Mobile Payment in Public Transport
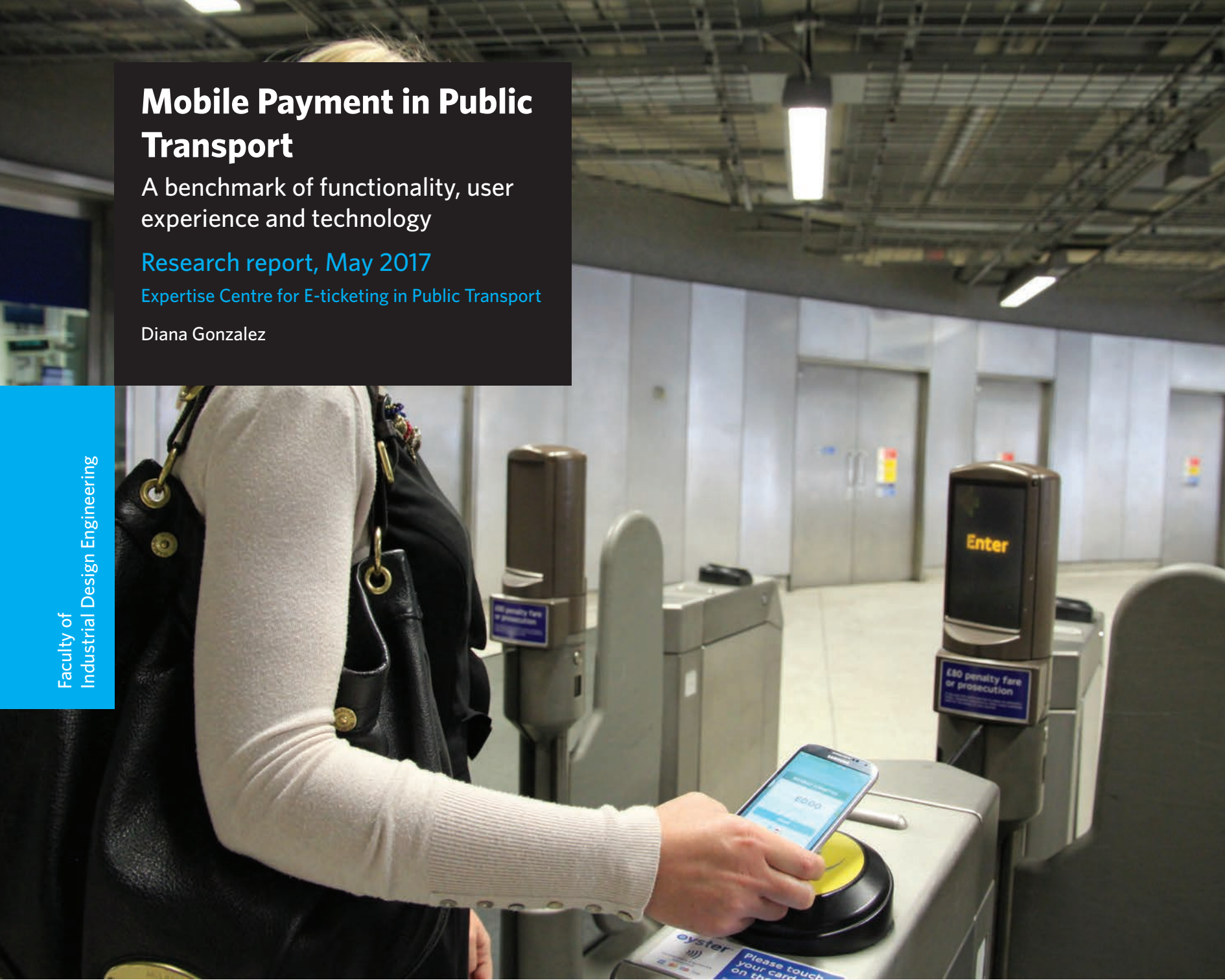
A benchmark of functionality, user experience and technology

Research report, May 2017
Expertise Centre for E-ticketing in Public Transport

Diana Gonzalez

Faculty of
Industrial Design Engineering

Mobile Payment in Public Transport

A benchmark of functionality, user experience and technology

Diana Lorena Gonzalez Sanchez
Student number: 4518675

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

Delft University of Technology

This report is part of the Expertise Centre for E-ticketing in Public Transport (X-CEPT).

May 2017 (version 1.0)

Author

Diana Lorena Gonzalez Sanchez

Project coordination

Dr.ir. J.I. van Kuijk

Project execution

Diana Lorena Gonzalez Sanchez

Academic supervisors

Dr.ir. J.I. van Kuijk

TABLE OF CONTENT

1. Introduction

This study benchmarks international mobile ticketing systems in public transport. Mobile payment in public transport comprises both pay-as-you-go options in which the mobile phone serves as a wallet (such as e.g., Apple Pay in London) and actual ticketing, where travellers buy and authenticate tickets on their mobile phone (such as, e.g., Ruter in Norway).

Public transport operators in the Netherlands are considering to implement mobile payment options (Reference to 'Visie OV-Betalen'), and knowledge of existing systems can improve successful introduction of such a system in the Netherlands.

Mobile payment can become a valuable addition for public transport, because for travelers it can make it easier to pay for trips, and for service providers it can reduce the costs for distribution of tickets and subscriptions.

The daily and extensive use of public transportation systems, with great numbers of people traveling everyday, a user-centered implementation of mobile payment in this sector can be a considerable improvement of the service, with the potential of drawing more people to public transport.

As mobile payment is likely to be a key feature of Dutch public transport in the (near) future, the user experience of this part of the service should of high quality. An important first step in creating a service with a high level of user experience is understanding the workings of existing systems. Different technologies are available and applied in different transportation systems worldwide, an analysis of which can show the strengths and weaknesses of these systems in terms of user experience.

Therefore, this study benchmarks the functionality, user experience and technological platform of 20 systems for payment in public transport worldwide, and analysis the user experience of four of those systems in more detail.

1.1. RESEARCH GOAL

Provide insight into the user experience of mobile payment systems for public transport around the world.

1.2. RESEARCH QUESTION

-Which mobile payment service for public transport are available worldwide?
-What functions do these services have?
-How do people experience the mobile payment service (features, payment process)?
-Which technological platforms are available nowadays to provide mobile payment services?

1.3. PROJECT CONTEXT

This study is done as part of the Expertise Center for E-ticketing in Public Transport (X-CEPT) of the faculty of Industrial Design Engineering at TU Delft. Through research-intensive design projects X-CEPT develops user-centered solutions for ticketing and payment in public transport, with a focus on the Dutch OV-chipkaart system. This study is used as input for a user-centered design project in which TU Delft and Translink explore the possibilities of introducing mobile phones for payment in the OV-chipkaart ecosystem.

1.5. METHOD

The study had two main stages:

Inventory:
An online review was conducted to identify mobile payment services worldwide. Sources included among others tech magazines, tech blogs, news, forums, public transport providers official websites, Google Play and app store.

The found services were listed and detailed, of twenty of the services that were identified a basic overview was created, in order to select the most relevant ones to analyse in more detail. Based on that information selection was made and the four services that were deemed to produce most relevant information for a future system for Dutch public transport were selected. (See Figure 1)

User experience:
User experience is characterized by its intangible interactions and multiple users perspectives, consequently it is a challenge to heuristically recognize patterns and draw conclusions. To that end of each of the selected services a customer journey was created, thus facilitating the analysis of the usage of the system by categorizing and visualizing the steps of the travel from an human centered design perspective. For each of the steps in the customer journey, it was assessed how travelers experienced these through comments made on forums, in reviews, etc.

The information that the customer journey was based upon was retrieved from user self reports online, specifically social media, blogs, reviews. In social media the search keywords included the name of the service, system, app or card. (See Figure 1)
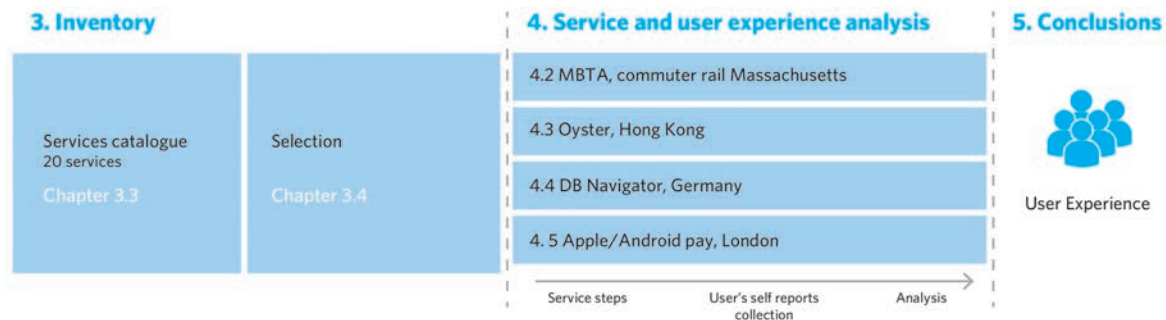
Figure 1. Research process

2

Apple pay in the tube, London

2. About e-ticketing in public transport

2.1. DEFINITION

Mobile payment is essentially a financial transaction authenticated, authorized and confirmed it by using a mobile device, for instance mobile phones, tablets or smart watches. (Changsu, Mirsobit and Lee, 2009). Notably the market of mobile payment has grown considerably in recent years and the forecast for the market tends to be positive.

Several technologies and service models have been developed to provide mobile payment service in different context, among others, mobile wallet, carrier billing (SMS), and of course Contactless payments with NFC (Near Field Communication) technology.

2.2. APPLICATION IN PUBLIC TRANSPORT

Specifically in the context of public transport, different technologies have been adapted to create new services models that respond to the challenges of this sector. The technology is also intrinsically related with the service structure, the options are: pay as you go, fixed tickets (from specific station of another) and subscriptions.

2.2.1 Self ticketing:

This is so far the most popular technology given the easiness of the implementation. Only by using an app the user is able to buy tickets from a specific departure to a specific ending station, wich means

that the travel route is fixed. The result of the transaction is a QR or barcode code that is visualized in the mobile phone. Depending on the public transport infrastructure there are two options for the execution of this service model:

Open stations:
When stations do not have gates or when boarding vehicles, the ticket must be activated before boarding. At that moment the ticket starts to display an animated background that the driver can easily check during the boarding. In most of the services there is an extra verification on board by an inspector.

Figure 2. QR Ticket example

Closed stations:

In stations with gates the challenge is to open the doors with the mobile device, for that end the gates are usually equipped with QR scanners.

Figure 3, Gate with scanner

2.2.2. Near Field Communication (NFC):

"It's a method of wireless data transfer that detects and then enables technology in close proximity to communicate without the need for an internet connection. It's easy, fast and works automagically." (Faulkner, 2015). It means that two devices are able to transfer data to another without either been connected to wifi nor use pairing code (as in bluetooth). Due to the encryption protocol, the chips embedded in most of the high tech smartphones are secure enough to be used in payments as a contactless card, this might eventually lead to the digitalization of the cards.

NFC is nowadays the most used technology in general mobile payment in physical stores and other services. However the implementation of this technology has major challenges that directly affect the opportunities in public transport. According to the RFID Journal (Will NFC Dominate Mobile Payments?, 2011) the biggest challenge is related related with the slow adoption process due to the lack of infrastructure, complex ecosystem of stakeholders and standards. Several NFC service models had been developed to adapt the technology to the specificities of public transport.

