

Exploring Mobile Ticketing in Public Transport

An analysis of enablers for successful
adoption in The Netherlands

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Expertise Centre for E-ticketing in Public Transport

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Industrial Design Engineering



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The Netherlands

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Delft University of Technology

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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).

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).

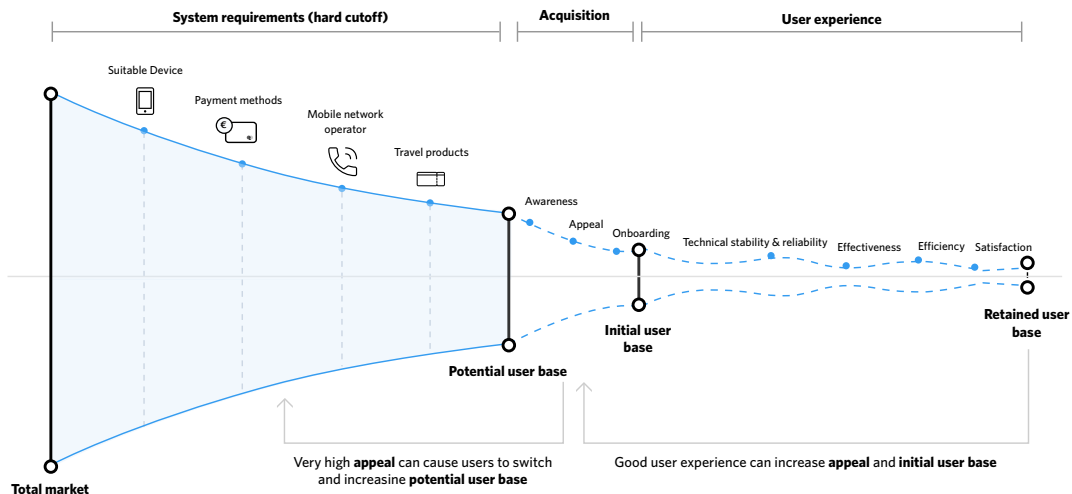
User/traveller. This research focusses on the end-user or traveller. In most cases, the term 'user' refers to a person performing actions in public transport with a mobile ticketing solution.

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. 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. As the development and introduction of the OV-chipkaart have shown, using a technology and business driven approach during the development of a new product service system can result in a suboptimal market introduction.

By taking a user-centred approach, 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, focussing on the factors influencing the adoption rate and traveller experience.

From this research, a potential usage funnel has been created, describing how system requirements, acquisition and user experience influence the potential, initial and retained user base of a mobile ticketing solution. This also identified factors influencing adoption, which served as the foundation for the proposed guidelines for a successful implementation of mobile ticketing solutions in the Netherlands.



Factors enhancing adoption

- A mobile phone is never forgotten
- Self-service capabilities (no need to go to convenience stores or ticket machines)
- The novelty of using a mobile phone as fare medium

Factors discouraging adoption

- The discomfort of using and relying on a mobile phone
- Privacy & security concerns
- No added value
- Unstable and unreliable check-in/out performance
- Battery concerns
- High level of adjustment

Guidelines for a user-centred mobile ticketing solution



Benchmark against the familiar

OV-chipkaart experience is leading. Benchmark against current performance, pricing and travel products.



Create clear value and benefit in proposition

Significant value and benefit over other ticketing options is needed, e.g. not having to wait for an OV-chipkaart to be delivered, cheaper than an OV-chipkaart, real-time data usage.



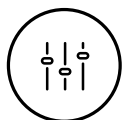
Ease and comfort of installation and use

Potential users can be discouraged through a complex set-up process and suboptimal usability. Make sure the required user effort does not exceed the benefits.



Communicate effectively

Provide clear in context information about costs, benefits, how to get started with the service. Educate travellers on how to use the service, e.g. by introducing fare-free days.



Keep level of adjustment at a minimum

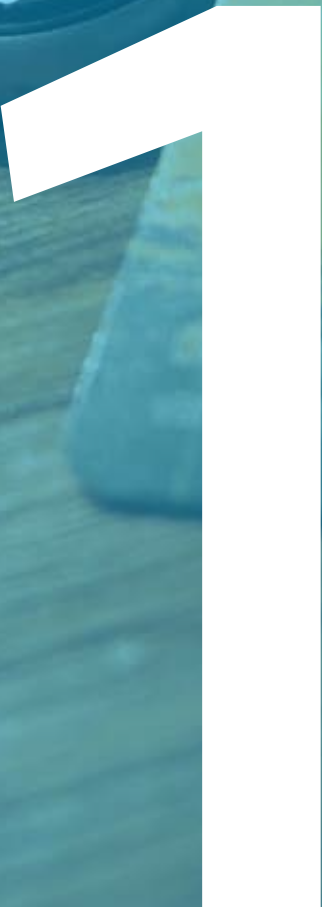
Holding a mobile phone against a validator needs a level of adjustment. Changes in accessories are likely needed to travel comfortably (earphones, phone cases).

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 **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 'Visie OV-betalen' (2014), describing new ticketing and payment technologies for the Dutch public transportation system. This document describes a vision where the bank card and mobile phone can be used as an alternative to the OV-chipkaart. This project 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.

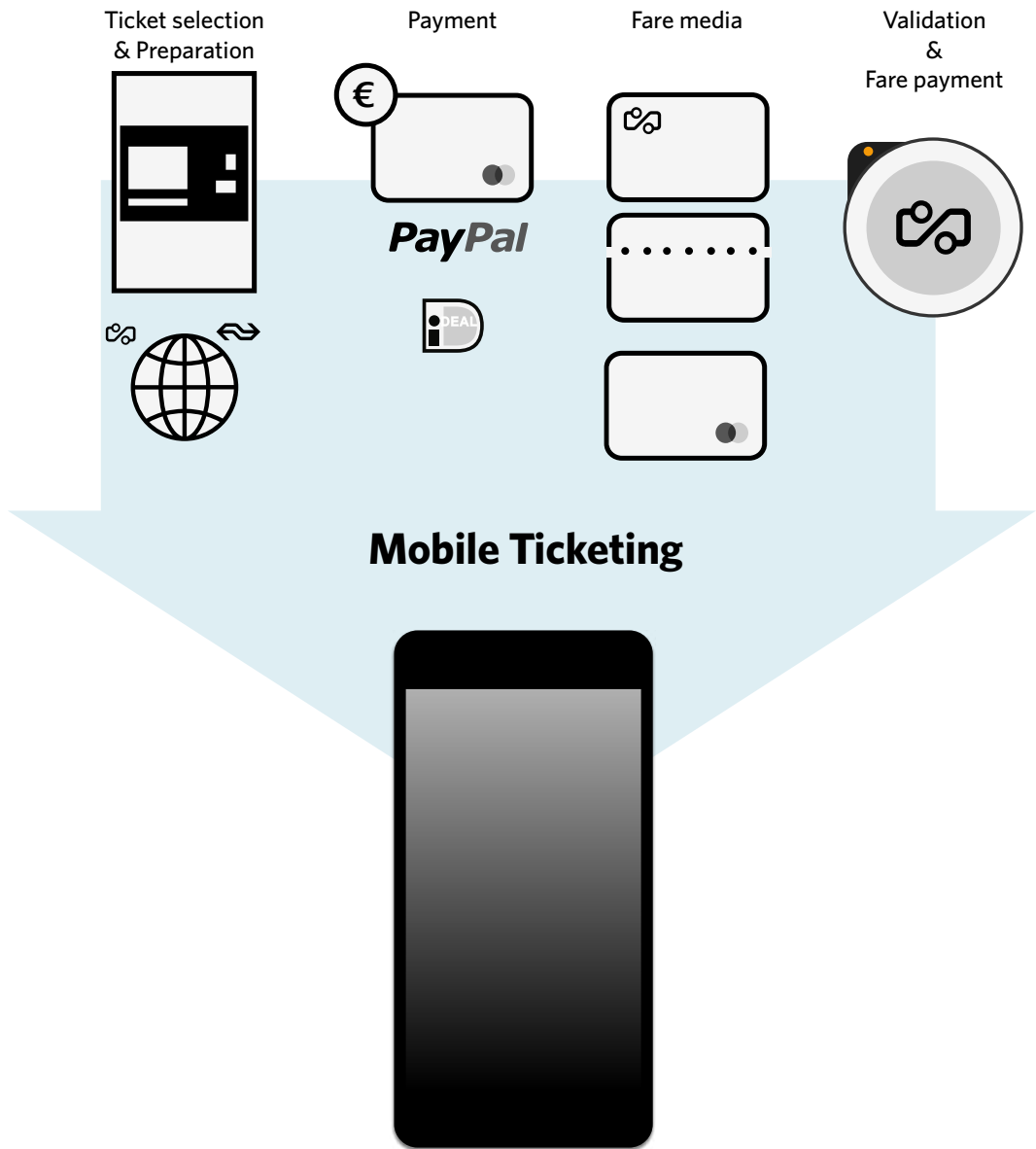


Figure 1. Representation of mobile ticketing

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.

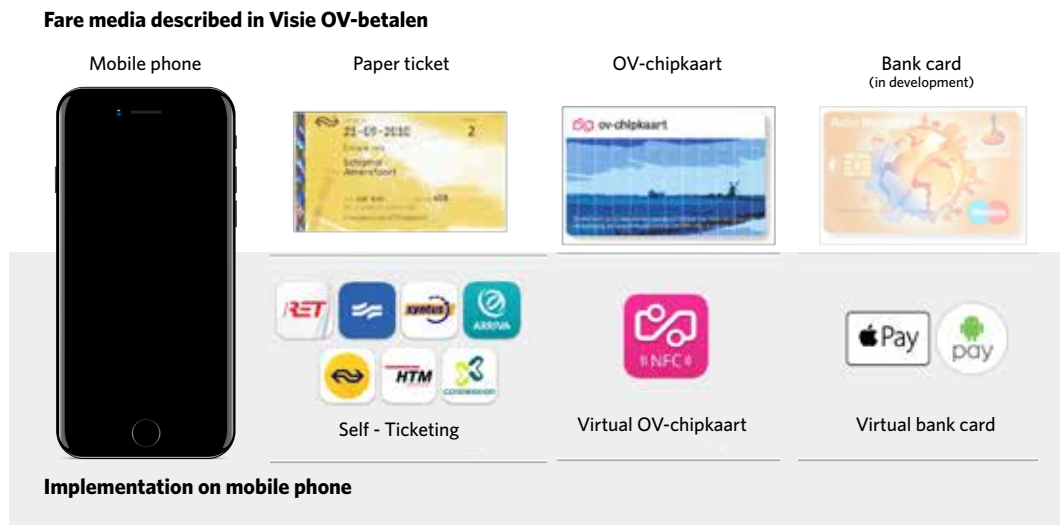


Figure 2. Mobile ticketing solutions that are in development for the Dutch public transportation system

1.3 PROJECT GOAL

The goal of this project is to develop user-centred solutions to improve travellers' experience in Dutch public transport, with the mobile phone as fare medium. This is done by creating and depicting a future customer journey using a mobile fare medium in Dutch public transport. The goal of this first report is to create an understanding of potential problem areas and concerns, the potential solution space, and factors influencing the adoption of a mobile ticketing solution in the Netherlands.

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).

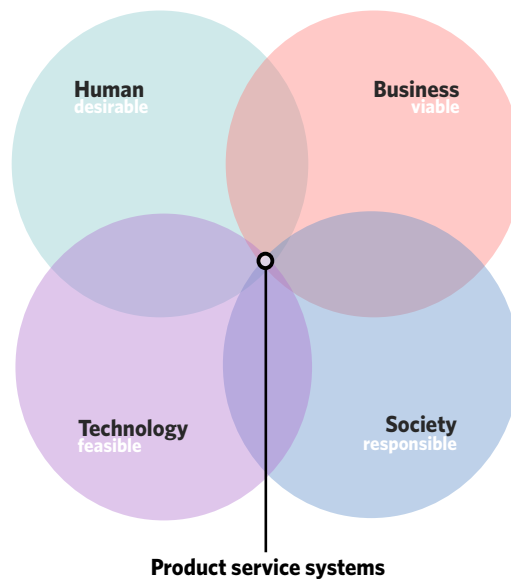


Figure 3. Integrated innovation model by van Kuijk (2015)

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 over a period of nine months (September 2016 to June 2017): an analysis phase and a design phase. This report covers the analysis which took place from September to January. The analysis phase takes a look at the Dutch public transportation context, trends and developments and the implementation of mobile ticketing solutions of similar systems abroad. These insights are combined in order to formulate guidelines for the implementation of 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).

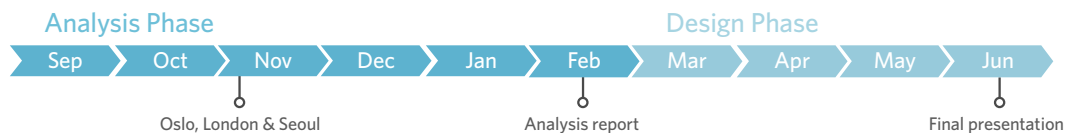


Figure 4. Timeline of the project

1.5 RESEARCH APPROACH

This section explains the research set-up for this analysis phase. It covers the research questions and the methodologies used to answer these.

1.5.1 Research Aim

The aim of the analysis phase, on which this project reports, is to determine opportunities and which factors influence the adoption of a mobile ticketing solution within the OV-chipkaart and Dutch public transport system. Identifying possible issues, patterns and opportunities that occur within mobile ticketing solutions abroad will lead to design parameters for solutions in the Netherlands.

1.5.2 Research questions

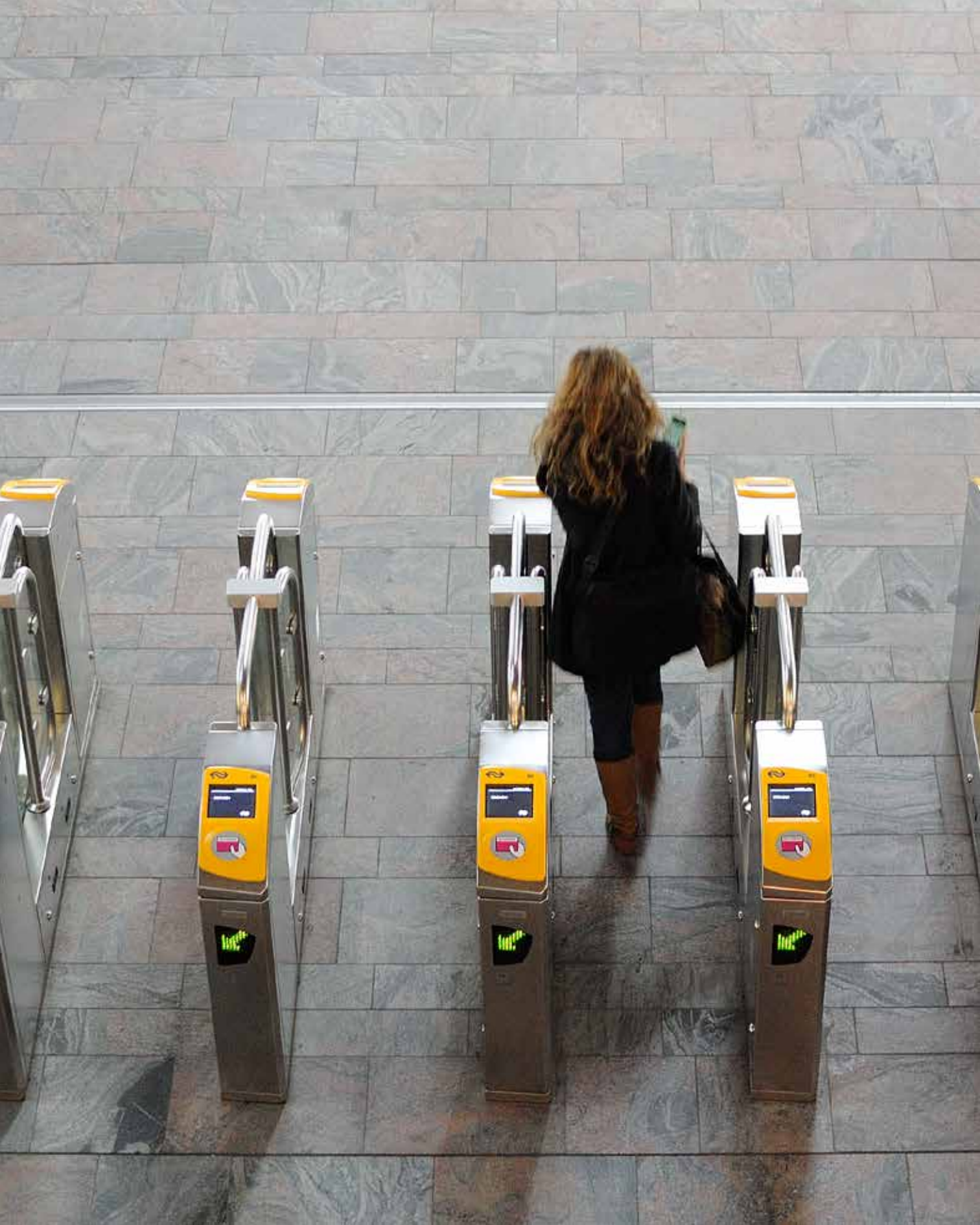
The following research questions were formulated for this analysis phase:

- How does the current OV-chipkaart system work?
- What are relevant trends and developments related to mobile phone usage?
- What types of mobile ticketing solutions are currently implemented in other public transportation contexts?
- Which factors influence the adaptation and implementation of a mobile ticketing solution in public transport?
- Which usability problems and opportunities can be identified for a mobile ticketing solution?

1.5.3 Method

To answer these research questions, a qualitative research approach was taken. This research approach aims to collect rich data, gaining insights into thoughts, expectations and attitudes of people. Qualitative research "is used in the exploration of meanings of social phenomena as experienced by individuals themselves, in their natural context." (Maletrud, 2001). 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 precise qualitative research methods used are described in each chapter's respective method section.



A large, bold white number '2' is positioned on the left side of the image. The background is a close-up of a ticket machine with a blue and purple color scheme. The letters 'OV' are visible in a stylized, rounded font on the machine's surface. The overall image has a soft, slightly blurred quality.

2

OV-chipkaart branding on a ticket machine

2. The OV-chipkaart system

2.1 INTRODUCTION

This chapter describes the OV-chipkaart system's workings, its stakeholders and system architecture, as well as future developments. The analysis of the current public transportation system in the Netherlands is important to identify opportunities that lie within the use of a mobile ticketing solution.

The aim of this chapter is to explore and understand the context of the OV-chipkaart and Dutch public transportation system. A better understanding of this context is needed to determine the boundaries and opportunities within these systems. These are relevant for the implementation of a mobile fare medium. This chapter provides answers to the following questions.

- How does the current OV-chipkaart system work?
- Who are the stakeholders of the OV-chipkaart system and what are their interests?
- Which developments are planned for the OV-chipkaart system?

In order to answer these questions, a literature review and expert interviews were conducted. Literature was obtained through the TU Delft Expertise Centre for E-ticking in Public Transport and Translink. Project partners (NS, GVB, RET and Translink) were consulted to learn about their roles and interests in the Dutch public transportation system.

2.2 ABOUT THE OV-CHIPKAART

The OV-chipkaart is an electronic payment system for public transportation services in the Netherlands. Since 2012 it has been possible to pay with the OV-chipkaart for all modalities of public transportation such as trains, buses metro and trams. The OV-chipkaart offers the possibility to use public transport in the Netherlands with the use of just a single card, eliminating separate tickets for all the different modes of public transport. The idea behind the OV-chipkaart is to use a prepaid system, where the trip fare is directly charged from the card. To calculate this trip fare, the Dutch public transportation infrastructure is relying on a check-in/check-out policy. With the use of contactless technology travellers can check-in at their point of departure and check-out at their point of arrival. Travellers are charged based on the number of travelled kilometres.

Contactless technology used in this case is Near Field Communication (NFC), a set of communication protocols that enable two electronic devices to establish communication. This check-in/check-out process is facilitated by in-field equipment placed by public transport operators called validation devices. Check-ins can be done at gates and poles at stations or at on-board card readers in buses and trams. These same validation devices can be used to check-out again when travellers end their trip or transfer to another public transport operator. While travelling, conductors may conduct ticket inspections with mobile ticket validators.

The OV-chipkaart (Figure 5) is a smart card issued by Translink. The OV-chipkaart follows the IOS/IEC 1443 international standard (Meeuwssen, 2016). This is an international standard that defines proximity cards used for identification, and the transmission protocols for communicating with it. In the case of the OV-chipkaart, an NFC chip is stored within the card. This chip communicates with the in-field validation equipment. In the current OV-chipkaart infrastructure, the OV-chipkaart itself is the carrier of the most up-to-date information through an integrated 'OV-Module' (Translink, 2016).

This OV-module is able to contain the following information:

- The 10 latest travel transactions
- The 2 latest top-up transactions
- Travel products (e.g. discounts, student products)
- Rights granted (e.g. automatic top up)
- Client profile (date of birth)



ov-chipkaart

Op deze kaart zijn de Algemene Voorwaarden OV-chipkaart van Trans Link Systems B.V.
van toepassing. Zie www.ov-chipkaart.nl of bel met 0900-0980 (0,30 euro p. min).



Figure 6. Personal (yellow) and anonymous (blue) OV-chipkaart

The OV-chipkaart is available in the following formats:

Personal OV-chipkaart

The personal OV-chipkaart (Figure 6) is connected to a single user. Only the cardholder is allowed to use this OV-chipkaart. Personal data such as name, date of birth and a photo are visible on the card. Travellers using a personal OV-chipkaart are able to make use of travel products such as public transport subscriptions, automatic top up and student discounts.

Anonymous OV-chipkaart

An anonymous OV-chipkaart (Figure 6) is not linked to any personal data. Multiple users are able to travel with this card, although not simultaneously. With the anonymous OV-chipkaart, it is not possible to make use of travel products (season tickets, discounts, etc.) that are available on the personal OV-chipkaart.

Business OV-chipkaart

Businesses are able to purchase the travel rights for their employees with the business OV-chipkaart. Just like the personal OV-chipkaart, travel products can be added to the card. Businesses are able to get invoices for the travel expenses of their employees.

Disposable OV-chipkaart

Travellers are also able to buy a disposable OV-chipkaart in the form of a paper ticket with an integrated chip. These tickets are issued through public transport operators and can only be used for a specific amount of travel, for example, a single journey. Another example is the Amsterdam Travel Ticket, which allows for unlimited use of public transport in Amsterdam.

