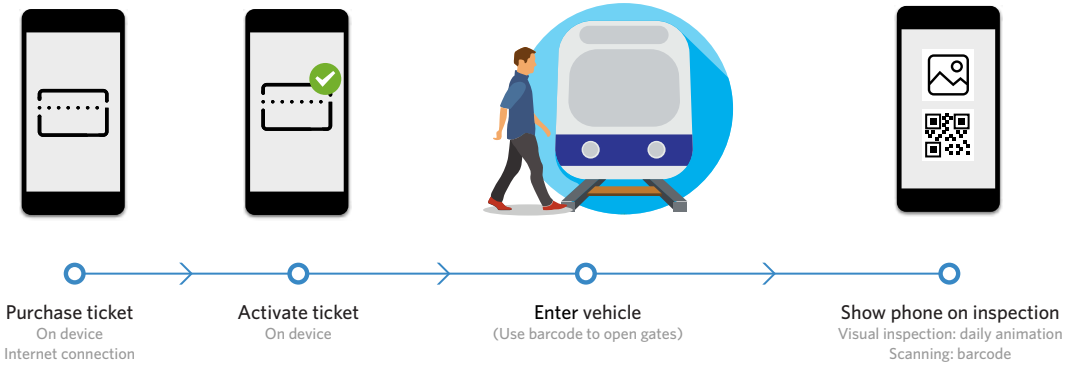


Figure 9. Representation of a mobile self-ticketing solution

3.2.2 Smart card emulation

Smart cards in public transport, such as the OV-chipkaart, are used worldwide in different public transportation systems. Systems in Hong Kong, Seoul and Singapore have implemented a mobile version of their smart card by using a SIM-based solution (Figure 11) to emulate their smart cards through Android phones. In these cases, travellers are able to top-up and manage their card through an app on their mobile phone. When travelling with a mobile smart card, travellers hold their phone to validators to check-in/out, similar to the use of a physical smart card. OV-chip mobiel (Figure 10) is a new mobile fare medium which travellers can use in Dutch public transport. It uses the same SIM-based solution to emulate an OV-chipkaart. This SIM-based solution is limited to selected Android phones and software version, as well as selected mobile network operators.

Figure 10. OV-chip mobiel

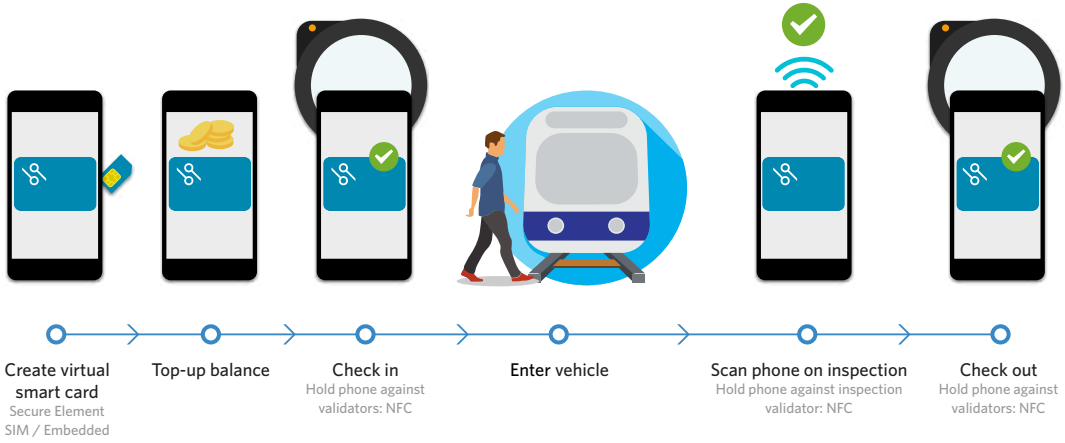


Figure 11. Representation of a smart card emulation

3.2.3 Mobile bank card (EMV)

Public transportation systems that support the EMV-contactless bank card, will also be able to support mobile EMV solutions (Figure 13). They can support solutions as Apple Pay, Android Pay, and other mobile wallet solutions described in Chapter 3 'Trends and Developments' of the analysis report. Transport for London (TfL) and Chicago Transit Authority are two public transportation systems that support mobile EMV solutions for ticketing in public transport. Travellers hold their mobile phones against validators placed on gates or turnstiles when entering and exiting public transport. This way travellers will get charged directly from their bank account, as one would when using a contactless bank card. The 'Visie OV Betalen' describes the mobile bank card as one of the most promising fare media, mainly due to not having to purchase an OV-chipkaart and having to top up their balance.

Figure 12. Android Pay in the London Underground

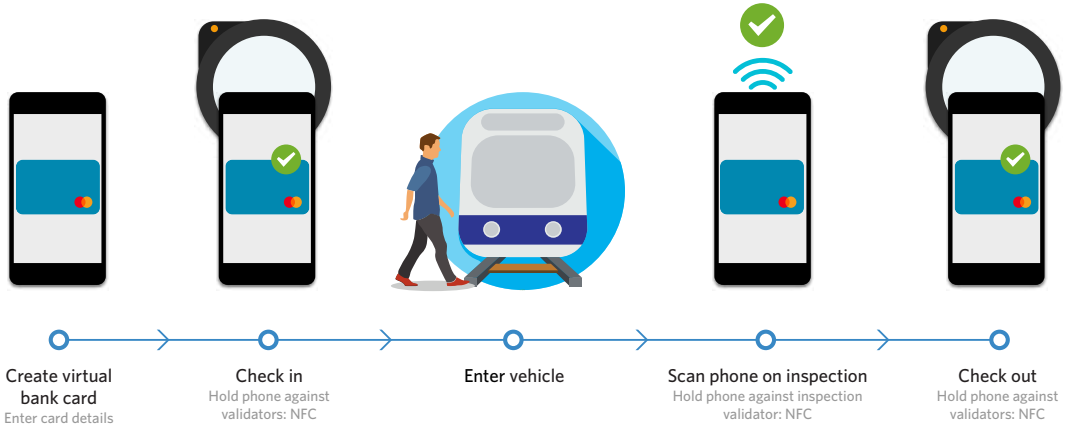


Figure 13. Representation of travelling with a mobile bank card

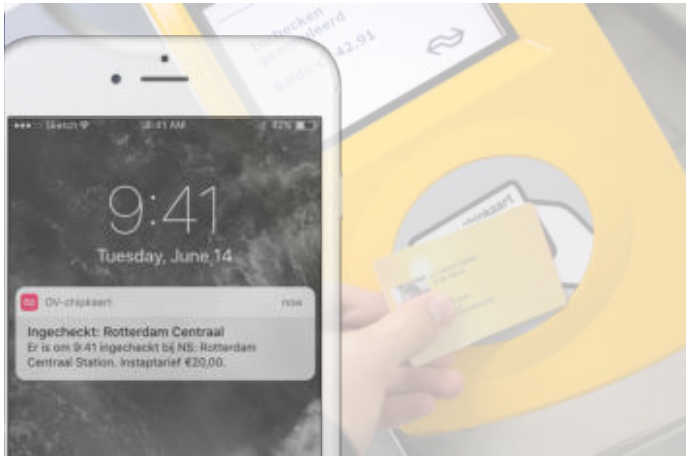
3.3 IDEA GENERATION

Based on the proposed guidelines and findings the research phase, various ideas for a mobile ticketing solution in the Netherlands have been developed. These ideas cover certain app functionalities that could be applicable to any of the three working principles. These ideas will be evaluated by travellers in order to see how they react to these proposals. Feedback can be collected that can help shape and maybe unite them into a complete mobile ticketing solution that is tailored to the user's needs and expectations. The ideas were generated for seven steps of the customer journeys defined in the analysis report.

Idea Examples

Using the steps mentioned in the previous section various ideas were created that could enhance travellers' experience through a mobile ticketing solution. In total over 40 of these ideas have been created and visualized. All of the ideas were presented with a UI visual, explanatory title and optionally a context photo, indicating during which step the idea takes place. Two examples can be seen below in Figure 14 and Figure 15. The check-in/out notification is an example of an idea generated for step 6. Travelling while the correct a missed check-out covers the post-travel step. A full overview of the generated ideas can be found in Appendix A..

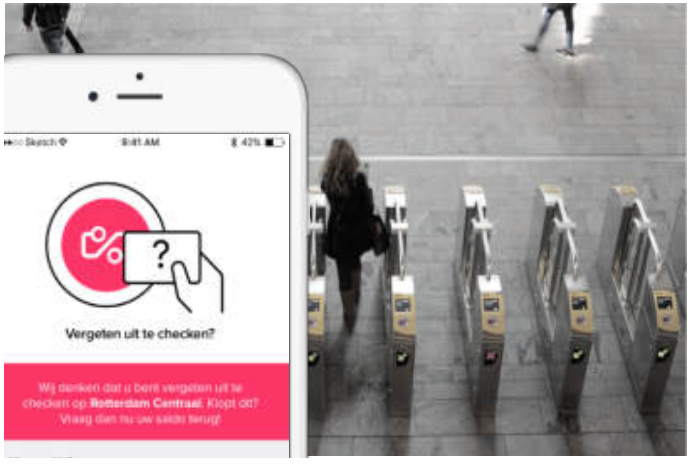
CHECK-IN/OUT NOTIFICATION



RECEIVE A NOTIFICATION CONFIRMING THAT YOU'VE CHECKED-IN/OUT

Figure 14. Idea example: check-in/out notification

CORRECT A MISSED CHECK-OUT



RECEIVE A NOTIFICATION CONFIRMING THAT YOU'VE CHECKED-IN/OUT

Figure 15. Idea example: correct a missed check-out

3.4 USER EVALUATION

Three mobile ticketing working principles, with corresponding developments, have been identified. Various ideas were generated based on the defined travel steps from the analysis report. In order to see what travellers think of these developments and ideas and to define their wishes and expectations regarding a mobile ticketing solution, a user evaluation was conducted.

3.4.1 Aim and research questions

The aim of this evaluation with travellers is to explore which of the proposed ideas match the user's needs and wishes related to a mobile ticketing solution in Dutch public transportation.

- What do travellers think of the three mobile ticketing principles and the current implementations?
- What are the wants, needs and expectations of travellers related to the use of a mobile ticketing solution?
- How do the proposed ideas match with the wishes of the travellers?

3.4.2 Method

Qualitative research helps to understand the ideas and wishes of the participants. Semi-structured interviews according to a predefined set of topic guides were used during this user evaluation. A four-point Likert scale was used to evaluate the generated ideas in order to allow for degrees of opinion, rating the ideas on from dislike to high like. Combining this with a semi-structured interview allows for rich insights to why travellers gave this rating.

Participants

9 participants were recruited for this study. For this user evaluation, the participants will be in possession of a smartphone. Since the new design of a mobile ticketing service is designed with an integral approach, participants were recruited based on their level of travel frequency in public transit as it should enhance the travel experience of all these travellers. In order to be representative of the actual overall user population, the selected participants have a homogeneous distribution of age and an equal ratio of women and men.

Commuters (frequent traveller)

Commuters are people who travel regularly from one place to another, e.g. from home to work, using public transport. This group uses public transport frequently, a few times a week, and use a personalised OV-chipkaart in combination with a travel product.

Day-trippers (frequent traveller)

Day-trippers use public transport are relatively experienced with public transport and mainly use it when visiting family or an event for example. This group uses public transport a few times a month and have an OV-chipkaart, either personal or anonymous and use a travel product or use pay as you go.

Incidental travellers (infrequent traveller)

The last group, the incidental travellers are inexperienced with public transport and usually buy tickets instead of owning an OV-chipkaart. This group rarely uses public transport, mainly in specific scenarios e.g. going to the airport.

Incidental: Travel frequency of less than once per month				
#	**Age**	**M/F**	**Fare media**	**Phone**
1	30	F	Personal OV-chipkaart Paper tickets	iPhone 5s
2	59	M	Personal OV-chipkaart	Samsung Galaxy

Infrequent: Travel frequency of 1/2 per month				
#	**Age**	**M/F**	**Fare media**	**Phone**
1	62	M	Personal OV-chipkaart	Samsung Galaxy
2	25	F	Personal OV-chipkaart	iPhone 5s

Frequent: Travel frequency of at least 1/2 per week				
#	**Age**	**M/F**	**Fare media**	**Phone**
1	53	M	Personal OV-chipkaart	iPhone 6
2	40	M	Personal OV-chipkaart	Huawei
3	38	M	Personal OV-chipkaart	Samsung Galaxy
4	54	F	Business OV-chipkaart Paper tickets	iPhone 6
5	26	F	Business OV-chipkaart	Huawei

Table 1. List of participants for the conducted user evaluation

Stimuli

Three mobile ticketing concepts, based on the mobile ticketing principles: self-ticketing, smart card emulation and mobile bank card, that are currently in development were presented to users. A3 foam boards display which steps one would need to take in order to travel in public transport with these concepts (Figure 16). The foam boards are an abstract representation of how the mobile ticketing principles are, or going to be, implemented.

Figure 16. Example of A3 working principle foam board

Video material was used from the field research done in the analysis phase (Figure 17). This video material helped to place the participants in the public transport context and also show the actual interaction of using the smartphone as a fare medium in public transport. Video material from Oslo was used to represent self-ticketing, videos recorded in Seoul were used to represent smart card emulation and gathered material in London was used to represent the mobile bank card.

Figure 17. Examples of videos shown: check-in/out with mobile bank card, ticket inspection with self-ticketing

For the idea evaluation section, the generated ideas were visualised on an A3 paper. The ideas were divided into several topics, each having its own A3 paper. The ideas were named and provided with blank space where participants could write down their ideas and thoughts.

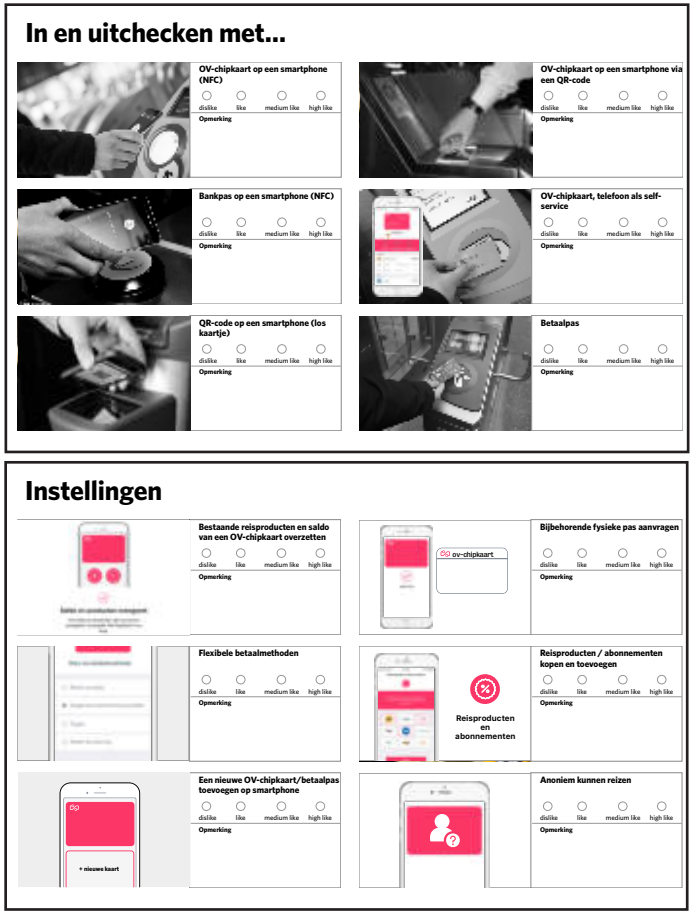


Figure 18. Examples of idea evaluation stimuli

Procedure

The user evaluation took place over the period of two days. Four participants on the first day and five on the next. Each user evaluation approximately took one hour.

5 min: Introduction
10 min: Current public transport experience
20 min: Developments for mobile ticketing for public transport in the Netherlands
20 min: Idea Evaluation
5 min: Debrief, capture the participant's overarching thoughts and impressions

Current experience in public transport, with a focus on ticketing

For this study, nine participants were guided in a 1-on-1 session. The participants were asked to reflect on their current experience in public transport, with a focus on ticketing, in order to define and verify travel habits and behaviour. This part also allowed the participants to share the things that were already on their mind, coming into this session.

Developments for mobile ticketing for public transport in the Netherlands

After this, the participants were asked to share their thoughts and give feedback about the current developments in relation to mobile ticketing in the Dutch public transport: self-ticketing, a mobile OV-chipkaart and the mobile bank card. These developments were displayed on an A3 foamboard, showing an abstract of how these developments would work. Gathered video material from field research in Oslo, London and Seoul were used to depict the usage of these mobile ticketing solutions in public transport. This part of the evaluation concludes by letting the participant indicate their preferred fare medium and elaborate on this decision.

Idea Evaluation

In the final section of this session, travellers were asked to score the generated ideas and give feedback on why they gave that score. The entire session is recorded on video and noted down.

3.4.3 Findings

This section describes the main findings from the conducted user evaluations. The findings are presented into two main sections: working principles of mobile ticketing and idea evaluation.

Working principles of mobile ticketing

Self-ticketing

For frequent traveller and infrequent travellers, the self-ticketing principle does not seem to fit their specific travel behaviour. For frequent travellers, it is more expensive and more of a hassle to buy a ticket for every time they take public transport. Infrequent travellers indicated that the flexibility of an OV-chipkaart is preferred as they don't have to get off at a pre-defined stop, but can decide where to get off while travelling. Incidental travellers have indicated to take interest in this option, as it seems less expensive than a physical OV-chipkaart and instead of buying a ticket at the ticket vending machines they can buy a ticket before hand. However, these participants have indicated to prefer other alternatives like a mobile OV-chipkaart or a physical bank card as these remove the steps of purchasing and downloading a ticket on the phone.

> *I would prefer a mobile OV-chipkaart, with mobile ticket you have to purchase them every time, put download them and open them. With the other one [Mobile OV-chipkaart] you can just check-in and go.*
>
> *- Female, age 30, Infrequent traveller (Less than 1 once per month)*

All participants did indicate that the use of a QR-code ticket is familiar due to experiences with other types of tickets such as Groupon, cinema and airport boarding tickets. The development that every transport operator is going to release their own self-ticketing app is perceived as a hassle. This would result in the traveller having to download multiple apps, while sometimes not even knowing which PTO is operating in certain areas.

> *It seems convenient that you don't need to go to a machine anymore to buy a ticket, what I think is really inconvenient is that I need to download a separate app for each transport operator, I just want 1 app for that. I don't know which bus operators run where for example.*
>
> *- Female, age 26, Frequent traveller (4/5 times per week)*

Mobile OV-chipkaart

There were various opinions on the working principle of a mobile OV-chipkaart, regardless of the defined traveller groups. First of all, there seems to be little benefit for most people in using their mobile phone to check-in/out rather than a card. Participants indicate that it requires the same action, grabbing something from your pocket and hold it against the validator. Needing a special NFC SIM card has been disliked by all participants. The fact that a lot of time passes by before one has obtained such a SIM card has evaluated as troublesome. When forgetting one's physical ov-chipkaart, this setup process doesn't make it possible to quickly be in possession of a back-up option.

Not sure if this is really that much more convenient just because it is on your phone...

- Female, age 54, Frequent traveller (3/4 times per week)

Some also indicated that there is no desire in stepping away from their current physical OV-chipkaart. Others indicated that the working principle would be preferable over their physical OV-chipkaart as they are less likely to forget their phone than their wallet. Participants indicated that price might be a driver to switch from a physical OV-chipkaart towards a mobile version. For the participants travelling with travel products, it was important that these were also available when using the mobile OV-chipkaart.

And how I would imagine it, is that I have an OV-chipkaart [physical], which I can cut in half, and my whole OV-account with travel products are on my phone

- Male, age 38, Frequent traveller (3/4 times per week)

The current implementation of OV-chip mobiel, however, creates concerns amongst all participants. The needed NFC-SIM card, which is only offered by selected mobile network operators, seems to be a too big of a hurdle for most of the people. The term NFC-SIM also seemed to suggest that the SIM card could be placed in any phone and enable the mobile OV-chipkaart. It is also not really clear why a separate wallet app is needed for the OV-chip mobiel app to function and why only wallets from the mobile network operator are supported. Both Apple and Android users have indicated to have expected OV-chip mobiel to be available on both platforms. All Apple users have indicated that OV-chip mobiel does not add enough value for them to consider switching to an Android phone.

So an NFC-sim card, why do you need an Android phone then, can't I just put the SIM-card in my iPhone then?

- Female, age 25, Infrequent traveller (1/2 times per month)

Not having to open an app during check-in/out was experienced as positive as most participants expected it to be necessary. For frequent travellers, time is an important factor in public transport, as they are one their way to their departing vehicle. As a result, most frequent travellers reacted negatively towards the shown check-in performance in Seoul. This was less of an issue for infrequent and incidental travellers. It was also stated that some participants feel uncomfortable holding their phone, a valuable personal object, against a validator as they are afraid to drop or damage it.

You don't have to open an app first to check-in? That is pretty convenient then.

- Female, age 26, Frequent traveller (4/5 times per week)

Mobile bank card (EMV)

Of the 9 participants, only 1 has used their mobile contactless bank card in stores before. This participant, however, stopped using it as it didn't add much value in comparison with his physical bank card. This is also one of the reasons, next to security and fraud concerns, that the other participants haven't orientated on the usage of a mobile bank card in stores.

I already have a bank card [physical], why would I want to put it in my phone? I'm so used to using that card.

- Male, age 62, Infrequent traveller (1/2 times per month)

The use of a mobile bank card in general, but also in public transport raises concerns amongst all traveller groups. The main benefit of using a bank card is that people get charged directly from their bank account rather than having to invest in an OV-chipkaart and top it up. There seems to be a strong preference to a physical bank card, as people are already used to paying contactless in other contexts such as retail. The mobile bank card seems like more of a hassle than the physical bank card. It needs to be connected to an app first, and when performing a transaction, authorization needs to be granted through a fingerprint for example, instead of just holding a card against a terminal. This extra step, however, was rated as positive by one of the participants, as it provided her with an extra security measure.

Because you can just also use your physical card. Why would I need to put my card in my phone and check-in with an extra code, feels like more steps, devious.

- Male, age 38, Frequent traveller (3/4 times per week)

The mobile bank card also seems to cause extra concerns regarding security and fraud. Participants indicate to be concerned about additional information such as contacts or files could be transferred during a transaction. It was also indicated that participants were not comfortable with having their bank card on their phone as this would make it more interesting for someone to steal their phone.

I'm also not really for with paying with my phone. I'm afraid that they can get much more information out if it. That's why I'm hesitant on putting my bank card on my phone, they're able to hack anything nowadays.

- Female, age 54, Frequent traveller (3/4 times per week)

User preferences

After expressing their opinion on the working principles, the travellers were asked to rate the discussed fare media on a four-point Likert scale. Looking at the results, it can be seen that both infrequent and frequent travellers seem to prefer physical versions of cards rather than the mobile versions. Frequent travellers seem to be satisfied with their OV-chipkaart, especially with the reliability when checking-in/out, while infrequent travellers prefer to use the bank card. This is mainly due to the initial investment, 7,50 Euros for a card, whereas this is not necessary with a bank card as most people already own one. Interesting to see is also that infrequent travellers seem to rate the mobile self-ticketing option lower than any other fare media, whilst it was expected that they would more likely gravitate towards this option. The findings also see that

Fare medium	Infrequent Travellers	Frequent Travellers
Mobile OV-chipkaart (NFC)	1.4	1.5
Mobile bank card (NFC)	1.2	1.3
Mobile self-ticketing	1.0	1.3
Mobile OV-chipkaart (QR)	1.6	1.5
OV-chipkaart (physical card)	1.6	2.3
Bank card (physical card)	2.6	1.8

Legend

Idea liked (2.3 - 3.0) | Idea somewhat liked (1.5-2.2) | Idea somewhat disliked (0.8 - 1.4) | Idea disliked (0.0 - 0.7)

Table 2. Ratings of the different kinds of fare media

Idea Evaluation

Participants were asked to evaluate the generated ideas for the defined journey steps. This idea evaluation is used to gain insights in the travellers' wishes and expectations. The results are shown per journey step, with the average score given by both frequent and infrequent travellers. The following legend will be used for the results in this section.