NFC + Sim card:

Most of current poles and gates are not equipped with NFC readers, because they have been put in the field before NFC emerged as a standard. Furtheremore, there is a wide variety of encryption systems according to the different mobiles models. That is why this solution proposes SIM-card plus NFC chip which emulates the protocol of the chip that is built into the gates and poles. Then, it is possible to open the gates and keep track of the user's transactions as a normal transport card, as well as to top it up with an app. This model is currently used in Hong Kong and will be further explained later.

NFC to scan the card:

In this case given the limited infrastructure in the readers, the NFC is used to scan the service card (e.g OV-chipkaart or Octopus Card) and to top it up through an app transaction.

Mobile wallet:

This is so far the most widespread use of the NFC for mobile payment because of the launch of Apple pay and Android pay in a a number of countries. By the use of an app that stores credit and debit card information the a smartphone can be used as the payment medium instead of the physical card.

Two other technologies not widely used were identified:

Hop on:

This technology was developed by an Israeli start-up as an alternative way to pay public transport with the cellphone. The technology sends information by ultrasonic sound waves transmitted from the

cellphone to the reader. It claims to be secure, low cost and fast.

GPS tracking:
Applied in Germany by the service "Touch and Travel", in this case GPS is used to keep track of the user's journey. User's are required to check in and out in the app when getting on and off.

In conclusion, different technologies respond to different needs in terms of infrastructure, scope and stakeholder involvement. Moreover each technology has remarkable opportunities and drawbacks. With this in mind, we will explore the impact of those in user experience.
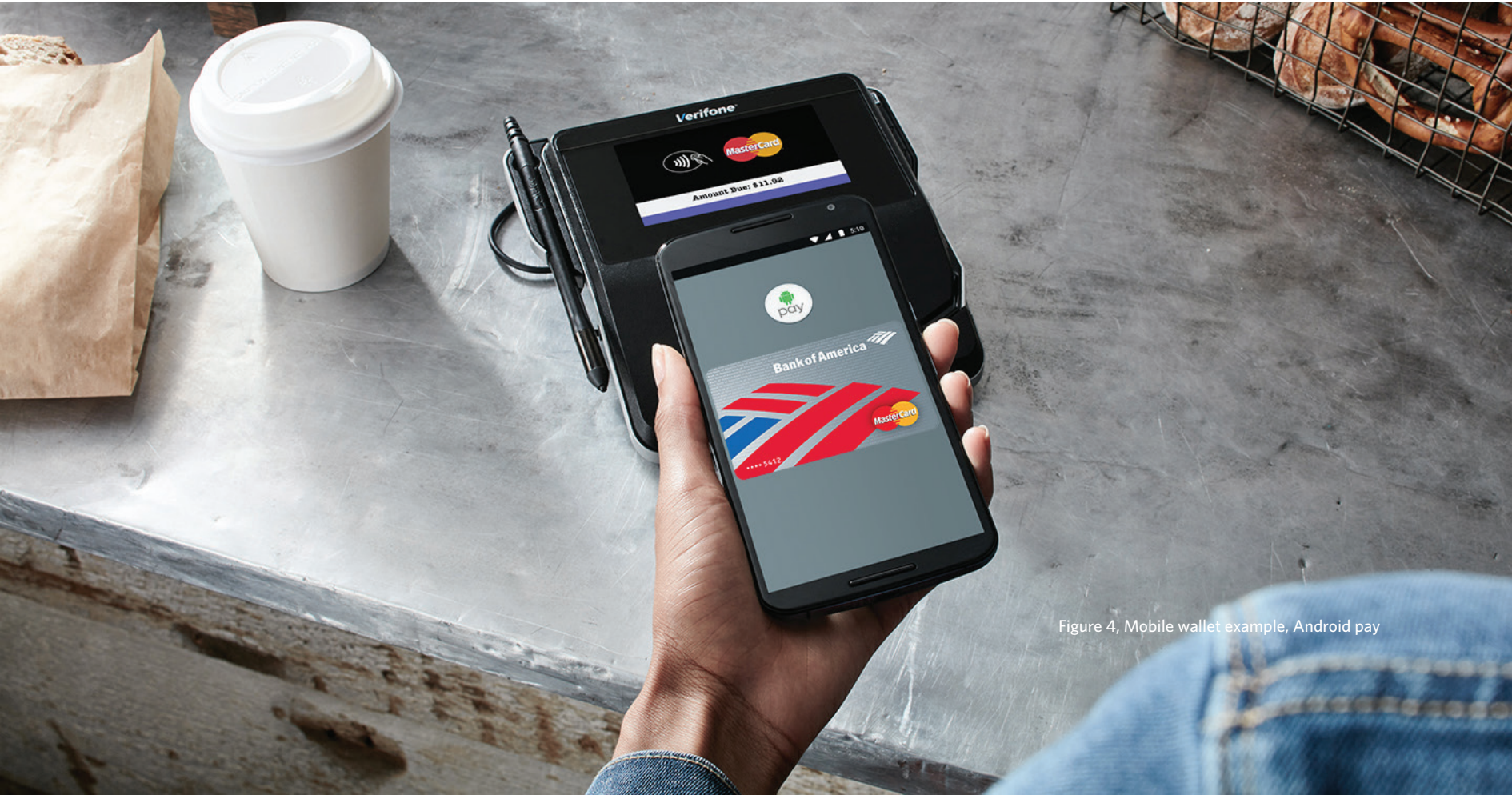
Figure 4, Mobile wallet example, Android pay

1. MBTA

Massachusetts region

The Massachusetts Bay Transportation Authority, often referred to as the MBTA or "The T", is the public operator of most bus, subway, commuter rail, and ferry routes in the greater Boston, Massachusetts area.

Lines: 12 (commuter rail), 4 (heavy rail), 5 (light rail), 4 (trolleybus), 4 (ferryboat), 183 (bus)

Stations: 123 (commuter rail), 51 (heavy rail), 74 (light rail), 23...

Google Play - Android

Update: November 29, 2013
Installs: 100,000 - 500,0...

4,2
★ ★ ★ ★
👤 870 insgesamt

★3 79
★2 25
★1 69

App store - iOs

Update: Sep 10, 2015

Current version: ★ ★
Ratings

MBTA mTicket

Self ticketing QR

The MBTA mTicket app is now available for all Commuter Rail and Ferry Lines. Purchase MBTA Commuter Rail and Ferry Single Ride, Round-Trip, 10 Ride, and Monthly tickets

Services:

Secure ticket purchasing with your credit or debit card
- Your smartphone is your ticket
- Never lose your ticket -- tickets can be easily transferred if your phone is lost or stolen
- Check Commuter Rail schedules, maps, and service alerts
- Allow fare reduced fare ticket and multiple tickets purchase

Technology:

You should activate your mobile ticket immediately before boarding your Commuter Rail train. Conductors will usually inspect tickets visually by checking the color changing ticket screen, but a conductor may occasionally ask to scan the barcode on your activated ticket.

- Never wait in line again
- No fumbling for cash
- Purchase a ticket in seconds
- Buy anywhere, any time
- Never lose your ticket again

View barcode

05:35:48 pm

ONE RIDE ZONE 4

My Tickets
Buy Tickets
Map
Settings

Ticket number:	M23LKUYQWG
From station:	Abington
To station:	JFK/UMASS
Line:	Kingston, Plymouth
Price:	17.50

No waiting in line or fumbling for cash.

Video URL: https://www.youtube.com/watch?v=C1I5MxnHR3c

3. Inventory of e-ticketing systems in public transport worldwide

This chapter includes the process and results of the first step of the research, which aims to produce an overview of mobile payment services in public transport worldwide. Firstly, the method of research is detailed, followed by the selection method that lead to the initial selection ('long list') of services. Secondly, an overview of these services and their primary properties is given. Finally, the method of selection of services considered most relevant to analyze further is presented.

3.1. METHOD

As it was mentioned in the introduction, the first step of the core research was to research mobile payment services around the world. To this end an online survey was performedby using the following keywords in combination with either "public transport" or "transport.

TYPE	KEY WORDS VARIATIONS
General	Mobile payment
	Mobile ticketing
	e-ticketing
App related	App ticket
	App payment
Technology related	NFC
	QR
	Self ticketing
	Apple pay
	Android pay

Finally, a number of the companies responsible for the design of those systems were looked into.

This process produced a list of 55 services, usually with a related app. This initial overview only included the name of and some general information about each service, and therefore in the next step more information was collected in order to select a range of services that would be documented in more detail. Of each service that was initially identified the following aspects were documented:

- Location: Geographical area covered by the system (either country, region or city).
- Public transport system size: measured by lines, stations, ridership.
- Technology used
- App that supports the service (if applicable)
- User satisfaction of the service's app in both Google play and App store
- Amount of installs on Android phones (information not available for iPhone)
- Transport modalities included in the service (e.g bus, ferry, commuter rail)

Thus we finally arrived at an overview of 20 mobile payment systems in public transport (See 3.3. Services catalogue). As this is a qualitative study, meant to produce insights into the advantages and disadvantages of existing systems, the process of choosing and analysing apps was stopped when multiple cases of all technology types had been identified.

3.2. SELECTION CRITERIA

A primary selection criterion was the coverage of the systems, taking into account that Dutch public transport is a countrywide system, complex and multimodal services were prefered. Furthermore the goal was to examine a wide variety of technologies to gain preliminary insights into the technological opportunities and drawbacks. The process stopped when getting to the saturation level, that is to say that no new relevant information was found.

Language barriers also played an important role in the selection process, since only services with enough online information in English could be assessed (See 5. Discussion).

3.3. SERVICES CATALOGUE

A format was established for presenting this 'long list' of mobile ticketing services. This provides information about the app that supports the payment, since most of the systems adopted apps as part of the service model. An overview of the selected mobile ticketing services is presented in Table 1. Details of each service can be found in the Appendix 1 (Services catalogue details).
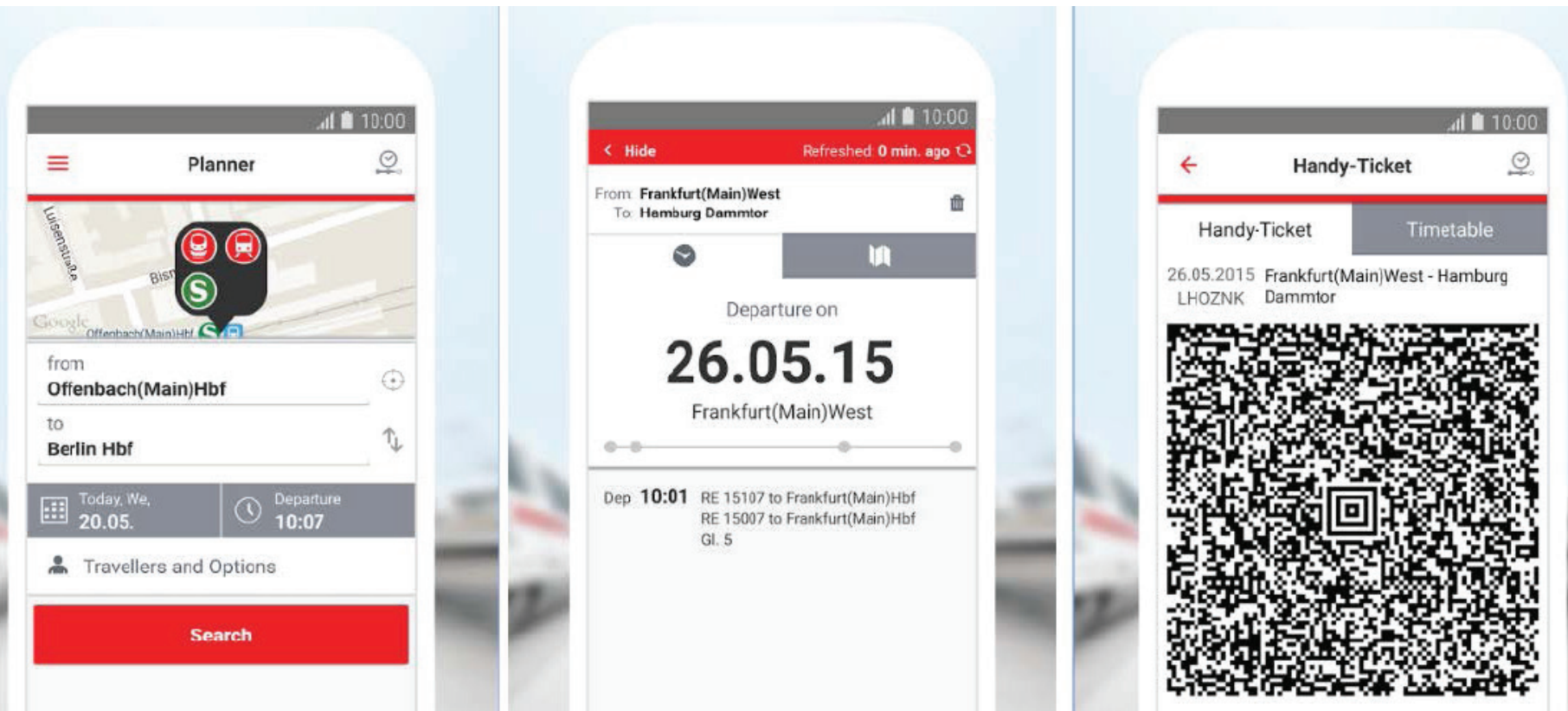
Table 1, Overview of mobile payment systems