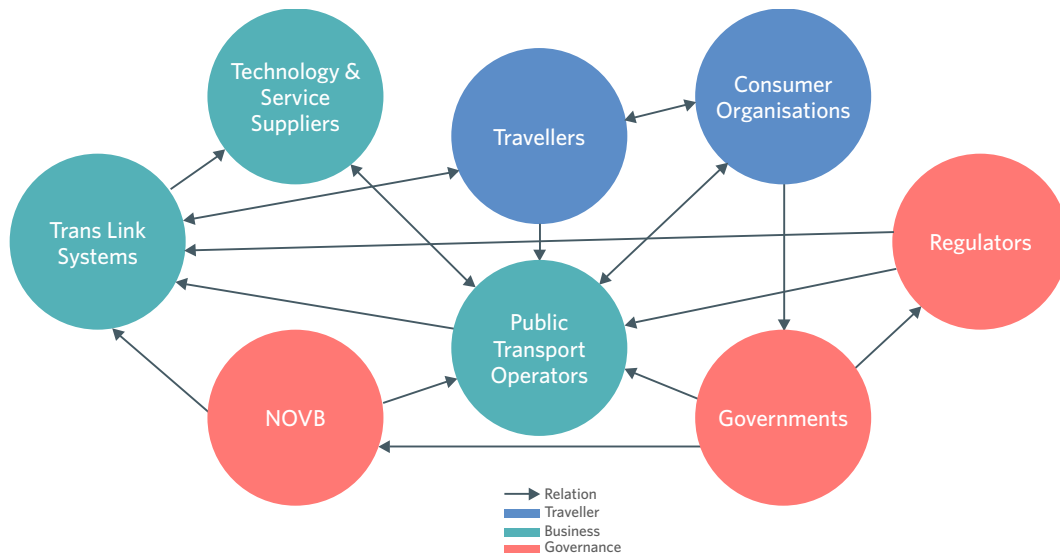


Figure 7. Stakeholder overview OV-chipkaart system

2.3 STAKEHOLDERS

Several stakeholders are involved in operating and managing the OV-chipkaart system (Figure 7). These stakeholders can be divided into eight main groups: travellers, public transport operators, governments, regulators, consumer organisations, technology & service suppliers, Translink and the Nationaal Openbaar Vervoerberaad (NOVB).

The need for public transport is created by the travellers. Public transport operators offer services to facilitate these travels. National and regional government institutions set requirements and grant concessions to the public transport operators. Travellers get represented by the consumer organisations. These organisations represent inform the other stakeholders about the traveller's concerns and experience. Translink is responsible for the system processing all the transactions. Public transport operators and Translink contract technology & service suppliers based on requirements in order to process these transactions. Regulators oversee whether Translink and public transport operators are operating within the law. The NOVB is a council tasked with inter-concession problems and concerns related to the OV-chipkaart and other forms of payment in public transport.

2.4 THE OV-CHIPKAART ECO-SYSTEM

This section covers the technical architecture of the system (Figure 8) and the online services that are available for the OV-chipkaart.

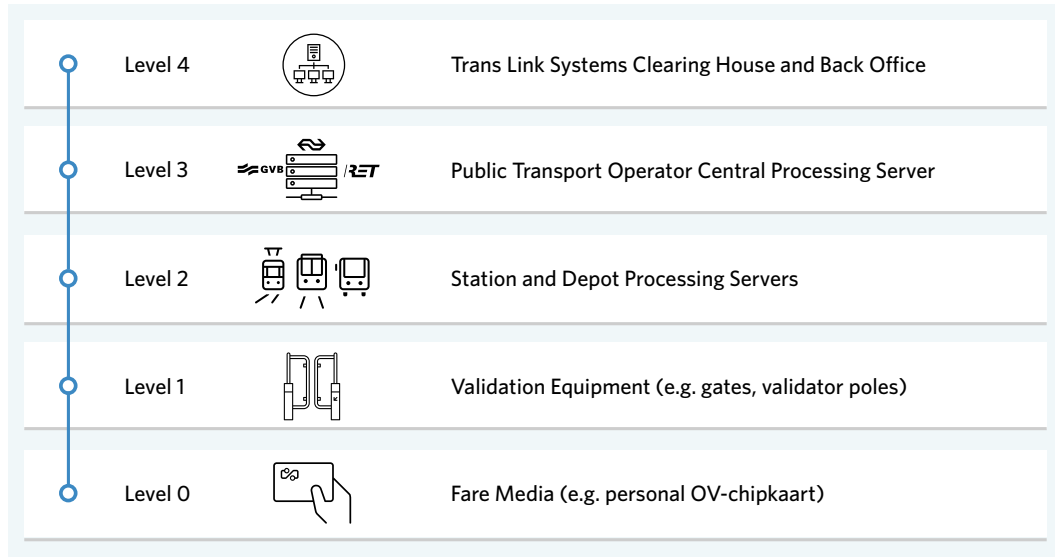


Figure 8. System architecture of the OV-chipkaart system

2.4.1 System Architecture

Level 0

The zero level consists of all the payment and identification cards issued by the public transport operators and Translink. All cards are used to communicate with the level 1 devices.

Level 1

This level consists of all equipment that is used to validate, sell, top up and inspect an OV-chipkaart. Examples of devices which classify as level 1 are station access gates, ticket vending machines, and hand-held inspection readers used by conductors. These devices need to contain information about subscriptions and fare prices, blocked cards and validation rules.

Level 2

Information collected by level 1 machines described earlier will go through the public transport operators on-site processing servers. These processing servers can be found at stations, bus stops and depots. These on-site systems are classified under level 2.

Level 3

Besides the on-site processing servers, every public transport operator also has a Central Processing Server (CPS). This CPS stores all transactions made with the OV-chipkaart within one public transport operator. These transactions contain trip information and credit balance changes. The collected data by these servers will be used to verify the financial transaction with Translink.

Level 4

The top-level part of the system is called the Central Back Office (CBO), operated by Translink. The CBO interacts with the public transport operator's central systems and the systems of relevant financial institutions. By processing and registering all card transactions, the CBO determines how much money each of the transport operators should get or need to pay. Another function of the CBO is to keep track of blocked cards and manage travel products such as automatic top-up.

2.4.2 Online services

Online services play an important role in the OV-chipkaart system for travellers. Two categories can be identified:

Websites

The OV-chipkaart website, www.ov-chipkaart.nl, is the central address for travellers to get information about the system, the different types of cards, and transactions. On the website, travellers are also able to purchase, order, or renew a personal OV-chipkaart. It is also possible to register for a 'Mijn OV-chipkaart' account. Travellers who have linked their personal OV-chipkaart to a 'Mijn OV-chipkaart' account will be able to view their current balance, block a lost or stolen card, order credit, see their travel overview, and create an expenses statement. At www.uitcheckgemist.nl, travellers are able to request a refund for forgotten check-ins/check-outs. Besides their own tickets and products, transport operators also provide information about the OV-chipkaart through their website.

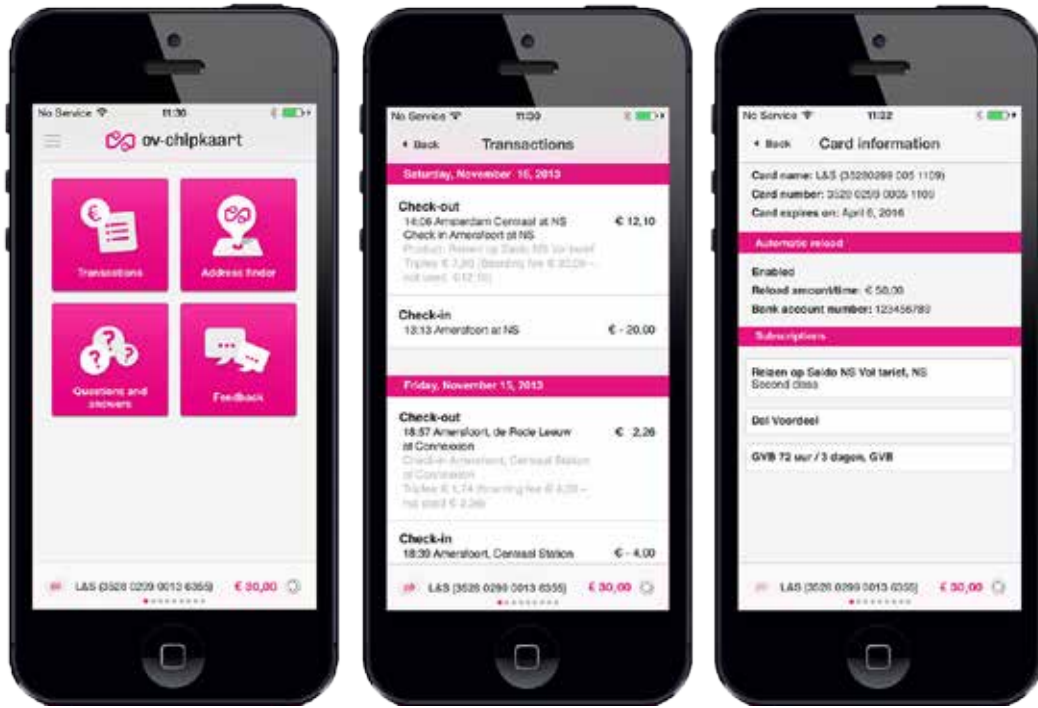


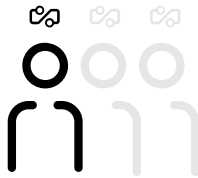
Figure 9. The OV-chipkaart app on iOS

Mobile Apps

The OV-chipkaart app (Figure 9) is available for Android and iOS devices. The app is able to provide travel history, service point locations and information about frequently asked questions. In order to use the app travellers need to have a 'Mijn OV-chipkaart' account connected with an OV-chipkaart. The app is a minimised version of the 'Mijn OV-chipkaart' web environment.

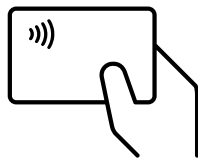
2.5 DEVELOPMENTS FOR THE OV-CHIPKAART SYSTEM

The NOVB has created a vision on payments for the Dutch public transportation system to improve the travel experience and traveller's satisfaction. The NOVB's vision has described several payment methods and tokens which could be implemented to provide travellers more freedom of choice besides the current OV-chipkaart. The prominent developments described in this vision are related to EMV-contactless bank cards and the mobile phone as ticket carrier. The following developments are planned for the OV-chipkaart system, to work towards the realisation of this vision:



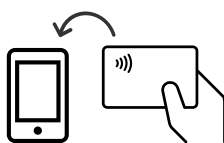
Account based back-office

Currently, all the travel information and data are stored inside the OV-chipkaart. In order to successfully implement the previously mentioned vision, the OV-chipkaart eco-system needs to migrate from a card-based system towards an account-based system (Scheidt & Bachmann, 2016). The difference between these systems is that all the travel information that is currently stored on the card, will be stored in an account in the back office. An account-based back office also allows travellers to connect and manage their OV-chipkaart and other future fare media (e.g. contactless bank card, smartphone). This back office enables travellers to have more payment options for their travels besides the current balance-based payment.



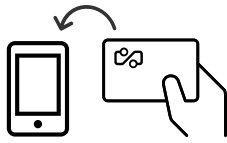
EMV-contactless bank cards

EMV is a security standard for payments. EMV is an abbreviation for Eurocard, MasterCard and Visa, which are the collaborating organisations responsible for the development of this standard. A contactless version of the EMV bank card uses NFC to make payment transactions without physical contact between the card and the payment terminal or ticket validators. For the Dutch public transportation system, this would mean that travellers can use their own bank card to check in and check out instead of using an OV-chipkaart. This is the first development which makes use of this account-based back office in order to provide the traveller with the ability to track their journey. In collaboration with Translink, Meeuwsen (2016) has developed a user-centred strategy for successful adoption of the contactless EMV bank card in Dutch public transport.



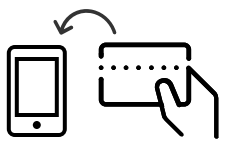
EMV-contactless on a mobile phone

With the implementation of the contactless bank card in public transport, the NOVB also wants to support the use of EMV-contactless enabled mobile phones. Like the EMV-contactless bank card, travellers can be charged directly from their bank account when travelling. With developments like Apple Pay and Android Pay, consumers are able to simulate a card payment with the NFC technology embedded in the mobile phone.



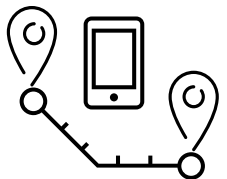
OV-Chip Mobiel

Mobile phone subscribers from participating mobile network operators (MNOs) can apply for SIM-card embedded OV-chipkaart. This SIM-card is equipped with the same MiFare chip as the OV-Chipkaart. In order to be eligible for OV-Chip Mobiel, users need to have an NFC-enabled Android smartphone. Users will also need to set up a digital wallet with one of the MNOs in order to store this mobile OV-chipkaart. Similar to the OV-chipkaart, users can check-in and check-out by putting their phone against the validator.



Mobile Self-ticketing

Mobile Self-ticketing enables travellers to use on-screen identification technologies, such as QR-codes, to enter public transport. Besides using these tickets on mobile devices, travellers can also choose to print out these tickets. Currently, some public transport operators are already using similar techniques to provide travellers with tickets. The NOVB, however, focusses on creating a joint standard for Dutch public transport.



Be-in/Be-out

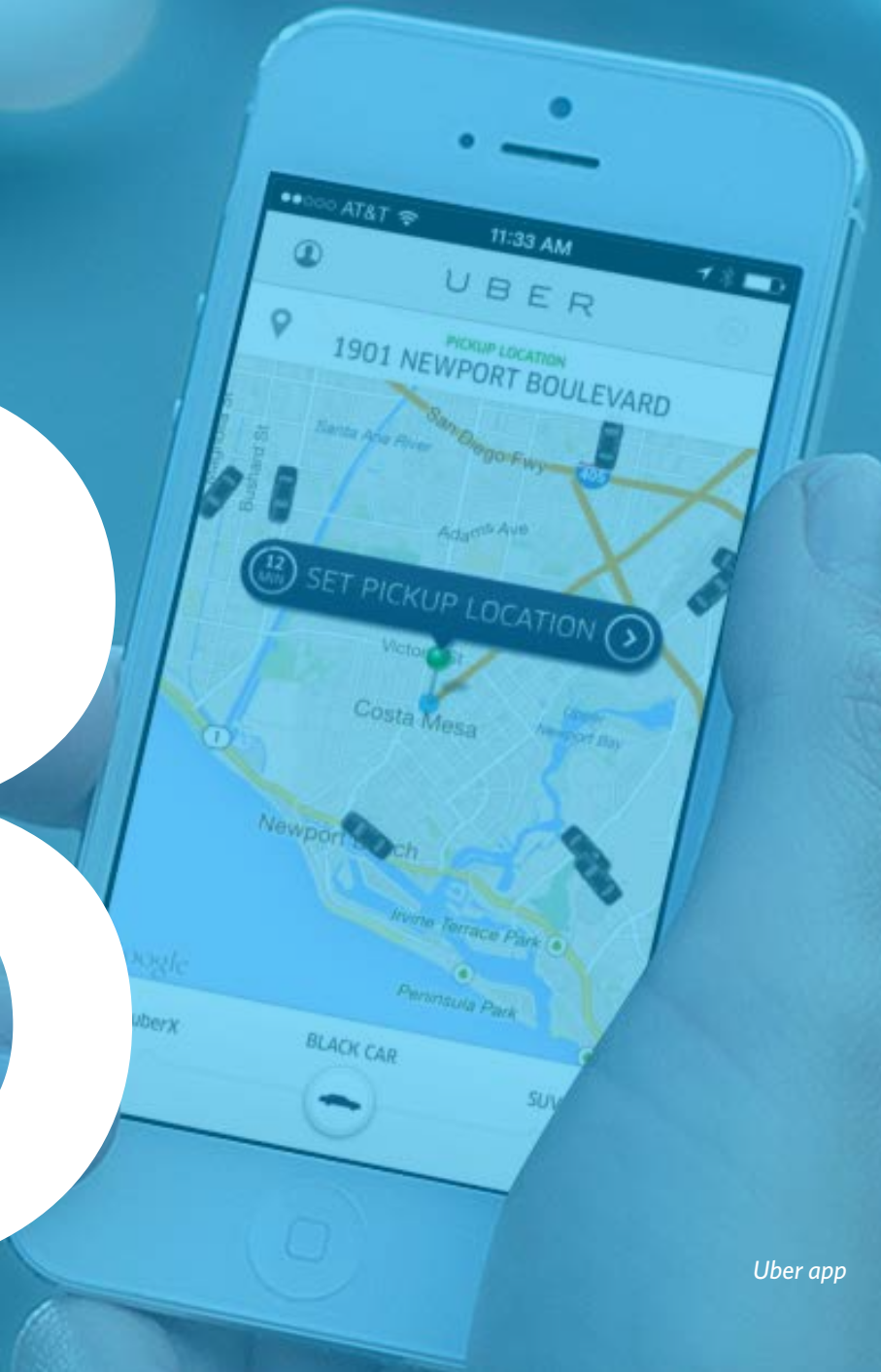
Be-in/be-out is an alternative payment principle to check-in/check-out. Beacons and location services (GPS) can determine if a traveller has boarded a vehicle or has entered a payment area, such as a station. Whenever a traveller leaves a vehicle or station, public transport operators can calculate how long the traveller has been using their service. This, in turn, will lead to the fare calculation of the trip. With this concept, the traveller no longer needs to actively check in and check out.

2.6 CONCLUSION

This chapter has given an overview of the current dynamics and functioning of the OV-chipkaart system in Dutch public transportation. The public transportation system in the Netherlands is a complex system which operates due to the cooperation of multiple stakeholders and parties. This complexity needs to be taken into account when developing a solution for the mobile phone as a fare medium. Looking at the future developments for the system has provided important information about how the system is changing. This chapter has shown that the system is very dependent on the data stored on the OV-chipkaart. The shift from a card-based system towards an account-based system is an important development for the implementation of new ticket media, such as the mobile phone. In the next chapter, mobile phone trends and developments will be studied.



3



3. Trends and developments

3.1 INTRODUCTION

In chapter 2, the OV-chipkaart system and its working were described to understand the context of Dutch public transport. The previous chapter showed which developments are currently planned for the OV-chipkaart system. This chapter presents trends and developments which are relevant to the usage of the mobile phone, mainly focussing on new digital services that are emerging. The aim of this chapter is to provide an overview of current trends and developments regarding smartphone usage, which are relevant for the implementation of a mobile ticketing solution in the Dutch public transportation system. Three categories have been identified to be relevant in relation to public transportation:

- Mobility services are discussed as it is expected that densification of cities will result in other transportation needs besides public transportation.
- Developments and trends regarding mobile payments have been taken into account as these offer new opportunities for travellers to pay for their ticket or trip fares.
- Self-service applications have been identified as more consumers expect companies to enable them to solve their own problems.

Next to these developments this chapter also describes a smartphone usage trend related to user retention and abandonment. Data was collected through an online survey about current services offered on a smartphone, internationally and in the Netherlands. Project partners and experts within Translink were consulted to gain further information about this subject.

3.2 MOBILITY

Several mobility services have emerged in recent years. Using the mobility framework defined by Holberg, P.E., Collado, M., Sarasini, S., Williander, M. (2016) as a starting point, four categories have been identified when looking at these services: peer transport, vehicle sharing, (multi-modal) planners, and combined mobility services.

Peer transport

Uber is one of the most well know mobility services and is the prime example of the peer transport service category, even though some its functionality are prohibited in certain countries. Peer transport uses excess capacity, either idle cars or empty seats, and shares it between travellers. The service provider, in this case, does not own any vehicles and only provide the platform that facilitates the travellers. In the case of *Uber*, car owners can act as taxi drivers and pick up travellers on request. *BlaBlaCar* connects drivers and travellers with the same departure and destination. *Snappcar* and *MyWheels* both offer a platform for car owners to rent out their own car.

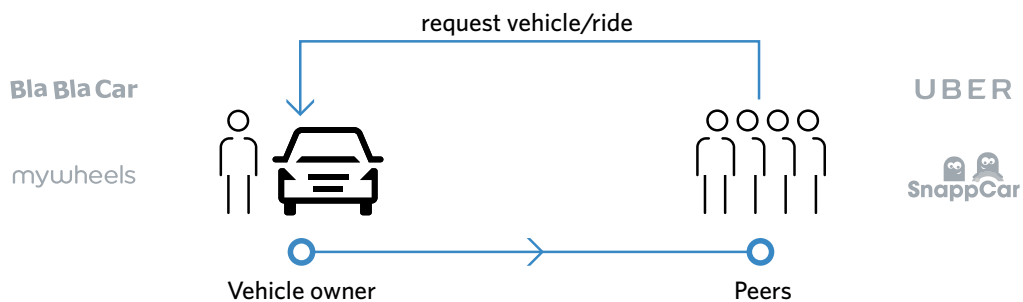


Figure 10. Representation of peer transportation services

Vehicle Sharing

Unlike the previous category, services that provide a vehicle sharing platform own the vehicles (Figure 11). In the Netherlands, most of these services are car sharing platforms such as *Greenwheels* and *Car2go*. Travellers can make a reservation to rent a car through a website or app. These cars are usually available at fixed urban locations. After use, the vehicles need to be returned to designated locations. Another example, the *OV-fiets*, is a bicycle-sharing service offered at selected NS train stations. Travellers can pick up a bicycle to navigate to their destination beyond the train station. For these services, a traveller can purchase a subscription, pay on a trip basis or a combination of both.

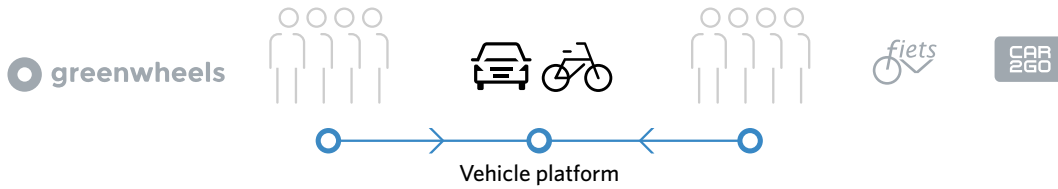


Figure 11. Representation of vehicle sharing services

Multimodal public transport planner

The multimodal public transport planner (Figure 12) helps the user to plan the most efficient route to their destination. This is done by combining all the available public transport options with real-time transportation data. Some of these planners also allow travellers to buy the necessary tickets for the suggested route. In the Netherlands, the prime example of this service is the 9292 planner. Most of the public transport operators in the Netherlands offer a similar service through their mobile app or website. International examples include *Moovit*, *Citymapper* and *Google Maps*.

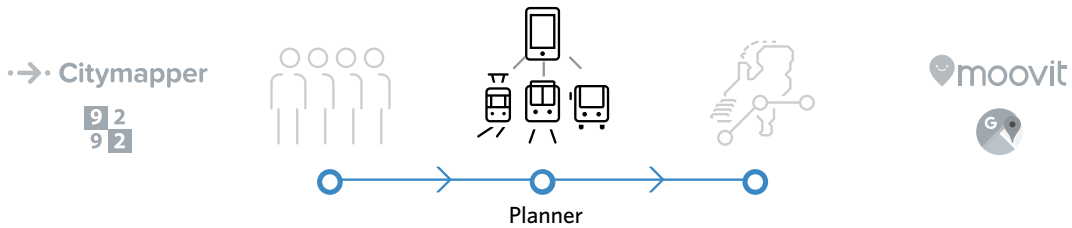


Figure 12. Representation of multimodal public transport planners

Combined mobility service

Combined mobility services offer a wide range of combined mobility options, usually aiming to integrate public transport with other mobility offers such as taxis, vehicle sharing and peer transport. These services can be offered to travellers on a subscription or pay as you use basis. The drive for such services is to give the user the possibility to plan, book and pay for a whole journey with several modes of transport in one service, which is usually represented in the form of an app or website. This requires an integration between all the mobility services to enable travellers shifting between modes for a single trip. Combined mobility

services are based on the idea of densification in cities without the need of a privately owned car. The *NS-Business card*, *XXImo* and *Mobility Mixx* currently offer this service to business in the Netherlands. An international example aimed at consumers is the *Whim* app launched in Helsinki (Export Finland, 2016). *Whim* is also set to pilot in the Amsterdam area by the end of 2017 (OV-Magazine, 2017).