Legend

- Idea liked (2.3 - 3.0)
- Idea somewhat liked (1.5-2.2)
- Idea somewhat disliked (0.8 - 1.4)
- Idea disliked (0.0 - 0.7)

Awareness

Travellers seem to indicate that they would mainly use online channels to get to know about new mobile initiatives. Three participants indicated to frequently read the 'This week's best Android and iOS apps' rubric from Nu.nl to get to know about new apps. App descriptions in the app store were not frequently used. The reviews and number of downloads stated in the app store, however, seemed to be of importance for travellers. Review gives insights into what other people think of the app. A low number of app downloads might cause doubt as this means not many people make use of the app.

Awareness	Infrequent Travellers	Frequent Travellers
Poster about mobile ticketing in vehicles	1.8	1.5
Information at stops/stations	1.4	1.8
Information at ticket vending machines	2.0	1.3
News article about mobile ticketing	2.6	2.8
App description in the app store	1.4	2.5
On the website of public transport organisations	2.8	2.5

Table 3. Ratings of the ideas regarding awareness

Installation and registration

Travellers seem to indicate that they would just like to download an app from the app store and possibly register if necessary for the usage of an app. Registrations was often described as a logical step that needs to be done. However registering through the use of social log-ins, such as Facebook or Google account, was not preferred as participants thought this would lead to access to their personal information. Using existing public transport accounts such as My OV-chipkaart or My NS seemed to be preferable. NFC SIM card solutions seemed to be disliked by all travellers as this causes extra hassle as one needs to be requested. Registering through a mobile wallet is also somewhat disliked by both groups due to unfamiliarity with the mobile wallet and previously mentioned security concerns.

Installation and registration	Infrequent Travellers	Frequent Travellers
Pre-installed on a phone	1.6	0.7
Download through app store	2.6	2.6
Through NFC SIM card	0.4	0.7
Registration for use	1.5	1.5
Register through existing accounts	0.6	1.1
Register through mobile wallet	1.0	1.1

Table 4. Ratings of the ideas regarding Installation and registration

Configuration

Connecting an existing OV-chipkaart towards an mobile ticketing solution was essential for all participants. This would allow participants to travel using their existing balance, travel products and subscriptions. Flexible billing methods were also liked. Postpaid billing methods would allow travellers not to worry about having balance on their card and topping up. For infrequent travellers the idea to request a physical card was disliked, while for frequent travellers this was highly liked. This could be caused by the check-in performance shown at the evaluation of the working principles, where frequent travellers indicated that time was an important factor.

Configuration	Infrequent Travellers	Frequent Travellers
Transfer travel products and credit from OV-chipkaart	2.4	2.5
Flexible payment methods	2.4	2.6
Add a new card to smartphone	1.4	1.8
Request a connected physical card	0.6	2.8
Buy and add travel products/subscriptions	2.6	2.5
Travel anonymously	1.2	1.5

Table 5. Ratings of the ideas regarding Configuration

Preparation

Being able to top up and add travel supplements were highly liked by frequent travellers. Topping up credit through an app gave the advantage of being able to top up on the spot and not being bound to a top up machine. Travellers with auto-reload also indicated that if topping up through an app were possible they would rather prefer that than auto-reload. This provides than with more control as to when a top-up happens as they usually don't see when an auto-reload occurs. Indicating business journeys were only relevant for people declaring their travel costs, but was of high importance for them. An integrated planner seemed handy but necessary as travellers already are used to using the NS Reisplanner Xtra or 9292 app for their trips.

Preparation	Infrequent Travellers	Frequent Travellers
Top up credit on device	1.8	2.5
Add travel supplements	1.6	2.5
Travel with multiple people	1.8	1.5
Indicate business journeys	1.3	2.0
Integrated planner	2.2	1.8

Table 6. Ratings of the ideas regarding Preparation

Travel

A real-time check-in/out and balance overview seemed to be highly liked by all travellers. Infrequent travellers indicated not knowing how much they've spent on a journey as the OV-chipkaart itself doesn't display any information. Infrequent travellers also liked the idea of an check-in/out notification more than frequent travellers. Frequent travellers indicated to trust the system enough to know when they've checked-in, while infrequent travellers have the need for some verification. Regarding inspection methods, it was often mentioned that it was not preferable for the phone to make contact with the inspection equipment. However, using visual methods also had the perception of not being a serious inspection, as it was perceived to be easily abused and duplicated. Most travellers also indicated that consistency during inspection is important as everyone should be inspected in a same manner.

Travel	Infrequent Travellers	Frequent Travellers
Realtime check-in and credit overview	3.0	2.8
Check-in/out notification	2.8	1.5
Check-out reminder	2.0	1.0
Show phone during inspection (Visual)	2.2	1.5
Read out phone during inspection (NFC)	1.4	1.5
Scan code on phone during inspection (Barcode)	1.6	2.1

Table 7. Ratings of the ideas regarding Travel

Post Travel

A forgotten check-out reminder and low balance notifications were rated highest amongst both groups. Travellers indicated to be useful to be pro-actively reminded of a forgotten check-out rather than the current situation, where one would notice that their balance is low when checking in as the boarding fare was not refunded. A balance notification was also rated highly as travellers usually noticed that their balance is too low at the moment of check-in. Having a balance notification at the moment of check-out would already prepare travellers for their next trip.

Post travel	Infrequent Travellers	Frequent Travellers
Subscription advice based on journeys made	1.6	2.0
Forgotten check-out notification	2.6	1.9
Credit lower limit notification	1.8	2.3
Create travel statement	1.4	2.3
Block or renew cards	2.0	1.8
Reimburse credit when cancelling service	1.6	2.0

Table 8. Ratings of the ideas regarding Post travel

3.5 LIMITATIONS

This user evaluation gave insights into travellers opinions about the current mobile ticketing working principles, as well as an look into their wishes and expectations for a mobile ticketing solution. This user evaluation, however, is subject to some limitations that might have influenced the results.

This user evaluation was held in a conversational setting. Even though an interview guide was consulted every interview, the conversations and questions asked would always differ. Other concerns using the described method include the trustworthiness of the result due to leading questions (Kvale, 1994).

The video material used to evaluate the mobile ticketing principles were made from material gathered in Oslo, London and Seoul. The shown video stimuli therefore does not fully represent the Dutch public transportation context. The self-ticketing video did also only show successfully executed trips, whereas the other videos also did show some instances where something did go wrong.

Using a four-point Likert scale also has its limitations (Jamieson, 2004). Participants may avoid extreme answers, especially negative ones. This allows to portray themselves in a more socially favourable light rather than being honest, and in the case of this user evaluation disliking something. (e.g. 'This idea is not interesting, but disliking it goes to far...'). Participants also might have agreed with statements and liked ideas to 'please' the researcher as they knew they were evaluating his ideas.

3.6 CONCLUSIONS

This chapter has presented how three mobile ticketing principles and generated ideas based on the defined travel steps, have been evaluated by users. The was important define user expectations , and in turn requirements, in order to come to a concept direction for a user-centred mobile ticketing solution. The following user expectations and requirements have been identified.

3.6.1 User expectations & requirements

Phone is (currently) mainly used as a user interface

This evaluation make it apparent that people are not just yet to using their mobile phone to perform NFC-transactions in both retail and public transport. People are used to use their phone as an user interface to get information or perform actions, but using it to perform wireless transactions seems still unusual and unfamiliar. Not offering enough benefit in comparison with a physical card is one of the reason withholding people. Other reasons are security concerns, not wanting to take out a valuable object, not being familiar with NFC yet and still having to carry around a wallet. This however could shift over time as mobile wallet initiatives such as Apple-, Android-, or Samsung Pay makes it way to the Netherlands and becomes more familiar. As soon as people are able to digitalize their whole wallet, mobile fare mediums become more interesting. This makes it important not to focus on a mobile fare medium, but rather on a mobile ticketing solution where travellers can choose their preferred fare medium.

More cost effective than physical OV-chipkaart

Mobile alternatives for physical cards such as an OV-chipkaart or bank card are expected to be more cost effective. Currently travellers can purchase a physical OV-chipkaart for 7,50 Euros, which is already perceived as expensive. Digital versions are expected to be more cost effective as nothing tangible is given back in return. In the traveller's mind, the card issuer saves on manufacturing costs and can therefore lower their prices for the digital alternatives they provide.

Quick setup

People have the expectation of mobile apps to be setup within a few minutes on their mobile phone. Having extra steps, such as needing a special SIM card is an illogical step as everything is expected to happen digitally within the app.

Time efficient interaction at check-in/out

The OV-chipkaart has set the standard for check-in/out performance at validators. Especially for frequent travellers, when using a mobile fare medium, maintaining this standard is important as time plays an import factor in their public transport journey. Extra steps such as opening an app or authorizing a check-in/out can be discouraging.

Support for multiple mobile operating systems and to all mobile network operators

Travellers have the expectation for digital public transportations services to be available on multiple operating systems. Services should also not be limited to customers of certain mobile network operators as this is not perceived as a factor which should limit ones possibilities in public transport.

Mobile self-service capabilities, not being bound to a machine

Topping up, loading travel products and supplements are currently actions travellers need to perform at an add value machine or ticket machine. A mobile ticketing solution should make these location-bound actions unnecessary, enabling the traveller to perform these actions at any place and point in time.

Real-time information provision

The timing and correctness of provided information is important for travellers using a mobile ticketing solution. Therefore information should be provided on a real-time basis in order to e.g. display the correct travel activity, current balance and check-in status. Providing this information on an too big of delayed interval causes distrust in the services.

Pro-actively remind and inform users

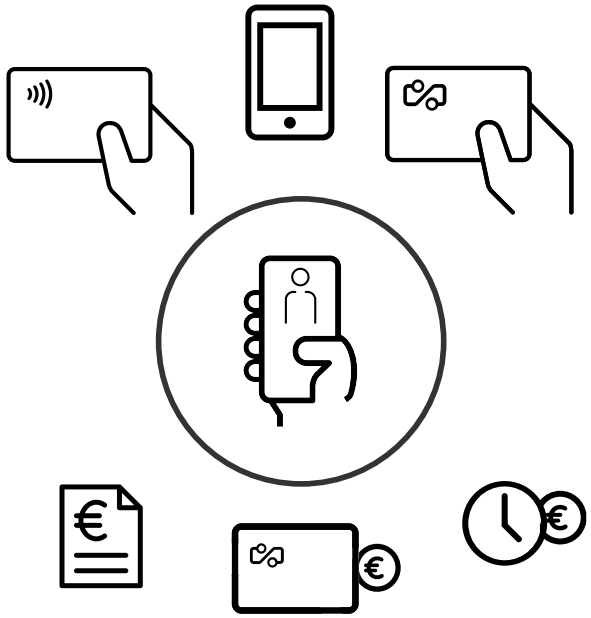
Pro-actively reminding and informing users of travel activity or missed check-outs is perceived as pleasant and expected as a baseline service. This improves travellers' experience in public transport by taking away certain doubts they have, e.g. did I correctly check-in?, by pro-actively reaching out. Travellers no longer need to actively go seek out this information themselves and would no longer encounter unpleasant situations such as not being able to check-in due to low balance.

Mobile self-ticketing seems redundant

Options such as using a contactless bank card or mobile OV-chipkaart seem more interesting for infrequent travellers. This is due to the extra steps of purchasing a ticket beforehand and being bound to a predefined route.

3.6.2 Concept direction: mobile ticketing with server stored data

Based on the defined user expectations and requirement, server stored data is essential for a mobile ticketing solution. This way real-time information can be provided towards the user's phone. In the current OV-chipkaart system, the data stored on the card is leading. It also became clear that travellers have the need to configure ticketing options on their mobile phone regardless of their fare medium. The next chapter elaborates how a shift toward server stored data can improve the travellers journey in public transport.



4

Concept development

4. Concept development & stakeholder evaluation

4.1 INTRODUCTION

This chapter presents the development of the defined concept direction from the previous chapter. The findings from the previous chapter, together with the knowledge of the analysis phase has proposed a concept direction based on data stored on a server. This is a step away from the current OV-chipkaart system, where fares are calculated in the validators and are written off the OV-chipkaart. This concept direction proposes a concept where this calculation and fare deduction takes place in the back office. Stakeholders are asked to evaluate the concept and display any concerns they might have with implementation. This allows for an integral design view for business, technology, human and society aspects of the to be designed mobile ticketing solution.

4.2 SERVICE POSITIONING

In order to narrow down the scope of the design phase, the focus of this phase needs to be decided. The following section describes current context factors, which are assumed to be fixed, and certain future factors, developments that are assumed to be implemented.

4.2.1 Fixed context factors

Check-in/Check-out

The public transportation system in the Netherlands is still based on checking in at the start at one's travel and checking out at the end. Transferring to another public transport operator also still requires you to check-out the first trip and check-in the new one. Fares are still calculated based on the travelled kilometers and travellers still can use travel products and subscriptions for their travels.

Gated & Non-gated contexts

This check-in/out process can be done in gated environments, such as the metro and closed off train station, as well as at non-gated contexts such as busses, trams and open train or metro stations.

Nationwide interoperability

The public transportation system in the Netherlands is still interoperable nationwide. Travellers are able to the same fare medium when traveling with different public transport operators.

Current market situation and stakeholder dynamic

The public transportation market is still split up into concession divided by the public transport authorities. This means that PTOs are still each other's competitors and different PTOs are present in different regions.

4.2.2. Assumed developments

Nationwide EMV

Validators are going to be equipped with new EMV-readers. When equipment is not prematurely upgraded, nationwide coverage is reached in 2028 (Meeuwsen, 2016).

Smart back office

This smart back office will have an open architectural system. This makes the system easily expandable and capable of handling future fare media and technologies without reducing feedback information that can be provided on validators, which is a potential issue pointed out by Meeuwsen (2016).

4.3 MOBILE TICKETING CONCEPT: ACCOUNT BASED TRAVEL

Several aspects have been defined that are essential for account based travel. Figure 19 shows a proposal of how of the new situation where data is stored in the back office, is organised.

4.3.1 Working principle

Account

Travellers can sign up for an OV-account. While in possession of an account, travellers are able to register, manage and configure their cards. Travellers can register their contactless bank card, as well as their OV-chipkaart. New travellers can request a new virtual or physical OV-chipkaart through this service. Registering for an account allows travellers to get real-time information and notifications on their travel activity, the ability to top up or sign up for a postpaid billing method and correct incomplete journeys. When not registering a card, travellers will have to use pick-up devices, ticket vending and add value machines to perform these actions.

Bank card and OV-chipkaart

In this proposed model, the bank card only functions as a full fare pay as you go ticket, as the mental model of connecting travel products to a bank card seems hard to grasp for travellers. Trips are always directly debited from the corresponding bank account. Connecting travel products and subscriptions will only available for the OV-chipkaart as the bank card seems ideal for infrequent and incidental travellers. Connecting a bank card to an OV-account is not necessary to use the bank card in public transport, but does allow travellers to get real-time information and notifications on their travel activity and also allows them to correct incomplete journeys.

Fare media

Fare media will be connected to a corresponding bank account number or OV-chipkaart number. For each OV-chipkaart number, two types of fare media can exist: a physical OV-chipkaart and a digitized mobile OV-chipkaart. The communication protocol of the OV-chipkaart will be upgraded from MiFare towards another protocol which allows for tokenization of the OV-chipkaart to a mobile version, without the need of an NFC-SIM card. Depending on the bank, similar fare media are also available for each bank account number: a physical bank card and a digitized mobile bank card. Travellers will need to check in and out with the same fare media to complete a trip. Checking in with a physical card and out with a mobile card will result in two incomplete journeys. Travellers will however be able to share their fare media, as the OV-chipkaart is no longer personalized, and use both of them at the same time. When a subscription is bought for a card, the first fare medium to check-in will travel with the subscription, whereas the next one will travel full fare.

Fare calculation

Fare calculation no longer takes places at the validators but is executed in the back office. This allows the validators to contain less intelligence and only to be used for communication with the fare media. Validators are directly connected to the back office, where the id-number of the read fare media will be traced back to a OV-chipkaart or bank account number, possibly connected to an OV-account.

Design focus

As this project's aim is to explore how a mobile ticketing solution can improve the travellers' experience in public transport, the design focus of this project is focussed on the mobile app. The OV-betalen app, as it will be called, is the portal to an OV-account, which will also be the channel that enables the mobile OV-chipkaart.

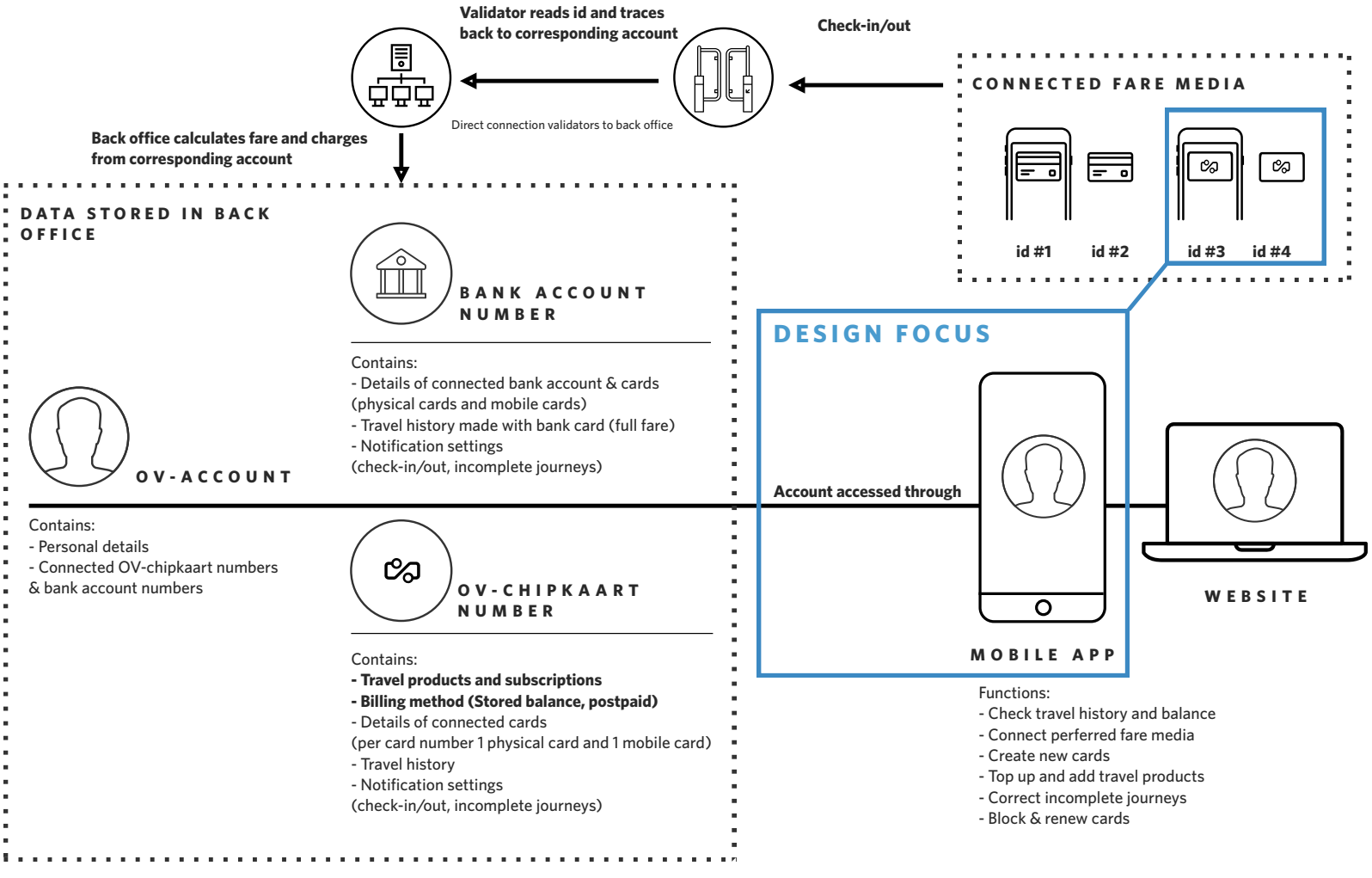
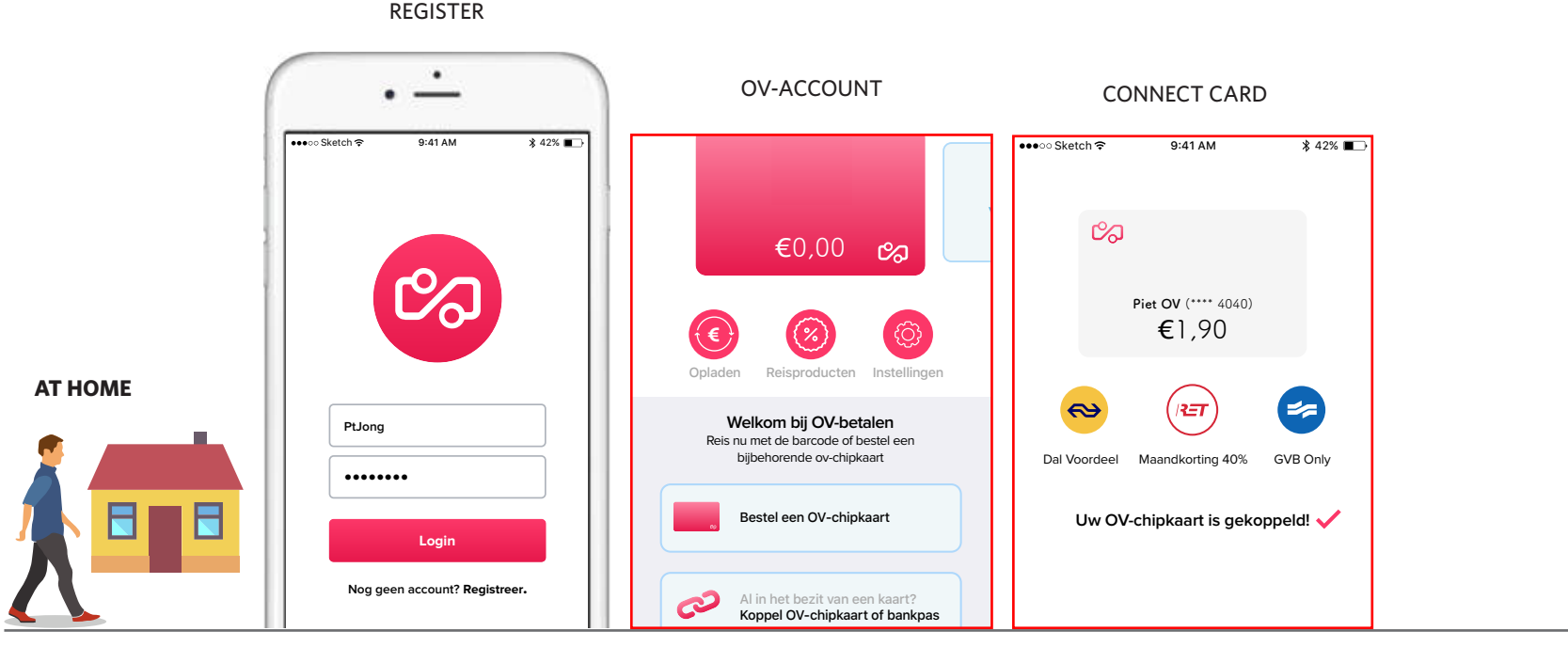


Figure 19. Account based travel: proposed working principle

4.3.2 Use case examples

This section proves examples of how the OV-betalen app can be used for certain use cases. The scenarios are illustrated using sketches of screens that represent certain functionalities. These use cases have also been used in communicating the concept to the stakeholders. These sketches do not represent the final design but are early visualisations for evaluation purposes.