	Transport system	Location	App	Technology	App satisfaction		Installs	Modalities	Coverage area	Ridership (per day)
					Android	iOS				
1	MBTA	Massachusets area	MBTA mTicket	Self ticketing QR	4.2	2.5	100,000 500,000	2	Regionwide	1.3 millions
2	TriMet	Portland	TriMet	Self ticketing QR	3.2	2.5	100,000 500,000	4	Regionwide	319,700
3	METRORail	Houston	Q-ticketing	Self ticketing QR	3.9	3	5,000 10,000	1	Citywide	43,900
4	MTA LIRR / MNR	New York area	MTA eTix	Self ticketing QR	2.8	2	10,000 50,000	4	Regionwide	637,700
5	Rutter	Oslo and Akershus/ Norway	RuterBillett	Self ticketing QR	3.7	-	500,000 100,000	6	Regionwide	300,000
6	SFMuni	San Francisco	MuniMobile	Self ticketing QR	2.9	2.5	10,000 50,000	4	Citywide	679,800
7	BVG	Berlin	BVG FahrInfo Plus	Self ticketing QR	3.7	3.5	1.000.000 5.000.000	6	Regionwide	1,390,000 U-Bahn
8	Deutsche Bahn	Germay	DB navigator	Self ticketing QR	4	4	10,000,000 50,000,000	6	Countrywide	2,5 millions
9	Chiltern Railways	London	Chiltern Railways	QR with gate scanners	3.8	-	50,000 100,000	1	Regionwide	-
10	NS Nederlandse Spoorwegen	The Netherlands	NS Reisplanner Xtra	QR with gate scanners	4.1	3	1.000.000 5.000.000	1	Countrywide	1,200,000

11	NS International	The Netherlands	NS International app	QR with gate scanners	3.3	2	10,000 50,000	1	Several countries	-
12	Deutsche Bahn	Germany	Touch and Travel	GPS track NFC GPS QR scanning	3.6	3.5	10,000 50,000	5	Regionwide	-
13	Opal Card	Sydney area	Opal travel	NFC for card scan	3.5	2.5	100,000 500,000	4	Regionwide	-
14	Metra, CTA, Pace	Chicago	Ventra	NFC QR Apple pay Android pay	3.4	2.5	100,000 500,000	4	Citywide	1,2 millions
15	Snapper card	New Zeland	Semble	NFC card scan. Mobile wallet	4	-	50,000 100,000	3	Countrywide	-
16	Transport for London	London	Android Pay ApplePay bPay	Mobile Wallet	4	-	-	6	Citywide	1.8 milions
17	EZ-Link Card	Singapore	EZ-Link	NFC to top up and check	2.7	-	100,000 500,000	5	Countrywide	3 millions
18	EZ-Link Card	Singapore	My EZ-Link Mobile	NFC + Simcard	3	-	10,000 50,000	5	Countrywide	3 millions
19	Octupus Card	Hong Kong	Octupus Card	NFC + Simcard	3.3	1.5	1.000.000 5.000.000	5	Countrywide	5 millions
20	HopOn	Israel	HopOn	HopOn	3	3	50,000 100,000	3	Regionwide	-

3.5. SELECTION FOR FURTHER ANALYSIS

A second selection process was performed to, from the 21 apps in the services catalogue, select those for analysis that would provide the most relevant insights for applying mobile ticketing in the Dutch public transport sector. To that end selection criteria and a weighing scheme were developed.

3.5.1. Selection criteria

In the criteria weighing scheme (Table 2) three levels were assigned to each selection criterion, which allowed for scoring services and then sorting out the most relevant ones to study in detail.

3.5.2 Selected services

From the quantitative evaluation four services were selected for a thorough user experience analysis.

- *Gemany: DB navigator*
- *Hong Kong: Octupus Card*
- *Massachusets area: MBTA*
- *London: Underground Android Pay and ApplePay*

BVG was not selected for further exploration given the potential barrier language during the user self report research. More details of the selection process are presented in the Appendix 2 (Services quantitative evaluation).

Table 2, Selection criteria

Charactersitic	Description		Criteria		
			Low	Medium	High
App satisfaction	Shows the quality of user experience. We assume that higher satisfaction means a better experience	Android	3.6-3.7	3.7 - 4	4.1 - 4
		iOS	2.5-3	3-3.5	3.5-4
Amount of installs	As an indicator of the maturity of the service (app) as well as the popularity. More people using it means more user self-reporting information online to evaluate user experience		100,000 - 500,000	500,000-1,000,000	1.000.000-5.000.000
Modalities	Multimodal transport systems have an special relevance given the Dutch transport system. If the service is multimodal means that it has overcame challenges associated with this complex service. Also will show opportunities in that matter.		4	5	6
Size of the system	Coverage area is an indicator of the transport system size and is directly related with the ridership		Citywide	Regionwide	Countrywide
	Ridership, as the ridership increases so do the possible issues with the different technologies, then providing valuable insights on the massive use of the service.		Between 500 thousand and 1 million per day	Between 1 million and 2 millions	More than 2 millions per day

4

Error message Octopus system gate

4. Service and user experience analysis

In this chapter the user experience is analysed by constructing a customer journey for the following services: Massachusetts commuter rail, the Hong Kong Octopus card, DB Navigator in Germany and Apple/Android Pay in London. First, the method is presented, followed by an analysis of each service analysis and ending with the conclusions, tips and tops for mobile payment.

4.1. METHOD

To evaluate the user experience it was crucial to have a clear understanding of the service steps and how those steps were perceived by the users, hence a customer journey was used toto visualise the service model structure. Applying a customer journey also makes possible to analyse in which steps the experience tends to be positive as well as negative and why.

Firstly, the customer journeys were structured according to the travel experience stages used in previous evaluations of the Dutch transport services (Joppien, Niks, Niermeijer & v. Kuijk 2013): purchase, pre-travel experience, travel experience and pos-travel experience. However, due to the differences in technology and service structure applied in the services under investigation, the steps inside those stages were significantly changed. The services steps were defined based on information from official websites, popular (technology) press, and online forums.

Once the service steps were clear, the collection of self-reported experiences from the users of these services started. The raw data was collected from user self reports online found in social media, more specifically Facebook, Twitter and Reeddit, and app reviews in both App store and Google play.. The keywords included: The name of the app or service alone, and the name plus "mobile payment". The collected self-reports where then located in a specific step of the customer journey.

Based on the collected self-reports an analysis of both the positive and negatives aspects of the service steps was performed.

Phases — **Purchase**   **Pre-travel experience**   **Travel experience**   **Post-travel experience**

Steps — Orientation | Purchase | Activation | Loading | Preparation | Check in | Station | Traveling | Interchange | Check out | Evaluation

Figure 5, Customer journey stages (Joppien et al., 2013)

4.1. MBTA, COMMUTER RAIL MASSACHUSETTS

4.1.1. Description
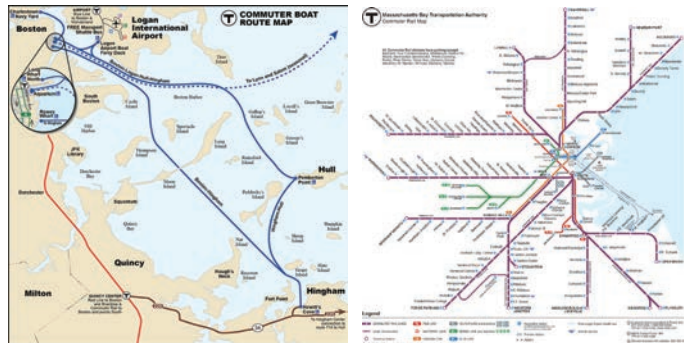
Figure 6, MBTA route map and lines

Transport system:
The MBTA Commuter Rail system serves as the commuter rail arm of the Massachusetts Bay Transportation Authority's transportation coverage of Greater Boston in the United States. The system is the sixth-busiest commuter rail in the U.S. Commuter Rail fares depend on the distance of traveled (zones).

Ridership levels on the Commuter Rail have grown since late 1960s, with overall average weekday ridership growing from 29,500 in 1969 to 76,000 in 1990 and 143,700 in 2008.

"#MBTA #mTicket mobile ticketing has hit over $35 million in sales since its intro in November 2012 #MBTAbyTheNumbers"
-MBTA Twitter account-

Mobile payment service:
It is a self-ticketing service model with open gates, the payment is done through the "MBTA mTicket" app, which gives the users a QR e-ticket. The ticket must be activated before boarding the train, so the driver is able to easily check it. It is important to notice that the app only offers tickets for commuting rail and ferry routes. During the research not relevant information regarding ferry use was found, consequently commuting rail is the focus and scope of this analysis.

The app uses the JustRide mobile ticketing platform, that includes a cloud based data management, pre-defined app design and the QR technology for validating the tickets. The system was designed and implemented by Masabi, a company well known for providing mobile ticketing solutions.
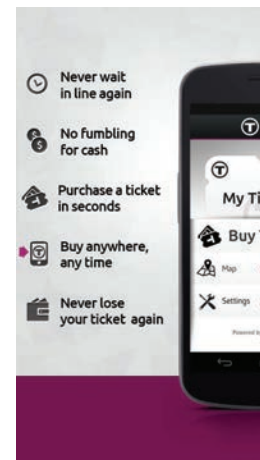
Figure 7, Mobile payment advertisement

4.1.2. App interface

The app was explored to gain insights into interface design and user experience. The "MBTA mTicket" is available for both Android and iOS devices and it includes extra services besides the e-tickets: Rail map and schedule.
The following section explains the app's main screen, the services provided, and the task flow for purchasing a ticket.