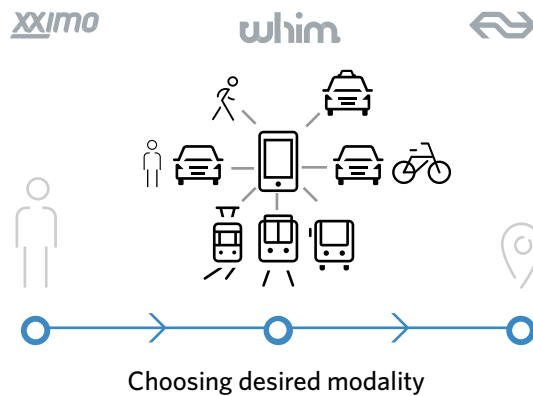


Figure 13. Representation of combined mobility services

3.3 PAYMENT

As an alternative to paying with cash, cheque or bank cards, a consumer can use their mobile phones to pay for a wide selection of services. Mobile payment can be referred to as a payment where a mobile device, e.g. a phone or personal digital assistant (PDA), is used at least for the initiation of the payment order and potentially also for the transfer of funds (European Central Bank, 2009). Three types of mobile payment services can be distinguished: mobile wallet, closed loop mobile payment and peer to peer payment platforms.

Mobile wallet

A mobile wallet is an application that serves as an electronic version of a physical wallet. These wallets digitise and replace credit or debit card transactions at point-of-sale terminals. Mobile wallet solutions are offered by several types of organisations such as banks, mobile network operators and mobile operating system and phone manufacturers. Mobile wallets work by using the phone to pay at a point-of-sale terminal using NFC technology or barcodes. These wallets can contain single or multiple payment cards, depending

on the chosen implementation of the provided service. An example of single payment card wallets are the solutions often offered by banks. The Dutch banks ING, Rabobank and ABN Amro have developed their own single card wallet. Besides payment cards, some wallets allow users to store coupons, boarding passes, event tickets and store loyalty cards (Figure 14). Apple, Google, Vodafone, Samsung and Microsoft are companies that offer these types of wallets.

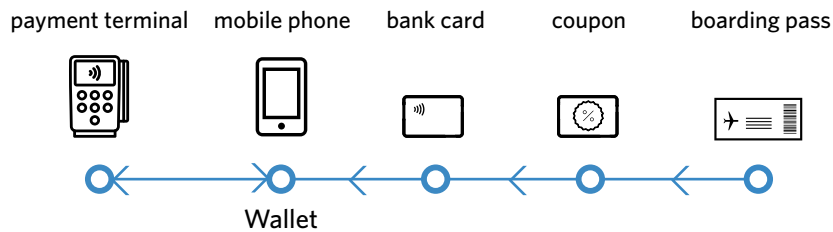


Figure 14. Mobile wallet principle

Closed loop mobile payment

Closed loop payments allow the consumer to load money into a spending account that is linked to a specific company (Clearbridge mobile, 2015). Consumers can pay in these companies' stores with the use of the closed loop payment app (Figure 15). These closed loop payment applications allow consumers to manage their account through their mobile device, enabling them to check their balance, top-up and pay in stores. Gift cards and loyalty-reward programs are also handled through these apps. Examples that have implemented closed loop payment apps include Starbucks, Walmart, CVS and Tim Hortons. For these companies, closed loop mobile payments allow them to bypass any point-of-sale processing fee and gain insights into customer buying behaviour.

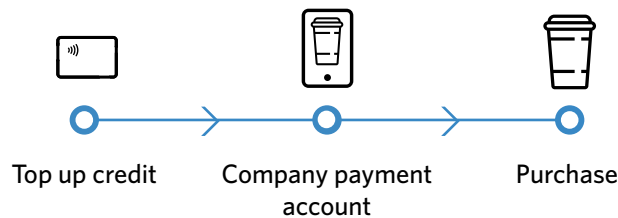


Figure 15. Closed loop mobile payment

Peer to peer payment platforms

These services offer peer to peer transactions, where users are able to send money from person-to-person or person-to-business (Figure 16). Examples of these systems include PayPal, Square cash and bunq. The transaction usually takes place by using a mobile phone number or account name as a proxy, without the need to disclose their account number. Payment requests can be sent and can take place within the dedicated payment app or via online messaging. These peer to peer payment systems work with stored balance or by connecting a bank account.

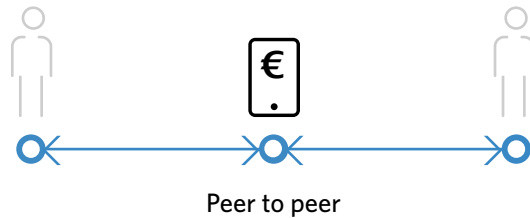
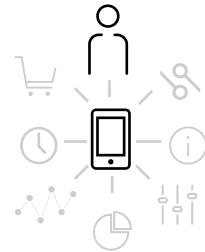


Figure 16. Peer to peer payment

3.4 SELF-SERVICE

According to Detecon Consulting (2014), approximately 78% of customers believe that company should provide a self-service option. The ability to assist themselves can positively or negatively reflect on a brand. Self-service reduces costs in resources and time for both customer and company and allows for a more immediate sense of satisfaction with the brand. Industries that have adopted self-service solutions include banking, e-commerce, telecommunications and energy. The banking industry in the Netherlands is a prime example of how their self-services solutions have been widely adopted by consumers. ING (2016) expects to see 1035 million log-ins through their mobile banking app and 383 million log-ins through their website in 2016. Self-service is attractive for consumers as they feel empowered to gain more knowledge and perform actions on their own and avoid talking to other people to try and fix their problems (Detecon Consulting, 2014).



3.5 APP USAGE, RETENTION AND ABANDONMENT

The growth in importance of the smartphone has also raised consumers' expectations for it. According to a study of Loyalties (2016), the percentage of users who abandon an app after one use was 23% in 2016. They also found that user retention, the percentage of users who return to an app eleven or more times, reached 38% in 2016. This means that 62% will use an app less than 11 times.

This is supported by a study conducted by Nielsen (2014), which states that smartphone owners use 27 apps per month on average. According to the findings from a study performed by Forrester (2014), consumers spend over 85% of their time on their smartphones using native applications, but the majority of their time, 84%, is spent using just five non-native apps they've installed from the App Store. Communication, gaming and social apps account for the most usage.

3.6 CONCLUSION

In this chapter, a picture has been painted of the trends and developments regarding mobile mobility, payment and self-service solutions. Combined mobility services, with the use of public transportation, seem to emerge in order to provide solutions for idle capacity and the densification of cities which leads to a decrease in vehicle ownership. As an alternative to paying with cash or bank cards, consumers can now use mobile phones to pay for a range of services. The rise of the mobile wallet has been adopted by technology companies such as Apple, Google and Microsoft, aiming to replace the physical wallet. Together with the expectation of companies providing a self-service solution, the described trends and developments will help to understand which services users can use on their mobile phone. Looking at the numbers related to app usage, retention and abandonment, indicates that it is important to look at how to retain user engagement.

4

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4. Market analysis: mobile ticketing for public transport

4.1 INTRODUCTION

The mobile phone has been used as a fare medium in various contexts around the world. This chapter gives an overview and categorization of these mobile ticketing concepts used in different public transport systems. For each of these concepts, a description is provided in relation to the used technology and how it is used by travellers in public transport. The aim is to provide an overview of current and upcoming mobile ticketing solutions in the international public transportation sector. These solutions will be analysed to gain a better understanding of their implications in the Dutch public transportation system. This chapter answers the following questions:

- Which types of mobile ticketing solutions have already been implemented in other public transportation contexts?
- How do these solutions work on a technical level?
- How do these solutions work on an interaction level between travellers and the public transportation system?
- In which types of public transportation contexts are these solutions used?

Data was collected by carrying out online research about current mobile ticketing solutions implemented in public transport systems. The existing desk research done by Gonzales Sanchez, D.L. (2016) on mobile ticketing was also looked into. Gonzalez Sanchez created a service catalogue, inventorying 20 mobile ticketing solutions, and conducted an in-depth analysis of four of these solutions on service and user experience. Innovation experts within Translink were consulted to gain further information about mobile ticketing solutions and upcoming developments that might be relevant for an implementation in the Dutch public transportation system.

A more detailed description of the technologies used in the mentioned mobile ticketing solutions can be found in Appendix A.

4.2 SELF-TICKETING

Self-ticketing is the mobile version of a ticket vending machine (Figure 17). With this mobile ticketing method, travellers need to be in possession of a valid ticket before boarding a vehicle. Depending on the transport operator, travellers can buy different kinds of tickets such as journey tickets (single or multiple) or time-based tickets (hour/day/week/month/year). An e-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.

With barcode readers, it is also possible to use e-tickets to open validator gates. This makes e-tickets suitable for both open and closed payment borders, provided that the necessary hardware is installed. However, due to the lack of mentioned hardware, self-ticketing solutions seem to be most prevalent in open payment systems.

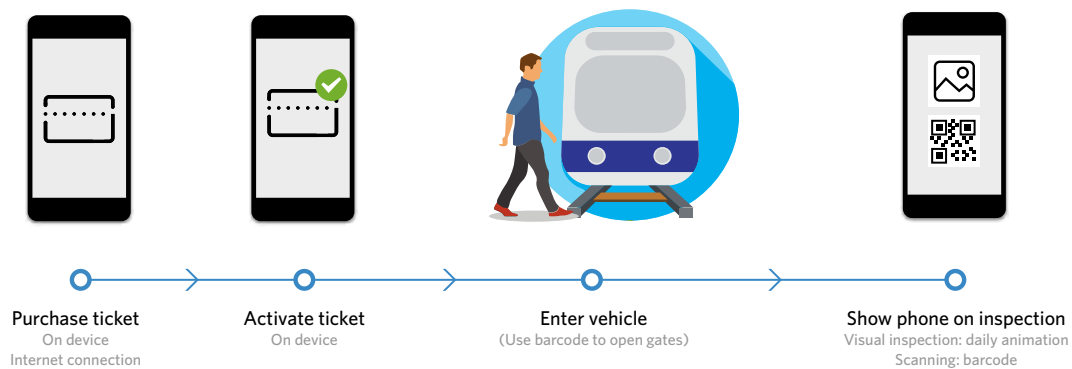


Figure 17. Representation of a mobile self-ticketing solution

4.3 NFC-BASED CARD EMULATION

Smartphones are able to emulate a card by using NFC. This allows for other NFC readers to read its content. A Secure Element (SE), which is a physical chip embedded in the phone or in the SIM card, enables this emulation (Bellid.com, 2014). The supported NFC protocols are determined by the manufacturer of the SE. For example, the MIFARE protocol which is used by the OV-chipkaart only supports Secure Elements made by the company NXP. On a side note, Apple has decided to close their NFC from third-party applications, which makes these SIM cards unusable for iPhones, leaving only Android phones.

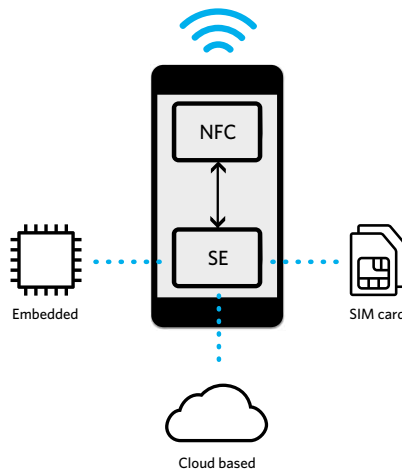


Figure 18. The different types of Secure Elements

The SE (Figure 18) within a mobile device provides a tamper-proof environment for storing data, performing cryptographic functions, and ensuring transaction security. Because of the SE, NFC offers strong cryptographic options, enabling financial or other secure transactions. For example, in the finance industry SEs are used to host personalised card applications and cryptographic keys required to perform financial (EMV) transactions at a point-of-sale terminal. Google has developed a cloud-based Secure Element, which is called Host Card Emulation (HCE). HCE is built into the device's operating system and eliminates the need for a physical secure element. The emulation of the card happens on the device while using a virtual credit card number. Then, that number is verified on the mobile payments provider's servers. After that, the real credit card number is sent to the merchant to authorise and complete the transaction. However, it is important to note that HCE is not able to emulate every protocol, with MIFARE being one of them. In public transport, there are two types of mobile ticketing solutions that use NFC: mobile-EMV and virtual smart cards.

4.3.1 Mobile-EMV

Public transportation systems that support the EMV-contactless bank card, will also be able to support mobile EMV solutions (Figure 19). They can support solutions as Apple Pay, Android Pay, and other mobile wallet solutions described in chapter 3 'Trends and Developments', where a bank card is emulated through the phone's NFC chip. These solutions can work with all the secure element types. Users create a virtual card by entering their card details. Mobile EMV solutions do not copy the signal used when making a contactless transaction with a debit card. Instead, a virtual card is created to make a transaction. This way none of the actual bank details are involved in the transaction. This process is referred to as tokenisation. Transport for London 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.

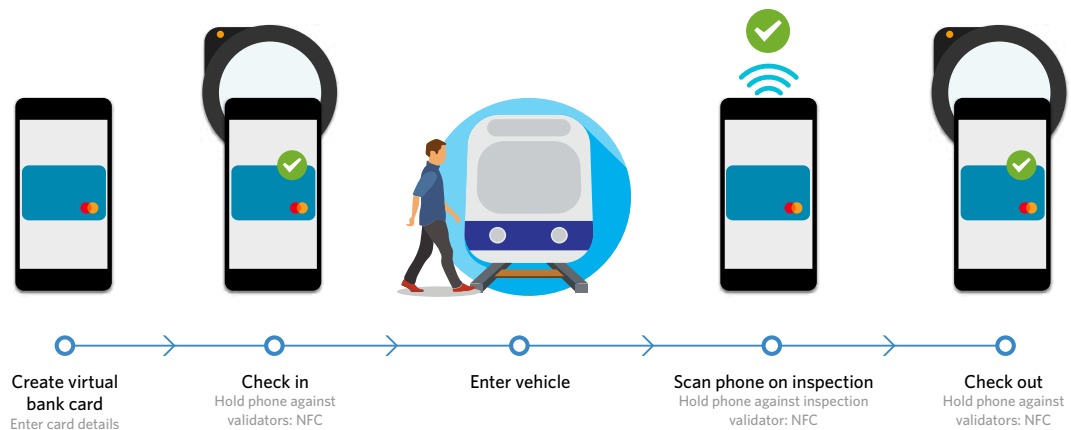


Figure 19. Travelling with a Mobile-EMV solution

4.3.2 Virtual smart card

Smart cards using NFC, such as the OV-chipkaart, are used worldwide in different public transportation systems including Hong Kong, Seoul, Singapore and Japan. These systems have implemented a mobile version of their smart card by using card emulation via NFC (Figure 20). In Hong Kong Seoul and Singapore, a SIM-based solution has been implemented to emulate their smart cards through Android phones. In Japan, it is possible to emulate their smart card with an iPhone 7, which is equipped with a special Secure Element, supporting their local communication protocol. In these cases, travellers are able to top-up, manage and in Japan even create new cards through an app on their mobile phone. The use of a mobile smart card in public transport is similar to that of a physical smart card. Travellers hold their phone to validators to check-in/out and get charged from the balance on the card.

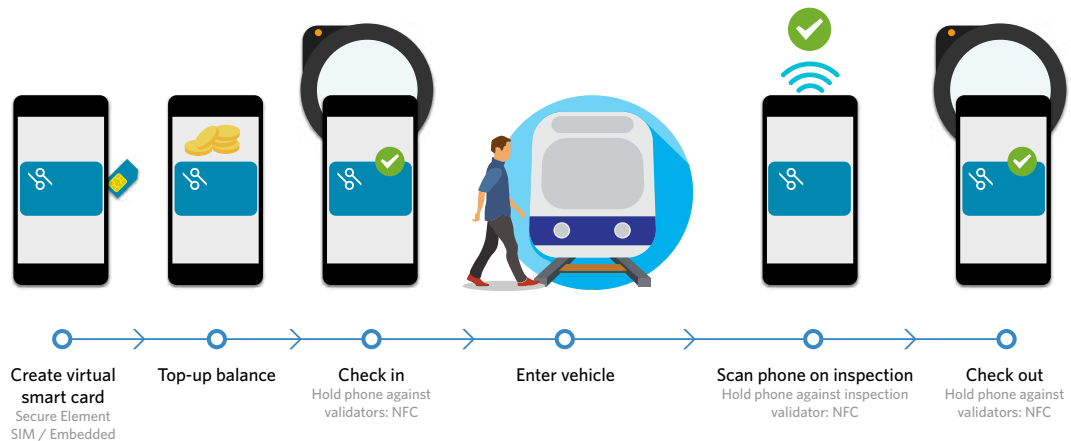


Figure 20. Representation of a virtual smart card solution

4.4 ON DEVICE CHECK-IN / CHECK-OUT

Travellers in certain public transportation systems can also manually check-in and out by performing actions on their mobile phone (Figure 21). An example of this is the Touch and Travel app by Deutsche Bahn. Travellers can check in and check out a corresponding train station by sending their GPS location. Based on these GPS coordinates the travel fare will be calculated. Besides this location based service, Touch and Travel also allows travellers to check in and out by either scanning a barcode, NFC-chip or entering a station code which are placed on stickers at stations. As a result of a new back office implementation, Deutsche Bahn has discontinued Touch and Travel in December 2016 (Golem.de, 2016). PostAuto in Switzerland has implemented a check-in be out trial on their buses. The traveller checks in by connecting to the WiFi provided by the bus, which registers the stop the traveller connected to the WiFi. Whenever the traveller gets off the bus, the WiFi connection will be out of range and dismissed.

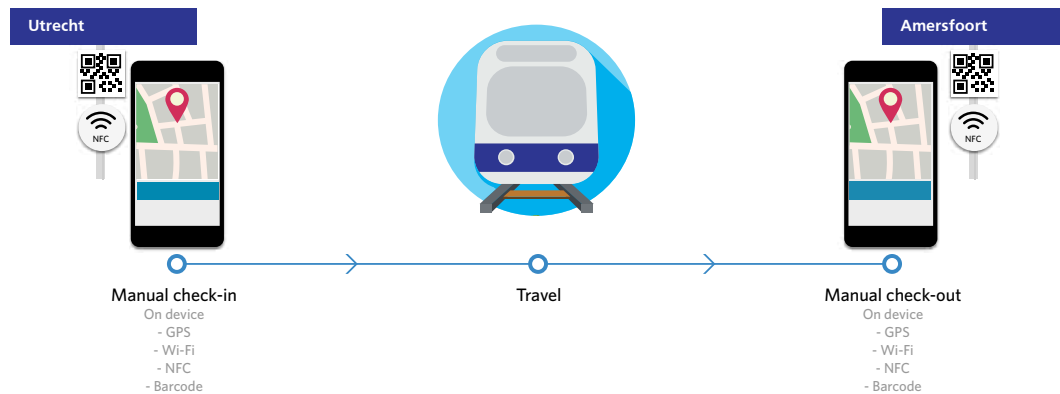


Figure 21. Travelling using a on device check-in/out solution

4.5 BE IN - BE OUT

In public transport, beacons can be used in a be in be out payment system, which is an alternative to check-in/check-out. Bluetooth or WiFi beacons can determine if a traveller has boarded a vehicle or has entered a payment area, such as a station (Figure 22). Whenever a traveller leaves a vehicle or station, transport operators can calculate how long the traveller has been using their service. This, in turn, will lead to the fare calculation of the trip. With this concept, the traveller no longer needs to actively check in and check out. Currently, there are no public transport systems that have implemented a be in - be out solution. Chiltern Railways (2017) is planning to trial a be in - be out solution based on Bluetooth beacon technology, which should also automatically open fare gates. The system will automatically charge the best available rate at the end of the day, based on the journeys taken.

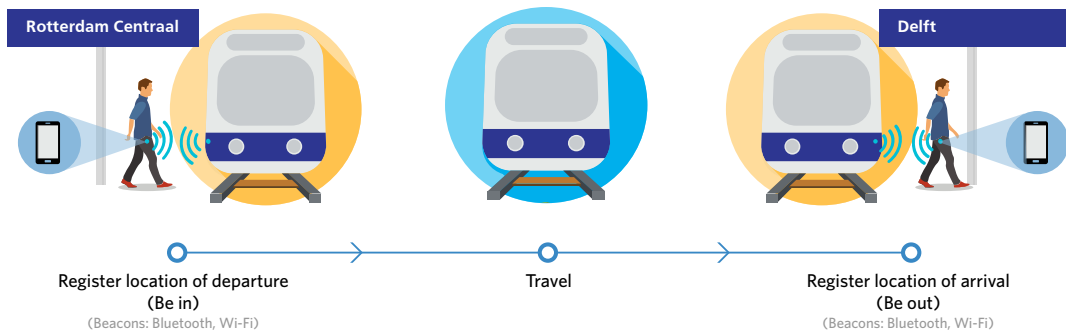


Figure 22. Working principle of a Be in - Be out solution

4.6 CONCLUSION

This chapter has presented a range of existing mobile ticketing solutions implemented in other public transportation contexts. Analysing the different concepts on a technical level has shown how different technologies can be incorporated into the infrastructure already available in public transport systems. It has shown that whether or not it is feasible to implement a technology, depends on context factors of the system, e.g. a gated versus open system. Figure 23 shows an overview of technologies and for what kind of infrastructure they are applicable. Knowing the workings behind the different mobile ticketing solutions will help understand which solutions are suitable for the Dutch public transport context.

Technology	Check in	Check out	Be in	Be out	Inspection	Infrastructure
NFC	●	●	●	●	●	Open & gated systems
Bluetooth	●	●	●	●	●	Open systems (as of now)
Animated picture	●	●	●	●	●	Open systems
GPS	●	●	●	●	●	Open systems
Wi-Fi	●	●	●	●	●	Open systems
Barcode	●	●	●	●	●	Open & gated systems

Figure 23. Overview of different technologies and their applications

5



Smart-OV pilot - Checking in using a mobile phone

5. Mobile OV-chipkaart

5.1 INTRODUCTION

In the coming years, it will be possible to use new fare media in public transport as described in the 'Visie OV betalen'. To implement these new fare media, a co-operation was established called 'Coöperatie Openbaar Vervoerbedrijven'. This co-operation performs pilots to validate and test new propositions for ticket carriers. The previous chapter has shown several technical solutions for mobile ticketing in public transport. This chapter is about the first steps that the co-operation has taken to make the mobile phone act as an OV-chipkaart ticket carrier.

The aim of this chapter is to get a better understanding of the first steps that have been taken to realise the 'Visie OV-Betalen'. Gaining insights in the chosen solution and stakeholders involved, as well as the limitations and first impressions. This chapter gives answers to the following questions:

- How does the mobile OV-chipkaart work?
- What were the roles of the parties involved in the mobile OV-chipkaart pilots?
- What are planned future developments for the mobile OV-chipkaart?
- What do travellers in Dutch public transport think about the mobile OV-chipkaart?

Relevant literature available at Translink was studied in order to gain an answer to these research questions. Experts were consulted by conducting semi-structured interviews (Patton, 2002). The remarks made in the interviews were noted. Ten travellers in the Dutch public transportation system were also interviewed, also using a semi-structured set-up, to gain insights about their opinion on the mobile OV-chipkaart (Appendix B).