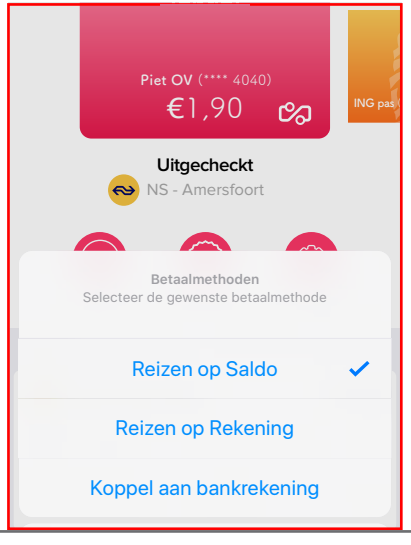
When one registers for an OV-account, an empty virtual card is created by default. The traveller can either choose to continue using this virtual card, order a physical OV-chipkaart or connect an existing OV-chipkaart or bank card. When connecting an OV-chipkaart, the card's balance, travel products and subscriptions will be synced with the app.



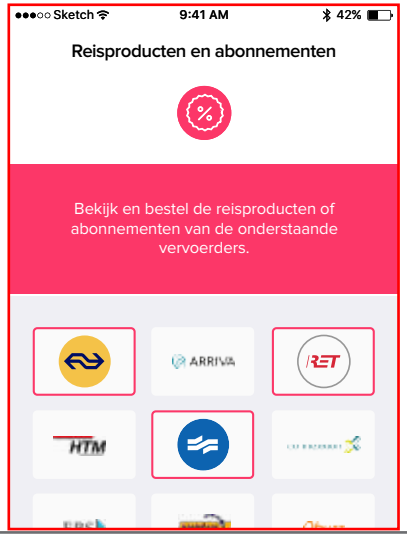
Once set up, users can choose to change their billing method from the a stored value basis (Reizen op saldo) towards a postpaid periodical payment (Reizen op rekening), or charge trips directly from a bank account (Koppel aan bankrekening). Travellers will also be able to explore and search for travel products and subscriptions from all public transport operators. Travellers could also ask for subscription advice by manually inputting their travel frequency and locations or let the app make an suggestion based on registered travel behaviour.

Before getting in the public transport context, travellers can manually top up their balance through the OV-betalen app. Several payment options will be available such as iDeal, Paypal and credit card in order to facilitate this top-up. It is no longer needed to go to a ticket machine or add value machine to top up.

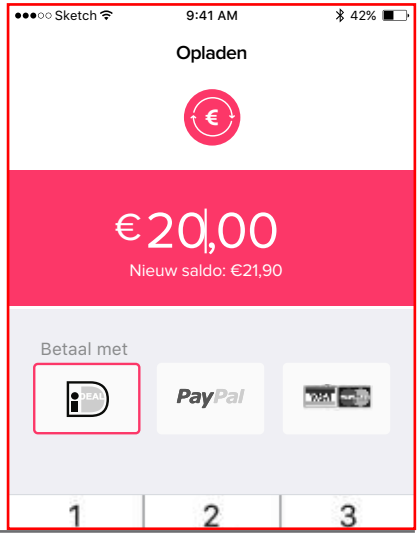
CONFIGURE BILLING METHOD



PURCHASE TRAVEL PRODUCTS

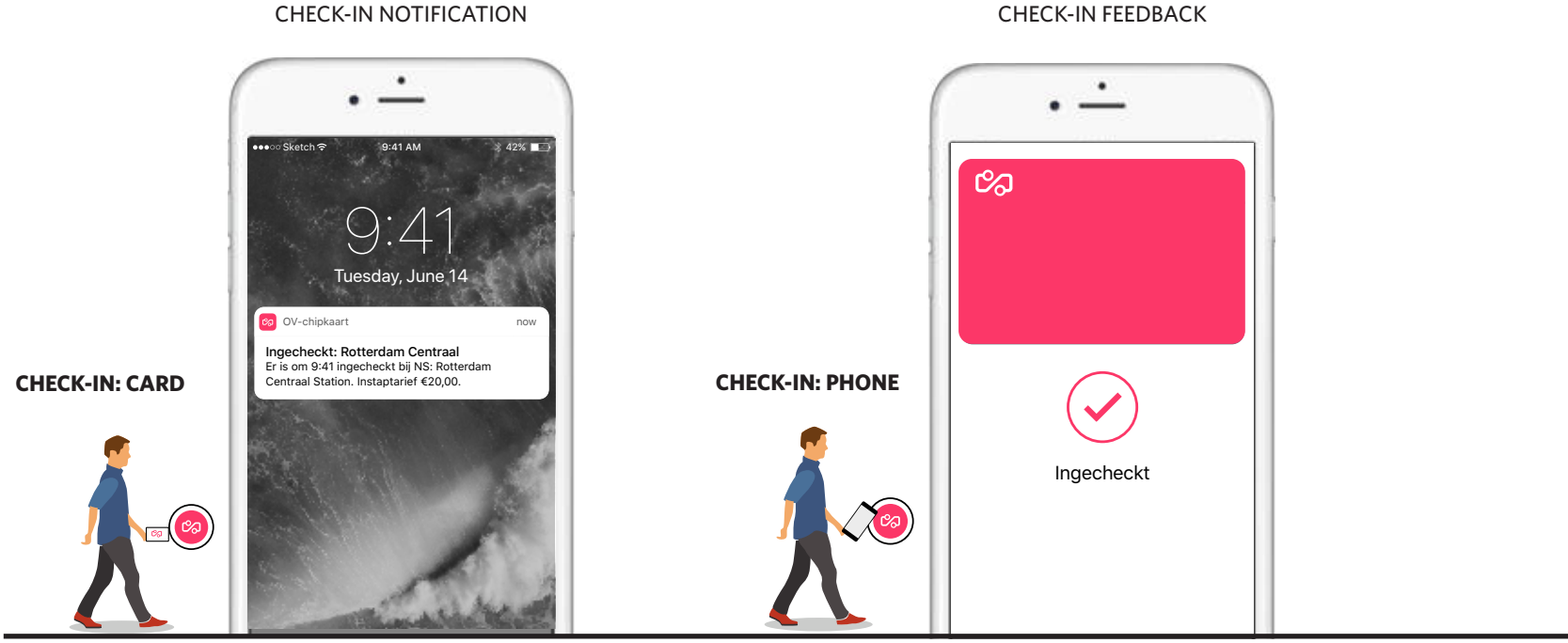


TOP UP CARD



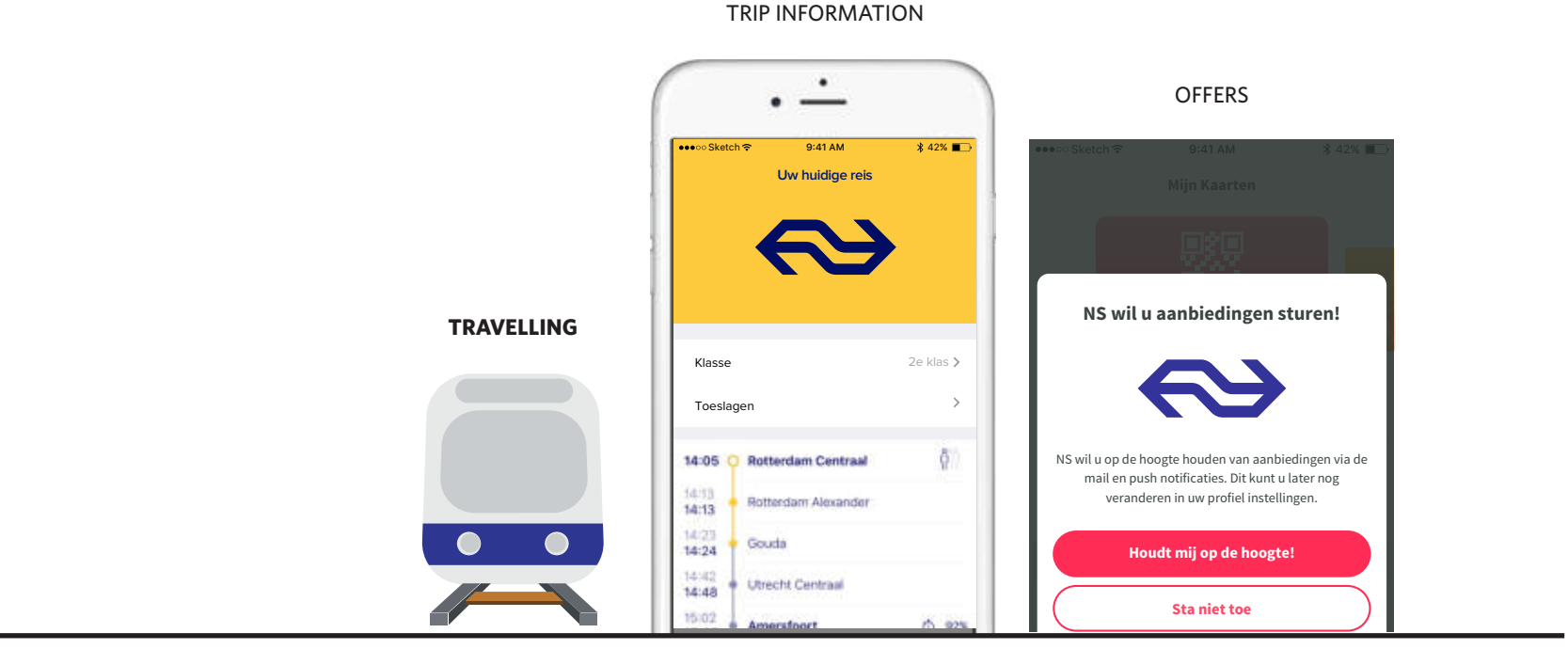
When one checks in with a registered physical card, be it either an OV-chipkaart or bank card, the traveller will get a check-in notification. This provides certainty and allows the traveller to verify that the check-in attempt was indeed successful.

Travellers can also choose to use their mobile OV-chipkaart to check-in. By holding their phone against a validator, the traveller will get on-screen feedback that a check-in has occurred.



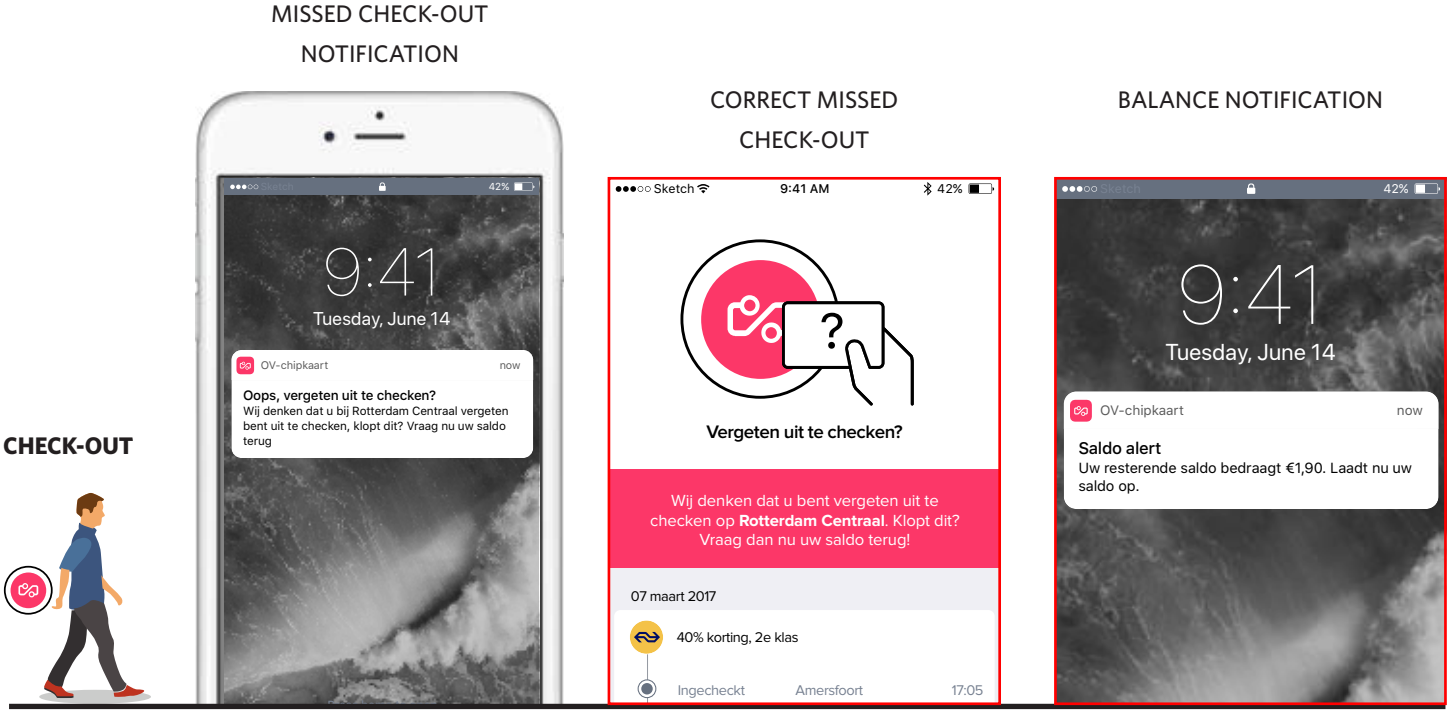
Opening the check-in notification pops up the current trip information. This displays the current seat class, available supplements and arrival info. Travellers will be able change seat class when the train is full or add supplements to their trip to take along their bike or dog, or when travelling in a vehicle that requires a travel supplement

Travellers will also be prompted to get offers from public transport operators after they have travelled with them for a certain amount of times. This allows for travellers to get deals and discounts, whereas it allows public transport organisations to build up a client relationship.



A missed check-out notification is given when a traveller is still checked-in after a certain amount of time. Instead of finding out during the next check-in, that there isn't sufficient balance available due to a missed checked-out, travellers are now pro-actively encouraged to correct an incomplete journey.

After checking out, travellers will also get a check-out notification stating their trip price. Travellers have the ability to set up auto reload or a balance reminder. This sends out a notification when the traveller's balance drops below a certain threshold. This already prepares the traveller for the next trip as this encourages to perform a top-up.



4.4 STAKEHOLDER EVALUATION

Various stakeholders were contacted to provide their opinion on the concept direction. This evaluation also checks if the concept is viable in terms of business, feasible in terms of technology and responsible in terms of the demands society puts on it. Public transport organisations, governments, market regulators and consumer organisations were contacted to get an complete view of the wishes and concerns. Their thoughts and considerations about the service concept, as well as their responses to users requirements and wishes defined in the previous chapter, are taken into account to provide final requirements for the service proposal.

4.4.1 Method

Aim

The aim of the stakeholder evaluation is to see if the concept direction is line with the stakeholders' wishes and needs. This evaluation is also aimed at getting feedback from stakeholders in order to define potential new concerns that need to be taken into account.

Research questions

- What do the stakeholders think of the defined concept direction?
- Which aspects of the concept do, or do not, match with the wishes and needs of the stakeholders and why?
- What are other concerns or wishes from the stakeholders?

Procedure

For this stakeholder evaluation meetings with representatives of public transport organisations, governments, market regulators and consumer organisations were scheduled. During this meeting a presentation was given showing the results from the analysis phase as well as the concept direction. The representatives were asked to provide feedback and to express their opinions on the concept and whether or not it would be feasible to implement the concept. The sessions have been either audio-recorded or noted down.

4.4.2 Results

The stakeholders discussed the strengths, weaknesses and possible limitations of the proposed concept direction. The results have been grouped into three stakeholder groups: public transport organizations, governments and lastly consumer organisations and regulators. The following section also describes these stakeholders' concerns and wishes.

Public transport scheme builder: Translink

All public transport organisations have indicated to find the concept interesting and align with their future vision. The concept is in line with the mission of seamless travel and lowering the threshold for new travellers to enter public transport. The public transport organizations also stated that leaving the fare media choice open to the travellers is a good choice. The fundamentals for the smart back office also already seem to be in place, which allows for the addition of new technologies and fare media.

Public transport operators

However the PTOs have a few concerns regarding this concept for a mobile ticketing solution. The client relationship with a the brand of the PTO seems to be important for some of the transport operators. This is due to the desire to send their travellers personalized offers and provide them with real-time departures. Selling travel products and subscription from one app also seems a concern amongst PTOs, as this would create a new competitive field. Some public transport operators would rather have centralized data whereas others rather have it more in own control. In terms of implementation, the concept heavily relies on upgrades in infrastructure. EMV validators for example are already bought by some of the PTOs, while others don't feel the need yet to upgrade their current equipment.

Government Institutions

According to the government institutions, lowering the threshold to use public transport should be one of the key drivers. They also stated it is also important to continue the user-centred mindset throughout the design process. It was also stated that it is up to the PTOs to run the innovations. These institutions have also indicated that it is important to provide the right information to travellers at the right time. Next to also lowering the threshold, they also think it is important to have one central data institution. Cross-concession data is something that is currently missing, which would allow for a more efficient division of routes and material. It is also important that new initiatives just work at launch, instead of having a similar introduction like the OV-chipkaart, where a lot of corrections where needed afterwards.

Consumer Organisations and market regulators

Consumer organisations have also stated to find it important to lower the threshold for new travellers in public transport. In their opinion, the mobile phone as fare medium is one of the most promising initiatives as almost everyone has access to one. It was also pointed out that holding on to the system as it is will always deliver suboptimal experiences for the travellers as the fundamentals seem wrong. The market regulators think it is important that the public transport organisations compete fair against each other and also protects consumer interests. When offering travel products through the app, the app cannot have a monopoly position as the only place that sells these travel products. Introducing such a feature should also allow other parties to be able to sell these.

4.4.3 Limitations

The stakeholder evaluation has been performed with several stakeholders of the public transportation system. However when implementing such a mobile ticketing solution, a lot of other parties such as technology providers will be involved. In order to involve these parties that will also have their own wishes and concerns, extra research would be needed. This evaluation took place over a period of two months during which the design matured and evolved. Thus, making the concept presented to the first party less in-depth than presented to other parties. This may have led to a less critical view from the stakeholder's perspective as the concept was more abstract at the time.

4.5 CONCLUSION

This chapter introduces the concept direction that was defined from the user evaluation in the previous chapter. A working principle has been established, together with a few usage scenarios, describing how this mobile ticketing concept can impact the traveller's experience in public transport. In order to check the feasibility and viability of this concept stakeholders were asked to evaluate this concept. One reoccurring comment is the emphasis on lowering the threshold to make use of public transport. Even though this seems doable with the proposed concept, it heavily relies on upgrades in infrastructure, namely validators. When not prematurely updating before the economical lifespan, this could take until 2028 before nationwide interoperability is guaranteed. Public transport operators also expressed the wish to be able to create a client relationship with their customers. For government institutions it is important that cross-concession data is available and that new initiatives are thoroughly tested before launched. The market regulators also points out that selling travel products and subscriptions in an app is allowed as long as other parties are also allowed to act as a broker for selling these products. Having verified the concept direction with several stakeholders, the concept will be detailed into a service design. The next chapter proposes this new service and evaluates it with travellers.

5


Mijn Kaarten
€3,90
Opwaarderen
Reisproducten
Instellingen
10 mei
NS
- € 14,88
RET
- € 0,98
NS
- € 4,20

5. Service design proposal & user evaluation

5.1 INTRODUCTION

Using the results from the user evaluation of the working principles and ideas for mobile ticketing and the stakeholder concept evaluation, a service design proposal was created which enables a mobile ticketing solution for public transport in the Netherlands. This chapter describes the proposed services as well as the user evaluation of this service. The results of the user evaluation can be found at the end of this chapter.

5.2 DESIGN PRINCIPLES

In order to come to a service design proposal, design principles were defined based on the insights gathered described in the previous chapters.

Efficient onboarding process

Users should be able to set-up the app within a set time frame. In the public transport context, time is an important factor. Therefore it is necessary for the mobile ticketing solution to provide a set-up process that travellers are able to conduct on the go.

Accessible, immediate travel

Once set-up the mobile ticketing solution should allow for immediate travel through a free virtual mobile OV-chipkaart. This would allow travellers to have valid fare medium within minutes of signing up without little financial barriers.

Dynamic interface, adaptive per phase

The interface should adapt to the traveller's current phase in his journey. This allows for context dependent information, such as arrival times.

Provide the right information at the right time

Unburden travellers from uncertainty by pro-actively providing them with important contextual information. Inform travellers when something might have gone wrong (e.g. missed check-out) or when action is needed (e.g. low balance).

Mix Matters

Provide clear distinguishable alternatives. In this case, the bank card is always full fare and an OV-chipkaart is needed for travel products and subscriptions. Travellers can still prefer physical cards over mobile cards due to reasons as being cautious with their mobile phone, fear of running out of battery, no perceived added value as a physical card works fine. Don't aim at transferring everybody to a mobile fare medium, but see it as an extra service for the ones interested.

Independence from location-bound machines

All actions that currently require a ticket vending machine or pick up device should be available to do on a mobile phone. Make sure that a mobile ticketing solution can operate independently from these location-bound machines.

5.3 CUSTOMER JOURNEY

Figure 20 depicts the customer journey steps for a new user of the OV-betalen app. This could be a frequent traveller, who already owns an OV-chipkaart with travel products, a new traveller requesting an OV-chipkaart, or an incidental traveller using a bank card who wants to track his trip history.