MBTA mTickets

Buy tickets

Main screen
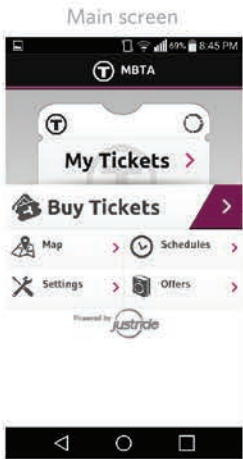
Additional services
- Map
- Offers
- Schedule

Select station from

Select station to

Select fare
Multiple tickets
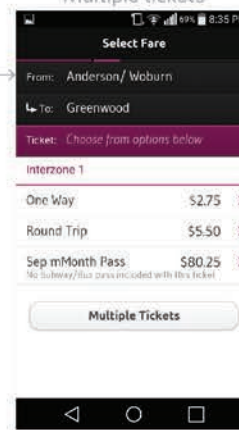
Select payment
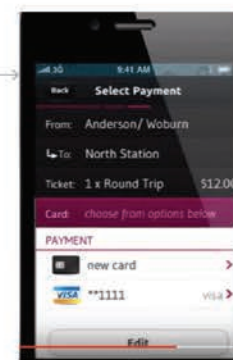
Card details
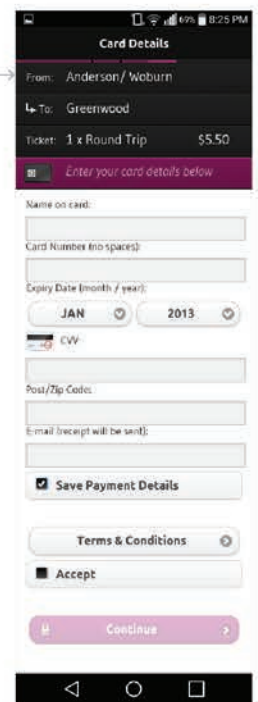
Payment details
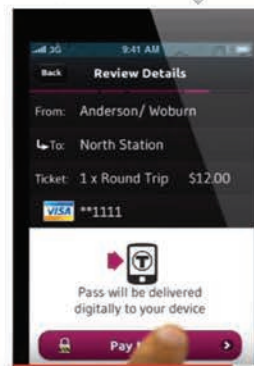
Validation
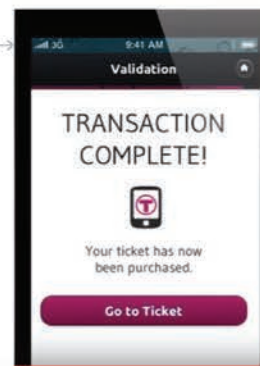
Ticket activation
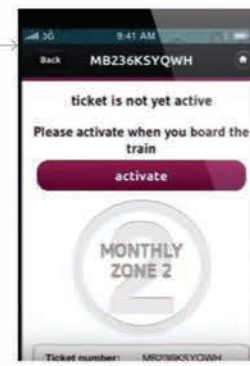
Ticket
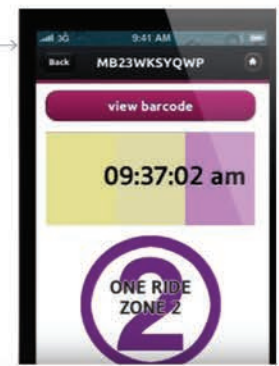
4.1.3. Customer Journey

The customer journey includes the conclusions drawn from user self-reports by stating the positive and negative aspects of the service that impact the user experience.

4.1.4. Insights

Positive aspects
- The convenience and easiness of paying with the app is positively perceived and deeply appreciated. The convenience is specially enhanced by not needing cash.

"It gets me peace of mind, knowing that if I need to get somewhere I can do it on my phone"
- Retrieved from Youtube-

"@MBTA_CR just tried your mTicket app. Simple and easy. Great job."
- Retrieved from Twitter-

- The use of e-tickets instead of printed ones, gives users a sense of environmental friendliness
- The process of purchase is perceived as simple and fast.

"I like that I can store my credit card, it remembers me my train stops, couple of clicks and I am done"
- Retrieved from Youtube-

- The special feature for event tickets is considered convenient

Negative aspects
- The app does not provide accurate and timely information about the schedule. This inaccuracy causes mistrust.

"The way schedules are displayed is bizarre. They write "04:25" for 4:25pm, which suggests the developers are just as bad at understanding the nature of time as they are at app navigation"
- Retrieved from Google play-

- The frequent technical issues negatively impacts user experience, causing uncertainty whether it will work or not

"Glitch Two times I clicked on a certain stop and it glitched to another stop. Resulted in 2 tickets that I couldn't use. Either be careful or don't use it "
- Retrieved from Google play-

"Purchasing tickets is nominally functional, but everything else is awful. The UX is pretty awful, with every screen displaying a "please wait" mask until you dismiss it."
- Retrieved from Google play-

- The interface does not consider that users have to access the ticket in different stages of the travel, therefore the screen should be the one the user is expecting (e.g ticket) and not the home screen.
- The app's interface does not provide shortcuts and filters for the schedule searching process
- The use of a personal account for managing the tickets is prefered by the users.
- There should be a refund option, the lacking of it causes hesitation and makes users afraid of making mistakes, some might even be upset.
- The app provides few multiple payment methods.
- When allowing monthly tickets in self-ticketing systems the app should alert the user in cases of inactivity.

CUSTOMER JOURNEY MBTA COMMUTER RAIL

	PURCHASE	PRE TRAVEL		TRAVEL								POS TRAVEL

STAGES

	Getting the app	Preparation	Station	Buy tickets	Activate	Get on	Travel	Inspection	Get off	Reflection

STEPS

	Search	Install	Check map (route)	Check trip planner	From home to station	Arrive at station	Select station from/to	Select fare	Select payment	Validate	Ticket	Look for platform	Activate	Show to the driver	Travel	Show to the inspector		Reflection

CURRENT EXPERIENCE

POSITIVE +

Getting the app	Preparation	Station	Buy tickets	Activate	Get on	Travel	Inspection	Get off	Reflection
		- Convenient to not miss the train when the users are in a hurry	- Stores card information and frequently used train stops - No need to have cash - Multiple type of tickets available (one way, 10 times tickets, round trip, monthly) "I like that I can store my credit card, it remembers me my train stops, couple clicks and I am done"			- Flexibility: possibility to use tickets later if user misses planned train "MBTA is very convenient and if you miss your train the tickets are usable for the next one. You can choose not to store your card info or have it store multiple cards. It's easy, simple, and very convenient"	- All in the mobile phone, there is no need to look for the paper ticket		- Easy, fast, simple and convenient. - Flexible to use the tickets later if the train is missed - Special train tickets for events - Intuitive interface - Reduces need for paper/printed tickets, perceived as environmentally friendly. - No need to have cash

NEGATIVE -

Getting the app	Preparation	Station	Buy tickets	Activate	Get on	Travel	Inspection	Get off	Reflection
- Non real time system status function (only schedule image). Increasing uncertainty - Unfriendly UI to search into the schedule. Did not foresee the user need of looking up a specific day and hour - No reliable/stable schedule function, it does not load at times. - The time format is not easy to understand - Appearance not consistent with Apple iOS. "The app should be able to do things like automatically tell me when the next train is at my (or any given) stop (taking alerts into consideration)."			- The tickets are not connected to an account, therefore there is no possibility to save tickets. If the cellphone is lost, changed or restored the tickets are gone, forcing the user to contact customer service. - Frequent technical issues when buying and activating tickets ('glitches') - Every time the app is minimized and then reopened, it shows the home screen, instead of the more frequently used current ticket. - Restricted acceptance of payment methods does not accept PayPal and Amazon - No way to undo user errors, no clear refund function "The other pain point is that when you leave the app and come back, it always returns you to the start screen. That's infuriating when trying to multi-task."	- The monthly ticket does not alert inactivity, so some users forget to inactivate it if they are not using it. - Home screen reset		- Home screen reset			-Does not support support reduced fare (seniors) Inconsistent with web information about the app. - The security of the process of payment is not clear for the users, therefore creating mistrust - The user is forced to contact customer service in case of reinstalling android, lost the cellphone or change it, because the lack of account feature "Wish it had a "log in" feature I love this app. I use it all the time. However, it sucks there is no "log in" because it means when ever you switch phones (or you have to reset your phone for some reason) you lose all your tickets. And it's a pain to contact them every time."

EMOTIONAL CURVE

"@MBTA @MBTA_CR First of September. Forget to switch out monthly pass. Conductor charges me for minor lapse. Not a great customer experience."

- Retrieved from Twitter-

- The service does not include all the potential users (e.g seniors, students)
- The service might be complemented with a feature to top up the card (this is already available in other systems)
- Integrate the app services with other MBTA public transport as metro and buses.

4.1.5. Conclusions

- It is clear that mobile payment positively impacts the traveling user experience in comparison with paper tickets. In this case no needing cash, the flexibility of buying the ticket in any step of the travel and the easiness (linear menu) to buy the tickets in the app are appreciated.

- Even though the system has a high satisfaction in Android with a 4.2 score, several complaints were identified. Inaccuracy and technical issues are the most common factors that create mistrust. This is complemented with the inability of the app to correct user mistakes (e.g through a refund option).

- From a user interface and information architecture perspective, the fact that the app does not foresee user needs negatively impact sthe user experience. For example, it does not provide filters for the schedule searching or shortcuts, it always return to home screen independently of the step of the travel, and finally it does not alert the user on the inactivity of monthly tickets.

Figure 8, MBTA station

4.2. OCTOPUS, HONG KONG

4.2.1. Description

Transport system:
Hong Kong has a broad transit system, including Mass Transit Railway (MTR), tramways, buses, light buses and ferries. It is known for having the highest rate of daily journeys (90%) in public transport worldwide (Lam & Bell, 2002). This is a multimodal system similar to the Dutch one, and has interesting technological proposals for mobile payment. However, Hong Kong is equipped with a fully gated system while OV-chipkaart is semi-open.

Figure 9, MTR system map

Mobile payment service:
The public transport payment in Hong Kong is based on the Octopus card. This is a reusable contactless card launched in 1997 to replace paper tickets (which had magnetic strips) in the transit system, and has increased its scope since then to retailer shops, parking meters, convenience stores, fast food and online payments, among others. The system is 'pay as you go' and works in buses, trains, ferries, and minibuses. The card can be purchased in any station of the Mass Mass Transit Railway (MTR).
To introduce mobile payment options to this system, in October

2013 a pilot of the Octopus mobile SIM card was launched, with the support of Sony and PCCS. The SIM card has both Octopus card and by mobile operator services and only can be used in mobile phones with NFC (Near Field Communication). The SIM is exclusively sold in Seven Eleven stores and mobile operators and it is available in 3 different SIM sizes.The SIM card must be paired with an app for checking the balance and topping up if required, the app is also essential for online payments.

It is important to highlight that even if the mobile phone is equipped with NFC, only tested devices by the operator are ensured to work in the gates. Due to the restriction of NFC encryption for iOS devices it is not possible to use iPhone or Apple Watch with the SIM. In addition to the initial Android-only app, in August 2016 Octopus launched a special app for topping up the card, on iPhones this requires an especial extra device called Octopus card reader.