5.2 ABOUT THE MOBILE OV-CHIPKAART

The mobile OV-chipkaart, also called 'OV-chip mobiel', is a new mobile ticket carrier to travel in Dutch public transport. A digital version of the OV-chipkaart is placed on the phone's SIM card. This mobile OV-chipkaart solution works the same as the plastic OV-chipkaart and is compatible with all the current equipment in the field. In order to travel with the mobile OV-chipkaart one needs an Android phone (Android version 4.0 or higher) with NFC-functionality, a postpaid cellular subscription with one of the participating mobile network operators, and an NFC-SIM card. A first pilot was conducted in the last quarter of 2015 with approximately 300 users under the name 'Smart-OV'. OV-chip mobiel, the continuation of Smart-OV, is set to be released in the second quarter of 2017 and will be available to 10.000 users in the first phase.

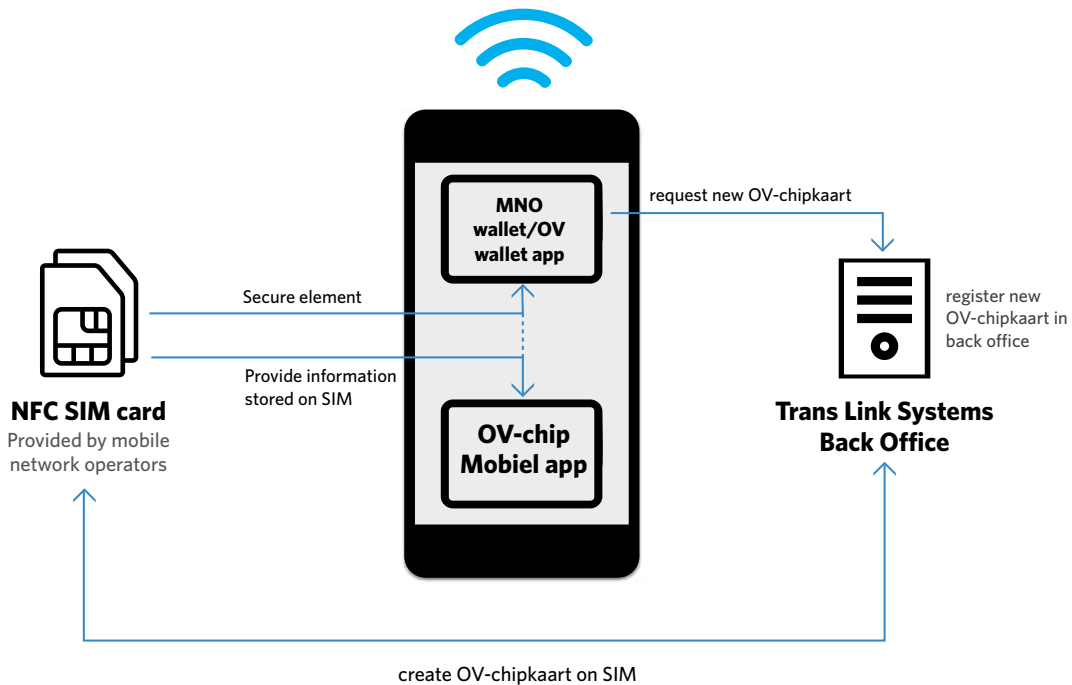


Figure 24. Working principle of OV-chip mobiel

In order for OV-chip mobiel to be installed (Figure 24), the user needs to have a virtual wallet, either a wallet app provided by a mobile network operator or the OV-wallet. The wallet checks if it is possible to add the OV-chip mobiel card, based on the user's device and the requirements mentioned earlier. The user

then is sent to the registration web-page. Once the registration has been accepted, the user is prompted to download the OV-chip mobil app. Once installed, a virtual OV-chipkaart is created on the SIM card and registered through Translink's back office. For the first phase, it is only possible to travel full fare and users have to enable automatic top-up. Users are able to see their check-in/out status and can check their remaining balance, the journey fare and their 10 last transactions (Figure 25). When checked in, the app notifies the users after a set amount of time to not forget to check out.

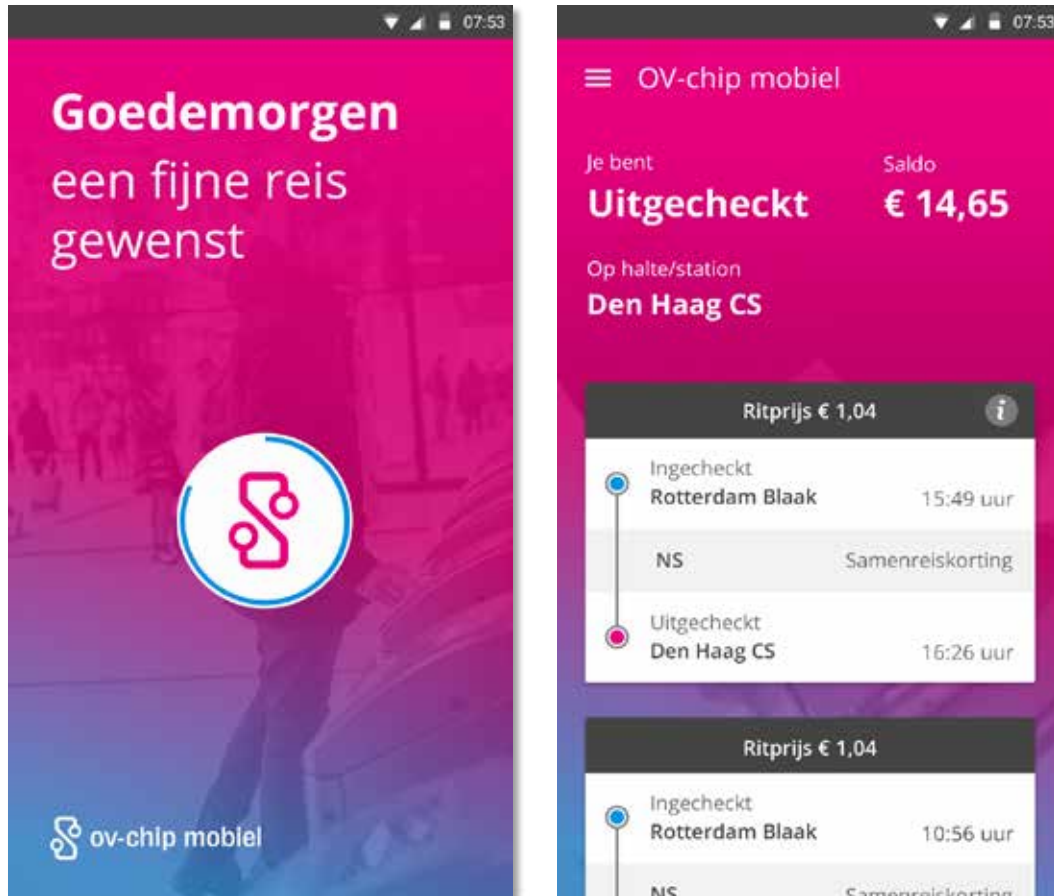


Figure 25. OV-chip mobil: Splash screen (left) and home screen showing latest journeys and transactions (right)

5.3 STAKEHOLDERS

This project is an initiative of the Cooperatie Openbaar Vervoerbedrijven in order to realise the Visie OV Betalen. In total, more than 35 parties are involved in the development of the mobile OV-chipkaart. In addition to the stakeholders described in chapter 2: The OV-chipkaart system, the participating mobile network operators play a big role in the implementation of this mobile OV-chipkaart solution (Figure 26). The mobile network operators are providing the travellers with the NFC SIM cards. One of the MNOs also provides their wallet app for the virtual OV-chipkaart. Technology suppliers provide the interfaces needed in order for these NFC SIM cards to communicate with Translink's back office.

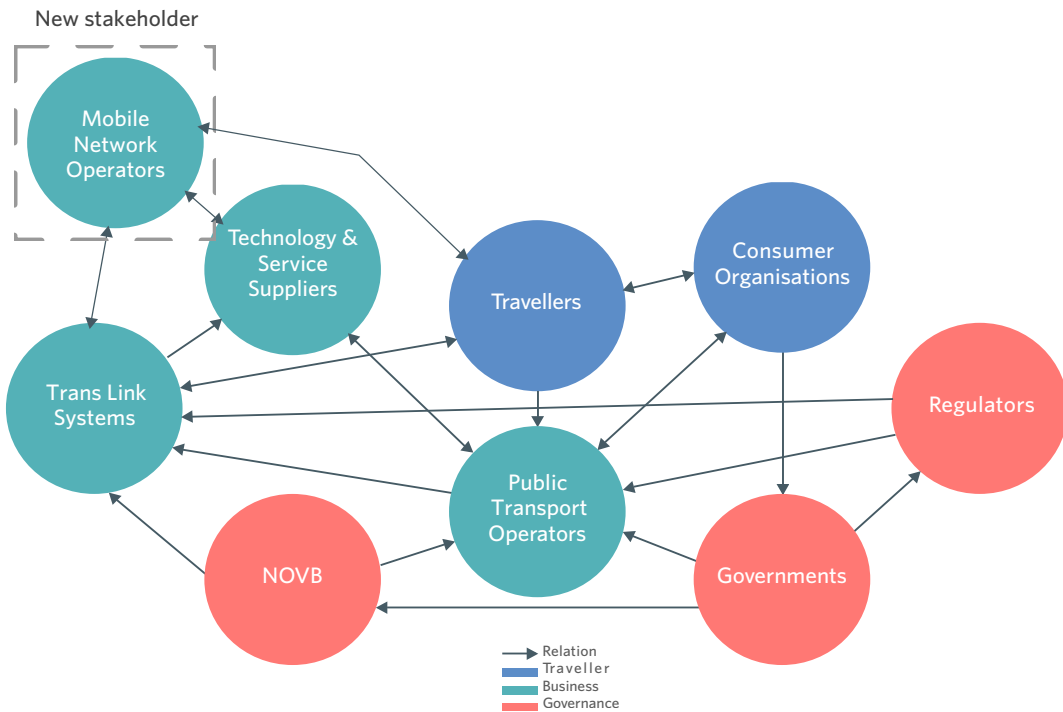


Figure 26. Stakeholder map with mobile network operators for OV-chip mobil

5.4 FUTURE DEVELOPMENTS

The vision for the mobile OV-chipkaart is to make the travel experience completely mobile by allowing requesting a mobile OV-chipkaart, check-in check-out, and purchase of travel products or balance to the mobile phone. Travellers will no longer need to go to ticket machines, but can just use their mobile phone. Figure 27 gives an overview of desired future releases and new functionalities for OV-chip mobiel.

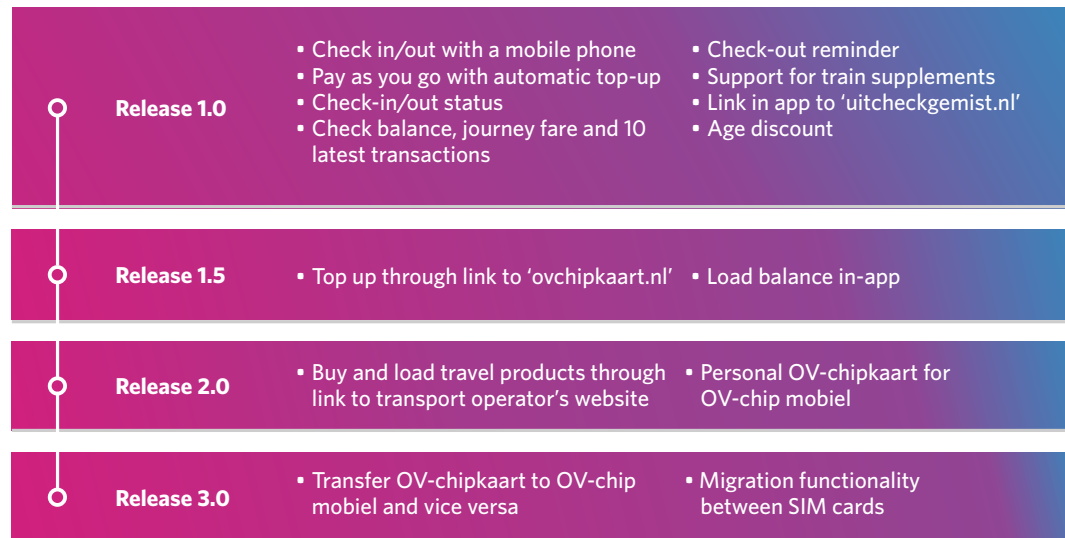


Figure 27. Desired next steps for OV-chip mobiel

5.5 LIMITATIONS AND FIRST THOUGHTS

Looking at the current solution for the mobile OV-chipkaart, OV-chip mobiel, certain limitations and possible issues have been identified by the involved parties. These limitations and issues could play a role in the implementation and adoption of the mobile OV-chipkaart. Travellers were also interviewed to gain insights on their thoughts of OV-chip mobiel.

Travellers are open to a mobile OV-chipkaart

Travellers seem to be positive about a mobile OV-chipkaart. Not having to carry an OV-chipkaart and always having your phone with you were perceived as benefits for travellers. Also, people have indicated that they were less likely to lose a phone than an OV-chipkaart.



'It's just more convenient, I've lost my OV-chipkaart a few times but never my phone. I always hold my phone. Those two minutes when at check-in/out that I'm looking for my OV-chipkaart, it would make a big difference'

Female, age: 25-30 (NL_IV08)

User base limited to Android and participating MNO users

With the current SIM-based solution, Apple iPhone users are excluded from the potential user base as the NFC-functionality of iPhones is exclusively available for Apple Pay and not open for third-party apps. According to research agency Blauw (2016), 24% of smartphone users in the Netherlands own an iPhone and 68% own an Android phone. Cellular subscriptions is also a limiting factor in the user base potential. Non-participating MNOs currently have a combined market share of 25% in the cellular subscription market (NRC, 2016).

Performance concerns

Issues experienced by travellers during the Smart-OV pilot were mostly related to the performance of validator equipment: gates, poles and inspection validators. These performance issues were related to the reading speed and distance. Travellers needed to validate multiple times or at a different gate or pole. These performance issues can have a negative impact on the usage of the mobile OV-chipkaart. Also, battery life issues seem to be a concern for travellers, as they would not be able to get to their destination.



'Your phone is broken or out of battery, and you are not carrying your OV-chipkaart anymore. How do I get to my destination? It is all of these small things, does it work? Does it work every time? Does it work when I need it to work?'

Male, age: 18-20 (NL_IV09)

Effort: Be in possession of NFC SIM, wallet app, and OV-chip mobiel app

The process of installing a mobile OV-chipkaart seems to be a complex process and requires high effort from the user. Especially when not in possession of a valid SIM card, the effort of having to request a new SIM might be a too big of a hurdle. Having to install both a wallet and the OV-chip mobiel app might cause confusion towards travellers.



'Oh that's unfortunate, does it mean I need a second SIM? I think it's too much of a hassle to request one, I would do it maybe when I change subscriptions and they send me a new SIM. I'm not sure if I would go to a store to change the SIM, I'm too lazy for that I think. Maybe if it works well.'

Female, age: 25-30 (NL_IV03)

5.6 CONCLUSION

The first steps have been made to realise the 'Visie OV-betalen' where the mobile phone acts as a ticket carrier. The current OV-chip mobiel solution is a complex system with many parties involved. Travellers do see the advantages of using a mobile OV-chipkaart. Always having a phone with them has been stated to be the main benefit. However, the Smart-OV pilot and traveller interviews have exposed several concerns and limitations of the current solution. The potential user base is cut off, based on technological restrictions and decisions. The set-up process is problematic for users and requires too much effort, while check-in/out performance also seems to be a concern.

In order to come to a successful implementation of the mobile phone as a fare medium, international examples of mobile ticketing solutions have been researched and analysed. The findings of this research are described in the next chapter, providing insights into how local travellers use, and which factors influenced the adoption of these solutions.

Way Out
出 口

⑦ 용산새싹길
Yongsan Saesakgil

⑧ 용산등기소
Yongsan Registry Office

⑬ 국방부
The Ministry of National Defense

서울지방
Seoul Regional Office of Patrol

6

6. Studying international examples of mobile ticketing

The previous chapter describes the first steps that the co-operation has taken to turn phones into a mobile OV-chipkaart. In this chapter, international examples of mobile ticketing solutions are researched in order to gain insights into their workings, adoption rates, and usage patterns of local travellers who use their mobile phone as a fare medium.

Three places were visited to do research: Oslo (Norway), London (United Kingdom), and Seoul (South Korea). These places were selected based on preliminary research on the internet, keeping in mind several criteria (see Appendix C):

- The system needs to have a mobile ticketing solution
- The system needs to cover multiple modalities of transportation
- The maturity of the mobile ticketing solution and the solution concept

Oslo has been selected based on their self-ticketing app RuterBillett, as public transport operators in the Netherlands are developing similar solutions. In London, travellers can use Mobile-EMV in public transport, while Seoul uses a similar SIM-emulated solution to OV-chip mobil. Researching these cases could identify certain pitfalls and will also show which factors influence the adoption of these different solutions. As each location has its own culture and context factors, it is necessary to identify and interpret these differences. It is important to translate these insights towards the Dutch context in order to predict how mobile ticketing solutions can successfully be implemented in the Netherlands.

In November 2016, Oslo (4 days), London (4 days) and Seoul (6 days) were visited.



6.1 METHOD

6.1.1 Aim

The aim of the research done in Oslo, London and Seoul was to gain insights into travellers' adoption rates of the mobile ticketing solutions in their respective public transport systems and travellers' experiences of these solutions. Through this field study, knowledge can be gathered about the factors influencing the implementation and adoption of these mobile ticketing systems. This research aims to deliver a cross-case comparison of these systems. By identifying the differences in the context factors, this research also serves to create guidelines and pitfalls to avoid for the implementation of a mobile ticketing solution in the Netherlands.

6.1.2 Research questions

- To what extent have travellers adopted the mobile ticketing solutions and what were the influencing factors?
- How do travellers experience mobile ticketing solutions in public transport?
 - How do travellers interact with the public transportation system with their mobile phones?
 - What motivates travellers to use mobile payment methods in public transport?
 - What problems do travellers encounter when using mobile payment methods in public transport?
- What are the context factors defining the public transportation systems in Oslo, London, Seoul?

6.1.3 Data collection

Several methods were used to extract the needed information to answer the research questions. Travellers were interviewed and observed in the public transport context in order to gain insight on what people think and how they use their mobile phone as fare medium. The mobile ticketing solutions in the different contexts were used in order to gain first-hand experiences. Per location, around 20 interviews were conducted, 10 stations/stops observed and 15 journeys recorded. An overview of the data can be found in Appendices D, E and F.

Experiencing the system

Own experience of the systems abroad was an important part and critical to the understand the mobile payment methods in the public transport systems. Insights were gained by being a user of the system myself. Observations and findings were video recorded, photographed and noted.

Semi-structured Interviews with: travellers, service personnel & stakeholders

Travellers, service personnel and stakeholders of the benchmark locations were interviewed, using an interview guide, to gain insights about their experience with mobile payments in public transport. These interviews helped to identify usability problems in the benchmark systems, which can be translated into guidelines for the Dutch public transportation system. Stakeholders of the public transportation systems will be interviewed in order to identify the system's context, processes, services and strategies. Interviews with travellers and service personnel were video recorded, as were stakeholder interviews.

Observations

Observations were conducted at stations, stops and in vehicles while travelling. Collecting data through observations provided descriptions of people's behaviour and actions carried out in the public transport setting. It also provided insights on subjects that are not necessarily talked about during an interview. People might behave differently from what they say and think they do. Observations were photographed, video recorded (Figure 28) and noted.



Figure 28. Observing a gateline in London

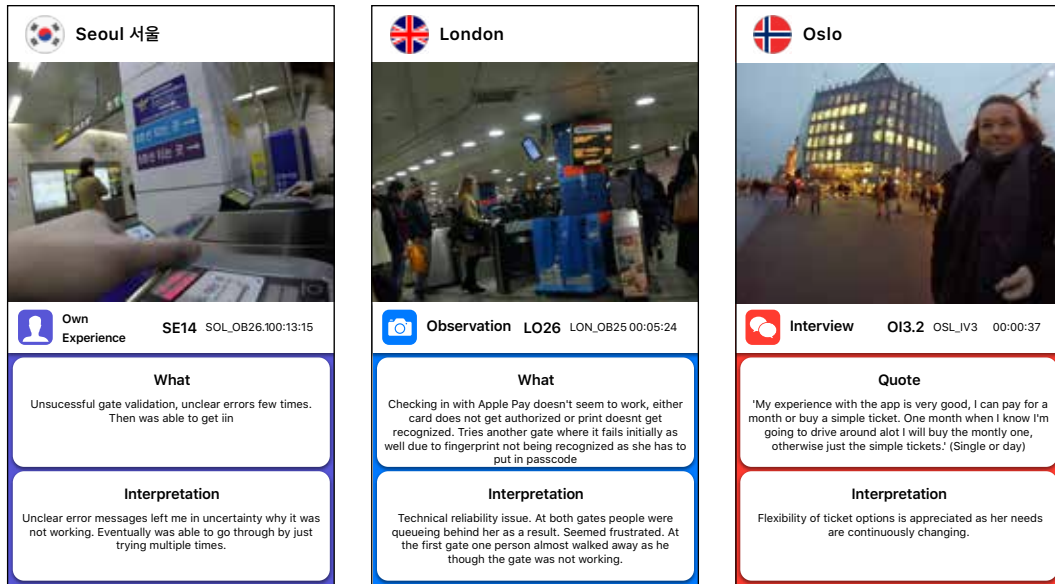


Figure 29. Statement card examples

6.1.4 Data analysis

In order to analyse the data in a comprehensive manner, the most important findings of the raw data were made into statement cards (Sanders & Stappers, 2012). As the data were recorded through different media, such as photos, videos and audio recordings, a standardised representation of the findings is needed to structure and cluster the obtained data. These cards (Figure 29) contain an illustrative image of the finding, a statement which describes the observed finding or a quote from an interview, and the interpretation of this finding. The cards have been labelled with the selected research location, the name of the source file and timestamp, to easily differentiate and track back the source of the data. By adding a coloured background and icon, the statement cards can be differentiated by data collection method (interview, observation, own experience, reviews). More than 400 statement cards were created and can be found in Appendices G, H and I.

Based on the retrieved data, a customer journey map (Nielsen Norman Group, 2016) was created for each research location. The travel phases: pre-travel experience, travel experience and post-travel experience defined by Joppien, Niermeijer and Niks (2013) were used to establish steps that travellers using mobile ticketing solutions go through. These steps were defined by clustering statement cards (Figure 30) within the pre-defined travel phases. These clusters reveal what the users do and experience at each step of their journey. The customer journeys were compared and used for the cross-case analysis.

TRAVEL

NOW

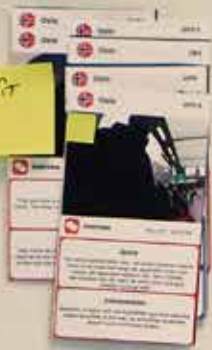
ENTERING PAID AREA

STATION/STOP

BOARDING

TRAVELING

2 MIN WAIT



READ UNEXPECTED PERFORMANCE



6.2 OSLO - RUTERBILLETT

6.2.1 Context of use

Ruter plans, coordinates, orders and markets public transport in Oslo and the county of Akershus. (Ruter, 2016). Ruter itself doesn't own any vehicles, all transport is operated by various operator companies contracted by Ruter. The Metro and Oslo Tram operative services are run by permanent contract partners, while bus and ferry contracts are rewarded on a competitive basis. Local trains in Oslo and Akershus are run by the NSB, which is a government-owned railway company in Norway. Ruter is owned by the Oslo municipality (60%) and Akershus County Council (40%).