Most travellers notice the existence of the app through word of mouth and web articles, namely ones describing newly launched apps. Frequent travellers might also encounter promotion in context, such as posters at stations or on in-vehicle screens. After downloading the app and registering for an OV-betalen account a virtual card is automatically made, travellers can register their existing bank or

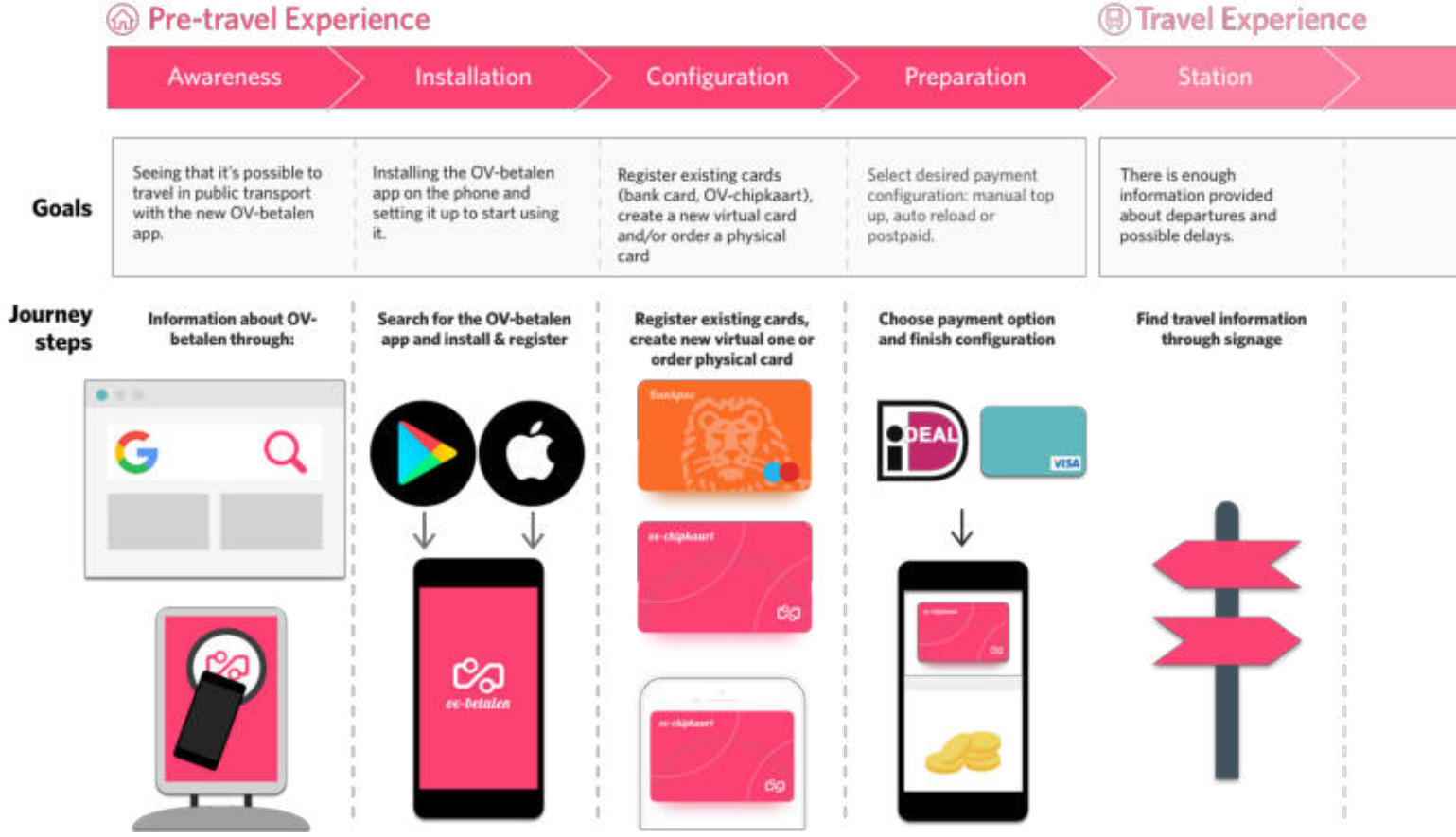
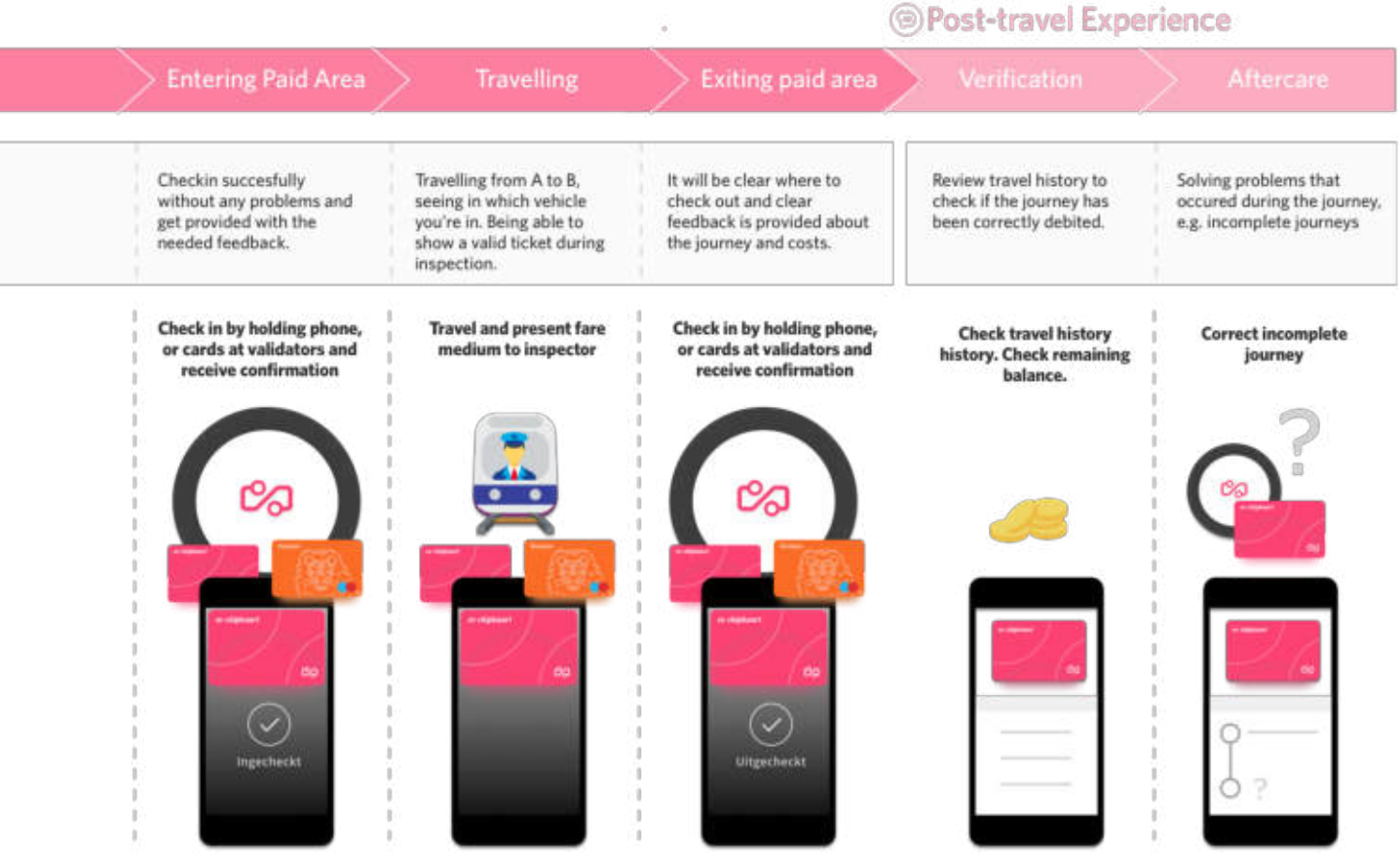


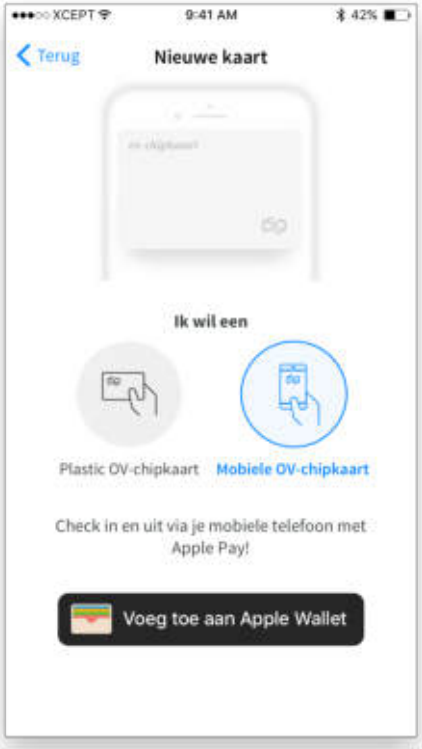
Figure 20. Customer journey map illustrating different steps when interacting with the systems

OV-chipkaart and travel with their current funds and travel products. New travellers can either start using the virtual card or request a new physical OV-chipkaart. Using the OV-betalen app, travellers are able to purchase travel products and subscriptions, top up credit and change to other billing methods such as a periodical post payment. Travellers who have registered their fare media in the OV-betalen app can be notified about card activity and provided with trip feedback. This service design mainly describes the OV-betalen app channel. Next to this app channel, there will also be a web environment where travellers can perform similar actions.

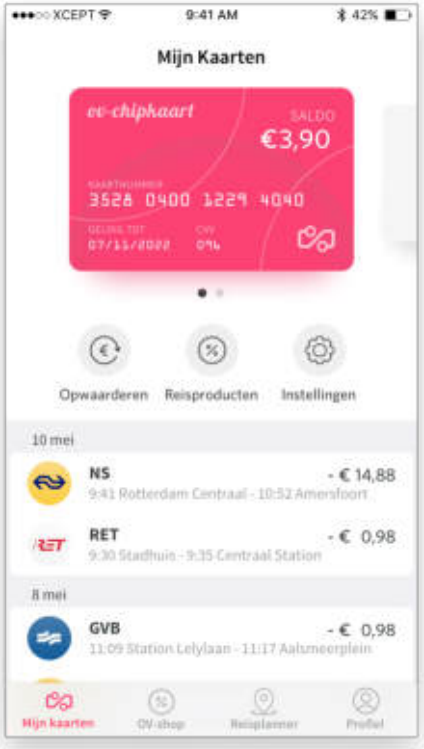


5.4 USER INTERFACE EXAMPLES

This sections shows a few important user interface examples. The final interface design can be found in Chapter 6: Final Design: Service design for user-centered mobile ticketing in public transport.

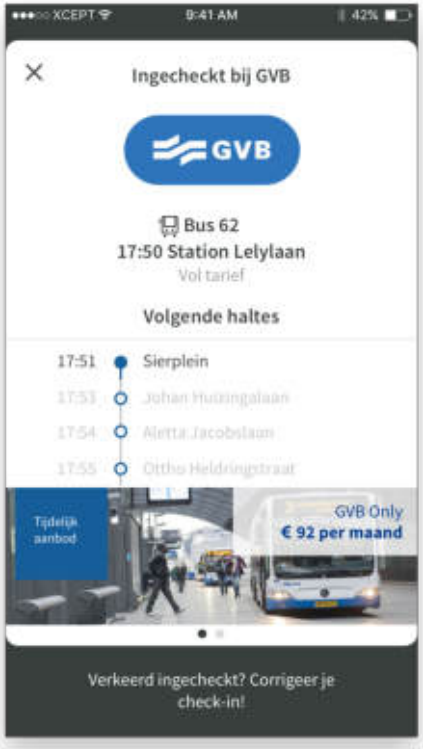


Request a new card



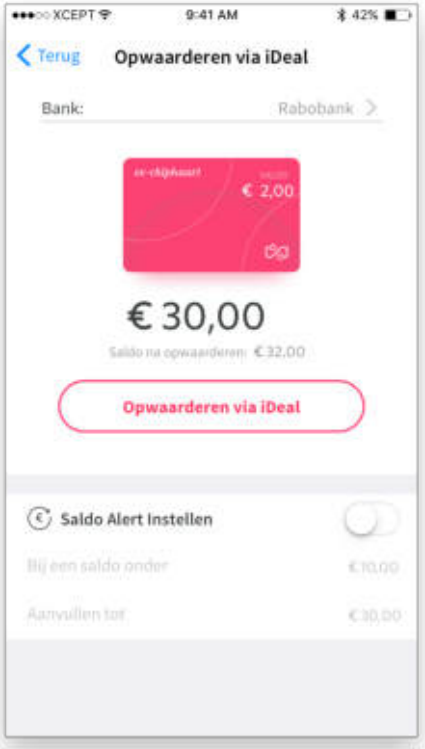
Card overview

Check-in notification



Current trip details

Check in and out with mobile OV-chipkaart



Top up OV-chipkaart

5.5 USER EVALUATION

5.5.1 Aim & Research Questions

The aim of the user evaluation is to determine how the proposed mobile ticketing concept for public transport in the Netherlands is experienced by users. This user evaluation is also meant to produce insights on which touch-point and design interventions are required in order to improve the experience when using public transport.

- How do users perceive and evaluate the proposed service design concept for mobile ticketing in Dutch public transport?
- How does the proposed service design concept for mobile ticketing match the user's wants and needs?
- How do users experience the usability of the proposed mobile ticketing service design vision?

5.5.2 Method

The user evaluation is done with a mix of both qualitative and qualitative research methods. Qualitative methods are used to gain rich insights into the user's thoughts, expectations, attitudes and processes in regards to the proposed mobile ticketing service concept. The System Usability Scale (Brooke, 1996) and AttrakDiff (Hassenzahl et al, 2008), both quantitative surveys, are used to allow participants to rate the perceived usability and user experience of the proposed service.

Participants

Nine participants were recruited for this study. For this concept evaluation, all but one of the participants were in possession of a smartphone. This participant, however, indicated to be considering the purchase of a smartphone.

Participants were also recruited based on three levels of travel frequency in public transit:

Frequent travellers

This group uses public transport frequently, a few times a week, and use a personalised OV-chipkaart in combination with a travel product. This group mainly contains commuters, people who travel regularly from one place to another, e.g. from home to work, using public transport.

Infrequent travellers

This group uses public transport a few times a month and have an OV-chipkaart, either personal or anonymous and use a travel product or use pay as you go. Day-trippers who use public transport are relatively experienced with public transport and mainly use it when visiting family or an event for example.

Incidental travellers

This last group, containing incidental travellers are inexperienced with public transport and usually buy tickets instead of owning an OV-chipkaart. This group rarely uses public transport, mainly in specific scenarios e.g. going to the airport.

Next to these travel requirements, the participants needed to be familiar with and have used mobile banking solutions. This could be the mobile banking website, app or payment solutions such as PayPal.

Incidental: Travel frequency of less than once per month					
#	**Age**	**M/F**	**Fare media**	**Travel Products**	**Phone**
1	57	M	Paper tickets	None	None
2	26	F	Personal OV-chipkaart	None	iPhone 5s
3	33	F	Paper tickets	None	iPhone 7

Infrequent: Travel frequency of 1/2 times per week					
#	**Age**	**M/F**	**Fare media**	**Travel Products**	**Phone**
1	30	F	Personal OV-chipkaart Paper tickets	None	Samsung Galaxy
2	68	M	Personal OV-chipkaart	40% off-peak train discount	iPhone 5s
3	37	M	Personal OV-chipkaart	40% off-peak train discount	iPhone 6

Frequent: Travel frequency of at least 5 days per week					
#	**Age**	**M/F**	**Fare media**	**Travel Products**	**Phone**
1	46	F	Personal OV-chipkaart	HTM (The Hague area) regional 1 year subscription (Unlimited travel in specific area)	iPhone 7 Plus
2	31	F	Personal OV-chipkaart	40% off-peak train discount RET (Rotterdam area) regional 1 year subscription (Unlimited travel in specific area)	iPhone 6
3	19	F	Personal OV-chipkaart	Student Travel Product (Unlimited travel Monday - Friday, 40% on weekends)	iPhone 7

Table 9. Overview of participants for this user evaluation

Procedure

The session took place over a period of three days in a closed off space at the faculty of Industrial Design Engineering at TU Delft. The evaluation procedure consisted of the following sections:

Welcoming and introduction to session: 5 minutes

The evaluation started by explaining the context of the project and the procedure of this evaluation.

Next, the participants were asked several questions in a semi-structured interview. This allowed the participants to share the things that were already on their mind, coming into this session.

Evaluation of the various stages of the proposed mobile ticketing service concept: 60 minutes

Once the participants were briefed about the procedure of the evaluation, several usage scenarios of the proposed service were shown. A list of the scenarios is shown below. The scenarios started based on physical card based travel, as this most relatable to the current ticketing solutions available in public transport. Afterwards, participants were introduced to the mobile phone as a fare medium and some less occurring travel scenario's (e.g. a missed check-out). This allowed for a build-up in this section of the evaluation as functions are introduced one by one.

Physical card based:

- Onboarding: How does the user get to know and start using the service?
- Pre-Travel: Prepare billing method (manual top up, automatic top up, postpaid)

- Travel: What happens during check-in/out, in vehicle
- Post Travel :Balance notification, Check travel history

Phone based:
- Awareness & installation: Let users know and install mobile OV-chipkaart
- Travel: Check-in/out with mobile phone

Travel scenarios:
- Correct a wrong check-in
- Correct a missed check-out
- Travel product advice

Rating the service concept with the System Usability Scale: 5 minutes
Participants were asked to evaluate the proposed mobile ticketing service according to the System Usability Scale (Brooke, 1996). The System Usability Scale was used to measure the usability of the proposed design. The participants are also asked to clarify why they rated the service as such.

Filling in the AttrakDiff: 10 minutes
Lastly, participants were asked to fill in an AttrakDiff questionnaire (Hassenzahl et al., 2008). In this AttrakDiff questionnaire, participants can reflect on their experience with the proposed mobile ticketing service concept by rating semantic differential of both hedonic and pragmatic dimensions of user experience.

Stimuli
Several stimuli (Figure 21) were used during the usage evaluation in order for the participants to experience the proposed design.

Context videos
Participants were shown several videos during this evaluation. These videos were used to explain a certain scenario and context to the participants. Using point of view shots, the videos allowed the participants to place themselves in the shown context. The videos also showed during which parts of one's journey the OV-betalen app would be used. Participants were asked to interact with the OV-betalen mobile prototype after each video.

Interactive prototype OV-betalen app
An interactive prototype of the OV-betalen app was made to let the participants experience the proposed design of the app. This prototype was loaded on a smartphone which was given to the participants. For this prototype, however, only selected task flows were made interactive making this prototype not fully functional. Mobile check-ins and outs were simulated by using a prototyped validator pole.

Website article, letter and a new OV-chipkaart
A website article and letter were made showing how one could get to know about the OV-betalen app. Both the article and letter describe the existence and functionalities of the OV-betalen app. The letter, accompanied with a mock-up of the new proposed design of the physical OV-chipkaart, were given to participants in possession of a personalized OV-chipkaart. Participants without an OV-chipkaart would receive the website article as a starting point.

Figure 21. Set-up of the user evaluation, with a context video show on the screen. Participant can be seen interacting with the prototypes of the mobile app as well as the validator.

5.5.3 Findings

This section describes the main findings from the conducted user evaluations. The findings are categorized for each of the evaluated stages of the proposed mobile ticketing solution and the filled in System Usability Scale and AttrakDiff questionnaires. Detailed findings can be found in Appendix B to D.

Getting to know about the service

Participants without an OV-chipkaart were presented with an online article about the OV-betalen app as starting scenario. Participants already in possession of an OV-chipkaart were presented with the letter containing a new OV-chipkaart. Both the article and the letter contained information about the functionality of the OV-betalen app. All participants indicated that it was clear what the app does and to be triggered to download the app after reading this information. Functionalities that were mentioned as interesting were: topping up, the realtime overview of travel activity, correcting missed check-ins/outs and checking in with a mobile phone. Two participants, however, indicated to be wondering if the newly received OV-chipkaart was also interoperable throughout the Netherlands like the current OV-chipkaart.

Not clear that this OV-chipkaart is interoperable amongst all public transport across the Netherlands

Clear overview of app functionalities and where to find the app.

Figure 22. Letter with new OV-chipkaart and information about the OV-betalen app

Download & Account Registration

Downloading the app from the app store caused no issues for the participants. Some participants indicated to look at the app reviews before downloading the app. Bad reviews would not result in them not downloading the app, instead participants mentioned to be less forgiving doesn't function and perform properly, usually resulting in them deleting the app.

Participants described the account registration process with words as simple, easy and fast. The registration process was experienced as similar to that of other services or apps that also use e-mail verification when creating an account. Being able to open the mail app through a button during the registration was described as pleasant. Automatically being logged in the app after confirming the e-mail address was handy as participants were not asked to fill in their account information again.

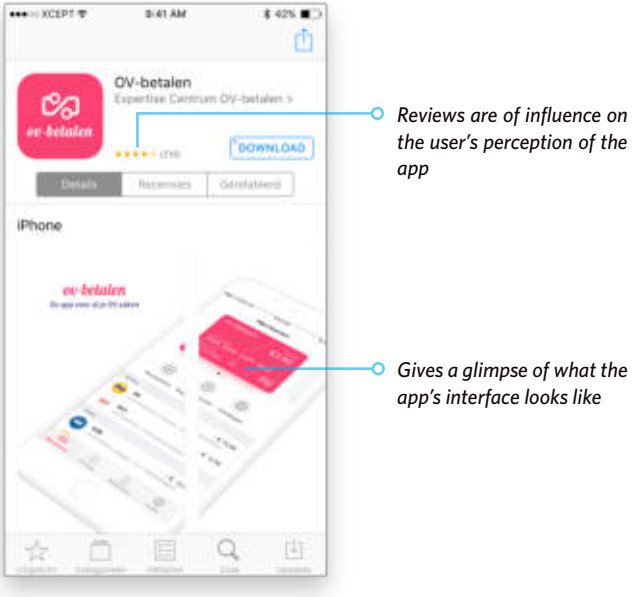


Figure 23. OV-betalen in the App Store

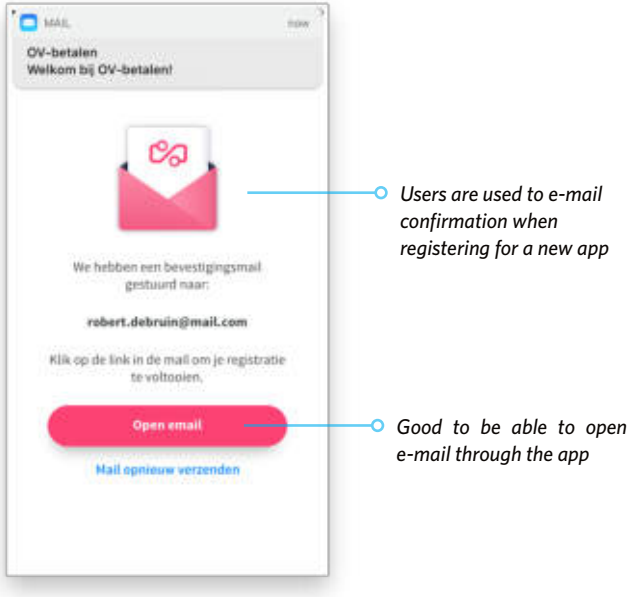


Figure 24. Account confirmation e-mail

Card setup: New card or link existing

Once registered and logged in, the next step was to either request a new OV-chipkaart or link their OV-chipkaart to the app. This caused confusion for most of the participants. Four of the seven participants in possession of an OV-chipkaart clicked on 'New card' when trying to link their card. Three of them immediately noticed after being redirected that this was the section to request a new card. The other participant requested a new mobile OV-chipkaart without linking his existing OV-chipkaart. One of the participants without an OV-chipkaart thought that it was necessary to purchase an OV-chipkaart at a store or ticket machine first, it was not clear that you could request a new card through the app.

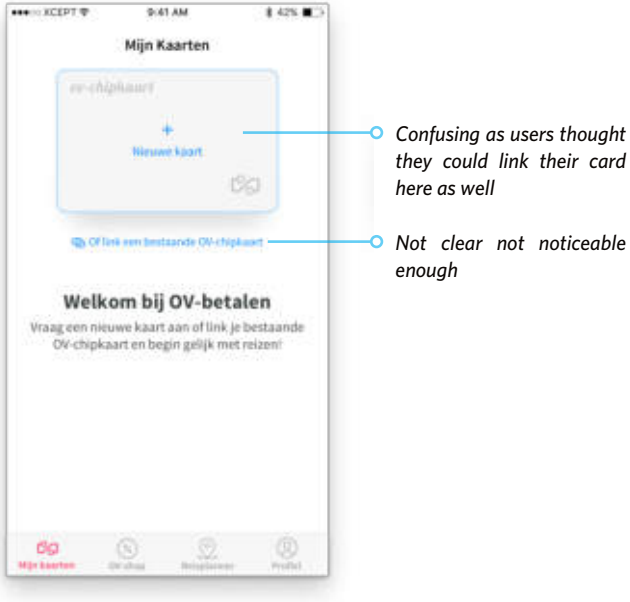


Figure 25. Linking a card or requesting a new card

The card linking process by taking a photo of the card was described as pleasant and fast as users did not have to fill in the card details manually. Both participants without an OV-chipkaart requested a physical OV-chipkaart. This was experienced as handy due to being able to request an OV-chipkaart in the app instead of in stores or stations as well as being able to keep track of the expected postal date.