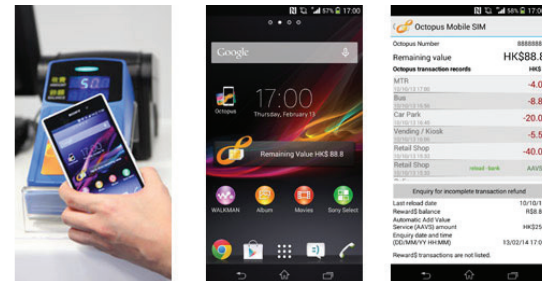Figure 10, Ocopus SIM card advertisement

4.2.2. App interface

The app seems to be designed more for electronic payments in general than for paying in public transport specifically. This might be due to the multiple features of the Octopus card and its extensive use in daily payments. In the following section the main functions are presented as well as the activation process of a SIM card for Android devices.
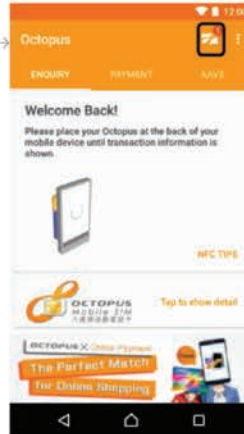
Octopus

Set up SIM card

Check the detection area of the mobile device

NFC Tips

Sony Xperia™ Z (C6603)
Octopus App - NFC detection area

- Please hold your Octopus steadily at a varied distance if it cannot be read.

OK

Enable the required system functions for using the "Octopus" App

Octopus

ENQUIRY   PAYMENT   AAVS

Attention

NFC is turned off   SET UP

Data connection is unavailable   SET UP

Register Octopus number   SET UP

Tap the "Register Octopus" icon at the top right corner

Octopus

ENQUIRY   PAYMENT   AAVS

Welcome Back!
Please place your Octopus at the back of your mobile device until transaction information is shown.

OCTOPUS Mobile SIM   Tap to show detail

OCTOPUS X Online Payment
The Perfect Match for Online Shopping

NFC TIPS

Click on the Octopus Mobile SIM entry at the top of the list

← Octopus List

17475233   SIM
2016/03/16 17:50

***66758(8)
2016/03/16 17:55

Click "Enquiry"

←

17475233

SIM
2016/03/16 17:50

Notification

Notifications (Update once per day)

Octopus Refund
As of 08/03/2016, you have HKD8.8 pending refund.

ENQUIRY

Register

Octopus
Remaining value   HKD 38.4
                         30/06/16 10:22

Please register your Octopus to receive more information.

REGISTER

You have successfully collected refund (Count 1, Total HKD10.0) to your Octopus.   ABOUT REFUND

Main screen

Octopus

ENQUIRY   PAYMENT   AAVS

Welcome Back!
Please place your Octopus at the back of your mobile device until transaction information is shown.

NFC TIPS

Additional services
- Consult balance in Octopus card with NFC
- Collect online payment refund
- Online payment
- Automatic add value service

Figure 11, Octopus mobile payment advertisement

4.2.3. Customer Journey

Notably, the mobile payment service do not directly provide pre-travel preparation support such as a map or schedules, it is more focused on money transfer services.

4.2.4. Insights

The interface shows the multiple payment services, besides public transport. This makes it challenging to evaluate the user experience,

The overall user experience of the app is determined by much more than just the experience of payments in public transport.

Positive aspects
- The wide availability and easy access to the SIM card (online, seven eleven) plus the free trial might increase the user's willingness to try the new service.
- The overall service is perceived as easy, simple and convenient. This might be due to the efficiency of just tapping the cellphone at the gates, as well as the prevention of card clash (gates detecting multiple RFID-enabled cards).
- The extensive adoption of the Octopus card itself make the mobile payment service more visible to users; it is a well-established brand.
- The transactions inquiry are straightforward showed in the app by the use of widgets. This make the access to that information effortless.

> *"Works like a charm. Payment and inquiry are all on point."*
> *- Retrieved from Google play-*

- Even with the implementation of a rather new technology (SIM card) and the weakness of the NFC, no comments were found with regard to the duration of validating at the gates (tapping the phone), which is remarkable considering remarks found in this area for Apple Pay and Android Pay.

Negative aspects
The overall user satisfaction is not high with a 3.3 score in Android and 1.5 in iOS. This might be due to some of the following issues.

- NFC technology is restricted to only high technology devices, and to ensure their use each one should be tested first, thus restricting even more the use of specific mobile phones.

- The technical issues when launching the app or reading the card at the gates, besides the compatibility problems (Android version, second sim card) are the most common complaints. These issues cause cause mistrust, making users perceive the system as unreliable.

I upgraded to Android 5.0.1. Then I discovered AFTER the upgrade that this app and the Octopus SIM won't work with the second generation of Samsung S5 (otherwise known as the SM-G906).
- Retrieved from Google play-

- Because of the limitations of the communication through NFC, some of users experience the payment as unreliable.
- The in-app advertisements are considered annoying, its elimination might lead to a most genuine and trustful experience

Why advertisement Easy to use. But why use advertisement in their own company product?
- Retrieved from Google play-

- The User Interface colors could be improved to provide a smoother experience.

The white on orange UI makes it very difficult to read.
- Retrieved from Google play-

4.2..4. Conclusions

- Octopus is a a well-established brand with multiple services and widespread use, nevertheless its focus is not solely on payment in public transport, but on payment services in general (e.g. online payment).

- Even though the purchase and pre travel experience are long and require some effort to be done, this effort is compensated with a very simple and effective daily use. No comments were found regarding the check-in time at the gates.
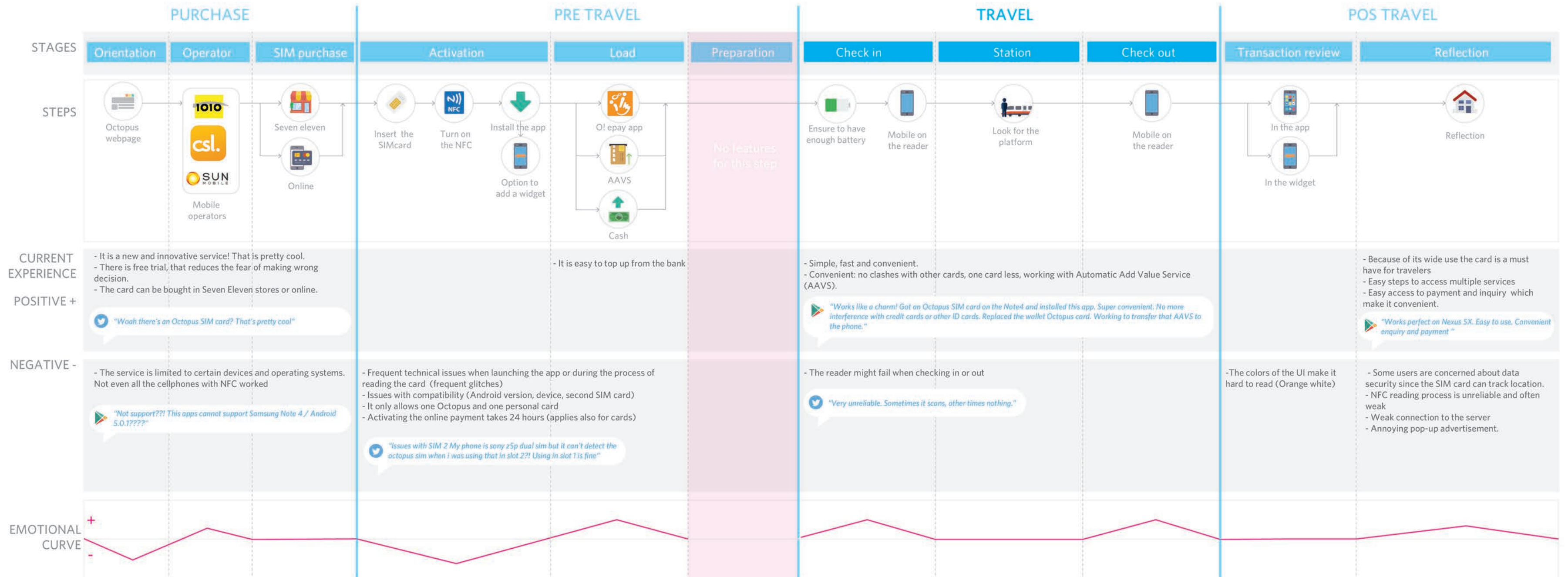
- The lack of a preparation step to search travel details and schedules does not seem to negatively impact the user perception of the system. This might be due to other apps fulfilling this need.

- In terms of user interface design, the use of widgets to show the balance immediately provides easy access to the most relevant information to the user but on the other hand the chosen colors do not provide a smooth experience.

- On the negative side, NFC technology is reduced to high-end devices and to phones running Android (for iOS devices a separate card reader is needed), thus limiting the potential user base.

- Finally, the technology itself is perceived as unreliable given the frequent technical issues in the app and the reading process of the SIM card either by the mobile phone or the gate reader.

CUSTOMER JOURNEY OCTOPUS, HONG KONG

	PURCHASE			PRE TRAVEL			TRAVEL			POS TRAVEL	

STAGES

Orientation	Operator	SIM purchase	Activation	Load	Preparation	Check in	Station	Check out	Transaction review	Reflection

STEPS

- Octopus webpage
- 1010 / csl. / SUN MOBILE — Mobile operators
- Seven eleven / Online
- Insert the SIMcard
- Turn on the NFC
- Install the app / Option to add a widget
- O! epay app / AAVS / Cash
- No features for this step
- Ensure to have enough battery
- Mobile on the reader
- Look for the platform
- Mobile on the reader
- In the app / In the widget
- Reflection

CURRENT EXPERIENCE POSITIVE +

Orientation:
- It is a new and innovative service! That is pretty cool.
- There is free trial, that reduces the fear of making wrong decision.
- The card can be bought in Seven Eleven stores or online.

🐦 "Woah there's an Octopus SIM card? That's pretty cool"

Load:
- It is easy to top up from the bank

Travel:
- Simple, fast and convenient.
- Convenient: no clashes with other cards, one card less, working with Automatic Add Value Service (AAVS).

▶ "Works like a charm! Got an Octopus SIM card on the Note4 and installed this app. Super convenient. No more interference with credit cards or other ID cards. Replaced the wallet Octopus card. Working to transfer that AAVS to the phone."

POS Travel:
- Because of its wide use the card is a must have for travelers
- Easy steps to access multiple services
- Easy access to payment and inquiry which make it convenient.

▶ "Works perfect on Nexus 5X. Easy to use. Convenient enquiry and payment "

NEGATIVE -

Purchase:
- The service is limited to certain devices and operating systems. Not even all the cellphones with NFC worked

▶ "Not support??! This apps cannot support Samsung Note 4 / Android 5.0.1????"

Activation:
- Frequent technical issues when launching the app or during the process of reading the card (frequent glitches)
- Issues with compatibility (Android version, device, second SIM card)
- It only allows one Octopus and one personal card
- Activating the online payment takes 24 hours (applies also for cards)

🐦 "Issues with SIM 2 My phone is sony z5p dual sim but it can't detect the octopus sim when i was using that in slot 2?! Using in slot 1 is fine"

Check in:
- The reader might fail when checking in or out

🐦 "Very unreliable. Sometimes it scans, other times nothing."

Transaction review:
- The colors of the UI make it hard to read (Orange white)

Reflection:
- Some users are concerned about data security since the SIM card can track location.
- NFC reading process is unreliable and often weak
- Weak connection to the server
- Annoying pop-up advertisement.