In Ruter's public transport system, it is possible to travel with a disposable ticket (Impulskort), smart card (Reisekort) or a smartphone (RuterBillett-app) as seen in Figure 31. The disposable Impulskort is only available as a 1-hour valid single ticket and a 24-hour valid day ticket. The Reisekort can be loaded with various tickets or used with pay-as-you-go credit. Both the Impulskort and the Reisekort need to be activated before the first travel to ensure the ticket is valid. This can be done at the validators placed in vehicles or at stations, stops or ticket offices.





Jernbanetorget Tram Stop - Oslo, Norway

When travelling with pay-as-you-go credit, the Reisekort needs to be validated every journey. The cost of a single ticket will be deducted from the card. The Impulskort and Reisekort can be purchased in convenience stores, services centres or at ticket vending machines at stations. In the case of the Reisekort, travellers often have a new ticket, or even multiple, 'on hold' loaded on the Reisekort.

In December 2012, Ruter launched their mobile ticketing app called 'RuterBillett', which translates to Ruter Ticket. Ruter made the switch from a gated system to an open system in order to drive their customers to use their smartphone (Fjaer, 2016). The app was designed and developed in collaboration with Knowit Experience, a user experience design agency. During the development of the app, Ruter performed user

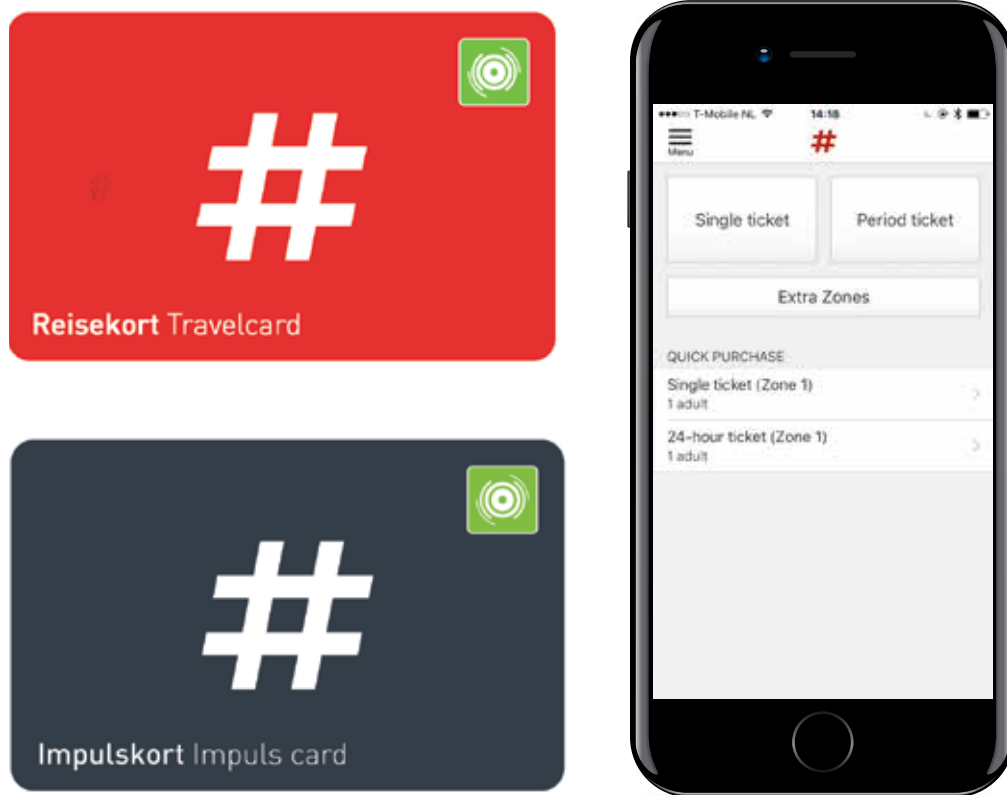


Figure 31. Ticketing options within Ruter's system

tests with prototypes varying from low to high fidelity, in both formal and informal settings (see Figure 32). With a focus on user experience and user testing, RuterBillett was voted app of the year 2013 by Mobile Trends (Ruter, 2013). The app initially only supported the purchase of single tickets. Through regular updates, Ruter expanded RuterBillett with functions as purchasing period tickets, multiple payment options and automatic renewal. The app is available for Android, iOS and Windows Phone (single tickets only).

The RuterBillett app can be categorised as a Mobile Self-ticketing app. The RuterBillett app offers the same ticket options as the Reisekort. Tickets bought on the app are activated two minutes after purchase. This prevents people buying a ticket right before they encounter ticket inspection. After the ticket is activated, a timer will show when the ticket will expire. Upon ticket inspection, the conductor can either scan a QR-code or check the validity of the ticket with a picture of the day. According to Ruter, RuterBillett currently accounts for 50 percent of both ticket revenue as well as the number of tickets sold. With over 90 percent of total tickets sold, single tickets are the most popular ticket option, followed by a monthly ticket. Of all mobile tickets sold through RuterBillett, 70 percent comes from iOS devices and 30 percent from Android devices.

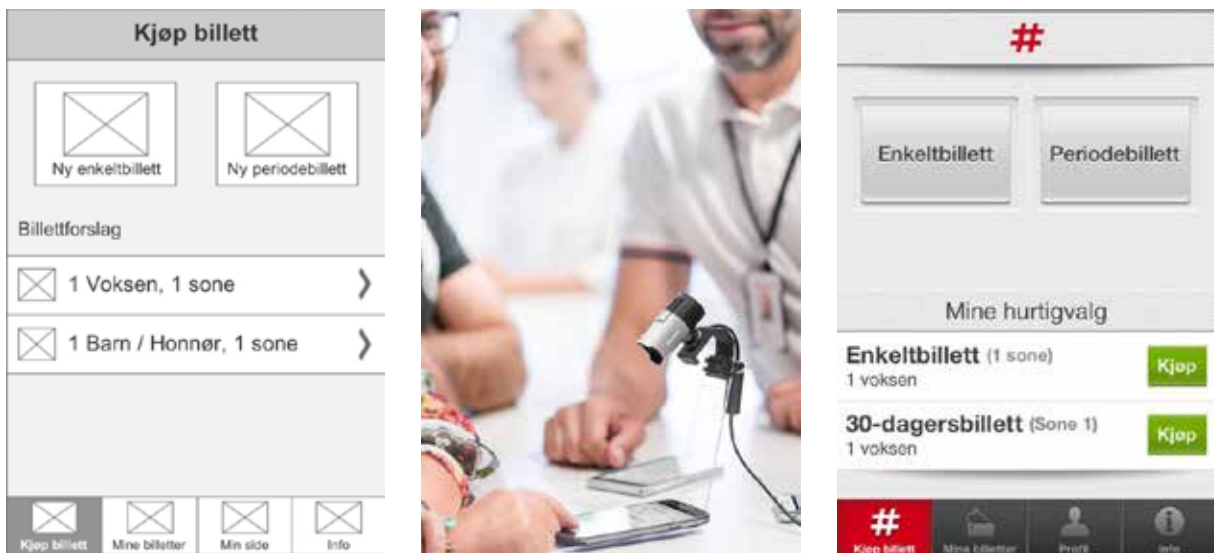


Figure 32. RuterBillett: process from wireframe, user test and visual design

6.2.2 Usage of the RuterBillett app in Oslo

Pre-travel Experience

When the RuterBillett app was released, the first thing that needed to be done was to make travellers aware of the existence of the app. Awareness is created by placing information about the RuterBillett app at stations and bus/tram stops, ticket vending machines and service centres. This is done in the form of posters and standalone signs. The provided information is focussing on creating awareness (e.g. 'Buy tickets with RuterBillett app!') or on how to travel within Ruter's public transport system using the RuterBillett app (e.g. 'Using your travelcard and mobile phone'). By placing this information at these touchpoints, awareness is created amongst new and existing users of Ruter's public transport system. The interviews also pointed out that users have the expectation of an app being there.

New users of Ruter's services can make a comparison between all the available ticketing options and decide according to their needs. This is mostly done on the Ruter website or at service centres. Existing users also need to check if the RuterBillett app supports the tickets they are currently travelling with (e.g. students who are eligible for discounted fares). The first version of the RuterBillett app only supported the purchase of single tickets. This is a reason for people to still use the Reisekort, as they still think this is the case. Due to the lack of exposure to updated information about updated features, people still use the Reisekort.



Figure 33. RuterBillett promotion at Oslo Central Station bus stop

Nattbuss Oslo

Went to Lørdag og søndag, lengst 31 + 37 alle nattbuss
Night before Saturday and Sunday, from 31 + 37 every night



Kjøp billett med RuterBillett-appen

Buy tickets with RuterBillett app!

Download available on the App Store and Google Play

Billetter og reisekort får du også på ruter.no, Ruters kundesenter og servicepunkt, hos Narvesen, 7-Eleven, Deli de Luca og mange andre.
You can also purchase tickets and travelcards at ruter.no, Ruters Service Centre, Service points, Narvesen, 7-Eleven, Deli de Luca and many more.

Not having to go to a kiosk or TVM is an important reason for people to transition towards using the RuterBillett app. It was also stated that the flexibility of buying a ticket on the spot is one of the benefits the app has over the Reisekort. People mentioned occasionally forgetting their Reisekort was a reason to choose for the app, as they are less likely to forget their mobile phone. Once the decision is made to make use of the RuterBillett, the app needs to be installed on the user's mobile phone. In contrast to the Reisekort (NOK50), Ruter does not charge for the use of RuterBillett app. Next to their own app, Ruter also offers their mobile tickets in the app of the NSB. This allows travellers to buy tickets for both services offered by the NSB and Ruter.

Travellers select their tickets (Figure 34) depending on price (discount eligibility on certain tickets), expected frequency of using public transport (single or period tickets) and the travel distance (single or multiple zones). Frequent users of Ruter's public transport services, such as students and daily commuters, will often choose a 30-day ticket. This ticket is cheaper than buying 7-day tickets but less of an investment than a 365-day ticket. For students, the 30-day ticket is the only ticket that is eligible for discount. Frequent travellers often repurchase the same type of ticket as their needs often change. Infrequent users, such as day-trippers, often make use of single tickets as their expected travel frequency is low.

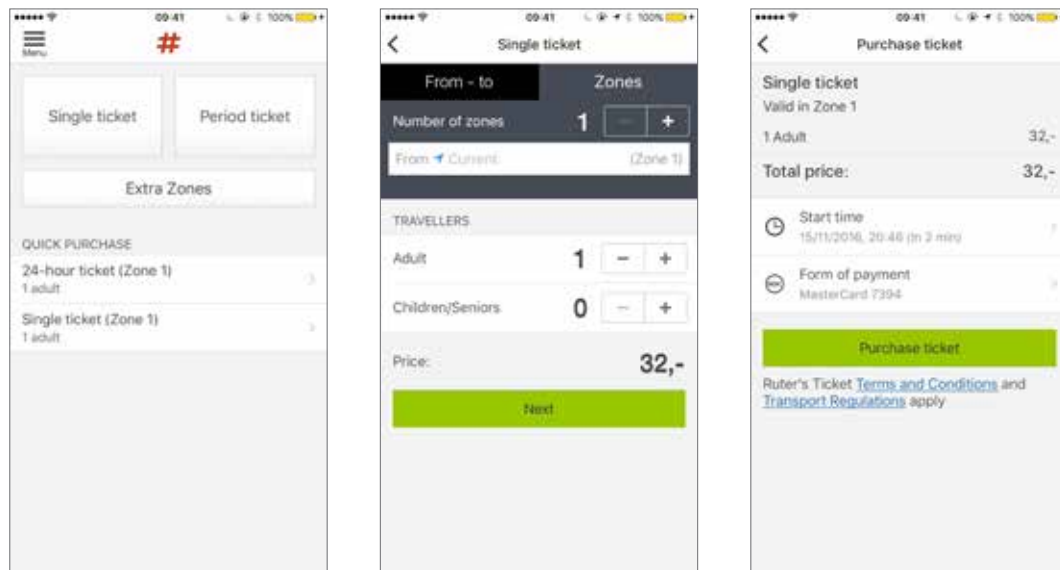


Figure 34. Screen flow of purchasing a ticket with RuterBillett

Users can choose to pay for their tickets by credit card, mobile payment apps or via their mobile phone bill. With the option of saving these payment methods, users won't have to fill in their payment details every time they repurchase a ticket. Regarding credit card payments, RuterBillett seems to only support Scandinavian issued MasterCard and Visa credit cards. As a result, foreigners who are either visiting or working in Oslo, with a valid foreign MasterCard or Visa credit card, are not able to pay for their tickets in the app. This causes dissatisfaction as it is not made clear that these cards are not accepted up until the point that the payment is rejected. The error message stating 'Payment failed' also causes uncertainty to why the payment has failed, as seen in Figure 35.

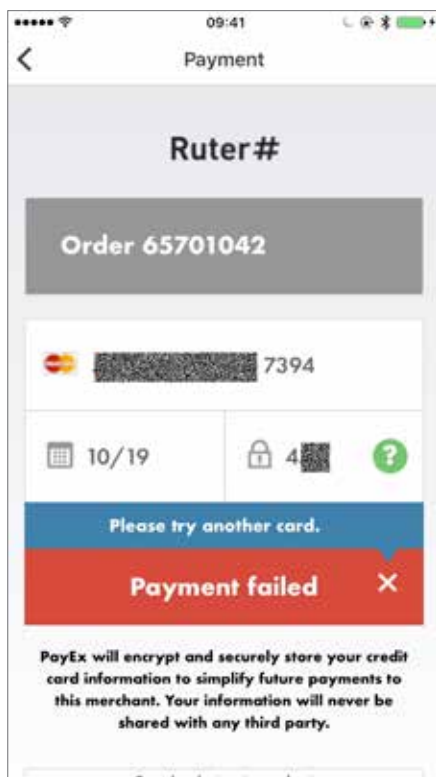


Figure 35. Unclear error message: Payment failed



'I don't have a Scandinavian card to buy (tickets) on the app. My credit card is from Brazil, but I don't have a credit card from here, so that's why I don't use the app.'

Reisekort user, female, age: 35-40 (OSL_IV12)

Mobile payment methods Vipps and MobilePay have positively impacted the payment process for both Ruter and the users of RuterBillett. Vipps and MobilePay are both mobile payment applications where one can perform peer-to-peer money transfers by connecting a bank account. In the case of MobilePay, transactions in selected retail stores are also supported. Interviewees revealed that as soon as credit cards expired, it was preferred to connect either Vipps or MobilePay to RuterBillett, rather than setting up a new credit card. This offers the convenience of not having to re-enter the new credit card details. According to Ruter, the implementation of these mobile payment options also increased the adoption of the RuterBillett app as people with a bank account but without a Visa or MasterCard were now able to add a payment method to the app.

As stated earlier, both the Impulskort and the Reisekort need to be activated before the first travel to ensure the ticket is valid (see Figure 36). Travellers would validate the card on each journey in order to be in possession of a valid ticket at all times. This is due to the lack of information on when the ticket on the Reisekort would expire. The RuterBillett app unburdens the user of taking the step of validating their ticket on every journey. Users of the app indicated that using the app was more reliable as the Impulskort or Reisekort often would take a few swipes before it would activate at the validators. On default tickets bought through the app activate 2 minutes after purchase and provide information on the remaining ticket duration. This 2-minute activation window seems to cause confusion. Even though the app displays 'boarding permitted', travellers are not sure if it is allowed to board a vehicle during this time window as the ticket is confirmed but not yet activated.



Figure 36. Activating a ticket loaded on a Reisekort when getting on the bus

Trip planning within Oslo mainly happens through the Ruter's trip planning app: RuterReise. Interviews revealed that travellers use the app when it is not known how to get to their destination. Departure times seemed redundant to daily commuters due to the high frequency of departures. People find it confusing that the RuterReise app and the RuterBillett app are not integrated as both apps come from the same company: Ruter. Having to install two separate apps to complete a journey can cause frustration amongst travellers.



'It really sucks that the planner and tickets are separate, I do not want to download two apps'

RuterBillett user, female, age: 25-30 (OSL_IV2)

Travel Experience

When travelling with the RuterBillett app, users no longer need to activate their ticket at the validation equipment before boarding a vehicle. While travelling, people often interact with the RuterBillett or RuterReise app to check their validity of the ticket, or the departures of connecting trips. Users of the RuterBillett app indicated that they are worried about running out of battery on their phones, as they would not be able to show a valid ticket upon ticket inspection and get fined. In order to prevent this from happening and lower this concern amongst travellers, Ruter has equipped their ticket inspectors with power banks (Figure 37).



Figure 37. Power bank carried by ticket inspectors

In general, ticket inspectors will ask for the animated daily picture for inspection (Figure 38). Most travellers will get this picture ready when they see an inspector enter the vehicle. When there is an active ticket in the RuterBillett app, launching the app will automatically redirect the user to this ticket. As the inspectors only look at the picture and not at the ticket concession, ticket fraud can occur where adults buy discounted tickets that they are not entitled to. Besides the daily picture, inspectors can ask for a QR-code. This causes uncertainty amongst users of the RuterBillett app with regard to which inspection method they have to show. According to Ruter, national inspection guidelines have been imposed for public transport ticketing apps in Norway. This can be seen in the NSB train app, which uses the same inspection methods.

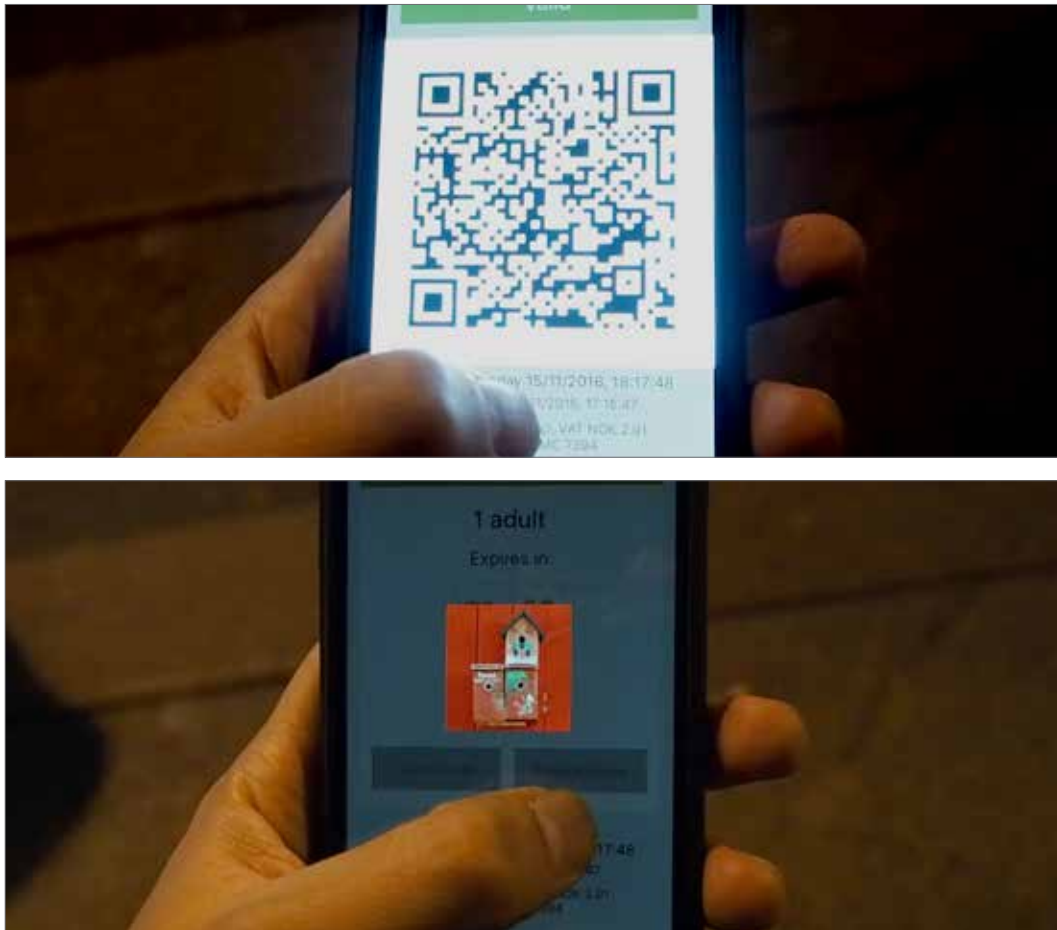


Figure 38. Ticket inspection: methods: RuterBillett QR code and daily picture.

Post-travel Experience

When finished with their journey, travellers check the remaining validity of their active ticket. On default, users of the RuterBillett app get a push notification when their ticket is about to expire (Figure 39). Users can choose to automatically renew their tickets or manually re-purchase a ticket. RuterBillett users have an overview of their expired tickets, which offers them the option to renew or receive a receipt by email. Users do not seem to know that they can adjust both these notification and renewal settings. This again seems to be the result of lack of information about added functionalities.



'When you're monthly card expires, they send you a message the day before. But they don't send you a message when it expires. If you forget that your card expires tomorrow, you might get fined. So why don't they send you a push message saying that it expired?'

RuterBillett user, male, age: 25-30 (OSL_IV5)

People that have experienced problems during their journey contact Ruter's customer service during this phase. In one particular case, a user's ticket didn't show up during ticket inspection. According to the rules, the ticket inspector fined this user NOK900 (roughly EUR90). By contacting customer service, Ruter was able to identify that the user, in fact, was in possession of a valid ticket at the time of inspection. The fine was revoked and the user's ticket was refunded.

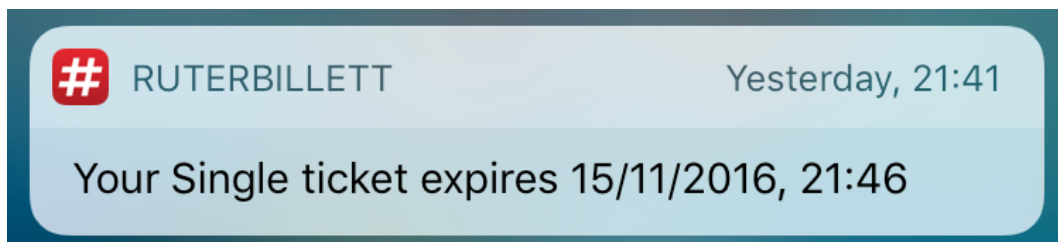


Figure 39. RuterBillett Notification: Ticket expiration

6.2.3 Customer Journey of RuterBillett

A customer journey was made to visualise the described travel experience when using RuterBillett in Oslo's public transport system. This customer journey is divided into ten steps categorised into three main phases. For each step, the user's goal, expectation and current experience are shown. This helps to identify where expectations are not met and how this has affected the user's view on the quality of their journey. The emotional curve also maps the use of the Reisekort. This shows how the use of RuterBillett compares in relation to the most popular card alternative, the Reisekort.

Based on interviews, online reviews and own experience, the System Usability Scale (SUS) was used to assess the usability of RuterBillett (usability.gov, 2016). RuterBillett is rated with a score of 80.0, which indicates good to excellent usability (Bangor et al., 2009). This corresponds with the positive experiences expressed by users.



'It's easy and fast, you have the ticket and receipt on the phone so then you can just run and get on the tube.'