'It's always those small numbers, I have reading glasses but I refuse to put them on. When I have to put them in myself, it will sometimes go wrong. This is way easier.

- Male, age 68, Infrequent traveller (1/2 times per week)

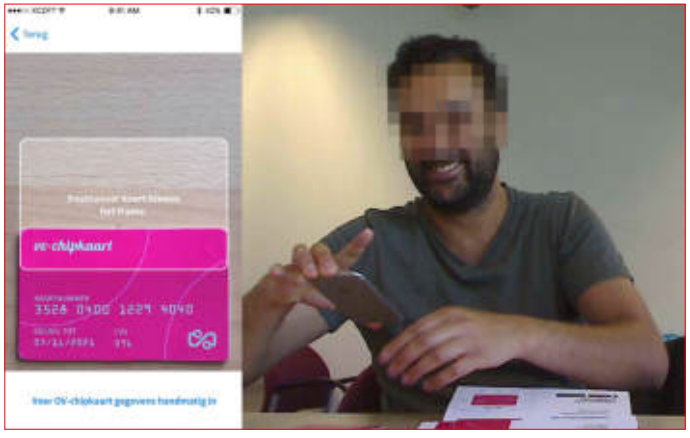


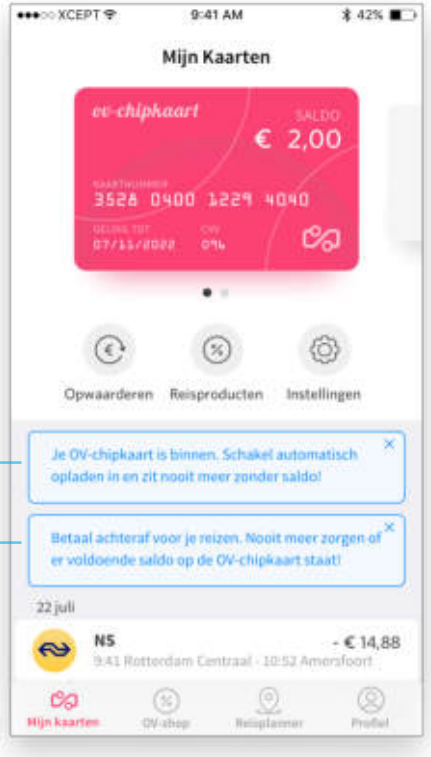
Figure 26. Linking a card to the app

Payment configuration

Once a card is linked or a new card has been requested, the user gets notified about the option to turn on automatic reload or a post payment option. Three of the participants did not notice these options when interacting with the app and were informed by the research about these options. Some participants also indicated that the information provided in the app about the several payment methods, especially auto reload and post payment, was insufficient to make a decision on which one to choose. It also seemed unclear to participants that they were able to click on the notification to get more info.

From the nine participants, five chose to manually top up, two decided to turn on auto reload and two requested the post payment option. One of the reasons participants gave to choose for topping up manually is being in control of when money is put on their OV-chipkaart, instead of it being automatically reloaded or be confronted later with extra costs when budget their might be limited. The low frequency of travelling with credit was also mentioned, e.g. a regional unlimited travel subscription and only travel with credit when using the train. Reasons given by participants to turn on auto reload include pleasant past experiences with auto reload and not having to worry about having enough credit on the OV-chipkaart. For the participants that preferred the post payment option, it was beneficial that they only pay for what they have travelled instead of paying money upfront. Both of these participants were incidental users of public transport. Another reason that was mentioned to choose for the post payment option, is that the credit stored on an OV-chipkaart would probably not be used for months which would be wasteful.

'How does auto reload work? I have the feeling it is a monthly subscription.'
- Female, age 33, Incidental traveller (Less than once per month)



'I would not be able to make a decision. There is not enough information about the concept behind these payment options. An information icon would help'
- Male, age 57, Incidental traveller (Less than once per month)

Figure 27. Payment configuration notifications

Participants found the process of topping up and requesting auto reload or the post payment option easy, clear, fast and familiar. The five participants who manually topped up, all chose to pay through iDeal, as this was the payment option they were the most familiar with. The credibility check of charging 0,01 Euro from one's bank account through iDeal when requesting auto reload or post payment was unclear for one of the participants as to why it was needed. All participants indicated that it was clear when the top up or request was succeeded as this could be seen in the transaction overview and was visible in the form of a notification.

Check-in notification

After configuring the payment method, participants were presented with the check-in notification one would get when checking in with a physical OV-chipkaart. All participants have indicated to see the benefit of being able to get a confirmation that a check-in has successfully been performed and possibly notice when someone else is travelling with your card. Four of the participants, however, have indicated that they would disable this feature if possible, as they perceive it as redundant for every time they check in public transport. For them, being able to look it up when in doubt is enough.

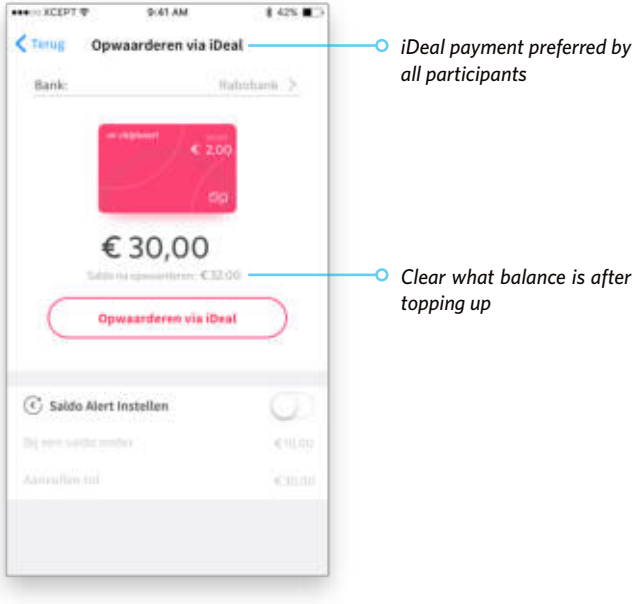


Figure 28. Top up through iDeal

'I would not want to have this, it goes a bit far. For me, personally, it would not be convenient. I would like to look it up myself though when I'm in doubt.'
- Male, age 37, Infrequent traveller (1/2 times per week)

Figure 29. Check-in notification

Current trip details & opt-in for latest updates

In general, the current trip details were pleasant to have as participants stated that it is nice to know the arrival times of the next stops, especially when traveling in an less familiar area. Some participants, however, indicated to prefer the information shown in vehicles on screens as it is easier than grabbing your phone to check. Participants that usually check their phone while traveling seem to prefer the information through the app as their phone is already in their hands.

Regarding the opt-in for receiving the latest news and offers from public transport operators, six participants indicated to decline this offer. They believed that the information they would receive would not add any value for them as it would be advertisement most likely. The three other participants would consider to opt-in, of which one did, if it was from an public transport operator they would frequently use and if it would be informative about for example road maintenance and disruptions.

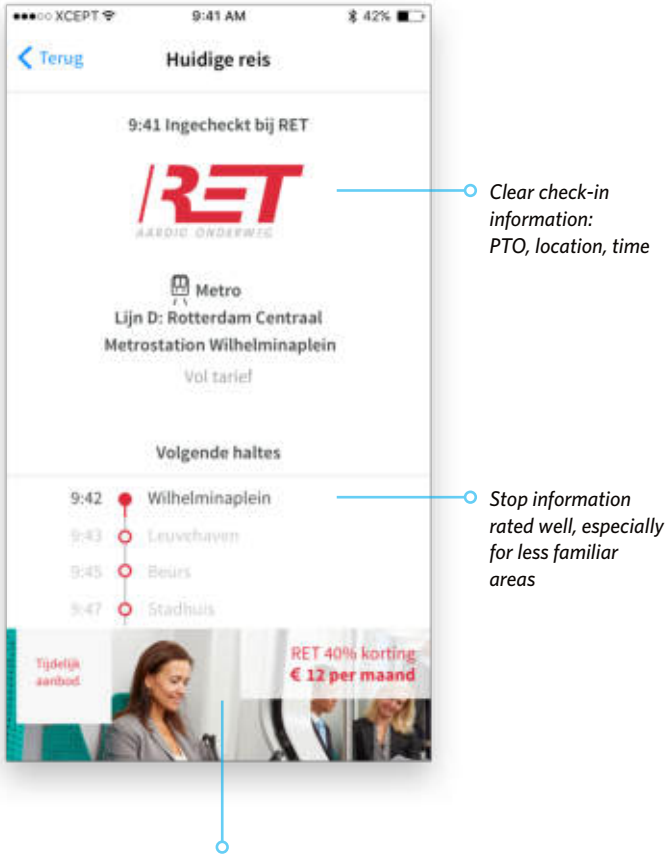


Figure 30. Current trip details

Check-out notification

The check-out notification seemed to be rated in a more positive manner than the check-in notification as this provided more valuable information. Especially the trip cost, accompanied with the taken route, was helpful as participants stated that they currently have no clue what their trip costs are. Informing participants about their remaining balance was valuable as they could decide whether or not they should top up or not. Similar to the check-in notification, few travellers indicated to rather look up the information themselves than receiving a notification.

Opening the notification would lead to a pop up showing the trip details. Participants, however, mentioned that this would be redundant as it shows approximately the same information as shown in the check-out notification.

I'm not sure if I'm enthusiastic about it (notification)...Maybe when I just started using the app I would look at it, but after 2/3 months I think you would just dismiss the notification and think its unnecessary.

- Female, age 33, Incidental traveller (Less than once per month)

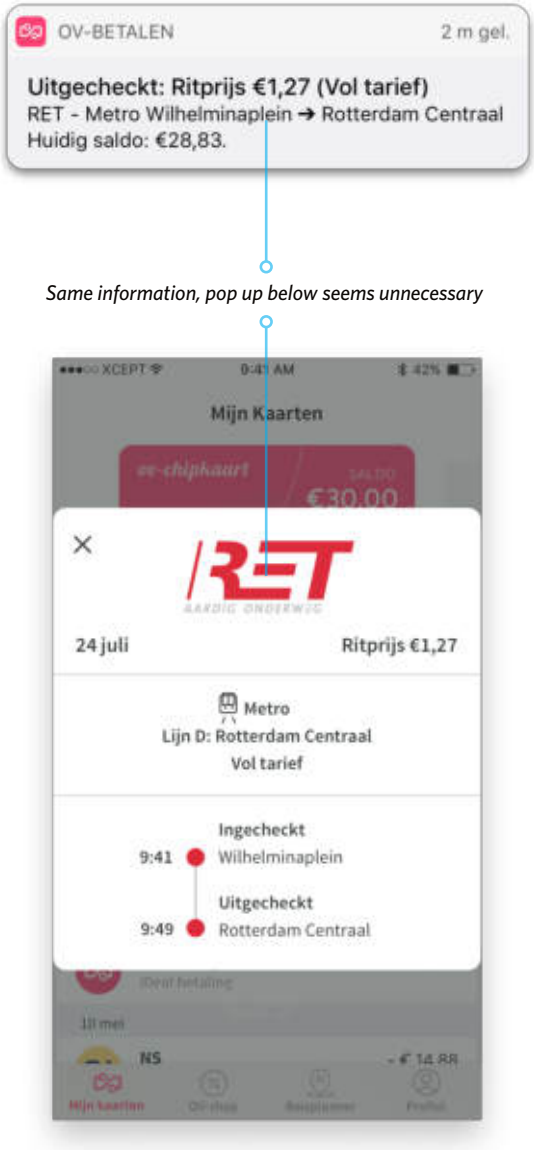


Figure 31. Check-out notification

Set up mobile OV-chipkaart

Participants were presented with the scenario where they would set up their mobile OV-chipkaart. Every participant got through the setup process without any problems. Few concerns did arise during this process. During the setup process, the user is asked to agree to the terms and conditions presented. The prototype used for this scenario, however, did not have a fully worked out terms and conditions statement. Three participants indicated to wanted to read the highlights, especially related to data sharing and privacy, first before agreeing to the terms and conditions. After setting up their mobile OV-chipkaart all participants struggled with what to do next. Some participants indicated to see a set-up confirmation notification, but as the interface did not look any different than before setting up it looked as if the set-up did not take place. Participants also assumed that they had to open a specific screen before they could check-in and out with the mobile OV-chipkaart. Participants were then explained that this was not necessary and asked to check in and out using the mobile OV-chipkaart.

OK...but now it is still not really clear how it works. I think I would just hold my phone against a gate and see what happens.

- Female, age 30, Infrequent traveller (1/2 times per week)

This is completely unclear. It is as if I didn't do anything [after setting up the mobile OV-chipkaart] at all.

- Female, age 30, Infrequent traveller (1/2 times per week)

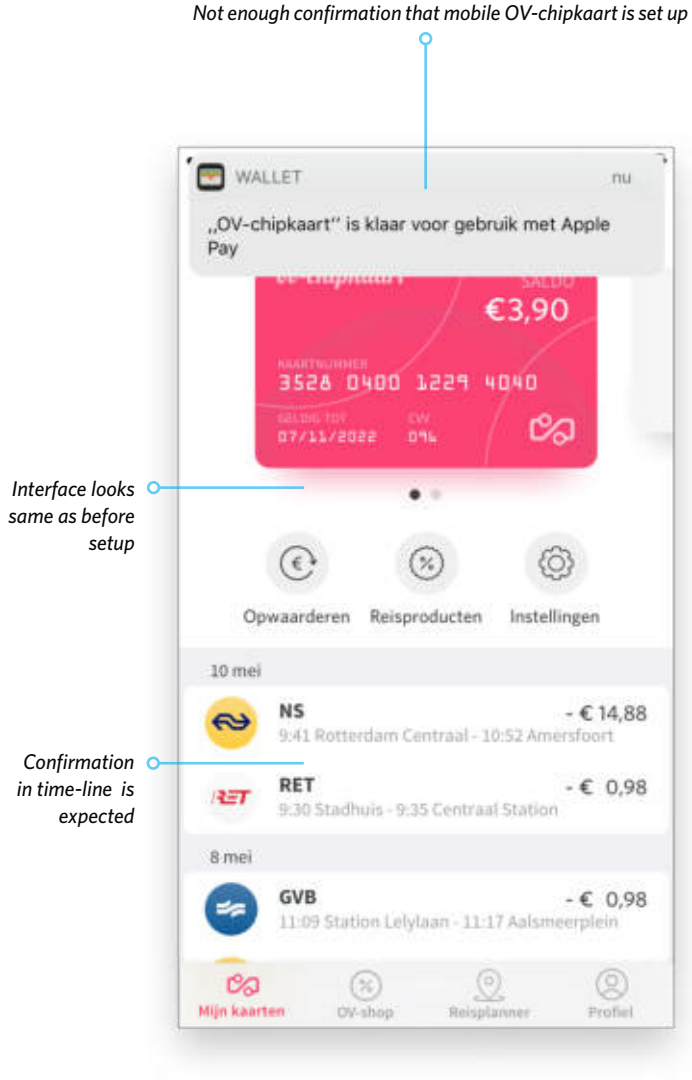


Figure 32. Notification after setting up mobile OV-chipkaart

Mobile OV-chipkaart check in and out

Checking in and out with the mobile OV-chipkaart seemed to be a pleasant experience for all of the travellers. This process was described as handy, fast, easy and similar to that of a physical OV-chipkaart. Just holding the phone against the validator and not needing to open a specific screen in the app seemed to positively surprise most of the participants. From observations, it seems that most of the participants look at the validator screen to get the check-in/out feedback and look at the information given on the phone afterwards. Three participants indicated to prefer using a physical card at first, with the mobile OV-chipkaart as a backup option. Similar reasons were given as described in chapter 3 (battery concerns, used to using a card, easier to grab card than phone). Travellers that preferred the mobile OV-chipkaart, indicated to never forget their phone, in contrast to their wallet. For them, their phone also seems to be easier accessible than their physical OV-chipkaart. Some of these travellers did indicate to want the physical OV-chipkaart as a backup for when their phone runs low on battery.

I think that I would use my card at first out of habit. Maybe if I often see people checking in with their phone I would switch.

- Female, age 26, Incidental traveller (Less than once per month)

This is exactly what I would do. I never forget my phone, I forget my wallet occasionally.

- Female, age 31, Frequent traveller (5+ times per week)

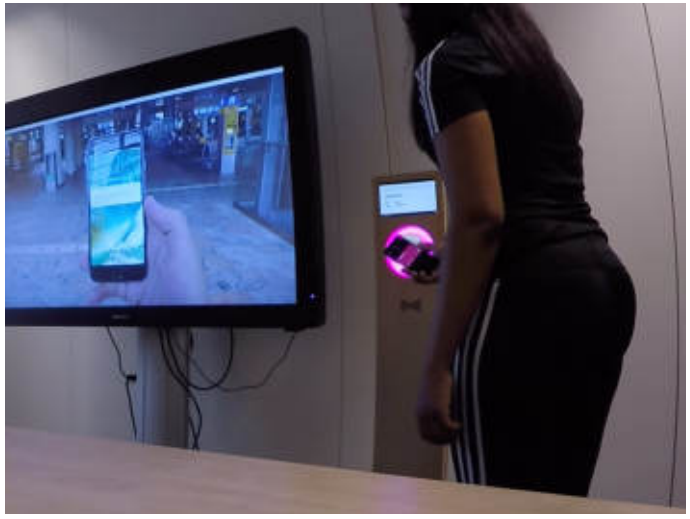


Figure 33. Participants checking in with the mobile OV-chipkaart

Wrong Check-in

Four of the participants have indicated to have experiences with a wrong check-in. The ability to correct this in the app seemed beneficial as an extra service. The notification and the phenomena of a wrong check-in, however, could be confusing to inexperienced travellers due to the complexity of checking in and out per public transport operator rather than per station/modality.

Gates all look a like, it shouldn't matter at which gate you check in but at which station. I would really appreciate if I would get this [notification], it would be convenient for me at least.

- Male, age 68, Infrequent traveller (1/2 times per week)

I did see the different gates, but I never thought about the fact that I can only travel with the one I checked in at. To me a gate is a gate.

- Female, age 30, Infrequent traveller (1/2 times per week)

Figure 34. Wrong check-in notification

Forgotten Check-out

Being notified to correct a missed check-out by providing the check-out location was rated well by all participants. Most of the travellers have had previous experiences with missed check-outs. Participants either didn't request their money back, as they thought the process was too much of a hassle or had issues with the refunding process as missed check-outs currently show up with a delay up to fourteen days. This way travellers would also be pro-actively be warned instead of realizing they have missed a check-out by being confronted with low balance during check-in.

It is convenient you get a notification. This is faster than noticing at check-in that you're missing 10 Euros from your balance. Now you can correct it right away in the app, more than that, it actually ask you you haven't checked out yet, do you want to correct that?

- Female, age 31, Frequent traveller (5+ times per week)

Figure 35. Forgotten check-out notification

Low balance notification

The main advantage stated by travellers of the low balance notification seems to be being prepared for the next trip. Instead of being denied access when checking in due to low balance, travellers indicated to top up through the app as soon as possible. Participants also stated that it was nice to be redirected directly to the top up section in the app when opening the notification.

> *Yeah this one is really handy. At first I was moderately positive about these notifications, but especially these last two are very good to have I think. You get a message when you actually have to do something now or else you'll be in trouble later.*
>
> *- Female, age 33, Incidental traveller (Less than once per month)*

Figure 36. Wrong check-in notification

Travel products

Lastly, participants were shown the travel products section. To all participants, it was clear where to find the travel products connected to the OV-chipkaart. Participants were also asked to show how they would explore and purchase new travel products in the app. Some travellers stated to prefer to look through the catalogue for a specific transport operator. For these travellers, it was already clear which transport operator suited their travel behaviour the most. Travellers who analysed their travel history pointed out that it was good to see the amount of money they would save with the proposed travel products and subscriptions. However, most travellers indicated to do extra research before purchasing as they also want to be sure that every product is looked at.

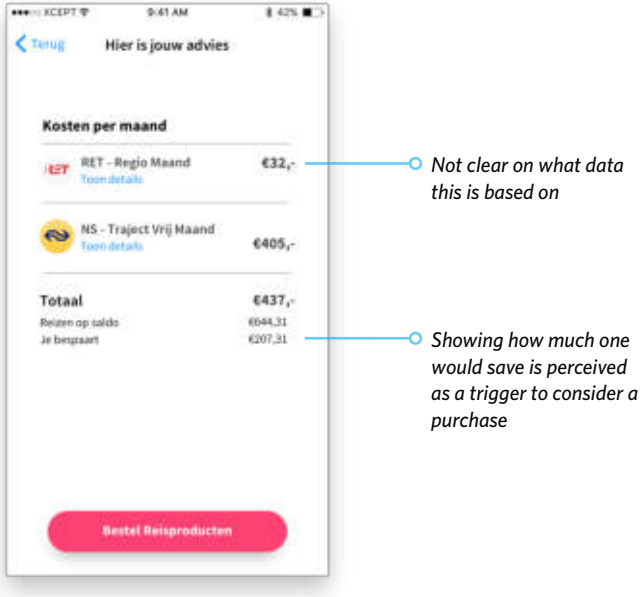


Figure 37. Travel product advice

System Usability Scale (SUS)

On average the participants gave a SUS score of 91.9 for the evaluated design as can be seen in Figure 38. According to Bangor et al. (2009), this SUS score would translate into an Adjective Rating of 'Best Imaginable' (SUS > 90.8). Noticeable is that participant without a smartphone and little public transport experience gave a SUS score of 65 (between 'OK' (50.9) and 'Good' (71.4)), whereas the other participants all rated the service with a SUS score of at least 90. A full overview of the SUS scores can be found in Appendix C.

'I am completely sold, this should really become reality. If it doesn't it would be really stupid of.....This would be super nice to use. It is efficient, clearly structured, everything you need is in the app. So yeah, it is a very good app, I have quite a lot of apps on my smartphone and I'm not exaggerating, but this would really be one of the better apps on there, even with the limited functionalities of this prototype. I really hope this is going to be it, I can't wait.'