EMOTIONAL CURVE

(emotional curve graph)

4.3. DB NAVIGATOR, GERMANY

4.3.1. Description

Transport system:
Deutsche Bahn AG (abbreviated as DB, DB AG or DBAG) is a German railway company . It is the second largest transport company in the world and the largest railway operator in the world with a ridership of 1.8 billions passengers a year ("Facts and figures 2016 | Deutsche Bahn," n.d.). Depending on infrastructure and location the company offers different services, namely:

- Fernverkehr (long distance trains)
- ICE (Intercity-Express) for high-speed rail services between major cities and regions
- IC (InterCity) for long-distance trains connecting regions with each other. If the trains cross international boundaries, they are usually called EuroCity (EC). There are also EuroCity services in Germany operated by foreign state railways
- Nahverkehr (local trains)
- IRE (Interregio-Express) serves regions and connects cities. There are IRE trains only in Baden-Württemberg and a Hamburg–Berlin service
- RE (Regional-Express) serves regions and connects cities
- RB (Regionalbahn) stops at all stations and is the most basic train service

Figure 12, Advertisement train services

- S (S-Bahn) are rapid transit and most of the lines stop at all stations.

Providing mobile payment for this complex system arises different challenges that might be relevant for the Dutch transport.

Mobile payment service:
Through a self-ticketing approach DB Navigator provides QR tickets for all DB railways services in Germany. The users are able to choose the most convenient ticket in the app and pay afterwards. The app pays substantial support for the pre travel experience by providing complete maps, different ways of searching for tickets, regional tickets and real time information (delays and cancellations). It is also possible to save favourite routes, places and itineraries, what which speeds up booking for frequent users. Finally, based on those favourites the user can activate delay alarms. For long travels the QR ticket is purchased for a specific journey so there is no need to for it to be activated, it is scanned by an inspector on board.

4.3.2. App interface

The app is available for iPhone, Apple Watch, Android mobile phones and tablets, and Windows phones. This offers users different options to plan the trip according to the user 's specific interests and needs. If the price is more important than time of departure there is a menu option for save fares, the same applies for real time information, favorites, and regional tickets, among others. It is remarkable that the app includes shortcut accesses to the most used features (trip planner, favourites and history, my tickets, and real time information "my trip")
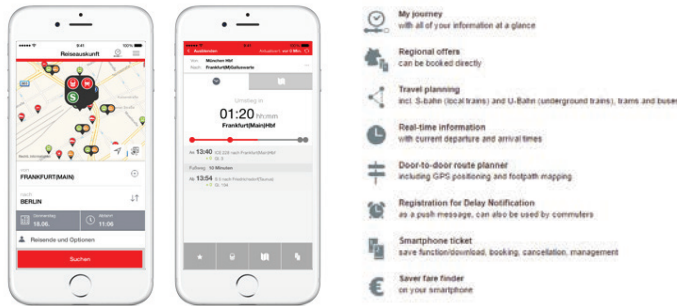
DB Navigator

Menu structure

Main side menu

My Navigator

Information & Booking
- ★ Favorites & History
- Trip planner
- Realtime information
- Saver fares
- Verbundtickets
- Regional offers

Tickets
- My tickets
- Load ticket
- Search Order

- Timetable
- Is my train on time?
- Delay Notifications
- Map
- BahnCard
- Carsharing & Co
- Dialog & Feedback
- Information & Help
- § Imprint

Additional services
- Carsharing / Bikes
- Dialogue and feedback

Shortcut menu

From:
To:

Departure/Change/Arrival in

00:00 hh:mm

Station

You can file a route as My Trip via Favourites/Trips, Tickets/Itineraries or Travel Information/Details.

Favourites and history

Favourites & History

Places | Connectio | Itineraries | Verbundtic

No favourites saved

Planner

Planner

from
Station, address...

to
Station, address...

Today, Fr. 07.10. | Departure 13:43

Travellers and options

Search

Map

Map

Station, address...

Locations nearby:

You have not selected a location. Please enter a location.

My tickets

My tickets

Today | Month | All

There are no orders in the view "All"

To refresh your mobile phone tickets and reservations in this list, please pull down with your finger.

Saver fares

Saver fares

from
Stop, ...

to
Stop, ...

Round trip

Today, Fr. 07.10.

Travellers and options

Search

Departure

Departure

Departure | Arrival

Station
Station, ...

Today, Fr. 07.10. | Departure 16:32

Direction
Station, ...

All means of transport

Search

Is my train on time?

Is my train on time?

Is my train on time?

Date
today

Means of transport
ICE

trainnumber

Search

Delay Notifications

Delay Notifications

To use the Delay notification service, you are required to enter your user name which you can save by entering it into the app's user management.

You can find further information over the Delay notification and which services you are monitoring here.

Show delay alarms

BahnCard

BahnCard

To use the BahnCard Services, you are required to enter your user name which you can save by entering it into the app's user management.

Further information on BahnCard Services and how you can register.

My BahnCards
- View BahnCard
- Buy BahnCard
- Load BahnCard
- BahnCard products

Figure 13, DB Navigator app interface and features

4.3.3. Customer Journey

The self ticketing is designed for an open system (without gates). The emphasis of the system is on the preparation step, which might be due to the multitude of services that is provided, from intercity services to internationals travels. Different features are provided to respond to different user needs and concerns.

4.3.4. Insights

Positive aspects:
- The app is perceived as easy to use, reliable and convenient for both long distance and short journeys. The tickets can be purchased anywhere and at any time, making it a life saver for both frequent users and tourists.

"omg the DB navigator app is amazing... it tells me not only what changes i'll have to make in 3 months, but what line the train is on!"
- Retrieved from Twitter-

"Easy all in one app Perfect for planning your trip, booking and keeping track of your tickets"
- Retrieved from Google play-

"DB Navigator iPhone app is awesome, bought my first mobile train ticket and showed matrix code on iphone to conductor"
- Retrieved from Twitter-

- Planning the trip as core function of the experience is perceived as reliable and therefore trustful.

"Fantastic DB ticket management Great tool for all your tickets, timetables,... You name it. Now it saves your BahnCard too."
- Retrieved from Google play-

- It has mapped out most of the stations and routes in Germany in a reliable way, this countywide approach is deeply appreciated.

"A Lifesaver The best public transit app I have ever used. I am a foreigner living in Germany, and I don't know what I would have done without this. I now feel like a master of the buses and trains here, even though I speak 0 German."
- Retrieved from Google play-

- Besides the trip planner and maps, it provides information about other one-shop stores, ATM and travel information among others.
- It is possible to log into an account, this provides connectivity between tickets bought in the computer or smartphone, as well as the possibility to manage personal tickets, store favorites and activate notifications if the transport is delayed.
- Various services are interconnected in one app in what seems to be a consistent manner.
- Widgets are provided for easy access to the most used functions, which contributes positively to the experienced usability.

CUSTOMER JOURNEY DB NAVIGATOR

PURCHASE · Function with shortcut access   **PRE TRAVEL**   **TRAVEL**   **POS TRAVEL**

STAGES

Getting the app	Searching	Booking	Station	Get on	Travel	Inspection	Get off	Connections	Reflection

STEPS

Search · Install

Favorites and history — Places, Use as departure/arrival, Connections, Itinerary

Real time information — Stations, Journeys Real time information, Journey details Not book option

Time Table — Stations, Journeys list, Journey details Not book option

Map — Map with filter options, Geolocalization, Select station, Route

Saver fares — Stations, Journeys sorted by price, Journey details confirm to book

Regional tickets — Region, Journey details multiple tickets

Trip planner — Trip planner, Geolocalization, Select station, Travels by time, Journey details, Prices/booking

Log in · Register

Payment · My tickets · Load ticket

Look for platform

Get on

Travel · My trip Time, connections, arrivals, departures, map

Show to the inspector

Get off

Change platform

Reflection

CURRENT EXPERIENCE — POSITIVE +

- Easy to use and reliable to plan travels and check schedules (Better app than Google aps and London Underground 'tube')
- Schedules available long time before the date of travel. Easy to book future schedules.
- Provides information for one-stop shop for travel info & services
- Experienced as convenient for both short distance and long distance trains.
- Easy to use for frequent travelers, it has functions of ticket management to keep track of the tickets
- Saves the BahnCard and links it with an user

- It consistently offers multiple services in just one app
- Provides better information than the webpage
- Widgets are provided for easy access to frequent journeys
- It is able to load tickets bought on the webpage
- Wide coverage, even small stations are included

- Has an Apple Watch version (High technology perception)
- The schedules might be flexible, any station in the city might be used for an international travel
- It supports Apple Wallet to load the ticket, making faster and easier to find it

  "First day with #AppleWatch. I'm at 39% battery right now. So far so good. Very impressed by DB Navigator!"

- The service is available worldwide in different countries, however it is more accurate in Germany, countrywide reliable information is appreciated.
- It is easy to use and convenient since tickets can be purchased anywhere
- Sometimes the tickets might be cheaper than in other service touchpoints
- Life saver for tourists
- It provides reliable and real time information for planning trip.

NEGATIVE -

- Frequent technical issues (crash), when opening, logging in and booking: No connection error, bug for changing the times,
- Problems during the searching, no results found.
- Widget failing to load, reduces positive perception of usability.
- There are some missing stations and schedules for bus and tram, as well as some inaccurate schedules
- Because of the use of a side central menu and the non-linear process, when there is no back option, pushing the back button completely shuts down the app.
- The real time information is only available for planning (future travels) not for keeping track of the current journey
- It consumes too much data (1 search is 2mb)

- Lack of user error feedback in the payment process with credit cards.
- It is not allowed to add two credit cards
- If the ticket is booked online, when loading the ticket it is required to use a pdf reader
- Windows app does not support mobile tickets

- Delay in real time information, bugs, and missing trip information for the trip
- The tickets bought online must be printed (contradictory information)
- The reservation tickets show as main date the booking day and not the travel one
- No automatic notifications show following the current trip (changes and delays). This must be found out in different menus

- Requires access to contacts informations to provide auto-complete, raising concerns about privacy.
- Not always shows the fares
- Conflicts with Android apps by the same developer
- Puzzling UI choices, such as back button
- Slow
- No offline schedule
- No function for managing multiple accounts.

EMOTIONAL CURVE

+ / -

- It is connected with Apple Wallet to facilitate the access to tickets.

Figure 14, Ticket in apple wallet

- When buying long distance tickets from city to city, the trip can start in any station of the city, thus making it quite flexible.
- The app runs on multiple devices (iPhone, iPad, Android Phones and tablets, Apple Watch). Apple Watch seems to be appealing to some users due to its novelty value.
- Notably, there are no comments related to ticket inspection.

Negative aspects:
- Frequent technical issues decrease user confidence and trust in the system.

- Some User Interface details as the lack of user error messages, the non-intuitive use of the back button (due to the side menu), and the problems to load schedules creates a negative perception of usability. This make the app seem slow.

- Even thoughthe rail domain is the core part of the services, the trip planner includes buses and trams, though some routes and stations of those might be missing.

Stupid DB Navigator app is not displaying connecting busses anymore. Instead just doesn't find anything at all. @DB_Info #fb

- Retrieved from Twitter-

- The real time feature information is only available for future journeys and not for keeping track of the current journey.
- Data consumption is high.

Just for one search take more than 2 mb. And also I think it takes data even when this app not in use. Crash sometimes.. Not opening search results in the 1st search. I had to go back and search again please fix this

- Retrieved from Google play-

-The Windows version of the app does not support mobile tickets purchase
- Real time trip feature might provide delayed information, hence creating mistrust.

@seatsixtyone shame it doesn't normally tell you with the same amount of accuracy how late your train is!