RuterBillett user, female, age: 40-45 (OSL_IV6)

'It's much quicker to buy tickets through the app. I don't like having so much tickets around that I need to take care of so I like to have it in one place.'

RuterBillett user, female, age: 20-25 (OSL_IV10)

🏠 Pre-travel Experience

🚉 Travel Experience

🗣️ Post-travel Experience



Goals

Being exposed to information about using the RuterBillett app to buy public transport tickets.	Making a decision on whether to use the RuterBillett app over the other ticketing options: Reisekort, Paper tickets.	Getting the RuterBillett app installed on the mobile phone.	Buying a ticket through the RuterBillett app.	Finding the right vehicle or platform for the journey.	Enter paid zone/vehicle with a valid ticket to start journey towards destination.	Travelling from A to B. Being able to show inspector a valid travel ticket.	Get off vehicle or leave station when destination is reached.	Checking remaining validity of the ticket in the RuterBillett app.	Evaluating the experience of travelling with the RuterBillett app.
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Expectations

Seeing that it's possible to buy public transport tickets with the RuterBillett app.	There is enough information available about pricing and ticket types to decide to use the app.	The RuterBillett app is available to download and easy to install on a mobile phone.	It is possible to purchase a ticket through the RuterBillett app with mobile payment apps or credit card.	There is enough information provided about departures and possible delays.	With the use of the RuterBillett app there is no need to activate a ticket using the validators.	The vehicle provides journey information and is comfortable. Ticket inspectors might come on board.	It will be clear when the destination is reached and where to exit.	The RuterBillett app is able to tell how much time is left until the current ticket expires.	Making a decision on whether or not to continue using the RuterBillett app.
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Journey Steps

Information about RuterBillett through:

Comparing options

Search for the app and install

Connect payment card or app and buy ticket

Find travel information through RuterReise app or signage

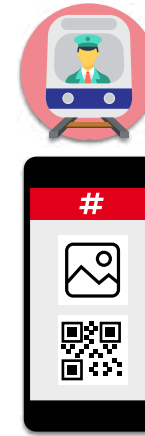
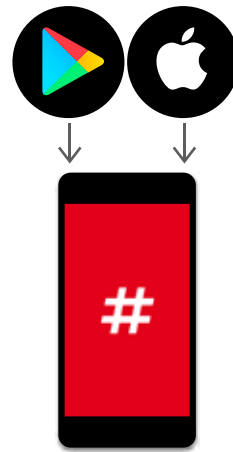
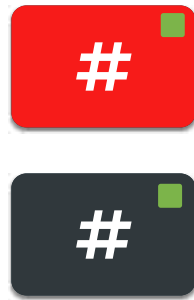
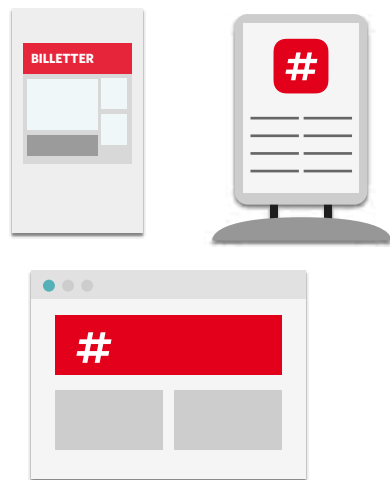
Check if ticket is activated and valid

Travel and show ticket validity with a daily picture or QR-code

Get off vehicle or leave station

Check remaining time on ticket and get notified when ticket is expiring

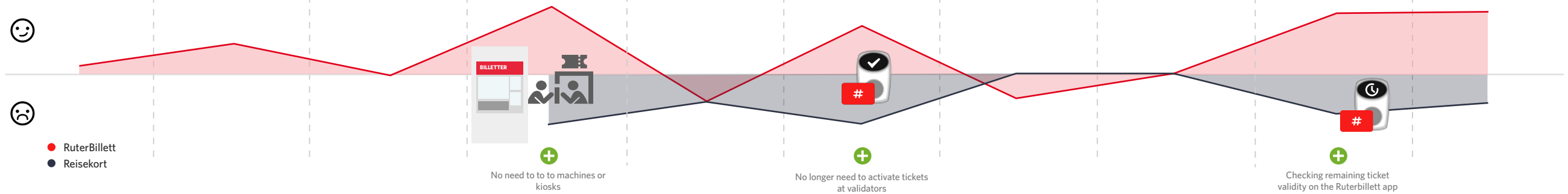
Think back about positive and negative experiences



Current Experience

<p>(+) High level of awareness through promotion and ads.</p> <p>(-) Outdated information about added functionality.</p>	<p>(+) 1 card less to carry.</p> <p>(+) Often forget card, won't forget phone.</p> <p>(+) All tickets types are available on RuterBillett.</p>	<p>(+) Available in Norwegian and English.</p> <p>(+) Support for iOS and Android.</p> <p>(-) Unclear that the NSB app also offers Ruter tickets.</p>	<p>(+) No need to go to a kiosk or ticket machine.</p> <p>(+) Saving payment method for faster repurchase, with both creditcards and mobile payment apps.</p>	<p>(-) Unclear why a second app, RuterReise is needed to check timetables and plan journeys.</p>	<p>(+) No longer need to activate a ticket at the ticket validators.</p> <p>(-) Uncertainty about boarding during the 2 minute activation window.</p>	<p>(-) Fear of running out of battery and getting fined.</p> <p>(-) Not sure when to show the QR-code instead of the daily picture.</p>	<p>(+) In vehicle information informs travellers about the next stop.</p>	<p>(+) Easy to check remaining ticket validity with RuterBillett.</p> <p>(+) Push notifications reminds users about expiring tickets.</p>	<p>(+) Fast ticket purchase</p> <p>(+) Not carrying ticket</p> <p>(+) Phone always with me</p> <p>(+) No activation needed at validators</p> <p>(-) Fear of running out of battery</p> <p>(-) 2 minute activation window confusing</p>
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Emotional Curve



● RuterBillett
● Reisekort

No need to go to machines or kiosks

No longer need to activate tickets at validators

Checking remaining ticket validity on the Ruterbillett app

6.2.4 Key insights

Clear benefits of RuterBillett over other ticketing options

Compared to the Reisekort and Impulskort, the RuterBillett app offers more convenience for travellers. Instead of going to a ticket machine or kiosk, tickets can be bought directly through the RuterBillett app and are activated automatically. As a result, activating tickets at validation poles is no longer necessary. By providing a visual indication of the ticket validity through the app's interface, users are no longer uncertain about whether they have an activated ticket.

Awareness and adoption through promotion

Observations have indicated that Ruter is trying to push travellers to use RuterBillett as main ticketing option. This is seen through the information and promotion material placed at service centres, stations and stops.

Optimised user base through platform, payment & tickets

By offering all the tickets that are available for the Impulskort and Reisekort, on the two most prominent mobile operating systems iOS and Android (Mobile Operating System Market Share in Norway, 2017), RuterBillett has become a solid alternative. Almost all travellers, even the ones that are travelling with discount, are able to buy their preferred ticket through the RuterBillett app.

Outdated information

RuterBillett initially only supported single ticket purchases. Travellers indicated that they were not using the app as they wrongly thought that their concession ticket was only available on the Reisekort. Interviews also exposed that users expressed the need for functionalities as flexible push notifications and automatic renewal while these were already implemented.

Ticket inspection: battery concerns and national guidelines

Battery level seemed to be a concern amongst travellers when encountering a ticket inspector. Travellers are afraid not being able to show a valid ticket due to an empty battery, resulting in a NOK900 fine. In order to relieve travellers from this concern, Ruter has equipped their ticket inspectors with a battery pack. In Norway, the national guidelines for mobile ticket inspection have also created a uniform way for travellers to show their mobile ticket on inspection.



Majorstuen Metro Station - Oslo, Norway

6.3 LONDON - APPLE PAY

6.3.1 Context of use

Transport for London (TfL) is a government organisation responsible for London's transport system. TfL is responsible for both surface transport, e.g. buses, trams and overground trains, as well as the London Underground (Transport for London, 2016). Similar to the metro in the Netherlands, London has a gated check-in and check-out system for the London Underground.

London uses the Oyster card, which is a smart card that can hold pay as you go credit, as well as seasonal tickets. Seasonal tickets are also available in the form of a paper ticket called a travelcard. An Oyster card can be either purchased online through the TfL website or at various stores and vending machines throughout London. Transport for London also offers discounted and concession fares for children, students and seniors in possession of an Oyster photocard.

Since 2014, it is possible to use contactless payments in the London transportation system. This was the result of the acceptance of contactless bank cards that use the EMV protocol. This also enabled London's transportation system to accept mobile EMV solutions. Currently, TfL accepts the following mobile EMV-payments: Android Pay, Apple Pay, Barclays Contactless Mobile, EE Cash on Tap and Vodafone SmartPass.





Aldgate Underground Station - London, United Kingdom

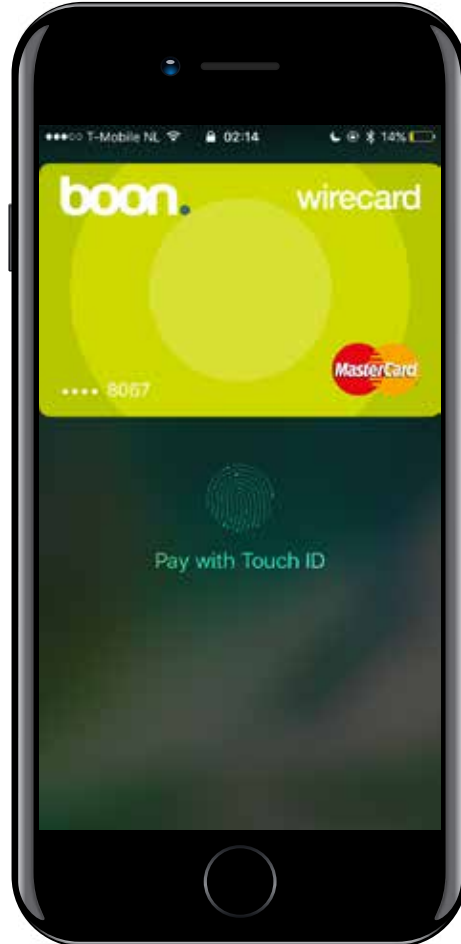
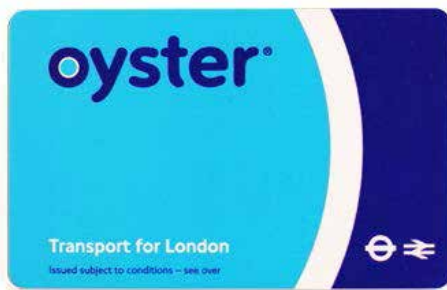


Figure 40. Fare media used by Transport for London

Through TfL's website, travellers are able to connect Oyster cards and contactless bank cards to their Oyster account (Figure 41). This allows the traveller to manage and top up their transportation cards, add tickets, have insights in their travel history and get notified for eligible refunds.

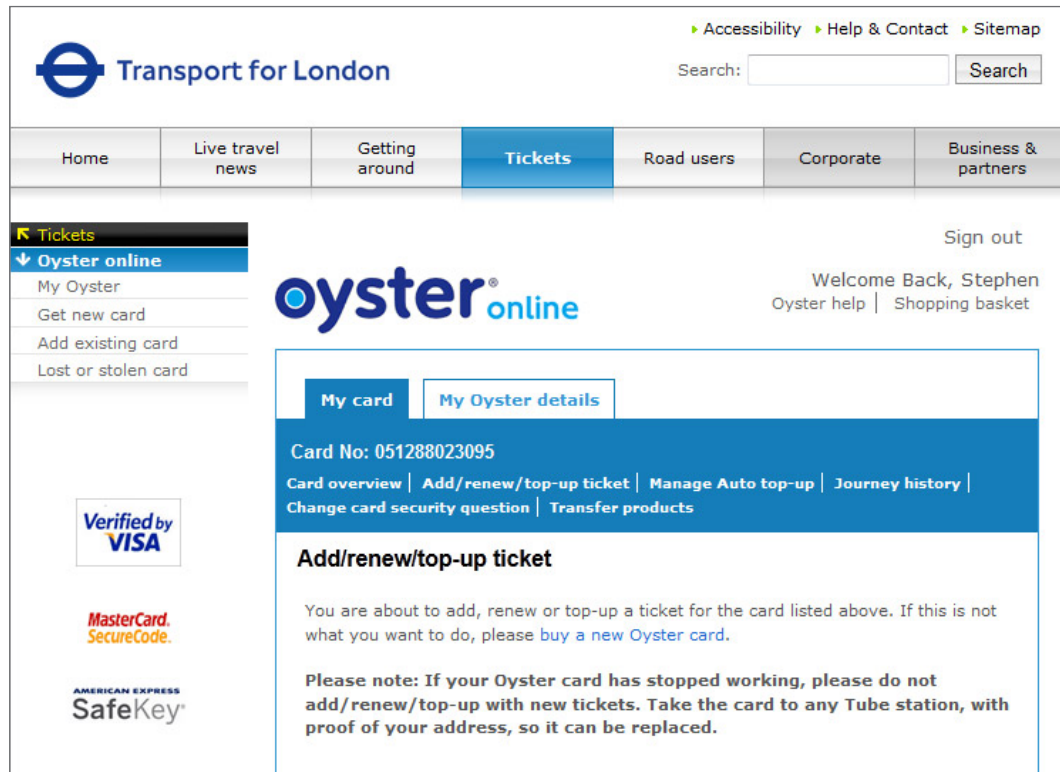


Figure 41. An online Oyster account

According to Transport for London, roughly one-third of all pay as you go journeys within the London fare zone are contactless payments, which is approximately a quarter of all journeys (30 million journeys made each day (Transport for London, 2015)). In the first half year of Apple Pay's release, over 3.2 million journeys have been made on the London transport network using mobile devices (Brown, M., 2016). In January 2016, the share of mobile devices in overall contactless use in the TfL system stood at approximately 3.5 percent. Based on interviews and observations, Apple Pay seems to account for the majority of these contactless mobile transactions as other mobile payment solutions were not encountered.

6.3.2 Usage of Apple Pay in public transport

Pre-travel Experience

When Apple and Google introduced their mobile payment services, Apple Pay and Android Pay, in the United Kingdom, both companies accompanied this with a nationwide advertisement campaign. Travellers in the London underground get exposed to posters, videos and even validation gates equipped with advertisement (Figure 42), letting them know it is possible to travel with using their mobile phones. Transport for London also informs travellers about the mobile payment options mainly through station announcements, posters and signage at underground stations. MasterCard, a partner of both Apple Pay (Telegraph, 2015) and Android Pay (Telegraph, 2016), also introduced 'Fare Free Mondays' when both mobile payment solutions were launched. On selected Mondays, travellers within the TfL system would get their journey fare reimbursed. With this campaign, travellers could try the new payment options for free and based on this experience, decide to continue using it. All of the travellers that were interviewed indicated to be aware of that they were able to travel using their phone. One of the interviewees, however, was not sure if his device supported Android Pay as it is not made clear from these advertisements. Transport for London has also placed signs stating that contactless fares are the same as Oyster fares, as some travellers seem to be under the impression that it is more expensive to pay with contactless and mobile phones.



Figure 42. Victoria Underground Station: Gateline with Android Pay advertisement



As stated earlier one-third of all pay as you go journeys are paid using contactless bank cards and mobile contactless. Contactless pay as you go journeys are subject to daily and weekly capping fares, whereas the Oyster card only supports daily capping. However daily commuters and travellers eligible for discount have indicated that it would be more expensive for them to use to use mobile contactless instead of their seasonal travelcard or Oyster photocard. As a result, mobile contactless payments is mostly interesting for pay as you go users. Interviews have revealed that travellers have made the switch to mobile contactless payments mainly due to not having to carry, top up and search for the Oyster card. Novelty also seems to play a part in the decision to travel with mobile contactless. For day-trippers from other parts of the United Kingdom have indicated to use mobile contactless payments as it doesn't make sense to buy an Oyster card. Apart from the novelty factor, contactless bank cards offer the same benefits as mobile contactless. The difference in the adoption rate of these two contactless methods is also partially due to not all retail vendors supporting contactless transactions. As a result, it is still necessary to carry around a bank card.



'There is not necessary a benefit. I just like it, I find it fun.'

Apple Pay user, male, age: 30-35 (LON_IV13)

'I was using the contactless on my bank card and that works fine, but my girlfriend doesn't have contactless so she's using my card and that is probably really why I've been using my phone. It's the only two methods we got'

Apple Pay user, male, age: 25-30 (LON_IV8)

Security issues seem to be a concern which holds travellers back from using mobile contactless payments in public transport. Travellers have the fear of their personal details and money getting stolen. This is also the result of people not feeling comfortable with getting something valuable out, like a mobile phone, to touch a validator. Mobile contactless travel does not seem to offer enough benefits for travellers that are satisfied with their current travel method to make the switch. Even when these travellers have shown interest in using their mobile phone in public transport, they indicated that they 'just haven't gotten around to it'. This indicates that the travellers do not want to go through the effort of setting up their mobile phone. This is also a reason why the majority of contactless users prefer the bank card over the mobile phone. With the contactless bank card, there is no setup process, it can be used right away.

Once the decision has been made to travel using mobile contactless, travellers can connect their bank card by downloading their preferred mobile contactless app and entering the bank card details. When the bank card has been connected, travellers can directly go to the gate or reader to check-in without having to spend time at the ticket machines.

Travel Experience

In order to start a journey and make use of public transport services, users have to check-in. This check-in process, however, seems to have added complexity when compared to an Oyster card or bank card. Instead of just holding the phone against a reader, like an Oyster card, users have to take additional steps in order to perform a valid check-in. With Apple Pay, the iPhone user's fingerprint needs to be validated using TouchID in order to perform a transaction, whereas users of Android Pay will need to unlock their phone first. When holding an iPhone against the reader, the connected bankcard will show up on the screen with a 'Pay with TouchID' message. Once the fingerprint is read a check-in can be processed by the gate or reader. This whole process can take up to four seconds from the moment the phone was held against the reader. Upon a check-in, the phone will vibrate and show a tick that the transaction was successful (Figure 43). This feedback was experienced positively as it gives users confirmation that they have checked in and do not have to worry about paying the full day fare due to a failed check in or out.



'I do like that you get a solid notification when you've checked out though, in a morning when the barriers are pretty much constantly open it must be easy to just walk through without knowing you've checked out or not when using a oyster or contactless.'

Apple Pay user, Reddit (LON_RED13)



Figure 43. On-screen feedback when a check-in/out is successful

Interviews with service personnel and Apple Pay users have indicated that new users are not familiar with the process of performing a transaction with Apple Pay. Users were still used to the speed and usage of an Oyster card where a quick tap was sufficient, as opposed to holding the phone against the reader for a few seconds. Transport for London has stated that the reading speed for the different cards are approximately 250ms for an Oyster card, 500ms for a contactless bank card and 750ms for Apple Pay. Travelling with Apple Pay has also shown that it is needed to consider changes in the usage of accessories. Using wired earphones (can't reach validator) or a card case (card clash) can be experienced as uncomfortable while checking in or out.

Another way to pay using Apple Pay is by pre-authorizing the fingerprint before touching the phone at the reader. This is done by bringing up the bank card set up in Apple Pay by double clicking the home button when the phone is locked. By placing the fingerprint on the TouchID sensor a 'Hold near Reader to pay' message will be displayed on the phone. For the next minute, the user can perform a contactless transaction without having to authorise their fingerprint again. Using this method can save up to two seconds at the gate readers. Experienced users have indicated that it took time to get accustomed to this process and still experience problems. When the double click isn't performed right, the phone unlocks instead of authorising a transaction. Another problem occurring is related to the fingerprint not being scanned due to for example sweat. This has a negative influence on the user's experience as this can cause anger with other people as they queue up behind them. (Figure 44).

When a user correctly checks in, the gates will open and the interaction is similar to the Oyster card. When checking in at poles or in-vehicle readers as found in buses, users have to rely on feedback given on the phone about the transaction. During ticket inspection, the user needs to perform the same steps as during check-in. This can cause confusion as users still have to authorise their fingerprint while no actual transaction is performed.

When leaving a gated system, users also have to check-out at the gates. Users have indicated that they are worried about their phone battery running out and not being able to check-out. Not only would they not be able to get out, but they would also have to buy a full day fare for their trip. All interviewed users of mobile contactless have indicated to always carry at least on backup option. People are also under the impression that if they check in with their phone, they would be able to check out with the physical version of their bank card. In reality, the phone and physical bank card are treated as separate cards which would lead to two incomplete journeys and two daily fare cap charges.



Figure 44. Traveller pre-authorizing fingerprint (top), an unsuccessful check-in causing a queue (middle) and a ticket inspection (bottom)

Post-travel Experience

After a successful transaction has taken place in public transport using mobile contactless, users often will not get charged immediately. This is due to the capping system calculating and charging the costs overnight based on the travels made. As a result, when looking in the Apple Pays transaction history it would only show that a transaction had taken place (Figure 45). Information such as check-in location and price are missing. Android Pay's transaction history, however, does show where a transaction has taken place but is also missing the price. This delay makes it hard for the traveller to keep track of how much they have been charged. Connecting their bankcard to an online Oyster account would reveal their journey and where they have travelled to and from. Connecting their bankcard to an Oyster account also enables travellers to apply for a refund for incomplete journeys. Android Pay users will get a notification through the app when a journey looks incomplete. This notification contains a link to TfL's website to request a refund through an Oyster account.



'Also that is a detail that a lot of customers don't know, so we have to tell them: register your card and they can see the journeys themselves. Otherwise, if they don't register their card it just goes straight into the payment screen in their bank. And it doesn't tell them where they've travelled from and to.'

Transport for London: Underground service staff member

Most travellers have indicated that they have not set up an Oyster account, either for their contactless payment methods or Oyster card. People do not seem to know for what purposes they can use an Oyster account. Transport for London seems to rely on service personnel to tell travellers about the advantages of an Oyster account. Interviewees have indicated that the benefits seem to be too insignificant for them to go through the hassle of setting up an account.



'I don't, I should do but I need to register it. It would make life easier and quicker. It's just one of those things I've never got around to really. And it's not a major thing, it's not going to make a huge material difference to my life, but it would make it a little tiny bit better.'

Oyster card user, male, age: 35 (LON_IV10)

3 UK 3G

15:06



boon.

wirecard

**** 8067



LAST TRANSACTION

Payment

Just Now



6.3.3 Customer Journey

A customer journey was made to visualise the described travel experience when using Apple Pay in Transport for London system. This customer journey uses the same set-up that was used in Oslo's customer journey. In this case, the emotional curve also maps the use of the Oyster card. This again, shows how the use of Apple Pay compares in relation to the most popular card alternative, the Oyster card.

The System Usability Scale (SUS) was used to assess the usability of Apple Pay in the Transport for London system. Again, this assessment is based on the insights gathered from interviews, observations, online reviews and own experience. Apple Pay was assessed with a SUS score of 52.5, indicating 'ok' usability. This corresponds with the concerns expressed by the users related to the fingerprint scanner and slow validation speeds. Apple Pay also requires a somewhat steep learning curve to comfortably use it in public transport (e.g. pre-authorizing).



'It was a bit fiddly over there, but generally I'm not impressed really.'

Apple Pay user, male, age: 25-30 (LON_IV8)

'It works pretty well actually, it takes a while to get used to at first, but once you've got that going it's all good.'