- Female, age 47, Frequent traveller (5+ times per week)

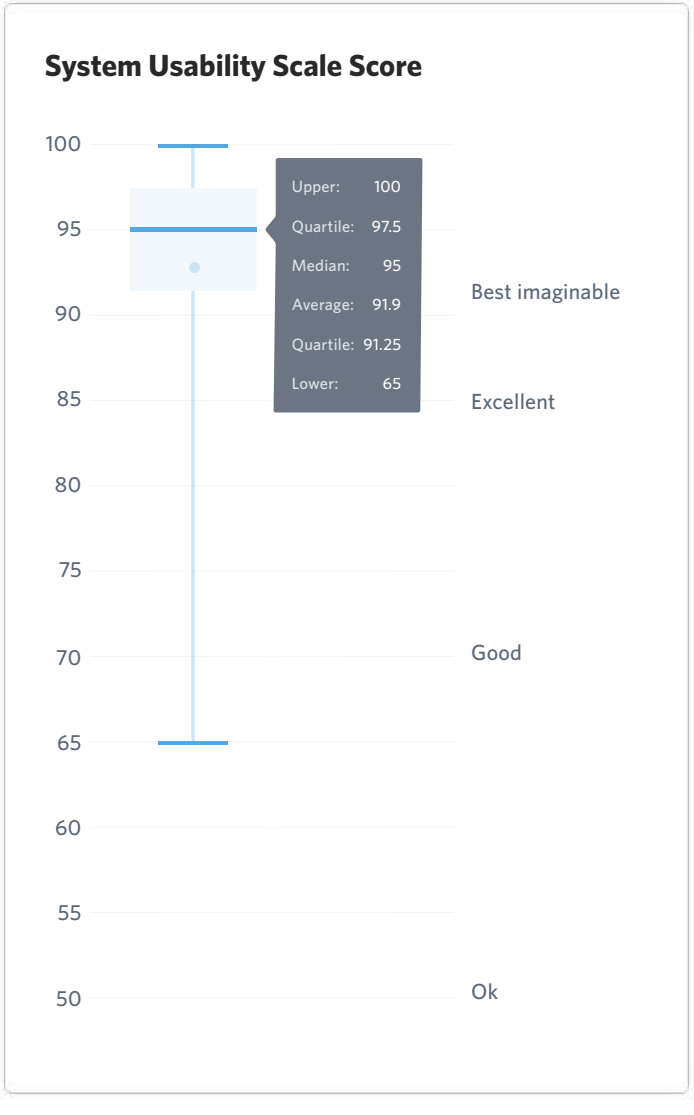


Figure 38. SUS score for the proposed OV-betalen app

Looking at the average scores per question (Figure 39), the service seems to score well on all of them. Both learnability (questions #4 and #10) and usability (remaining eight questions) were well rated by the participants. Only for three questions (#3, #9 and #10), the range of the given scores is bigger than 1, two of which, #3 and #10, are caused by the previously mentioned participant without a smartphone.

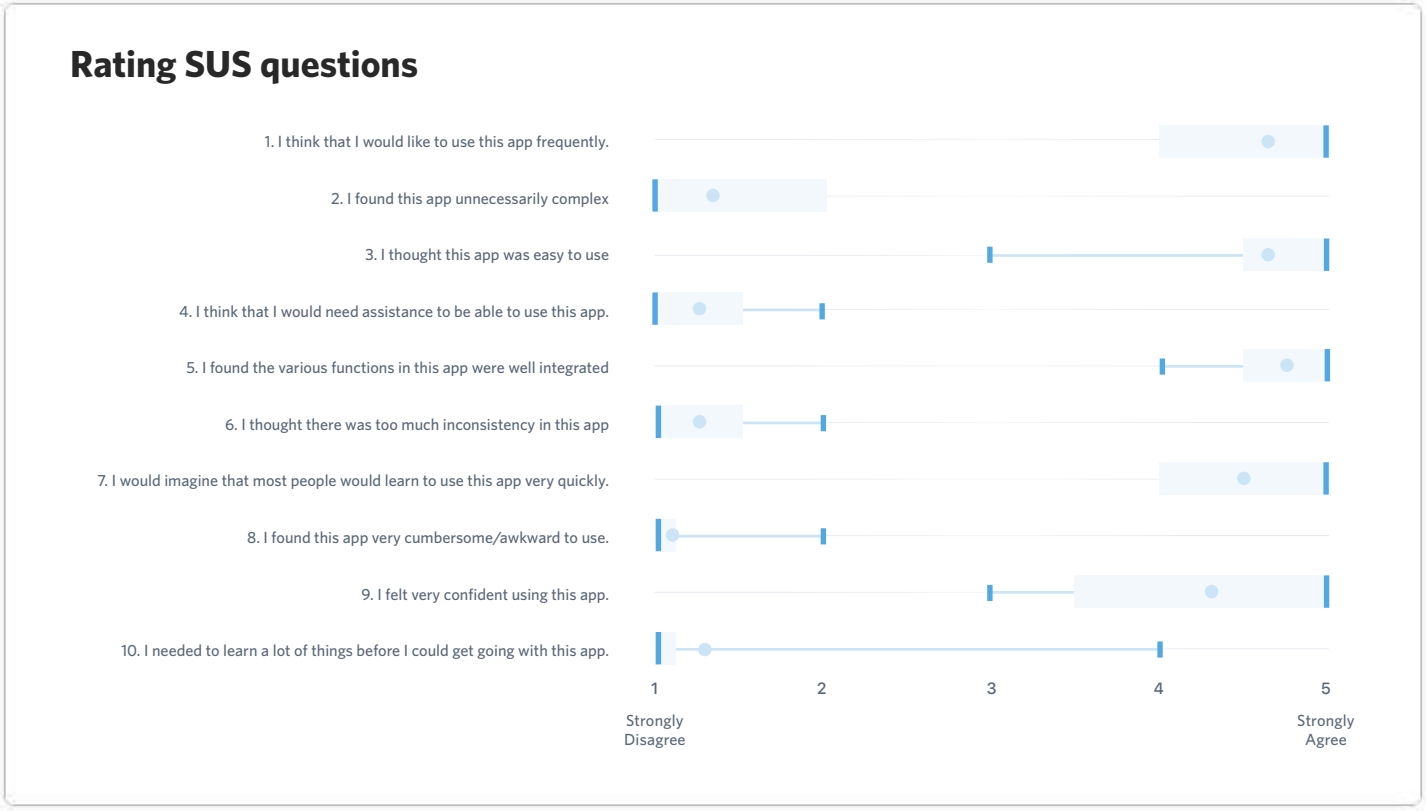


Figure 39. Rating of the System Usability Scale questions

AttrakDiff

Participants were asked to fill in an AttrakDiff form to rate the proposed design on semantic qualities based on four dimensions. A detailed list of all word-pairs forming the items in AttrakDiff is shown in Figure 40. The mean values of each word-pair for the proposed design are shown. Participants tend to rate the design with positive extremes for characteristics such as practical, straightforward, clearly structured, pleasant and good. On the other hand, participants hardly rated the service as inventive. Some participants have mentioned that they have not seen anything new in terms of what apps can do.

'I can only use one word: convenient. This is exactly what I've been waiting for. Especially with how technology is developing, this is something what I now, well actually 2/3 years ago already felt I needed and that need is only growing. With what I have seen this is exactly what I imagined it would be and it all makes sense.

I would be really happy with this.'

- Female, age 31, Frequent traveller (5+ times per week)

Figure 40. Average rating of the AttrakDiff word-pairs

Figure 41 shows the mean values of the four dimensions. The proposed design seems to be rated well on all dimensions. The lowest mean value (1.5) has been given to the hedonic quality - stimulation characteristics. Again this seems be due to the fact that the OV-betalen app seems similar in usage to apps in general, as no 'new' interaction patterns or technologies were incorporated with the design. The best value (2.5) has been achieved in the attractiveness dimension. The hedonic quality - identity (2.3) and pragmatic quality (2.1) dimensions are also rated highly. This suggests that the participants rated the proposed design good on user experience. High ratings on pragmatic qualities indicate good usability, whereas the rating for the hedonic qualities indicate commitment from the users, where stimulation and motivation can still be improved. In line with received comments from participants, when plotting the scores on the AttrakDiff diagram, the proposed design can be categorized as desired.

'I haven't seen any new elements regarding app usage. I also don't think it is a bold attempt, but I also really don't mind that it isn't (...) Again, I would use this and would also want to use it. There were no elements that really caught me off guard, it just worked like I expected it to work.'

- Male, age 67, Infrequent traveller (1/2 times per week)

Figure 41. Average rating of AttrakDiff dimensions and the corresponding AttrakDiff diagram

5.6 LIMITATIONS

The results of this user evaluation give an indication on how travellers experienced the proposed design. It also shows to what degree the design fulfils their wishes and needs regarding ticketing in public transport. This user evaluation, however, is subject to limitations that need to be taken into consideration when looking at the validity of the results.

Mobile app prototype

The prototype of the OV-betalen app used in the evaluation is not the final design of the proposed mobile ticketing solution but a representation of how it would work. The prototype, however, was made in such a way that only specific flows were interactive. When a participant would perform an incorrect action, such as tapping the wrong button, the prototype would not respond, whereas in reality the user would get a response and could be redirected to a different screen. This could have been leading the participants towards the correct flow. User input fields would also automatically fill in when one would tap on it. This could have affected the participant's perception of the length of the registration process for example. Thus, this prototype also neglected error states, such as when one, in reality, would input an invalid email address for example. Showing these ideal situations, participants might have a more positive attitude towards the app in terms of technical stability and reliability. Loading times were incorporated in the prototype, however, it is not clear to what degree they match if the app was developed.

Participants

Nine participants were recruited for this user evaluation. As the number of participants is limited, both the System Usability Scale as the AttrakDiff questionnaire can only give an indication of the perceived usability and user experience of the proposed design. This sample also makes the data too limited to be used for statistical analyses. As only three participants were recruited per defined user group, analysing the data on a group level would be too unreliable. The participants recruited based on a set of given criteria described in section 5.5.2 Method, such as fare media, travel frequency and smartphone ownership. A characteristic which was not taken into account, however, which might have influenced the results is the participant's financial situation. It was mentioned by some participants that the financial compensation was a welcome addition to their monthly income. Amongst the participants were retirees, students and part-timers for example. As one needed to be available for roughly two hours during the day to participate in these sessions, this has also limited the pool of users to select from. This might have influenced the results from the payment configuration scenario and should be taken into account.

Test environment

This evaluation took place at the faculty of Industrial Design Engineering from TU Delft. This could have influenced the participants' experience with the proposed design as they had to place themselves in the actual context of use. Time pressure in the

public transport context, for example, is hard to replicate. Where one would be in a rush in reality, one could take the time to extensively read the information given in the prototype. The combination of observing the participants and using cameras to record the session could have also resulted in positively biased responses due to the observer effect (MeasuringU, 2012). As the participants were informed that the presented work was made by the researcher, this could have also contributed to positively biased results.

5.7 CONCLUSION

The proposed design of a new mobile ticketing solution has been evaluated with nine participants, representing three user groups. The participants were shown the design by using an interactive prototype of the OV-betalen app and asked to rate it on its usability and user experience. In general, the participants were enthusiastic about the proposed design. Some even indicating that they hope that the app shown becomes reality soon. This evaluation has shown that the concept fits the needs and wishes of travellers in relation to ticketing in public transport in the Netherlands. Real-time access to clear presented data, notifications, self-service functionalities as topping up and correcting missed check-ins/outs and using the mobile phone as a fare medium were all aspects which were rated well by the participants. On a concept level, as what the service has to do, no real changes are needed. On a more detailed user interface level, some aspects were less understood and need to be redesigned. The following elements will need to be redesigned in order to improve the design.

Payment configuration

Information about the several payment configuration options was unclear for participants. Participants had either too little information to make a choice or had misinterpreted the actual workings of either the auto reload or post payment option.

New card and linking existing card

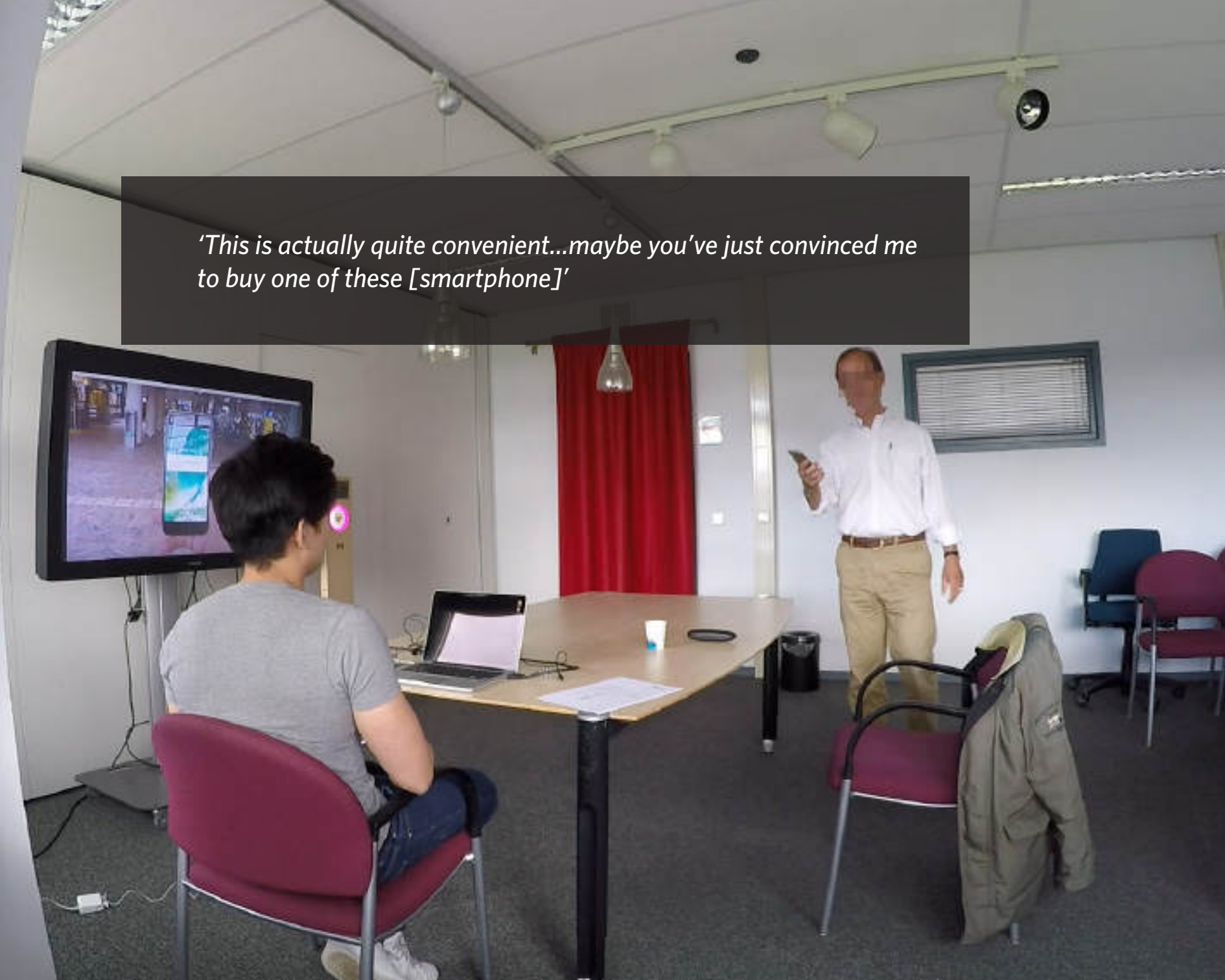
Several participants accessed the section where one can order a new card when trying to link their existing card. Even though participants seemed to immediately notice that they had entered the wrong section, improvements can be made to make this phenomenon less frequent.

Installed mobile OV-chipkaart

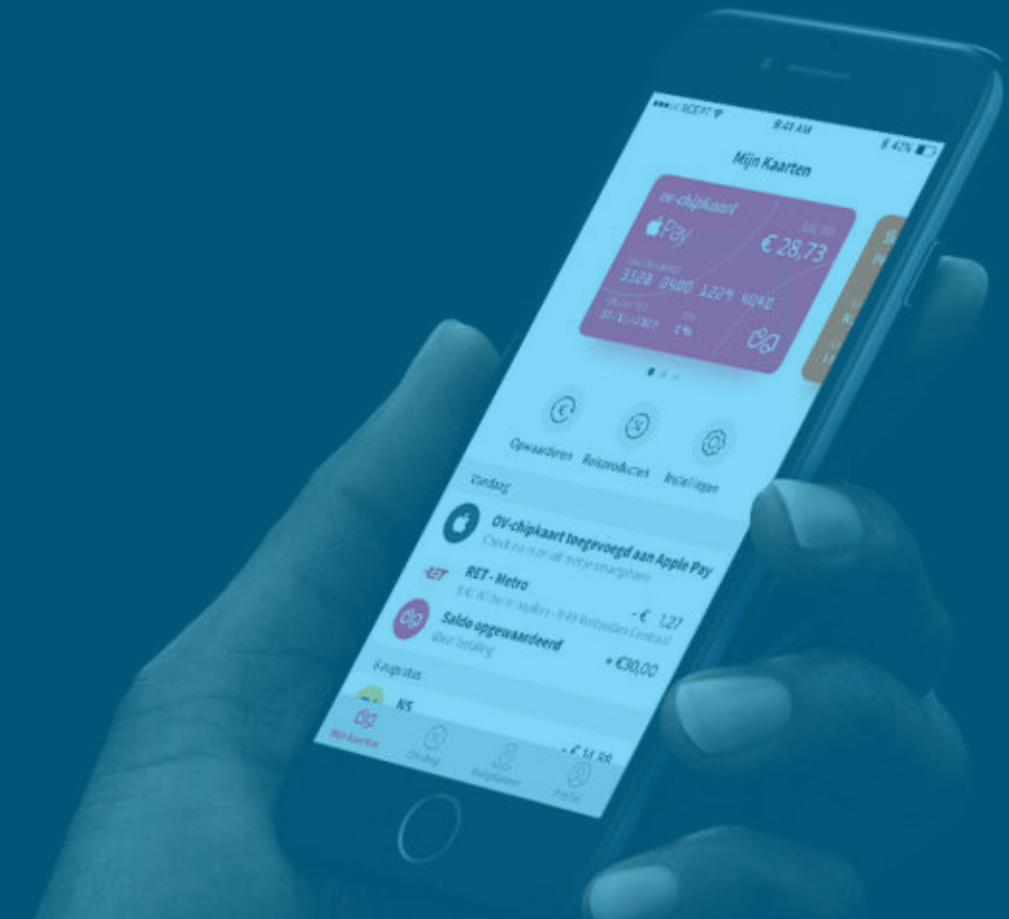
Every participant seemed to struggle about their next steps after installing the mobile OV-chipkaart. Even though the setup of a mobile OV-chipkaart was successful, it was not clear how one would check in with their mobile phone. Often participants thought they needed to bring up a certain screen from the OV-betalen app which would enable the check-in.

Travel products based on analyses travel behaviour

Even though this functionality seemed to be of value for users, it is still subject to improvements. Participants indicated to want to be certain that all travel products were considered. It was also indicated that more feedback was needed on which data was used to form the travel product recommendation.


'This is actually quite convenient...maybe you've just convinced me to buy one of these [smartphone]'

6


Mijn Kaarten
OV-chipkaart
Pay
€ 28,73
Opwaardeer
Reisopdracht
Instellingen
Vandaag
OV-chipkaart toegevoegd aan Apple Pay
RET - Metro
- € 1,27
Saldo opgewaardeerd
+ €30,00
NS

6. A user-centred mobile ticketing solution for Dutch public transport

6.1 INTRODUCTION

In the previous chapter, the proposed concept for a mobile ticketing solution was evaluated by travellers. The proposed design showed promising results as it seemed to align with the travellers' wishes and needs related to ticketing in public transport. This evaluation also exposed some points of improvement. This chapter proposes the final design for a user-centred mobile ticketing solution. A service blueprint will be used to have an overview of both the user and system interactions. This blueprint will also define which technological and business requirements are needed in order to be able to deliver the proposed service. After showing the detailed design of the proposed service, this chapter will conclude with a roadmap and implementation strategy.

6.2 PROPOSED SERVICE DESIGN

As described in the previous chapter, design principles were set up as the foundation for this design vision.

Efficient onboarding process - provide a set-up process that travellers are able to conduct on the go.

Accessible, immediate travel - allow for immediate travel through a virtual mobile OV-chipkaart without high financial barriers.

Dynamic interface, adaptive per phase - adapt to the traveller's journey by providing context dependent information, such as arrival times.

Provide the right information at the right time Unburden travellers from uncertainty by pro-actively providing them with important contextual information.

Mix Matters

Provide clear distinguishable alternatives as travellers can have different preferences for fare media.

6.2.1 Service blueprint

A service blueprint is made in order to visualize the system behind the OV-betalen from both the travellers' and businesses' perspective. The service blueprint maps out four steps that a user of a service goes through when interacting and using the system. These steps are when one becomes aware of the service, joins the service, uses and commits to the service and lastly when one leaves the service (Løvlie and Polaine, 2013).

The service blueprint shown in Figure 42 on the next page is based on the customer journey map shown in section **5.3 Customer Journey.** Looking at how the journey should look for a traveller, the front end and back end interactions were defined for the service blueprint. The front end interactions are there to meet the travellers' goals and expectations, whereas the back end interactions are there to make these front end interactions possible. This also determines which requirements the back end should comply to in order to be able to deliver the desired service.