- Retrieved from Twitter-

Oh no Will be late for #duth because of train delay. Worst thing: I could have been in the right ICE if #dbnavigator would have let me know

- Retrieved from Twitter-

- The most notable date on the virtual ticket is the data of purchase and not the date of travel, which leads to confusion.
- It is not possible to activate notifications for the journey. Making this possible would provide travelers with more guidance while traveling, thus increasing user confidence that the trip is proceeding correctly.
-The app at times conflicts with other Android apps (by the same

developer)
- There is not an offline schedule, without data access this app feature became useless.

4.3.5. Conclusions

- Overall the service is positively evaluated with the highest score among the four analysed services. It is also the one with the most accepted deviceincluding Apple Watch and tablets.

- The core service of planning journeys creates a strong positive bond with the users given the daily use, as well as the multiple services for both short and long travels and the accuracy of schedules.

- Contradictory opinions were found regarding the accuracy of the mapping. Some users found it highly reliable in terms of routes and stations while others complain about the lack of information. This duality is also identified with the real time information feature.

- The use of widgets and shortcuts in the interface, plus the side menu and multiple options for searching provide a rich experience that aligns with the preferences that different users might have.

- Aspects of the app that are highly appreciated by users are the ability to store favorites (journeys, stations and routes), as well as the easy access to information about the current trip. However users are expecting even more "smart" and real time features as reliable and accurate alerts.

- Frequent technical issues, especially during booking and searching, is the most common negative concern.

4.4. APPLE AND ANDROID PAY, LONDON

4.4.1. Description:

Transport system:
Operated by Transport for London (TfL) the London transport system includes, among others various rail networks including the London Underground, London Overground, Docklands Light Railway and TfL Rail, and London's trams and buses. The Underground (or 'Tube') is by far the most used service with a ridership of 4.8 million a day and 11 lines that connect Greater London and some nearby counties. TfL uses a zonal fare system to calculate fares as well as variation between peak and off-peak hours, however for contactless payment and Oyster cards fare can be reduced by using pay as you go.

TfL has developed a contactless payment system, including contactless payment cards (Visa, American Express, Mastercard and Maestro), Apple Pay, Android pay and Barclaycard. All contactless work with pay as you go fare, therefore there is no need to top up or buy a ticket in advance, besides users can benefit from daily and weekly capping, this means a limit in a single day or week cost regardless of the number of trips.

Figure 15, The tube map

Mobile payment service:
Mobile payments are mostly done through Apple and Android Pay. Both Apple and Android pay work by providing a mobile wallet for a bank card and since the system is already set for contactless payment it is possible to check in and out with the cellphone as a card. To that end the user must tap in and out at station gates. Mobile payments are available for the following services: Tube DLR, London Overground, TfL Rail, Emirates Air Line and Thames Clippers River Bus.

The service is restricted to only card issuers with a previous agreement with both Apple and Android. It is essential to use always the same payment method (mobile or card) because even if the card is the same in the mobile wallet, when using it the system recognizes a specific card and not a specific mobile device, and if users check in with one virtual card (on their phone) and check out with another, extra charging will occur for incomplete travels.. Another possible issue is related with the battery, because when running out of battery the gates are not able to recognize the payment device, again exposing the user to incomplete journeyand thus extra fees.

Finally, the mobile wallet can be connected with an contactless and Oyster account, allowing the user to check the trips, get email alerts and apply for refunds.

Figure 16, Apple pay advertisement

CUSTOMER JOURNEY APPLE AND ANDROID PAY, TfL

	PURCHASE	PRE TRAVEL			TRAVEL					POS TRAVEL	
STAGES		Getting the app	Setting	Preparation	Check in		Station	Travel	Check out	Transaction review	Reflection
STEPS		Search / Install	Apple / Android / Add cards	No features for this step	Ensure to have enough battery / Mobile on the reader / Confirm fingerprint / Open gate		Look for platform	Travel	Mobile on the reader / Confirm fingerprint / Open gate	In the app	Reflection
CURRENT EXPERIENCE POSITIVE +		- Easy to set up - Mastercard offers free rides on monday (advertisement)			- The use is intuitive, the vibration feedback is clear - The time in the gate is apparently the same as a contactless card (a bit more than an oyster) - The app is able to foresee if the user is having issues with the fingerprint scan, and suggest the use code instead. - Android might be faster than Apple pay, because there is no need to unlock it is just tap and go. *"Using Apple Pay on the tube is absolutely genius! Who needs an Oyster Card"* *"First payment with Android Pay at the train station today. Seamless. En route to London so will go cashless all day including tube as a test Android Pay is therefore the devil."*					- Convenient to buy not only tickets but other stuff on the go, Life saver for those who left the wallet at hom- - As it is and extra device one person might have multiple ways of payment - Easy to use, and convenient. Life saver for those who forgot the wallet at home. - Since it is a centralized way of payment, by using it in a wide service as public transport, the chance of being used in stores increases. - Able to use multiple modes of transport. - The high technology of the service is appealing for some users. - It is possible to connect the oyster account with the mobile payment.	
NEGATIVE -		- Limited to some bank services			- Using different cards or devices increases the fare for incomplete travel. - The reading performance of the fingerprint scan changes according to the iPhone type, old models might encounter more issues - The mobile reading on the gate is a bit longer than the oyster, people in the line get annoyed because of the delay. It is an awkward and embarrassing situation - Apple Pay might start updating while users need to use it to validate. *"I use Apple Pay to tap in and out on the tube and people sure do get annoyed at me that I take 0.5 seconds longer "*		- Since gate reader is located on the left side Apple Watch users must tap on that side even if they are wearing the watch on the right hand so creating an inconvenient interaction. - Validating the phone at gates is unreliable. The action often fails. This situation is even worse with readers on buses. - Some users are caught up in the station because it works to check in but not to check out - It relies on battery, without battery the user is exposed to fees for incomplete journeys. - It requires data connection to tap in and out, without it the user might have to pay extra fare or fees *"Why can't they get it right? @ApplePay falters and stutters at both ends of my tube journey. Even I am getting fed up with this"* *"I used Android Pay on the tube today which was fine, second journey it wouldn't let me out at all. I had to use the same card as instructed by the member of staff."*			- When activated the capping system is cumulative, so the fee does not appear immediately after the use but during the cap in the night. Therefore it is hard to keep track of travel costs in real time. - It is not clear the if the use of international cards is allowed, some users found out that even though the card is from an authorized bank the payment didn't work` - Unreliable on the gates, might or not work *"@TfL I keep having trouble with Apple Pay/Contactless card payments. Lots of "Unpaid fares" showing up and I'm being overcharged???"*	
EMOTIONAL CURVE	+ / -										

4.4.2. Customer Journey

Similarly to the Octopus service in Hong Kong, the Oyster mobile payments service does not provide any support for preparation in pre travel experience. There are some additional apps that can be used ascomplementary services for trip planner and map consultation.

4.4.3. Insights

Positive aspects:
- It is easy to setup and use. It is convenient as there is no need for cards or cash. Life saving when leaving the wallet at home, resulting in a positive experience.

Saw an add for Barclaycard Apple Pay on the tube. While leaving the station I set it up and within 5 minutes I paid for a coffee.
- Retrieved from Twitter-

I've used it every day I commute for just over a month, and it's great. Works exactly as intended.
- Retrieved from Reddit-

Finally can use Android Pay now @santanderuk has been added. I'm so excited for this. So much easier on the tube, cafes ect.
- Retrieved from Twitter-

- It is intuitive to use and the visual feedback is clear.
- It is possible to use it in multimodal systems of transport.
- Users enjoy to be part of the innovative technology, it is experienced as novel and exciting, and therefore a reason to show off and proudly promoting.

Left wallet in office yesterday. Oyster, bank and credit cards all in safe hands of @ DominicPreston Used Apple Pay for tube. Love. It.
- Retrieved from Twitter-

My boss used his Apple Watch on the tube this morning. Source: He won't stop talking about it.
- Retrieved from Reddit-

- The mobile payment can be connected with an account, which allows users to have more detailed information about their journey.

@TfL ok thanks. I like how each tap in/out shows up inside the Android Pay app initially as pending then grouped under the final charge
- Retrieved from Twitter-

- For Android Pay, the process of opening the gates might be faster than Apple Pay, since Android Pay does not require fingerprint validation.
- Especially for frequent travellers the 'pay as you go' fare system (with daily or weekly capping) can make commuting cheaper.

Negative aspects
- The services is limited to certain mobile phones, and to banks with agreement with the mobile wallet (Apple/Android Pay), therefore restricting the use to a certain target group.
- Users face some financial risks some risks when using the mobile payment system. Using a different card virtual card to check in and out, not having a data connection while checking in/out, and running out of battery all might lead to higher fares or fees. Even though these issues can be circumvented by the user, prevention is the complete responsibility of the user, there are no system failsafes in place.-

Using apple pay for the tube is all fun n games until your phones about to die and you didn't bring an Oyster card out
- Retrieved from Twitter-

- The most common complaint is related to the gate opening time. It

is definitely perceived as longer than an Oyster card, and for users without experience and with old mobile phone models might even increase. This is not an issue only for the person paying but also for the people waiting in the queue, which makes the social experience awkward and embarrassing.

I use Apple Pay on the Tube. I'm also one of the top ten most hated people currently at large in the capital today.
- Retrieved from Twitter-

Used Apple Pay on tube for first time today. Delay is crazy - I was milliseconds later than I should have been!! Thought contactless was bad
- Retrieved from Twitter-

@TfLTravelAlerts any tip on how to make Android Pay work better on tube gates? I'm very happy about it but it still takes ages to open gates
- Retrieved from Twitter-

- Gate readers are located on the left, thus Apple Watch users are must tap on that side regardless of the side they use the watch, this interaction might be inconvenient and cumbersome.
- The process of opening the gate can fail for different reasons, either the reader or mobile phone might encounter a technological issue, this makes the service unreliable, especially in buses where users often reported that the readers are weak.

Apple Pay, you do choose not to work and embarrass me on the tube at the worst moments!
- Retrieved from Twitter-

@TfL many contactless machines seems to show error msg while using android pay. Need some fix
- Retrieved from Twitter-

- The latter leads to one of the most serious issues, the user might be caught up into the station because it was possible to check in but not check out, leading to frustration given the fee for incomplete journey.

AAARGH use Android pay on @TfL all day yesterday and this morning, works fine. Fails on way home, have to use my card and pay more.
- Retrieved from Twitter-

This morning none of the gates at Chancery Lane worked when I tried to exit. The guy just let me through but I now have an unfinished journey to get a refund for. Not a great experience using android pay
- Retrieved from Twitter-

- The fare is cumulative so the final fare is shown at the end of the day, making hard to follow up the cost of the journey. However some users seem to appreciate how the information is presented at the end of the day.

4.4.3. Conclusions

- The user experience might be affected by the complete service of the mobile wallet, that allows not only payments in the public transports but also in stores.

- Both Apple and Android Pay are easy to configure and use, the steps for purchase and configuration are short as well as the check in and check out.

- The novelty of the technology positively influences the experience, the users feel proud.

- Similar to Hong Kong service, this is limited to certain high end

mobile phones. Secondly, the technology can fail at the gates for different reasons (weakness of the reader or NFC). The latter might lock the user inside the station or increase the fee for an incomplete journey.