Apple Pay user, male, age: 20-25 (LON_IV87)

Pre-travel Experience

Travel Experience

Post-travel Experience



Goals

Being exposed to information about using Apple Pay to check in and out in London public transport.	Making a decision on whether to use Apple Pay over the other ticketing options.	Getting Apple Pay installed on the mobile phone.	Connecting a bankcard to Apple Pay in order to perform transactions.	Finding the right vehicle or platform for the journey.	Check in using Apple Pay to enter public transport vehicle.	Travelling from A to B. Being able to show a valid ticket.	Check out and leave the station or vehicle.	Review transaction overview and check if journeys have been correctly charged.	Evaluating the experience of travelling with Apple Pay.
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Expectations

Seeing that it's possible to travel in public transport with Apple Pay.	There is enough information available about pricing and ticket types to make a decision to use Apple Pay.	The Apple Pay app is available to download and easy to install on a mobile phone.	It is easy to connect a bankcard to Apple Pay. There is no need to go to a ticket machine.	There is enough information provided about departures and possible delays.	Since I don't have to top up, checking in will be easy and without any problems and will be similar to an Oyster card.	The vehicle provides journey information and is comfortable. Ticket inspectors might come on board.	It will be clear where to check out and clear feedback is provided about the journey and costs.	The transaction history in Apple Pay will display the journeys made and provide a clear and correct overview.	Making a decision on whether or not to continue using Apple Pay.
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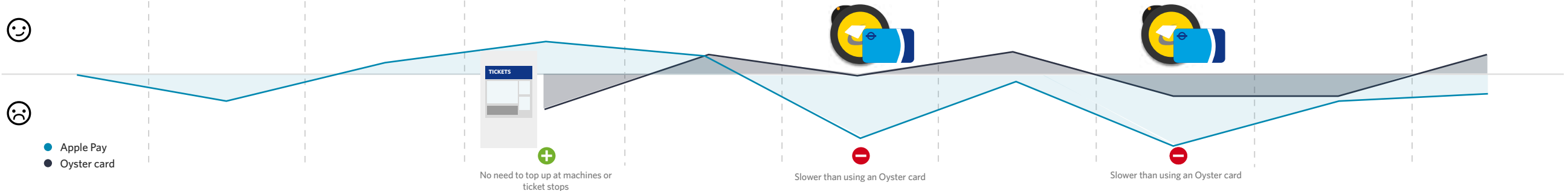
Journey Steps

<p>Information about Apple Pay through:</p>	<p>Comparing options</p>	<p>Enable Apple Pay through the Wallet app</p>	<p>Set up payment card in Apple Pay</p>	<p>Find travel information through signage</p>	<p>Check in at validators with Apple Pay through TouchID</p>	<p>Travel and present phone to inspector</p>	<p>Check out at validators with Apple Pay through TouchID</p>	<p>Keep track of journeys made and fares through Apple Pay</p>	<p>Think back about positive and negative experiences</p>
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Current Experience

(+) High level of awareness through promotion and ads in and outside of the public transport context.	(+) Always have phone with me, sometimes forget card. (+) Weekly capping available through contactless. (-) Difficult to understand fare system.	(+) No need to go to a ticket machine or ticket stops to recharge. (+) Easy to add bank card to Apple Pay.	(+) No need to go to a ticket machine or ticket stops to recharge. (+) Easy to add bank card to Apple Pay.	(+) Stations provide clear signage and leads to the correct place or vehicle.	(-) Slower than an Oyster. (-) TouchID complex. (-) Not knowing where the NFC sensor is. (-) Uncomfortable when people queue up behind you.	(-) Fear of running out of battery, getting fined or not being able to check out. (-) Uncomfortable showing phone to ticket inspector.	(-) Wrong assumption of being able to perform a check out for the same journey with physical bank card or Apple Watch when running out of battery. (-) Slow, TouchID complex, uncomf of people queueing.	(-) Hard to keep track of travel costs and journeys made. (-) Delayed daily charges. (-) No detailed description on journeys.	(+) No need to go to machines (+) Phone always with me (-) Using Apple Pay is slower and more complex than using an Oyster (-) Uncomfort of people queueing behind you (-) Fear of running out of battery
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Emotional Curve



6.3.4 Key Insights

Limited benefit of mobile contactless

Interviews have indicated that the main benefit for users of mobile contactless payments in London, is that travellers no longer have to worry about topping up their card. The same, however, goes for a contactless bank card. As an interviewee stated, there seems to be no clear benefit of mobile contactless over other fare media.

High awareness of mobile contactless through promotion

The option of paying with mobile contactless in London's public transport has been highly advertised through promotion in the public transport context. An example is the Android Pay branded gate line found at the underground stations. Transport for London has also informed travellers about mobile contactless through posters, signage and travel announcements at stations. MasterCard has also been involved in promoting Android Pay and Apple Pay by reimbursing travel fares made on selected days. This combination of factors has led to a high awareness of mobile contactless, as a payment option in London's public transport, amongst travellers.

Mobile contactless is slower and more complex than using a contactless bank card or Oyster card

Observations and travelling in the London public transport system has indicated that there is a noticeable difference in reading speed at the validation gates. Transport for London confirmed this by stating the following reading speeds for Oyster card (250ms), contactless bankcards (500ms) and mobile contactless (750ms). With the added complexity of authenticating with TouchID for Apple Pay and having to unlock the device for Android Pay, the process of passing through a gate is currently slower using mobile contactless in comparison to the Oyster card and contactless bank card.

Low adoption of mobile payments in both public transport and retail

Lack of trust in technology seems to be one of the main concerns. This has been expressed by interviewees in terms of both technical stability and security. With mobile contactless, people are worried about their money and personal details getting stolen and do not seem comfortable with using their mobile phone as a fare medium.



Aldgate Underground Station - London, United Kingdom

6.4 SEOUL - MOBILE T-MONEY

6.4.1 Context of use

Public transport in Seoul is operated by the Seoul Metropolitan Government and private bus and metro operators. In terms of transport modalities, public transport in Seoul consists of buses and the metro. The T-money card can be used to pay for bus, metro and taxi fares within Seoul. Besides transport fares, the card can also be used for transactions in selected convenience stores, attractions and vending machines, and works as a prepaid rechargeable card. The card can be recharged in convenience stores, subway stations and tourist information offices. Similar to the Netherlands, buses in Seoul are provided with on-board validators while the metro is equipped with gates and turnstiles. In order to be charged the correct fare, travellers need to check-in and check-out when travelling using public transport. The T-money card has expanded to public transport services in multiple cities in South Korea. South Korean banks have also integrated the T-money card into their credit cards (Shinhan Bank, n.d.). When using these credit cards in public transport, the user gets charged through their credit card bill and does not need to recharge. Based on observations, the credit card seems to be the most popular card amongst travellers.





Yongsan Metro Station - Seoul, South - Korea

In 2010, Korea Smart Card introduced Mobile T-money (Korea Smart Card, n.d.). Android smartphones equipped with NFC capabilities can be enabled to act as a T-money card by downloading the Mobile T-money app from the Google Play Store. The three Korean mobile network operators SK Telecom, Korea Telecom and LG offer SIM cards embedded with a T-money card called USIM, which is required to enable checking in and out with the mobile phone. The Mobile T-money app provides a graphical user interface for the data stored on the USIM. The Mobile T-money app (Figure 46) enables travellers to accumulate mileage points that can be used to pay for public transport fares. Users can track their NFC transaction history and check their balance through the information stored on the USIM. It also enables NFC Android mobile devices to transfer credit from physical T-money cards by placing them on the back of the mobile device. The app also supports features as auto and manual top-up, online payments, receiving refunds and transferring funds between mobile phones.

According to Korea Smart Card (2016), it has issued 120 million T-money cards, 240 million T-money enabled credit cards and 60 million T-money SIM cards. As of December 2015, Samsung Pay, Samsung's mobile payment app, has launched the Samsung Pay Transportation Card Service (Samsung, 2015). Users can use the Samsung Pay app instead of the Mobile T-money app to manage the T-money USIM. Users can recharge their USIM with the credit cards that are set up in their Samsung Pay app.

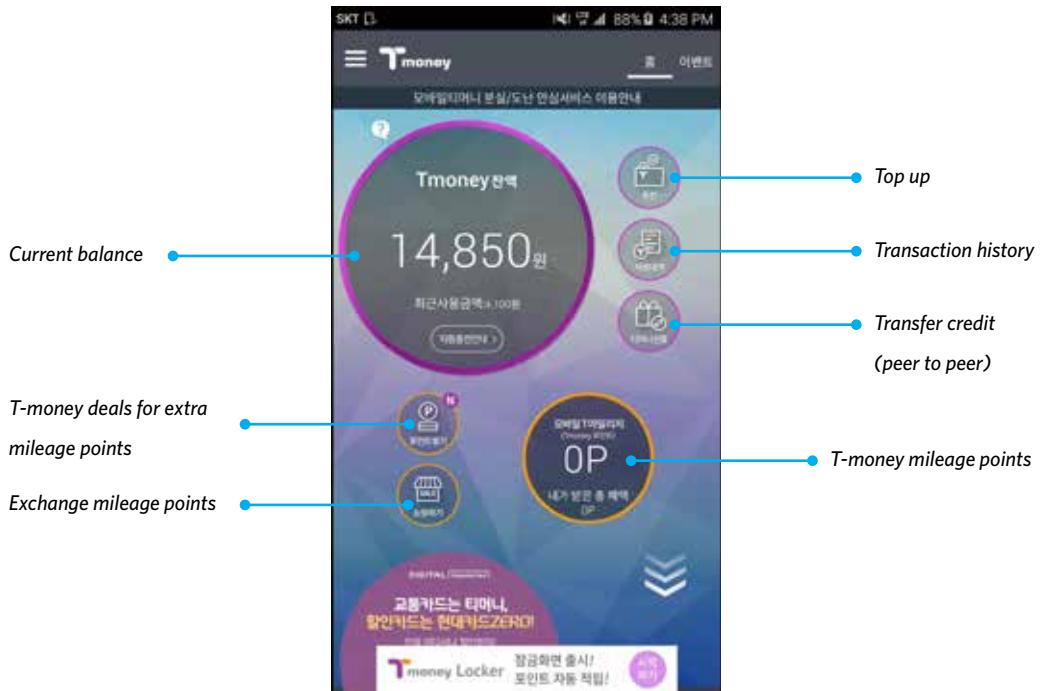


Figure 46. Mobile T-money home screen



Figure 47. T-Money enabled fare media

Pre-travel experience

Contrary to Oslo and London, there were no Mobile T-money advertisements or promotional material placed in context at stations or bus stops. This could be one of the reasons that people still do not seem to know about the existence of the Mobile T-money app, even though the app has been released since 2010.



'I haven't really seen many people using it. I think that it is a PR problem as well, people just don't seem to know about it.'

Mobile T-money user, male, age: 25-30 (SOL_IV14)

Users of the app have indicated various reasons for how they got to know about the Mobile T-money app, including recommendations by peers, such as friends or family, based on satisfactory experiences with the Mobile T-money app. Mobile advertisement through other apps and websites have also informed people about the existence of the app. During the purchase of a new phone, staff at the retail stores of mobile network operators will inform people about the Mobile T-money functionality. In some cases, the mobile phone even comes pre-installed with the T-money app. Interviewees also pointed out to have learned about the app through searching for it on the internet through their own initiative.

One of the primary benefits stated by users of the Mobile T-money app, is not having to go to a convenience store or ticket machine. Users also indicated that losing cards in the past was also a reason to use the app, as it is less likely to lose their phone and it's easier to take out than a card. Interviews pointed out that most of the Mobile T-money users also no longer needed to carry any credit cards or T-money cards with them. These users have indicated to use the app or solutions like Samsung Pay for transactions in retail and convenience store.

As stated earlier, most travellers seem to use their T-money enabled credit card in public transport. Using a credit card also has the benefit of not having to go to a convenience store or ticket machine to top up. Some travellers have purchased a phone case with an integrated slot for their credit card (Figure 48). People using this combination of card and phone case, basically enjoy the same benefits stated by app users. Interviews revealed that, even though people seemed interested in the idea of using their phone as a T-money card, they couldn't be bothered to make the change.



Similar to London, dependencies on accessories and other cards, such as an employee ID card, also seem to be a limiting factor for people to not use the T-money app. One interviewee stopped using the T-money app for this very reason. As he was carrying multiple cards in his phone case, the gate would not open as the reader would not know which card to read. Another limiting factor is that the T-money app is not available for iPhone users. These users have indicated they see the benefits and are positive towards using the app, but that it would not be a reason to switch to an Android phone. Interviewees have also indicated to feel uncomfortable about the amount of private information that is needed to sign up. This gives the impression that they are being monitored where they check in or out.

In order to successfully install the Mobile T-money app, one needs to be in possession of a USIM (Figure 49). Interviews revealed that most of the users were already in possession of a USIM and only needed to download the app from the Google Play Store. When one was not in possession of a USIM, one can be obtained through the mobile network operator's store or website. One interviewee had tried to use the app in the past but needed a new USIM. Even though there were no extra costs for him involved, he just couldn't



'The process was a little tricky. I once tried to sign up but it was just annoying to figure it all out. I couldn't be bothered anymore and just kept using my credit card.'

T-money enabled credit card user, male, age: 25-30 (SOL_IV10)



Figure 49. T-Money compatible USIM

be bothered as it was annoying to figure it all out. This seems to indicate that a complicated installation process can discourage potential users.

Once the app is installed users can top up their Mobile T-money card. This can be done manually, automatically or on a postpaid billing basis (Figure 50). The Mobile T-money card can also be topped up by placing the phone in ticket machines. Users can choose to get charged through their credit card or via their mobile phone bill. When one performs a recharge through the app, a small commission fee of a few percent will be charged which is experienced as unpleasant. Topping up manually is preferred by people who want to be in control of their expenses. People who do not want to worry about topping up use automatic top up and the postpaid billing option.

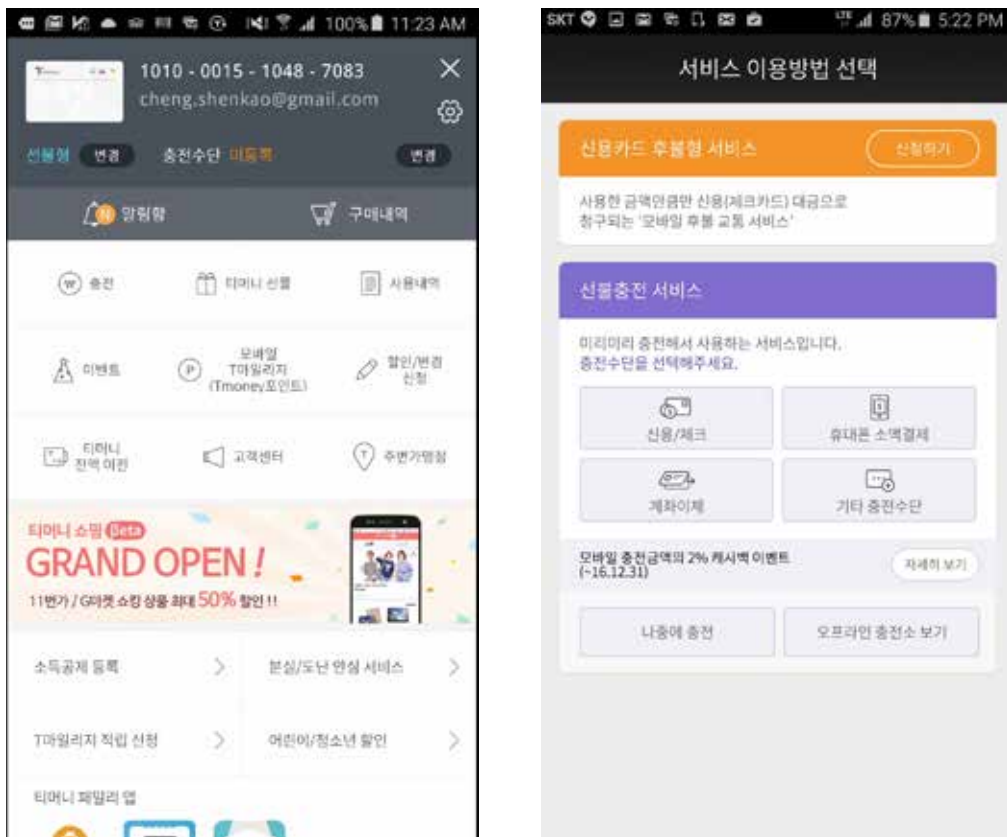


Figure 50. Mobile T-money app menu screen and overview of payment methods

Travel Experience

Similar to the Netherlands, travellers have to check-in at the start of their journey. Users check in by holding their phone at the readers just as one would do with a credit card or T-money card. The Mobile T-money app does not provide any feedback on whether the check-in was successful or not. Travellers are completely relying on the feedback given by the readers (Figure 51). These readers are labelled with stickers which indicate that it's possible to use Mobile T-money (Figure 52).



Figure 51. When checking in using Mobile T-money, the phone gives no feedback

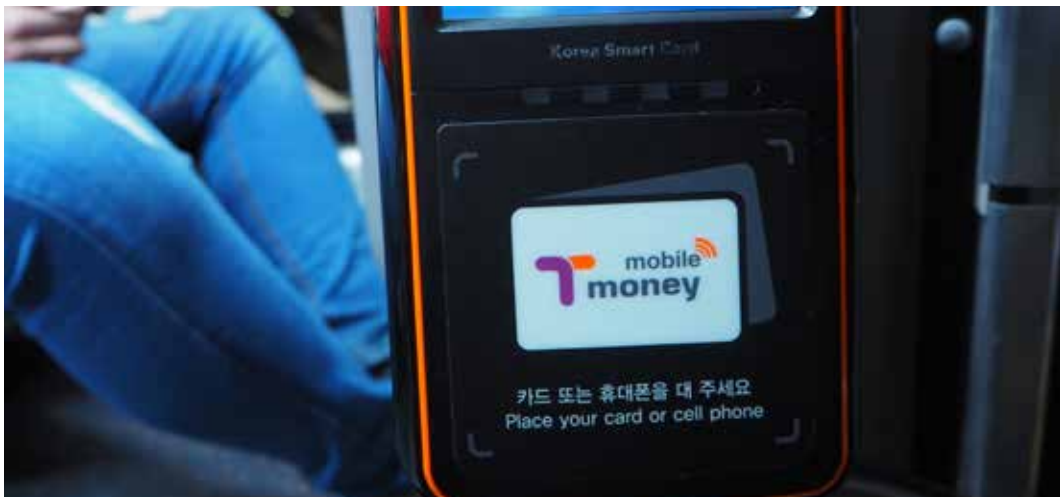


Figure 52. Validator labelled with Mobile T-money



Figure 53. Mobile T-money is not working for a traveller. After multiple check-in attempts resorts to his card.

Users have indicated to have experienced multiple problems regarding reliability when validating with their phone at a reader. Travellers have indicated that occasionally the reader is slow or doesn't recognise the phone at all, which makes using the Mobile T-money app unpredictable. In some cases, this was caused by the use of a phone case which was blocking the NFC signal from the phone or as mentioned earlier, the result of card clash. Users have also indicated problems related to the phone itself. One would have to reboot their phone in order for it to work, or even in some cases switch phones to reduce problems. For one of the interviewees, the slow reading speed during validation was a reason to switch back to using a credit card.



'I tried it [Mobile T-money] but it didn't really work that well. It was slow at recognising my phone at the gates, so I prefer using an actual card instead.'

T-money enabled credit card user, male, age: 25-30 (SOL_IV19)

In order to get charged the correct fare for their journey, users need to check out at their destination. Similar to London, users are worried about their phone running out of battery and not being able to check out. Some users are also under the impression that the NFC function runs out their battery faster.



Post-travel Experience

With the Mobile T-money app, users are able to look at their transaction and recharge history. Transactions in the app are saved up until 3 months back. The app is also able to distinguish transactions made in public transport from retail transactions. When travelling on a prepaid basis, users can get a notification when their balance drops below a certain amount and will top up when automatic recharge is turned on.



'When I have to charge a notification comes up. I know about the automatic recharge option, but I use manual top up. It's my own choice.'

Mobile T-money user, male, age: 45-50 (SOL_IV12)

For every transaction made with the Mobile T-money app, users also get rewarded with mileage points. By accumulating these points users are able to redeem these for free journeys in public transport or discount coupons in retail stores. Users are also presented with certain offers which contribute to the accumulation of these points. These offers can vary from watching a video to downloading an app. These offers, however, are experienced as excessive and annoying. Users of the app have indicated that the mileage system is a welcomed addition, but was never the main reason to use the app.



'So I check how much I use the app. And there is a mileage system that I check on the app as well. If I accumulate enough, I can use it for one round-trip travel. So it's a little thing but still counts.'

Mobile T-money user, male, age: 30 (SOL_IV13)



6.4.3 Customer Journey

A customer journey was made to visualise the described travel experience when using Mobile T-money in the public transportation system of Seoul. This customer journey uses the same set-up that was used in the two previous customer journeys. The emotional curve also maps the use of the T-money enabled credit card. This show how the usage of Mobile T-money compares in relation to the most popular card alternative, the T-money enabled credit card. The following data was retrieved in Seoul.

Similar to RuterBillett and Apple Pay, the System Usability Scale (SUS) was used to assess the usability of Mobile T-money in Seoul's public transport system. Again, this assessment is based on the insights gathered from interviews, observations, online reviews and own experience. Mobile T-money was assessed with a SUS score of 55, indicating, similar to Apple Pay, an 'ok' usability. This corresponds with the concerns expressed by the users related to the complex set-up process and unreliable check-in/out performance.



'I use mobile T-money everyday it's really convenient. The money is charged automatically on the phone.'