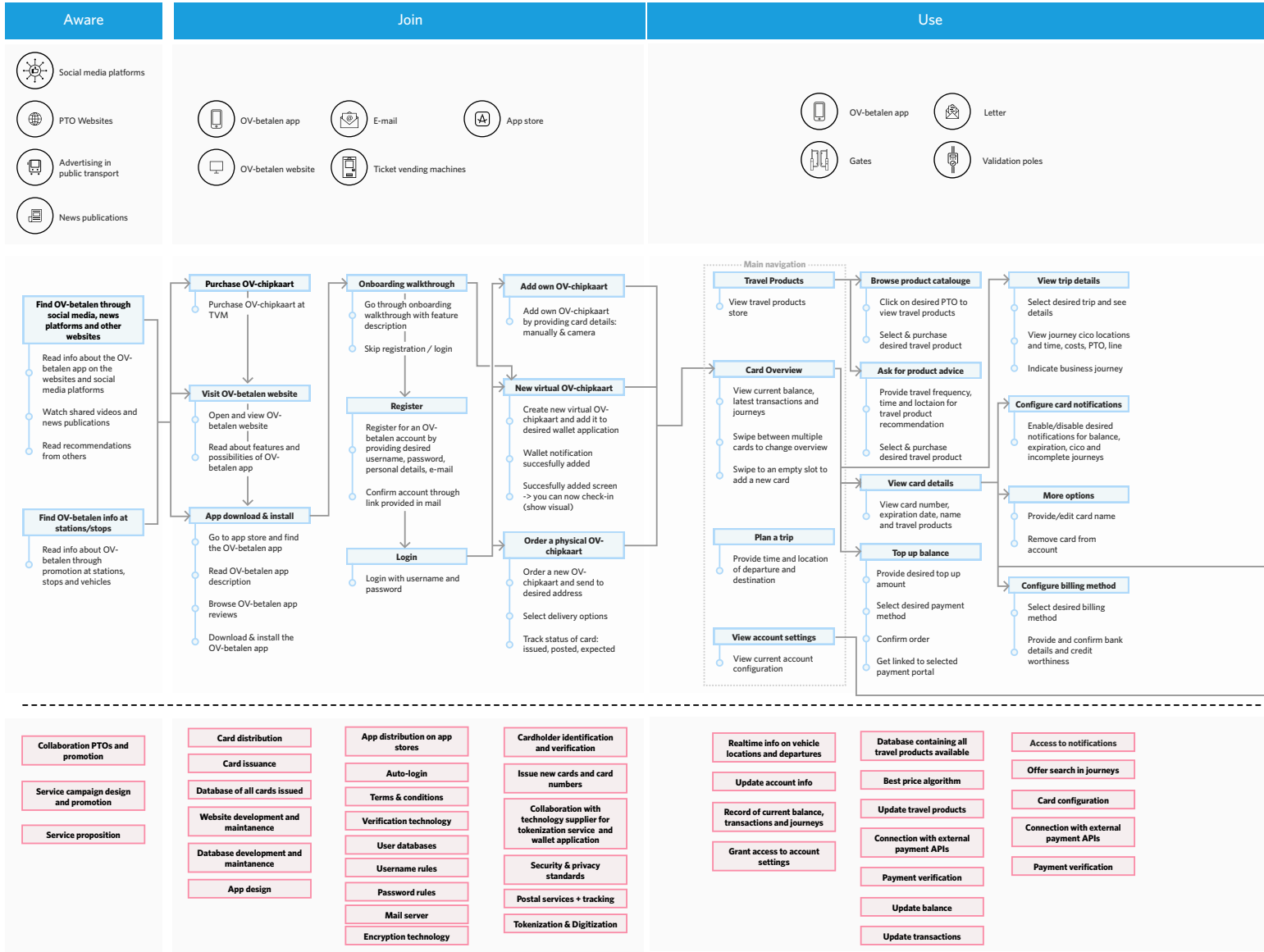
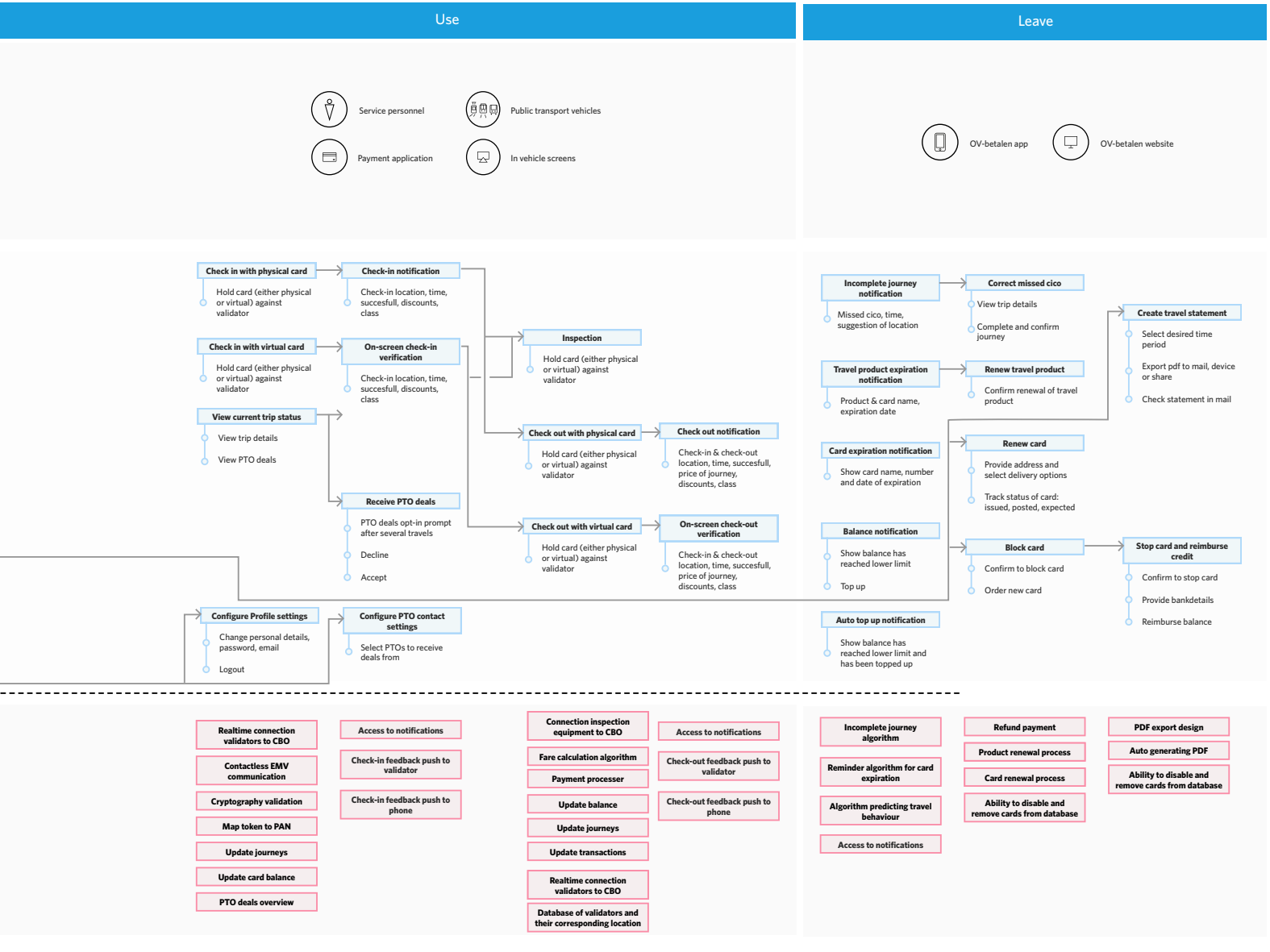


Figure 42. Service blueprint for the proposed design


Use
Leave
Service personnel
Public transport vehicles
Payment application
In vehicle screens
OV-betalen app
OV-betalen website
Check in with physical card
Hold card (either physical or virtual) against validator
Check-in notification
Check-in location, time, succesfull, discounts, class
Check in with virtual card
Hold card (either physical or virtual) against validator
On-screen check-in verification
Check-in location, time, succesfull, discounts, class
View current trip status
View trip details
View PTO deals
Receive PTO deals
PTO deals opt-in prompt after several travels
Decline
Accept
Inspection
Hold card (either physical or virtual) against validator
Check out with physical card
Hold card (either physical or virtual) against validator
Check out notification
Check-in & check-out location, time, succesfull, price of journey, discounts, class
Check out with virtual card
Hold card (either physical or virtual) against validator
On-screen check-out verification
Check-in & check-out location, time, succesfull, price of journey, discounts, class
Configure Profile settings
Change personal details, password, email
Logout
Configure PTO contact settings
Select PTOs to receive deals from
Incomplete journey notification
Missed cico, time, suggestion of location
Correct missed cico
View trip details
Complete and confirm journey
Travel product expiration notification
Product & card name, expiration date
Renew travel product
Confirm renewal of travel product
Card expiration notification
Show card name, number and date of expiration
Renew card
Provide address and select delivery options
Track status of card: issued, posted, expected
Balance notification
Show balance has reached lower limit
Top up
Block card
Confirm to block card
Order new card
Auto top up notification
Show balance has reached lower limit and has been topped up
Create travel statement
Select desired time period
Export pdf to mail, device or share
Check statement in mail
Stop card and reimburse credit
Confirm to stop card
Provide bankdetails
Reimburse balance
Realtime connection validators to CBO
Contactless EMV communication
Cryptography validation
Map token to PAN
Update journeys
Update card balance
PTO deals overview
Access to notifications
Check-in feedback push to validator
Check-in feedback push to phone
Connection inspection equipment to CBO
Fare calculation algorithm
Payment processer
Update balance
Update journeys
Update transactions
Realtime connection validators to CBO
Database of validators and their corresponding location
Access to notifications
Check-out feedback push to validator
Check-out feedback push to phone
Incomplete journey algorithm
Reminder algorithm for card expiration
Algorithm predicting travel behaviour
Access to notifications
Refund payment
Product renewal process
Card renewal process
Ability to disable and remove cards from database
PDF export design
Auto generating PDF
Ability to disable and remove cards from database

6.2.2 Technological & business requirements

Looking at the defined service blueprint, several technical requirements are needed for the proposed frontend interactions a traveller can have with the service.

Figure 43 shows the current fare calculation model. Currently the OV-chipkaart uses a card-centric model, where data is written and stored on the card itself. This has the advantage that the system can work offline. This, however, also means that travellers are restricted to location-based equipment such as add value machines to top up their card or pick up their travel products. The proprietary MIFARE protocol is currently used for the communication between the OV-chipkaart and the validators, limiting the possibilities for other fare media as a special SIM card is needed for mobile fare media.

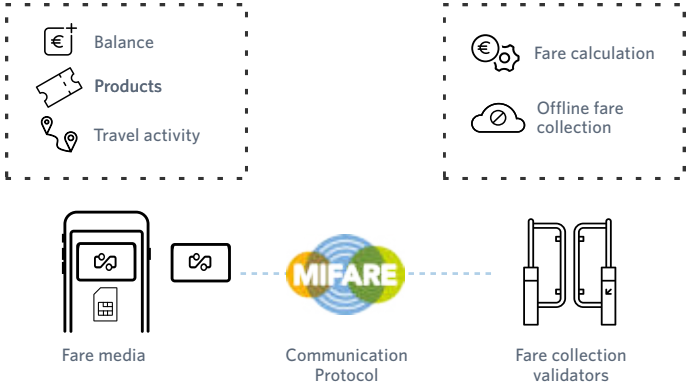


Figure 43. Visualisation of current fare calculation model

Online validators & back end fare calculation with EMV

In the proposed fare calculation model (Figure 44), data is no longer stored on the fare media but in account in a back end system. Fare media are now only used as an identifier to a corresponding account. As data is stored in the back end, it is accessible through a client portal, such as the OV-betalen app. This enables travellers to perform top ups from a mobile phone for example. Validators are directly connected with this back end through an online connection. This allows travellers to receive a real-time travel overview and their current balance, without having to go to a ticket machine. The EMV protocol is used as the communication channel between fare media and the validator equipment, enabling the use of the contactless bank card. Using an EMV OV-chipkaart enables more variety in fare media, as NFC equipped phones and wearables such as smartwatches, will be able to emulate an OV-chipkaart without the need of a special SIM card.

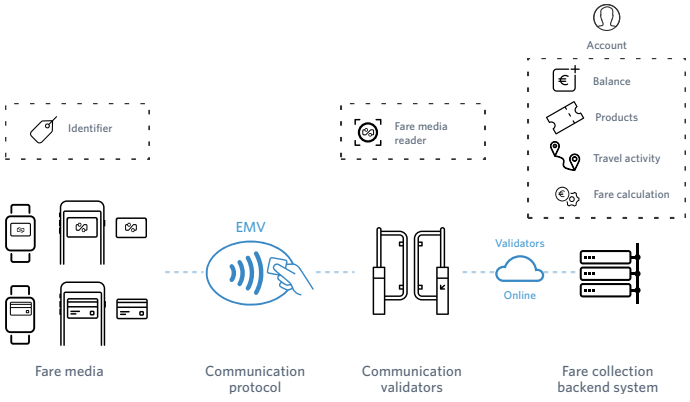


Figure 44. Visualisation of proposed fare calculation model

This, however, means that the current validators need to be upgraded to EMV validators by the public transport operators, who currently own the equipment. According to Meeuwsen (2016), when looking at the replacement cycle of these validators, this would take until 2028 if no early investments are going to be made.

Co-operation with tech and payment companies

As stated earlier, using an EMV OV-chipkaart will allow for more variety in fare media. This is done by tokenising an OV-chipkaart as shown in figure Figure 45. When issuing a digital card, transaction information is mapped into several tokens, rather than using sensitive payment information (e.g. card number, name). A token is sent to the acquirer when performing an transaction. The acquirer will then be able to validate this token and remap it to the corresponding account. As explained in the analysis report (Cheng, 2017), these tokens are stored in a secure element, either embedded in the phone or a cloud based secure element. NFC solutions such as Apple Pay, Android Pay and Samung Pay make use of this tokenisation process for smartphones as well as wearables such as smartwatches (MasterCard, 2016). These solutions grant access to the secure element, whereas the tokenisation of the card and decrypting these tokens is provided by payment companies as MasterCard and Visa. This design proposes a co-operation with tech companies such as Apple, Google and Samsung, for access to their NFC-solutions, enabling a bigger variety of accessible fare media. Co-operation with one of the payment companies is suggested for their card-issuing service for both physical cards and these tokenised cards.

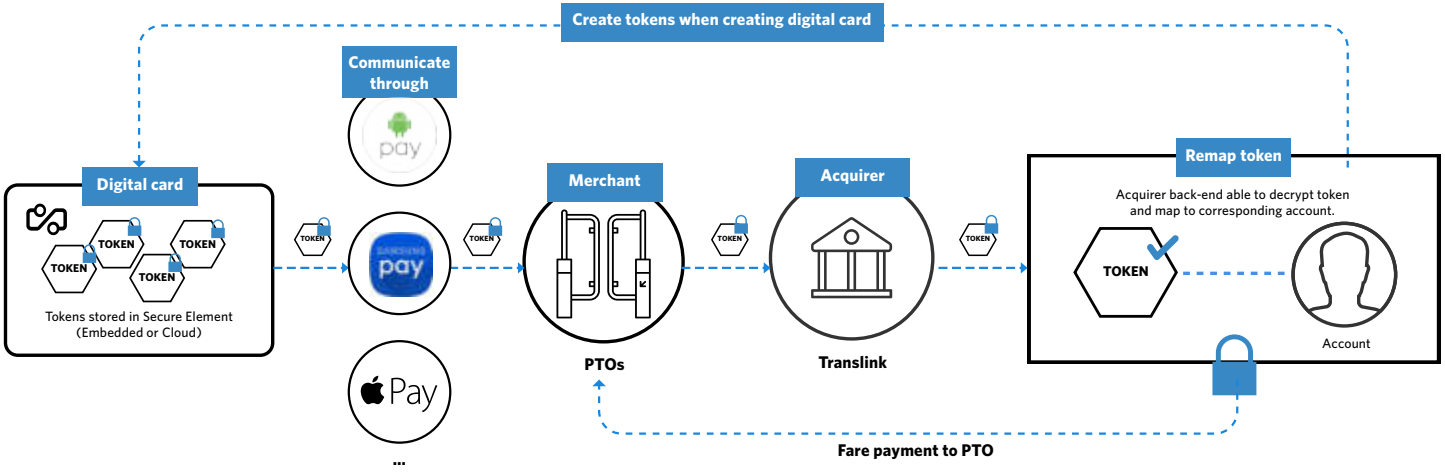


Figure 45. Tokenisation of an OV-chipkaart

6.3 DETAILED DESIGN

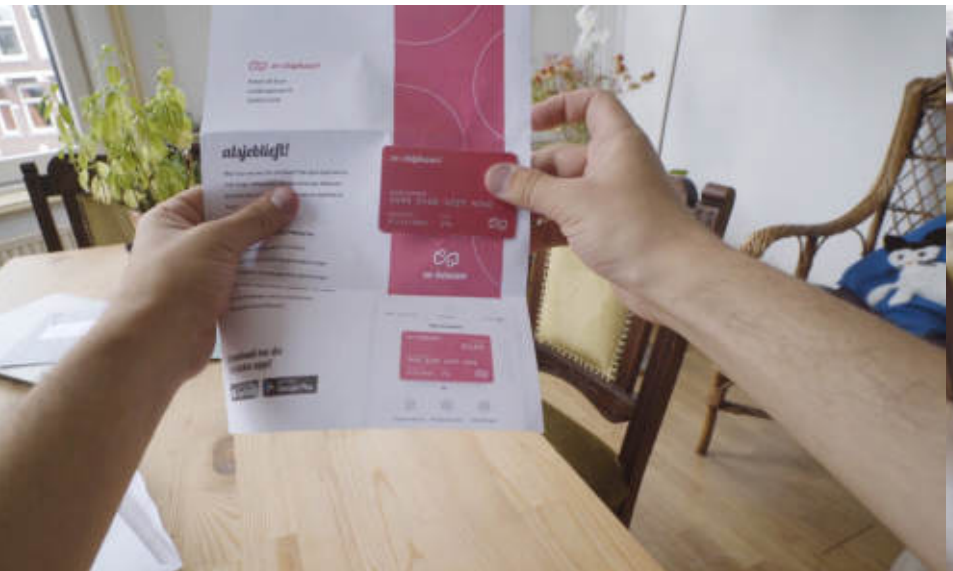
This following section describes the design of the OV-betalen app and how it can be integrated in one's travel behaviour.

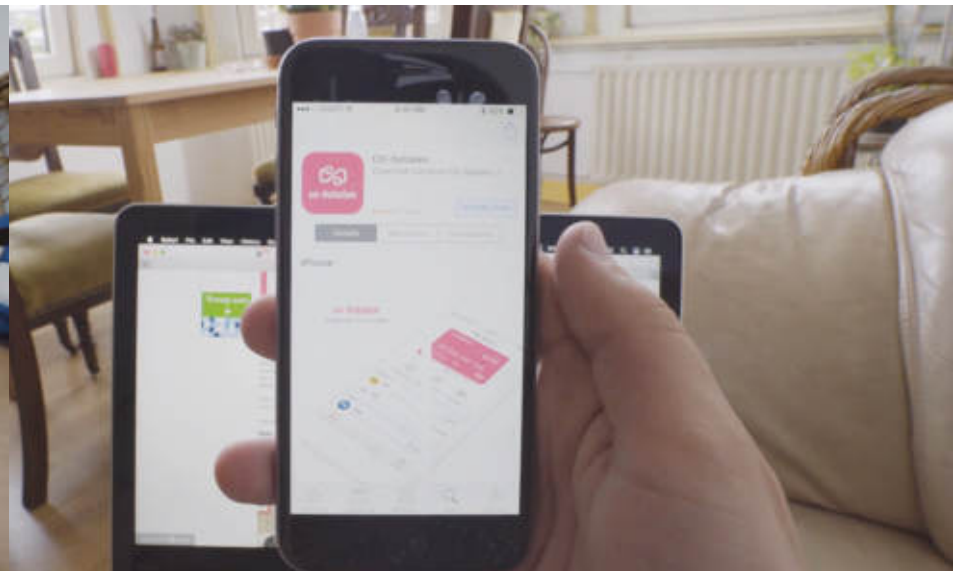
Awareness

Travellers whose personal details are known will receive a new generation OV-chipkaart through the postal services. Accompanied with this OV-chipkaart is a letter informing the traveller about the new OV-betalen app, stating that their current OV-chipkaart is being replaced. Balance and travel products have been transferred to this new card. This letter also sums up some of the main functionalities of signing up for an account in the app, such as a realtime overview of travel activity and balance, topping up balance through the app, correcting missed check-outs and checking in and out with your smartphone. Icons indicate in which app stores the app is available in. Advertisement channels such as signs at stations and stops, and online articles can create awareness amongst travellers without an OV-chipkaart.

Download & Registration

After downloading the app from the app store, one is presented with a walkthrough of the app's features. The user can also decide to skip this walkthrough and go straight to registration or login. People with an account from My OV-chipkaart will be able to use these login credentials. New users will need to register for an account in order to use the app. With an account users will be able to login to their account from different devices, e.g. a laptop or a new phone. New users are asked to confirm their registration through a confirmation link in sent to their email. This also ensures that there is a way to contact the users through a valid email address in case something needs attention. Confirming through this link will automatically open the OV-betalen app and fill in the login credentials, instead of the user needing to fill it in again.

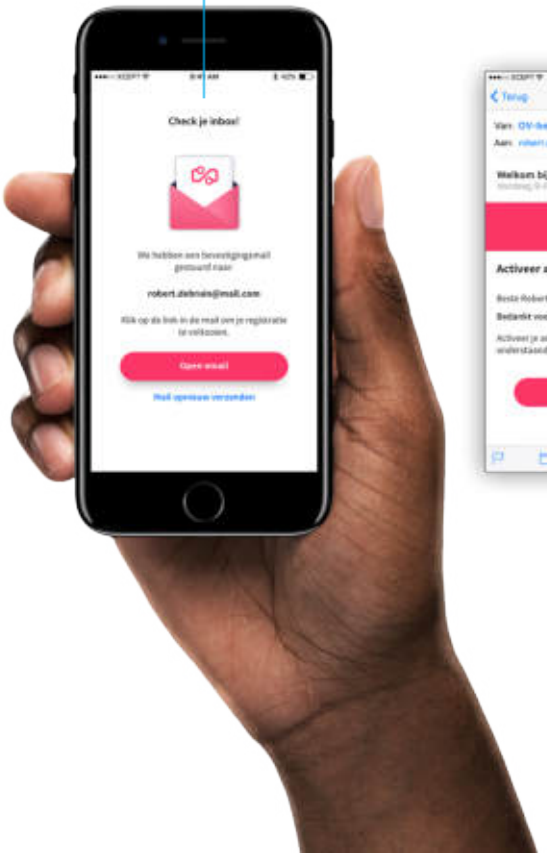




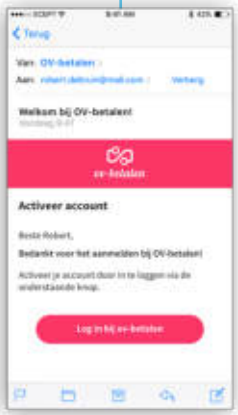
Walkthrough

Registration form

Confirm account



Email confirmation



Login credentials

New card

When logging in for the first time, the user is prompted with two choices. Requesting a new OV-chipkaart or connecting an existing one. New OV-chipkaart users have the choice between a physical OV-chipkaart and a mobile OV-chipkaart. Ordering a physical card will take up to three working days. The app will give updates on the current state of this process. When one prefers to travel immediately a mobile OV-chipkaart can be requested, which will be available in a matter of minutes. This mobile OV-chipkaart will be created and stored in one of the usually pre-installed wallet applications such as Apple Pay, Android Pay or Samsung Pay.

Linking an existing card

Users in possession of an existing card are able to link this card to the OV-betalen app. By default, the user is asked to take a picture of the card, which will automatically fill in the needed information. Based on preference, one could also decide to manually put in the information.

Order status

New card

First login

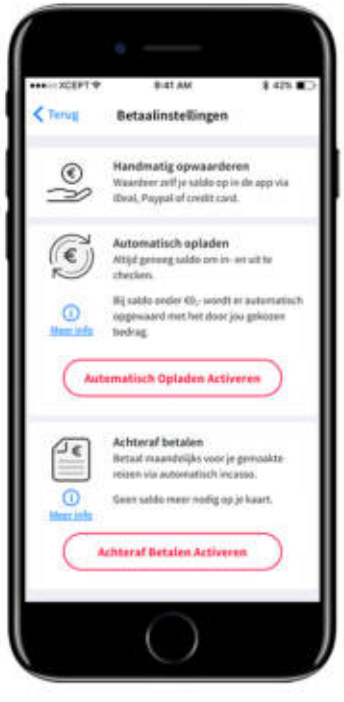
Link through photo

Link manually

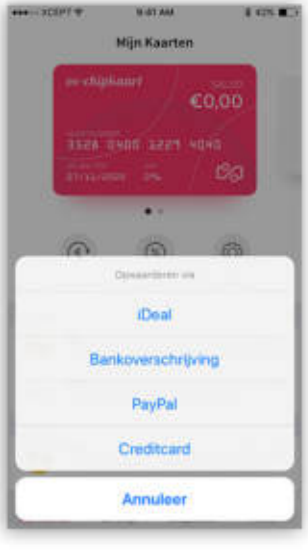
Payment configuration

After linking, or requesting an OV-chipkaart, users are asked to configure their payment setting for their card. Manually topping up is set as the baseline, where auto-reload can be added to that. Manual top up lets users be in total control of their public transport spending, whereas auto-reload will give the convenience of not having to worry about having enough credit on the OV-chipkaart. Post payment is available for the users who wish to not store money on a card, as they won't know when they'll use it again. All these options are accompanied with some explanatory text. Users are able to get more information about these options when they need more info. Manual top-ups can be performed through iDeal, mobile wallets, bank transfer, PayPal and credit card, allowing for a higher potential users base as shown in the usage potential funnel. When requesting auto-reload and the pospaid option, users need to be in possession of a valid credible bank account. A credibility check will be done through an iDeal payment of 0,01 Euro to finish this request. When the postpaid option is enabled, the user will see an overview of his bill, instead of his remaining balance displayed in the OV-chipkaart.

Configuration options

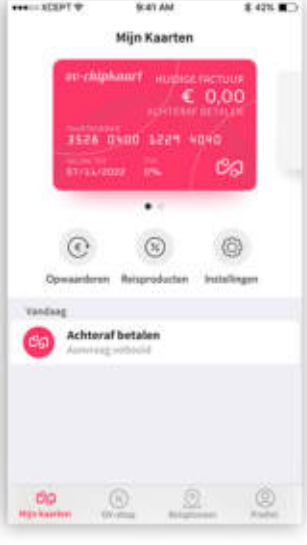


Top up options



Auto reload set-up

Postpaid enabled

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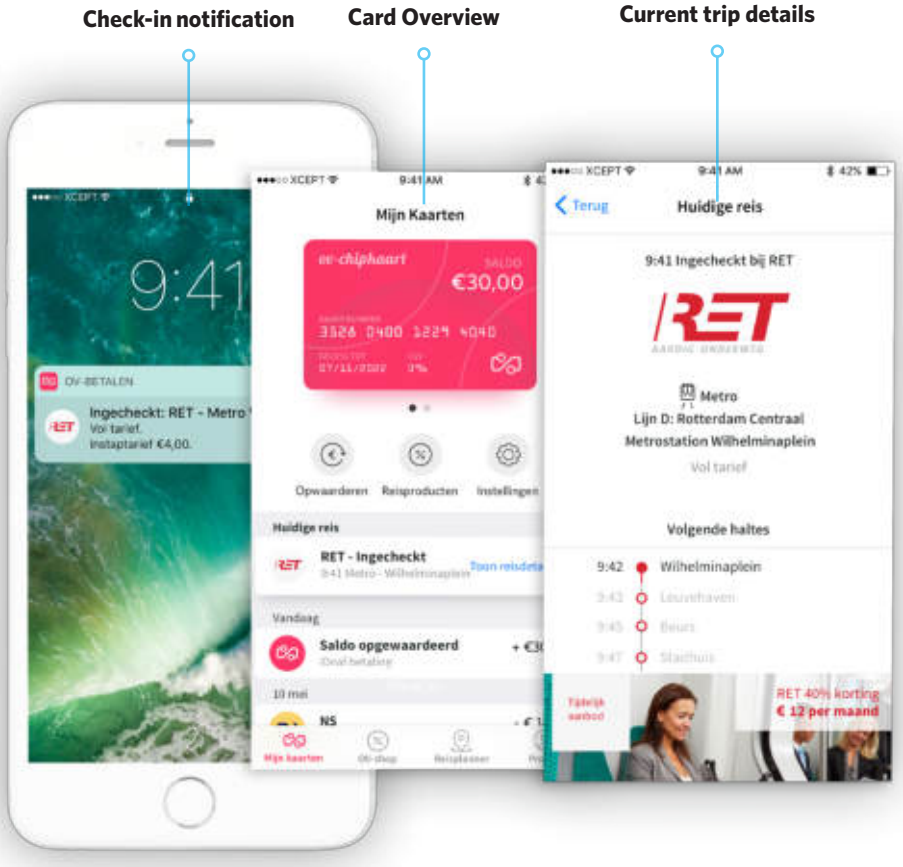

Travelling

When checking in and out of public transport users have the option to get a check-in/out notification. This shows where and with which operator they have checked in and out, and will also show the trip fare. This way travellers will be sure they have checked in, and will also be notified of someone else is using their card to travel. When opening this notification the user will be taken to the current trip overview. Users with this notification turned off, can access their current trip through their card overview. In addition to the earlier mentioned information, this also shows the arrival times for the upcoming stops. With bus and tram this is done as it is known in which vehicle they have stepped in. With train and metro, this can be done with a location tracking technology such as GPS, or beacons. This, however, needs to be further researched to come to the best solution for implementation.


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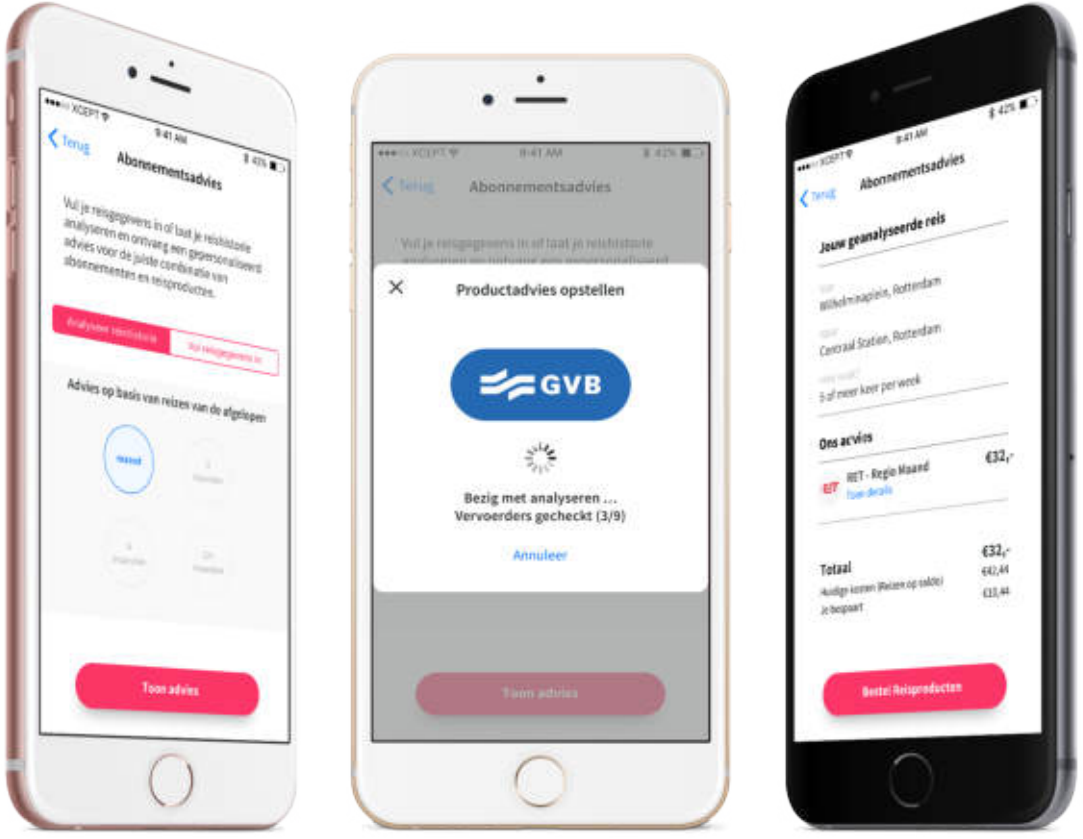
Mobile Check-in and out

Once a mobile OV-chipkaart is created through the OV-betalen app, travellers can check in and out of public transport using their smartphones. A small tutorial is given after setting op this Mobile OV-chipkaart in order to avoid confusion about how it would work. Travellers can check in and out by holding their phone against the validator, as one would do with a physical OV-chipkaart. No additional actions are needed, e.g. having to open a specific section in the OV-betalen app. Once the phone is held against the validator, the user's phone will automatically bring up the OV-chipkaart in screen and show that a check-in has occurred. Soon after, the card disappears again and a notification will come in it's place stating the previously mention check-in or check-out information.

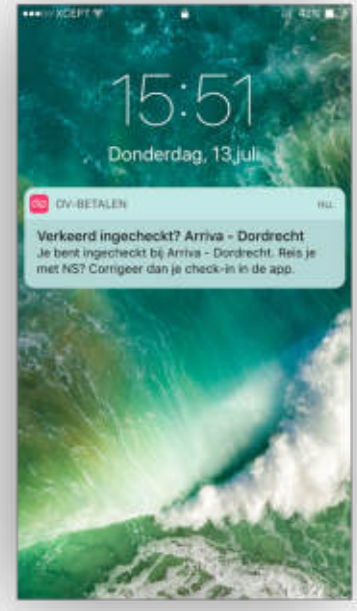
Travel product advice

Travellers can choose to analyse their travel behaviour to get a recommendation on which travel products would be interesting for them to consider. This analysis can be done based on the travels made in the past month, 3 months, 6 months or 12 months. Users can also choose to manually input information about their travel behaviour, such as frequency, route, peak-time to get a recommendation. Showing that the app is analysing the assortment of all public transport operators gives assurance that every product is considered. A recommendation is done compared on costs one currently make, versus the costs one would have when purchasing the recommended travel products. Showing how much one can save can be trigger for travellers to actually purchase the recommended travel products.



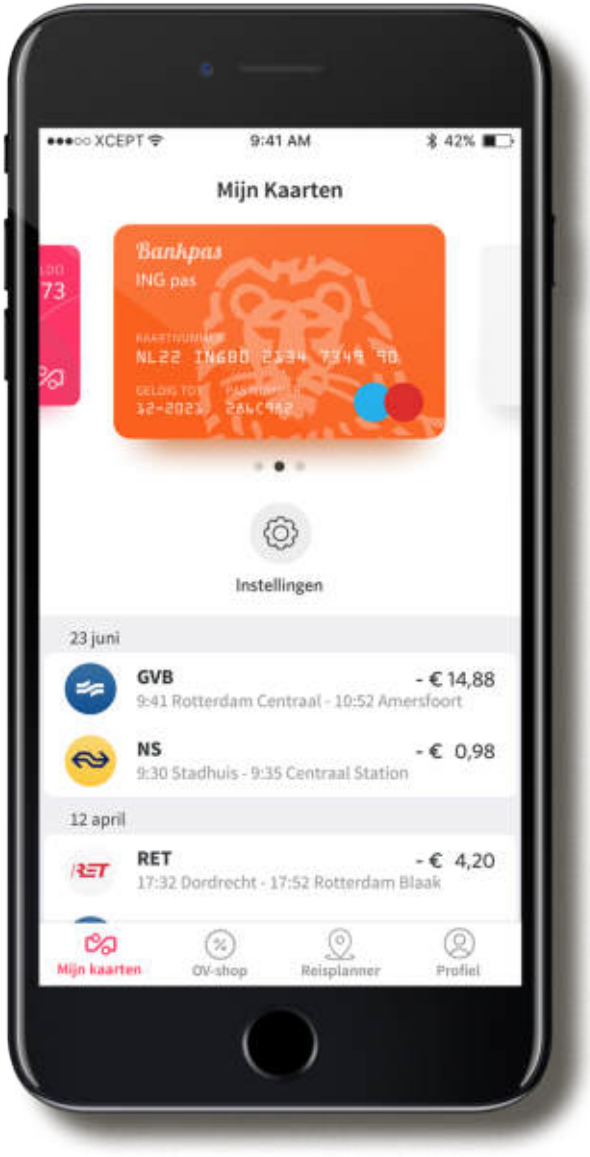
Alert notifications

Alert notifications notify the user when something needs their attention, mostly in cases something might have gone or are about to go wrong. Just like the check-in and check-out notification users these can be turned off and are considered an extra service. Alerts include forgotten check-outs, based on when someone hasn't checked out after a set time, wrong check-ins (either preventive, based on previous travel behaviour or location based through GPS) at stations with multiple public transport operators, and low balance warning, in order to prevent the user from getting stuck at the next check-in.



Contactless bank card

Travellers can use their contactless bank card to check-in and out in public transport. In contrary to the OV-chipkaart, users cannot will not be able to purchase travel products for their bank card. As explained in section 4.3 ‘Mobile Ticketing Concept: Account Based Travel‘, the mental model of connecting travel products to a bank card seems hard to grasp for travellers. When one would link their bank card in the OV-betalen app, they have access to their trip overview. Linking a bank card to an account also allows the user to receive the alerts mentioned earlier, such as check-in/out alerts and the forgotten check-out alert.



6.4 IMPLEMENTATION STRATEGY

Starting from the current infrastructure, an implementation strategy has been developed for the proposed design. This implementation strategy shows how the vision can be realised by gradual developments. This strategy aims at converting the current OV-chipkaart app to the proposed OV-betalen app with incremental improvements. These improvements are aimed at drawing users to this app.

Current infrastructure

While the current infrastructure has its limitations, the current OV-chipkaart system can still be optimised. It is suggested to optimize the OV-chipkaart app to match and improve the functions that are available in the My OV-chipkaart web environment, such as ordering/renewing an OV-chipkaart. Also look at how the current processes of OV-chip Mobiel (OVCM) can be improved and integrated in the OV-chipkaart app.

Back office calculations

With back office calculations, postpaid propositions can be facilitated. Enabling this option through the OV-chipkaart app could give travellers a low sign-up threshold. These back office calculations also serve as the foundation for travelling with a contactless bank card.

Partial EMV reader rollout

With the first public transport operators starting pilots with travelling with the contactless bank card, the OV-chipkaart app should be developed to support the contactless bank card. Travellers should be able to track their activities from both their OV-chipkaart, as their bank card through the improved and re-branded OV-chipkaart app: OV-betalen.

All vehicles online

Once all public transport vehicles as busses and trams go online, they are able to periodically upload and download transaction information. This would account for more accurate trip history in the OV-betalen app. This also makes it possible to collect top-ups and travel products in these vehicles when checking in/out with a certain delay.

Direct connection validators - back office

The next step is uploading every check-in/out to the back office. This allows for realtime trip history and balance information through the OV-betalen app. This would also allow for the data stored in the back office to be leading instead of the data stored on the OV-chipkaart. At every check-in/out the OV-chipkaart is synced with the data stored in the back office.

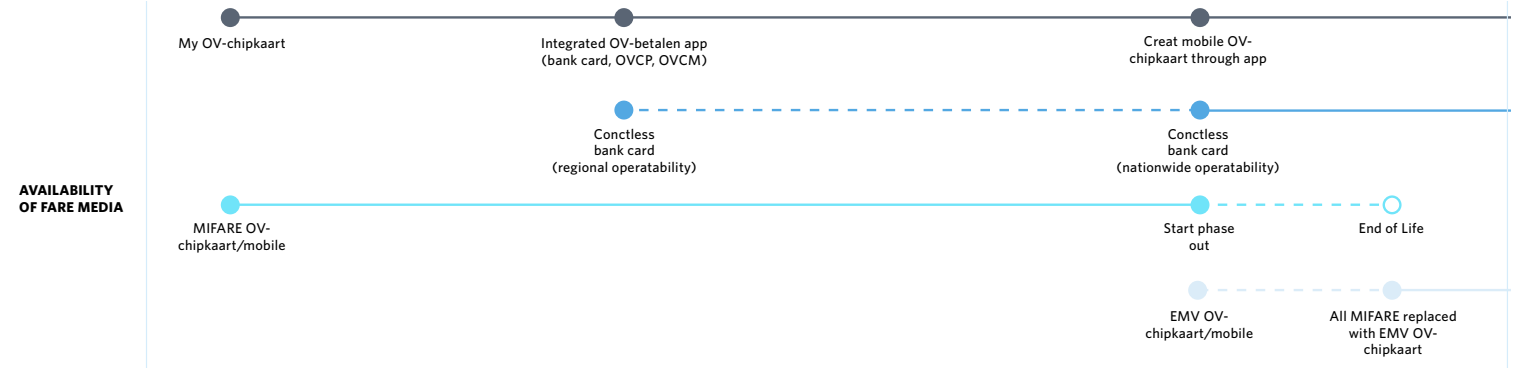
100% nationwide EMV coverage

Once nationwide EMV coverage is reached, it is possible to travel nationwide with the contactless bank card. This is also means the MIFARE OV-chipkaart no longer needs to be issued, and the EMV OV-chipkaart can be rolled out. Tokenisation allows for travellers to create a mobile OV-chipkaart on their phone through the app.

(5 years) after 100% EMV coverage

As soon as all MIFARE cards have been expired, or actively replaced it is possible to disable the MIFARE infrastructure, only holding the EMV infrastructure in place.

Roadmap towards proposed service design



	CURRENT INFRASTRUCTURE	BACK OFFICE CALCULATIONS	PARTIAL EMV READER ROLLOUT	ALL VEHICLES ONLINE	DIRECT CONNECTION VALIDATORS - BACK OFFICE	100% NATIONWIDE EMV COVERAGE	(5 YEARS) AFTER 100% EMV COVERAGE
OV-BETALEN ACCOUNT	Optimize My OVCP Same functionalities over channels (app, web)	Sign up for postpaid payment through My OVCP	Add contactless bank card support to My OVCP Create integrated OV app for OVCP, OVCM, bank card	Faster uploads transactions More accurate trip history	Upload per transaction performed (instead of batch upload periodically) Real-time travel history, balance info etc	Add support for EMV OVCP/ OVCM	
MIFARE OVCP/OVCM	Optimize OVCM Sign-up Optimize OVCP services: order card, renew card, travel history etc.	Enable OVCP as identifier		Enable validators as pick up device for top-up, travel products	Receive top up, travel products at moment of check-in from validators, at station/stop of choice Data stored on card no longer leading, data stored in back office is (data synced to card at check-in/out)	Stop issueing new OVCP & OVCM cards	Actively replace Mifare OVCP/OVCM with EMV versions Disable Mifare infrastructure
CONTACTLESS BANK CARD		Charging on a postpaid basis from bank account (e.g. per day/week/ month)	Enable contactless bank card pilot in selected areas Track travel history of contactless bank cards			Lower threshold of OV for incidental travellers Enable contactless bank card pilot in selected areas	
EMV OVCP/OVCM	Start developing EMV OVCP service design					Start issueing EMV OVCP Add tokenization support of OVCP for platforms such as Apple Pay, Android Pay, Samsung Pay etc	Increase usage potential for mobile fare medium


7

7. Conclusion & discussion

In the previous chapter, the design vision for a user-centred mobile ticketing solution for Dutch public transport has been proposed. This chapter discusses the results and corresponding conclusions of this project. The limitations of this project and recommendations for further development will conclude this chapter.

7.1 CONCLUSION

The goal of this project was to develop user-centred solutions to improve travellers' experience in Dutch public transport by creating and depicting a future customer journey using a mobile ticketing solution in Dutch public transport. The research done in Oslo, London and Seoul led to various insights and formed guidelines for the implementation of a mobile ticketing solution in the Netherlands.

This analysis formed the start of the design phase. This phase started off by evaluating ideas and mobile ticketing working principles with Dutch travellers. This was done in order to gain insights in the thought process , concerns, needs and wishes of the Dutch travellers. This evaluation exposed that a mobile phone is, currently, mainly used as an user interface, as people appeared to not be used to using their phone to perform NFC-transactions with. Digital versions are expected to be more cost effective as nothing tangible is given back in return. In the traveller's mind, the card issuer saves on manufacturing costs and can therefore lower their prices for the digital alternatives they provide. People have the expectation of mobile apps to be setup within a few minutes on their mobile phone as everything is expected to happen digitally within the app. Travellers have also indicated to assume that digital public transportations services are available on multiple operating systems. Topping up, loading travel products and supplements are currently actions travellers need to perform at an add value machine or ticket machine. It became clear that a mobile ticketing solution should make these location-bound actions unnecessary, enabling the traveller to perform these actions at any place and point in time. Nest to this information should be provided on a real-time basis in order to e.g. display the correct travel activity, current balance and check-in status. Providing this information on an too big of delayed interval causes distrust in the services. Pro-actively reminding and informing users of travel activity or missed check-outs is perceived as pleasant and expected as a baseline service. This improves travellers' experience in public transport by taking away certain doubts they have, e.g. did I correctly check-in?

Based on the defined user expectations and requirements, server stored data is essential for a mobile ticketing solution. This way real-time information can be provided towards the user's phone. In the current OV-chipkaart system, the data stored on the card is leading. It also became clear that travellers have the need to configure ticketing options on their mobile phone regardless of their fare medium.

In order to check the feasibility and viability of this concept stakeholders were asked to evaluate this concept. One reoccurring comment is the emphasis on lowering the threshold to make use of public transport. Even though this seems doable with the proposed concept as most technology used already exsists, it heavily relies on upgrades in infrastructure, namely validators. When not prematurely updating, this could take until 2028 before nationwide interoperability is guaranteed. Public transport operators also expressed the wish to be able to create a client relationship with their customers.

Having gather this information, a customer journey was made depicting a design vision for a new mobile ticketing solution. A prototype of the envisioned solution was made and evaluated with users. In general, the participants were enthusiastic about the proposed design. This evaluation showed that the proposed design fits the needs and wishes of travellers. Real-time access to clear presented data, self-service capabilities and using the mobile phone as fare medium were all aspects which were rated well. This resulted in participants mentioning that they hope the proposed design is released soon.

This project has shown, how a user-centred approach can lead to a design solution fit to the needs and wishes of the travellers. For it to become reality, however, a long way still lies ahead as can seen in the roadmap towards the proposed service.

7.2 LIMITATIONS

The insights and results of this project were mostly gained by using qualitative research methods. Field research was done based on interviews, observations and personally experiencing mobile ticketing solutions in public transport. User ans stakeholder evaluations were also held in a semi-structured manner. Possible concerns using these methods include debatable trustworthiness due to interview bias, reliability as a result of leading questions and that different interpreters find different meanings (Kvale, 1994). This approach, however, has proven to provide rich data and an understanding how people use and experience the use of a mobile ticketing solution.

The stakeholder evaluation has been performed with several stakeholders of the public transportation system. This evaluation took place over a period of two months, which makes the material presented to the first party less in-depth than presented to other parties. This could have led to a less critical view from the stakeholder's perspective as the concept was more abstract at the time.

The final design shown in Chapter 6 contains redesigned aspects based on feedback gather from the last user evaluation. These redesigned elements, however, have not been evaluated. This means it is unclear to what degree these adjustment can be considered as improvements towards the design.

7.3 RECOMMENDATIONS

There are several recommendations that can be made to help the development of a mobile ticketing solution in the Netherlands. These recommendations look beyond the scope set in this project and look at what can be done to improve further development.

Don't wait too long: the future is now

As stated earlier, this proposed design vision is highly dependant on investments in infrastructure, and when not prematurely updated, another ten years are needed for this can become reality. It is recommended, however, too shorten this duration as much as possible as travellers have indicated to be wanting this service now and some even indicated to be ready to use such a service for over two years already.

Look beyond ticketing

For this proposed service design, only the aspects related to ticketing have been worked out. Other aspects such as trip planning have been defined in the service blueprint, but were taken out of scope for this project to further deep in to. Further exploration is needed as this is an integral part of one's travel.

UX/UI Design

The proposed design was thought out on a more conceptual level, where general use flows have been worked out. The designed service did pay attention to UX/UI details regarding the app, however, no clear rules or styleguides were developed for this service. Creating a stylguide would help improve the consistency amongst the different sections of the service.

Internationals

The proposed design is currently made in Dutch. Multilingual support, with at least English, could help internationals who are either visiting or staying here long term with getting around the complex Dutch public transport system. This is supported by the research done by Lehr (2016).

Copywriting

Especially for new users, some terms introduced using this service were unclear, even when explanatory text was provided in some occasions. A balance needs to be found in providing just enough information where it is not too much too read.

Test with first time users

Testing with a first time user, although unintentionally, has exposed a lot valuable insights. Elements which seem so obvious to you can surprisingly unclear to someone else. Especially in a context as complex as the Dutch public transport system, first time users point out valuable points of improvement.

Test earlier with 'non-functional' prototypes

For the prototype that was developed for this project, not a single line of code was written. By using app prototyping tools, one can simulate an functioning app experiences, while in fact no real data is stored or used in the prototype. Using these prototyping tools, ideas can be rapidly evaluated in a time and cost efficient manner.

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Colophon

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Project

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