Mobile T-money user, male, age: 15-18 (SOL_IV9)

'I used to use the app, but I stopped using it because whenever I checked in, there were so many cards [in phone case] it wouldn't work, I have the app and a physical card in my case. So I turned off the app.' (Card clash)

Mobile T-money user, male, age: 30-35 (SOL_IV20)

Pre-travel Experience

Travel Experience

Post-travel Experience



Goals

Being exposed to information about using Mobile T-money to check in and out in public transport.	Making a decision on whether to use Mobile T-money over the other ticketing options.	Installing the Mobile T-money app on the phone.	Choose to travel pay as you go or use post-payments. Top up credit.	Finding the right vehicle or platform for the journey.	Check in using Mobile T-money to enter public transport vehicle.	Travelling from A to B. Being able to show a valid ticket.	Check out and leave the station or vehicle.	Review transaction and mileage overview and check if journeys have been correctly charged.	Evaluating the experience of travelling with Mobile T-money.
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Expectations

Seeing that it's possible to travel in public transport with Mobile T-money.	There is enough information available about pricing and ticket types to make a decision to use Mobile T-money.	The Mobile T-money app is available to download and easy to install on a mobile phone.	It is easy to connect a payment method to the Mobile T-money app. There is no need to go to a ticket machine or convenience store.	There is enough information provided about departures and possible delays.	Checking in will be easy, without any problems and will be similar to using a bank card or T-Money card.	The vehicle provides journey information and is comfortable. Ticket inspectors might come on board.	It will be clear where to check out and clear feedback is provided about the journey and costs.	The transaction and mileage history in the Mobile T-money app will display the journeys made and provide a clear and correct overview.	Making a decision on whether or not to continue using the Mobile T-money app.
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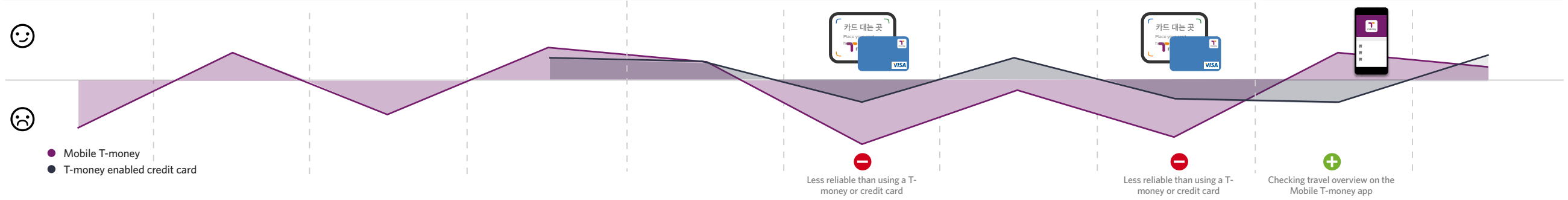
Journey Steps

<p>Information about Mobile T-money through:</p>	<p>Comparing options</p>	<p>Get USIM and search for the Mobile T-money app and install</p>	<p>Choose payment option and top up credit</p>	<p>Find travel information through signage</p>	<p>Check in by holding phone at validators</p>	<p>Travel and present phone to inspector</p>	<p>Check out by holding phone at validators</p>	<p>Track travel and mileage history. Check remaining balance.</p>	<p>Think back about positive and negative experiences</p>
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Current Experience

<p>(+) Awareness created through word-of-mouth and positive experiences of others.</p> <p>(-) Low level of awareness due to lack of promotion in public transport context.</p>	<p>(+) Always have phone with me, sometimes forget card.</p> <p>(+) Same travel fares with all cards.</p> <p>(-) Satisfied with current card.</p> <p>(-) Dependent on other cards.</p>	<p>(+) Just have to install the app when in possession of a USIM.</p> <p>(-) Installation process is a hassle and annoying when not in possession of a USIM.</p> <p>(-) Complicated installation process discourages potential users.</p>	<p>(+) No need to go to a ticket machine or convenience store to recharge.</p> <p>(+) Variety in payment methods: postpaid billing, manual and automatic recharge with cash, credit card or phone bill.</p>	<p>(+) Stations provide clear signage and leads to the correct place or vehicle.</p>	<p>(+) Similar interaction as using a card, easier to take out phone.</p> <p>(-) Check-in unreliable and unpredictable, random error messages.</p> <p>(-) Performance issues due to card clash or phone case.</p>	<p>(-) Fear of running out of battery, getting fined or not being able to check out.</p>	<p>(+) Similar interaction as using a card, easier to take out phone.</p> <p>(-) Check-in unreliable and unpredictable, random error messages.</p> <p>(-) Performance issues due to card clash or phone case.</p>	<p>(+) Clear overview of travel and mileage history.</p> <p>(+) Auto top-up or notification when almost out of balance.</p> <p>(+) Usage of Mobile T-money in retail stores.</p>	<p>(+) Phone always with me</p> <p>(+) Recharge on phone</p> <p>(+) Easier to take out phone</p> <p>(+) Travel overview</p> <p>(-) Difficult set-up process</p> <p>(-) CiCo unreliable</p> <p>(-) Fear of running out of battery</p>
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Emotional Curve



6.4.4 Key Insights

Main benefit of Mobile T-money: Not having to carry around other cards and not having to go to convenience store or ticket machine

Interviews have indicated that the Mobile T-money app offers users the convenience of not having to carry or search for their credit card or T-money card. Topping up credit on the spot and not having to go to a convenience store or ticket machine is seen as beneficial. Most interviewees also indicated to carry just their phone with them. Mobile T-money users usually did not carry around a credit card or T-money card as they also use it for retail purposes, albeit in combination with virtual credit card apps.

Little information about the Mobile T-money app

Based on the conducted interviews, it seems that there is a lack of awareness about the Mobile T-money app amongst users of public transport. Even though the app has been released in 2010, many travellers do not know of the existence of Mobile T-money. In contrast to Oslo and London, there was no promotional material on display at metro stations or bus stops. Awareness amongst users was mainly created through word-of-mouth by friends, family or staff at mobile network operator stores.

Unreliable check-in and check-out

Travelling using the Mobile T-money app and observations have shown that the checking in and out with the app is unreliable. Occasionally, the gate readers would unsuccessfully read the phone's NFC signal and give an unclear error to the user. In these situations, multiple check-in or check-out attempts or a device reboot were often needed in order for it to successfully register the phone's signal. This is experienced as unpleasant and has also discouraged travellers in using the Mobile T-money app.

Different installation experiences with USIM

Due to the high penetration of the USIM in South Korea, most of the Mobile T-money users only had to install the app. Some travellers even indicated that the app was already pre-installed on the phone when it was purchased. Travellers who were initially interested in using the Mobile T-money app, but did not possess a USIM, described the installation process as annoying and bothersome.



Hongkik University Metro Station - Seoul, South Korea

6.5 CROSS-CASE COMPARISON

By comparing the three customer journeys of these three case studies, one can recognise similarities and differences in how these mobile ticketing solutions function are applied within the three studied contexts. An overview of the differences and similarities between these systems is given in Figure 54. Both factors relating to the mobile ticketing solution as well as the public transportation system have been described. By comparing these similarities and differences, we can identify how the system and contextual factors have influenced the traveller's experience. This will also clarify how these factors affected the success rate of the studied mobile ticketing solutions.

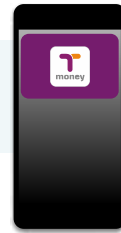
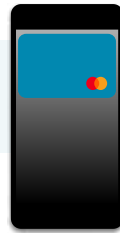
6.5.1. Pre-travel experience

Awareness

In both Oslo and London, promotion in the public transportation context has had a positive effect on awareness of mobile ticketing amongst travellers. In Oslo, RuterBillett was even promoted as the primary ticketing option. Posters, signage and announcements were the used media in order to communicate the mobile ticketing solutions and their benefits. In Seoul, no promotion in context and the lowest level awareness amongst travellers was found, even though the Mobile T-money has been available the longest of the three cases, as it launched in 2010.

Comparison

Travellers compare the mobile ticketing solution to their current fare medium. The compared media were the Reisekort in Oslo, the Oyster card or contactless bank card in London and in Seoul the T-money card or T-money enabled credit card. In all cases, the use of the mobile ticketing solution is free of charge, whereas a purchase (Reisekort, T-money card) or deposit(Oyster card) is needed for the smart card alternative. Looking at the tickets and fares, RuterBillett supports the same tickets and season pass for the same price as the Reisekort. In London, the mobile ticketing solutions use the same pay as you go fare system as the contactless bank cards, with daily and weekly capping. In contrary to the Oyster card and Travelcard, it is not possible to travel with season passes, making the mobile ticketing solutions less interesting for travellers currently using these season passes. In Seoul, the T-money card, T-money enabled credit card and Mobile T-money use the same pay as you go fare. Mobile T-money, however, commissions a small fee on in-app recharges making it more expensive than the other ticketing options. In both Oslo and London, confusion was found amongst travellers regarding ticket or fare information. In the case of Oslo, this might be related to the implementation strategy of RuterBillett, where the first release only supported single tickets. The complex fare system in London, with all the additional capping rules, resulted in travellers thinking pay as you go fares were more expensive for mobile contactless or bank cards than Oyster cards.



Oslo - RuterBillett

Self - Ticketing

London - Apple Pay

Mobile EMV-contactless

Seoul - Mobile T-money

Smart card emulation

Usability	Good/Excellent (80/100 SUS)	OK (52.5/100 SUS)	OK (55/100 SUS)
Adoption	50% of all tickets & seasonal passes sold	Approximately 1% of all journeys made	Approximately 1% of all journeys made
Released in	November 2012	July 2015	July 2010
Supported platforms	Android, iOS, Windows phone	iOS (Android alternatives available)	Android
Domain	Public transport	Public transport and retail	Public transport and retail
Costs	No costs for the app. Tickets same price as other carriers	App no costs. Same pay as you go fares as Oyster and contactless bank cards.	No costs for USIM and App. Additional recharge fee.
Tickets/fares	All tickets and season passes available	Pay as you go with daily & weekly capping	Pay as you go
Awareness	High level of awareness	High level of awareness	Low level of awareness
Installation	Download and install app	App already installed on suitable devices	(Request USIM) + Install app, or pre-installed at phone purchase
Payment	Credit card, Mobile payment apps (Vipps & Mobile Pay), add to phone bill	Charged directly from bank account	Credit card(post-paid and recharging), add to phone bill, add value at ticket machines
Entering public transport	In-app ticket activation	Slow and complex check-in performance	Unreliable check-in performance
Inspection	Show daily animation or QR code	Perform transaction with ticket inspector through NFC	Let inspectors read out USIM through NFC
System properties			
Size of System	Metropolitan (population - 900,000)	Metropolitan (population - 8,500,000)	Multiple metropolitan regions, mainly Seoul (population - 10,000,000)
System type	Open	Mostly closed (gated underground)	Mostly closed (gated metro)
Other fare media	Reisekort, paper tickets	Oystercard, contactless bank card, paper tickets	Credit card, T-money card, paper tickets
Costs	Reisekort: NOK50 purchase, 10 year validity	Oystercard: £5 deposit, no expiry Contactless bank card: Issued by bank, often free	T-money card: ₩2500 Credit card: Issued by bank, often free

Installation

In Oslo, the RuterBillett app can be downloaded for Android, iOS and Windows phone (only single tickets). In London, there are mobile ticketing solutions for both iOS (Apple Pay) and Android (Android Pay & Barclays contactless mobile), whereas in Seoul only an Android solution is available with Mobile T-money. The Mobile T-money solution also requires the traveller to be in possession of a USIM, which are provided by the mobile network operators in South Korea. For some, the Mobile T-money comes pre-installed when purchasing a new phone. However, for the ones that are not in possession of a USIM, requesting one at a mobile phone vendor is considered as a hassle. Even downloading an app can already be a hurdle when there is no direct incentive to.



'I just couldn't be bothered, because the current way is fine, it's working fine for me.'

T-money enabled credit card user, female, age: 25-30 (SOL_IV8)

'I would try it, but I just haven't gotten around to it, but it is a good idea.'

London Oyster card user, male, age: 35-40 (LON_IV10)

Ticket Preparation

Not having to go to a kiosk or ticket machine is a convenience mentioned by travellers experience using mobile ticketing solutions. RuterBillett allows for on-the-spot ticket purchase, whereas Mobile T-money allows for last-minute balance recharges. Both RuterBillett and Mobile T-money offer several payment options to purchase tickets or recharge balance, allowing the traveller to choose their preferred method. These payment options include credit card, mobile payment apps (RuterBillett) and adding the charges to the phone bill. Mobile T-money balances can also be recharged at ticket machines. Even though both solutions offer multiple payment options, only local credit cards seem to be supported. This excludes tourists and also expats from using these services. In London, travellers using a mobile bank card do not have to worry about recharging as they get charged from their bank account.

6.5.2 Travel Experience

Entering/Exiting paid area

As Oslo has an open public transportation system, travellers with a valid ticket can walk straight into the vehicle. However, travellers using a paper ticket or Reisekort need to activate their ticket at one of the ticket validators. RuterBillett automatically activates these tickets in the app, which offers the user the convenience of not having to use these ticket validators. Both public transportation systems in London and Seoul are mostly gated. The mobile ticketing options in these systems seem to perform less than the card alternatives. In the case of Apple Pay, the TouchID verification adds another dimension to the check-in/out interaction. Reading speed is also slower than that of an Oyster or bank card. In Seoul, compared to the T-money card and T-money enabled credit card, the check-in/out performance is less reliable when using the Mobile T-money. A check-in/out would occasionally fail at random. This suboptimal performance in both London and Seoul (Figure 55) has a negative impact on the traveller's experience and could discourage them from further use.

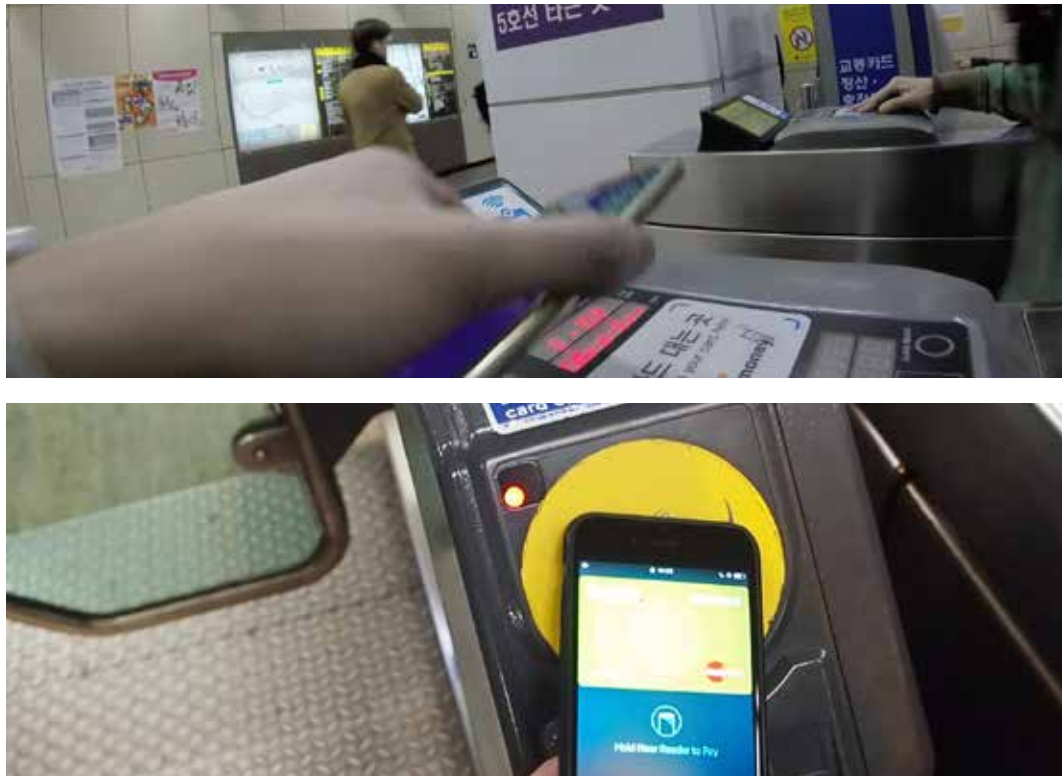


Figure 55. Slow and unreliable check-ins in both Seoul (top) and London (bottom)

Travelling

During ticket inspection, RuterBillett users can show a daily animation or let a QR-code be scanned to confirm that they're in possession of a valid ticket. In London and Seoul, users will have their phone read in order to confirm that they have checked in. In all contexts, travellers have the fear of running out of battery and getting fined as a result. In order to lower this fear, ticket inspectors in Oslo carry a battery pack.



Figure 56. Ticket inspection in London (top) and Oslo (bottom)

6.5.3 Post-travel experience

Evaluation

Due to the described differences above, the evaluation of the mobile ticketing solutions will also differ. In Oslo, travellers have widely adopted and seem very satisfied with the RuterBillett app. Compared to the Reisekarte, the usage of RuterBillett is less devious. Travellers no longer have to actively validate their ticket and are able to see their ticket information right on the spot. In both London and Seoul, the slow and

unreliable check-in/out performance adds an inconvenience and might even discourage travellers from further usage. A complicated installation process, as with Mobile T-money, also increasing the threshold for potential users.

6.6 CONCLUSION

In this chapter, the mobile ticketing solutions in Oslo, London and Seoul have been researched and analysed in order to identify what worked well and which usability issues travellers encounter when using these solutions. A cross-case comparison of these contexts was done in order to identify the factors that have played a role in the adoption and user experience of these mobile ticketing 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.

6.6.2 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.

6.6.3 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.

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. 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.

6.6.4 Potential usage funnel

A potential usage funnel has been created based on the previously mentioned enhancing and discouraging factors of adoption. This funnel illustrates how system requirements, acquisition and user experience is of influence on the potential, initial and retained user base. 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. Mobile T-money has excluded iOS users as it only supports Android devices. London has shown that a lack of value has led to a relatively low amount of mobile contactless users, whereas a lack of awareness and a difficult onboarding process has not worked in Mobile T-money's favour. A retained user base can be established by providing a pleasant experience when using the mobile ticketing solution. 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 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)

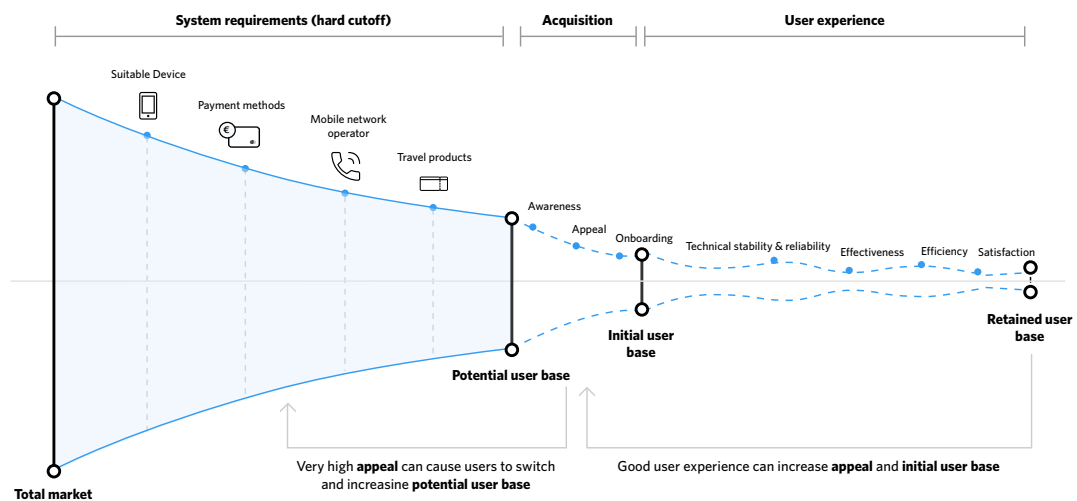


Figure 57. Potential usage funnel



7

Traveller using OV-chip mobiel

7. Conclusion & discussion

This last chapter will take a look at the results that have been found in this study by combining the insights as described in the previous chapters. The overall conclusion of this analysis will be reviewed and the research will be discussed. This chapter concludes by proposing guidelines for a user-centred ticketing solution for the Dutch public transportation system.

7.1 CONCLUSION

The complexity of the OV-chipkaart system has shown the existing boundaries and restrictions one has to deal with when developing a design vision for a mobile ticketing solution in the Netherlands. Looking at the future developments for the OV-chipkaart system has provided a better view of the system and how it is changing, namely in the support of new fare media. By shifting from a card-based system (data stored on the card), towards an account-based system (data stored in the back office), new opportunities arise for new fare media such as the mobile phone.

Three relevant trends and developments have been identified regarding mobile phone usage: mobility, payment and self-service solutions. Mobility services are emerging as densification of cities leads to an expected decrease in vehicle ownership. Mobile payment solutions are providing consumer an alternative to cash and bank cards, and are aiming to replace the physical wallet. With the expectation of self-service solutions, these are developments in smartphone usage which offer opportunities for public transportation.

The analysis and categorization of different mobile ticketing solutions implemented in other contexts have shown which types of technical and conceptual solutions are feasible and how they are applied to different types of public transport infrastructures and systems. This led to the understanding of the current implementation of OV-chip Mobiel, where an NFC-SIM is used to emulate the OV-chipkaart on an Android phone. As it is still an OV-chipkaart, no changes are needed for the in-field validation hardware, such as gates and poles. Although travellers do see the advantages of using a mobile OV-chipkaart, the first pilot has exposed several concerns and limitations of the current solution. The potential user base is cut off based on technological restrictions and the set-up process might be tricky for new users. Check-in/out performance has also shown to be inferior to that of an OV-chipkaart.

Field research in Oslo, London and Seoul exposed what factors influenced the adoption and traveller's experience of mobile ticketing solutions in these contexts. The Oslo ticketing solution, the RuterBillett app, has been widely adopted by both frequent and infrequent travellers since its launch in 2012. Currently, the app accounts for 50% of Ruter's tickets sold. The app has found a solution to bypass the downsides of the Reisekort and increase the ease and speed of buying a ticket and. On-screen ticket information makes the traveller independent of ticket machines and validator equipment. RuterBillett offers clear benefits over other ticketing options.

The low adoption of Apple Pay in London, the mobile EMV ticketing solution, can be attributed to lacking clear benefit and value for travellers. The more recent introduction of Apple Pay in the United Kingdom in 2015 could also play a role. As mobile EMV only supports pay as you go journeys, it is less interesting for frequent travellers who have season passes. The benefit of not having to worry about topping up is also covered by the use of a contactless bank card. Novelty seems to play the biggest role for travellers in London to use mobile EMV in public transport. Slower check-in/out speeds, when compared to the Oyster card seems to be a discouraging factor for travellers to continue using mobile EMV in London's public transport.

In Seoul the awareness and adoption of Mobile T-money is rather low. Even though Mobile T-money, the NFC emulated smart card through a SIM card, has been available since 2010. Lack of information and marketing seems to cause travellers not to know about the existence of the app. Due to the high penetration of the USIM in South Korea, most users only had to install the app. Travellers who had to request a new USIM indicated that this process was too annoying and bothersome to actually go through with it. Experience with unreliable check-in/out performance with the Mobile T-money has, similar to London, discouraged travellers from further usage.

From these insights found in each research location, the following influencing factors of adoption have been identified.

Factors enhancing the adoption include:

- A mobile phone is never forgotten
- Self-service capabilities (no need to go to convenience stores or ticket machines)
- The novelty of using a mobile phone as fare medium

Factors discouraging adoption include:

- The discomfort of using and relying on a mobile phone
- Privacy & security concerns
- No clear benefit
- Check-in/out performance
- Battery concerns
- Level of adjustment
- Potential usage cutoff

7.2 LIMITATIONS

The insights and results of this study 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. Possible concerns using these methods include 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.

Within the given capacity and time constraints, the findings of the field research abroad were repeatedly encountered, which lends a certain amount of confidence to these findings. However, one can argue that further and more extensive research would offer more confidence and possibly some new findings.

The interviews held with travellers were of a conversational nature. Even though an interview guide was consulted during every interview, the conversations with interviewees would always differ. This resulted in different type of information gathered from each interview, as interviewees would engage their own thoughts into this conversation. Due to this semi-structured approach, a broader range of insights could be distilled. Interviewee selection bias might have also occurred as interviewees were randomly approached and selected by the researcher. Due to the language barrier in Seoul, a translator was needed to conduct user interviews.

The contexts of the visited locations abroad differ in terms of complexity and size when compared to the Netherlands. This makes it impossible to directly link certain findings and insights to the Dutch public transportation system. Oslo, London and Seoul all mainly focus on a metropolitan area, whereas the Netherlands has a nationwide implementation. This results in different stakeholder relationships and makes it impossible to make one-on-one assumptions about travellers in the Netherlands adopting similar mobile ticketing solution as users did in the studied contexts.

7.3 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.



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.



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.

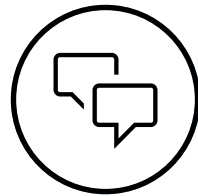
Ease and comfort of installation and use

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).



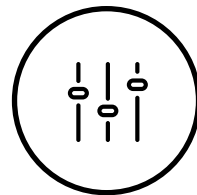
Communicate effectively

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.



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