- The most common complaint is related to the time it takes to check in or out. It is slightly longer than the oyster card, this is not only affecting the user checking in, but also the people in the cue behind him/her, thus creating an awkward social experience.
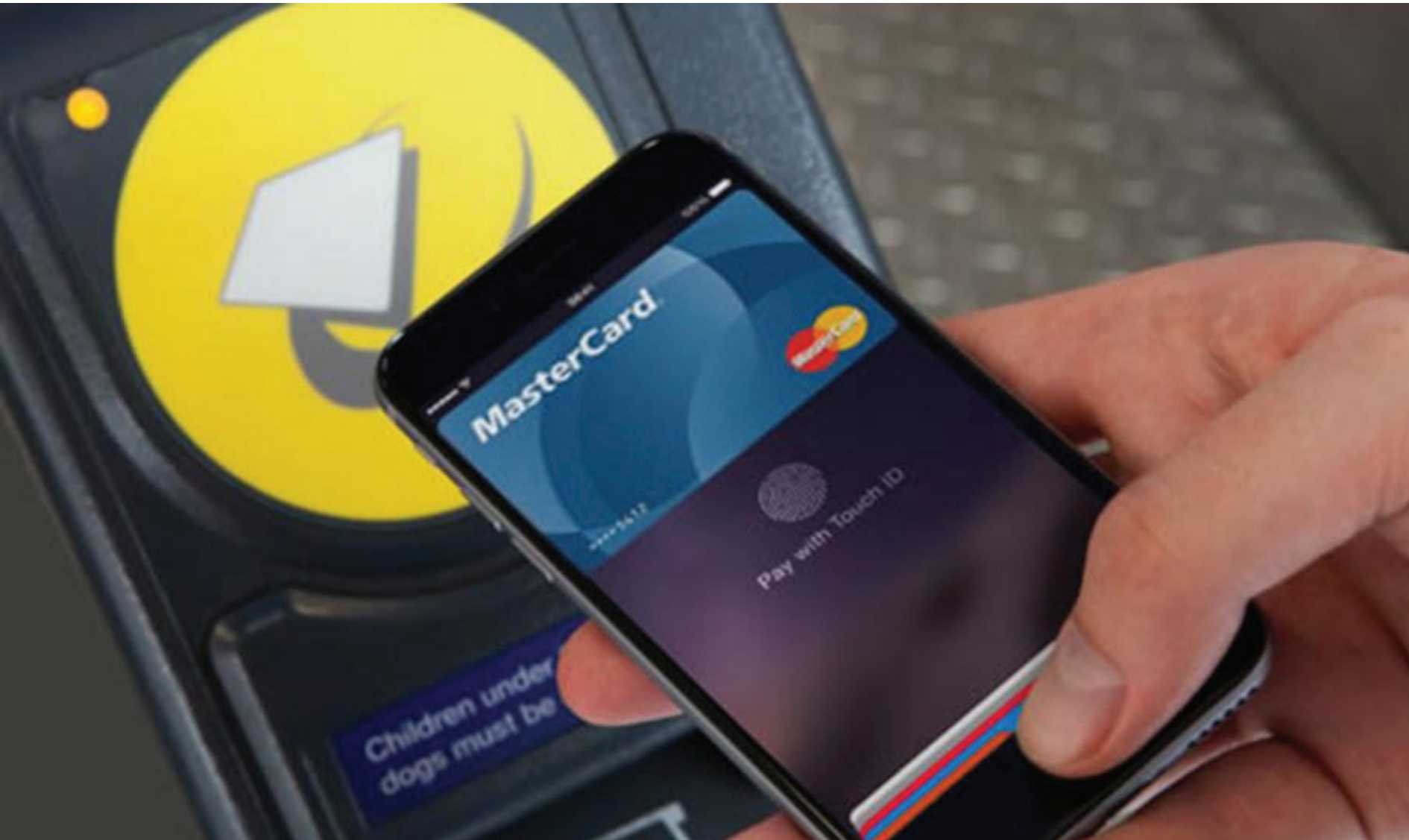
5. Discussion

Even with some clear limitations, online users self-reports on social media, forums and blogs seems to be a convenient and useful source of information for a preliminary user experience evaluation. This also might give a design team a much needed overview in case of limited resources for engaging in a actual field research.

The initial overview of mobile payment systems provided in this study provides a clear overview of how the different mobile payment technologies have been adapted to create specific service models that respond to the requirements of the context. The current infrastructure and the sociocultural context seem to have a strong influence on how the mobile payment is designed in each country, region or city. For instance, DB Navigator, which is a self-ticketing based service, is possible in Germany given the open stations and in contrast Octopus in Hong Kong has had to create a complex purchase process to be able to open the gates.

Different business models lead to different customer journey steps. Even though the stages are the same, some services put more emphasis on either the pre travel experience or on the purchase process. However it is complicated to determine how those

differences are affecting the user experience given that in each location (country, region or city) users have different expectations of public transport and mobile payment services. Interestingly, lacking a preparation step for searching the schedule and tracking the map does not seem to detrimental per se to the user experience of the service.

Nevertheless differences are not only found between technologies. Even between systems that shared the same technological platform, considerable differences were identified in terms of interface design, menu structure , advertisement, available services, and accuracy and reliability of the service. Those details can certainly change the user experience. Therefore, all the details should be carefully designed to actually respond to user concerns. In the case of DBNavigator the multiple options for searching are a good example of how a complex menu is perceived as simple and easy to use because aligns with what is important to the user.

For the design of a positive experience there are two words that constantly pop up along all the research, technical issues and reliability. All the services and technologies have their own flaws, the consequences of those directly impact the user perception and willingness of using the service. With the check in and out time Apple and Android Pay are a clear example of how an apparent

small flaw can be perceived as a massive inconvenience, and not only personally but socially. On the other hand, design can help to counter those flaws and therefore grant a more positive experience, that is specially notable between MBTA and DB Navigator which are even based on the same technology but have a different user satisfaction, in which the latter tends to be more positive.

In conclusion, awareness of how differences in the context of use can and should impact how a service is designed is essential for the future design of the Dutch mobile payment service. Moreover it is essential to assess the advantages and disadvantages of technological platforms that are considered, as this choice seriously impacts user experience of the designed service. The examples of service structures represented in the customer journey of the anlysed services, as well as the overview of issues per service, can form valuable input when designing services for mobile payment in public transport.

5.2. LIMITATIONS

The presented results were collected through online desk research, therefore some limitations apply.

Language barrier:
Really interesting and potentially insightful services were not thoroughly investigated because of the limitation to access information in English (e.g mobile T-money in South Korea).

Cultural tendency to social media sharing:
Clearly an exploration of any kind with a worldwide approach is affected by cultural preferences and habits. In this case, the disposition of an specific culture to self-report on social media (e.g complaint and congratulate) impacted the amount of available information. For instance, more comments were found for services located in United States than in Hong Kong, regardless of the maturity of the services

Social media:
Because social media and online reviews were the main source of information, the information collected may have been biased because the sample of informants may not have been representative for the whole traveller population, for example in terms of age, level of education and access to Internet.

Searching location:
Internet searching is influenced by the location of the connection, and it should therefore be noted that most of the research done for the inventory was performed with a connection in United States, which may have influenced the services identified.

6

6. Conclusions

6.1. CONCLUSIONS

The chosen technological platform for a service for mobile payssible to see how the features and design in each step can change the user experience in either positive or negative way. This means that even services that share the same technology can offer a completely different user experience.

The conditions for which the service is designed, the socio-cultural context, the current infrastructure, the type of public transport services, and the type of payment are primary factors influencing the service structure, steps, stages and all the customer journey.

The preparation step (checking map and/or trip planner) is not essential for providing a positive experience, however it might be able to strengthen the brand customer relationship on a daily basis if if in this step an accurate and reliable service is provided.

Reliability is essential for a positive experience as a reliable system promotes trust. Being able to trust the service is deeply appreciated, on the other hand unreliable systems are strongly criticised. Basically any technical issue has the potential of travelers forming a bad opinion of the service.

Given the fast development of technology nowadays users expect even "smarter" systems that foresee their needs and provide them with required information at the right time. In the case of preparation specifically, real time accurate information is imperative (e.g alerts). Also the use of favorites or autocomplete functions are appreciated..

The user interface design (e.g. menus structure, interaction gestures, colors, error messages) are crucial for providing a smooth usey experience of the app.

Having a deep understanding of the user concerns in each step of the travel process is indispensable for offering a simple and easy going experience. For instance, a feature that allows the user to undo mistakes (e.g refund) might reduce the perception of risk and consequently increase the willingness of using mobile payment.

Some features that are appreciated are:
- Personal log in with ticket management, allowing the user to check transactions, and history.
- Widgets for instantly checking information, as well as shortcuts for accesing the most relevant features.
- Multiple methods of payment.

Technologies based on NFC are limited to certain types of mobile phones, hence reducing the target group potential user base. Secondly, users of mobile payment services seem to often encounter technical issues, which may be due to the novelty of the technology.

The main conclusions might be that all details are crucial, user experience in mobile payment is complex and does not depend on one specific feature or step. Traveling start way before check in in the station or boarding the train, and it therefore transcends the physical interaction at the gate. Mobile payment in public transport is definitely about more than opening a gate or obtaining an e-ticket.

All the small decisions in the interface design, the check in time, the feedback, the access to information, the reliability of the information -among others- are interconnected and together form what we call user experience.

6.3. FURTHER RESEARCH

Due to its setup (online desk research) this study has limitations in uncovering certain aspects of the user experience, and it is unknown how the information retrieved differs from what might be found through in situ user research. Therefore field research is recommended for confirming the results and gaining more insights into the user experience of mobile payment user experience in public transport.

7

APPENDIX

1. MBTA

Massachusetts region

The Massachusetts Bay Transportation Authority, often referred to as the MBTA or "The T", is the public operator of most bus, subway, commuter rail, and ferry routes in the greater Boston, Massachusetts area.

Lines: 12 (commuter rail), 4 (heavy rail), 5 (light rail), 4 (trolleybus), 4 (ferryboat), 183 (bus)

Stations: 123 (commuter rail), 51 (heavy rail), 74 (light rail), 22 (BRT)

Ridership: 1.3 millions riders per day

Google Play - Android

Update: November 29, 2013
Installs: 100,000 - 500,000

4,2
★★★★☆
👤 870 insgesamt

★5	471
★4	226
★3	79
★2	25
★1	69
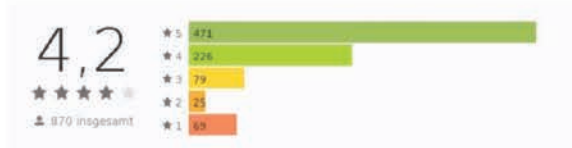
App store - iOs

Update: Sep 10, 2015

Current version: ★★
28 Ratings

All versions: ★★⯨
211 Ratings

MBTA mTicket

Self ticketing QR

The MBTA mTicket app is now available for all Commuter Rail and Ferry Lines. Purchase MBTA Commuter Rail and Ferry Single Ride, Round-Trip, 10 Ride, and Monthly tickets

Services:

Secure ticket purchasing with your credit or debit card
- Your smartphone is your ticket
- Never lose your ticket -- tickets can be easily transferred if your phone is lost or stolen
- Check Commuter Rail schedules, maps, and service alerts
- Allow fare reduced fare ticket and multiple tickets purchase

Technology:

You should activate your mobile ticket immediately before boarding your Commuter Rail train. Conductors will usually inspect tickets visually by checking the color changing ticket screen, but a conductor may occasionally ask to scan the barcode on your activated ticket.

Video URL: https://www.youtube.com/watch?v=C1lSMxnHR3c

2. TriMet

Portland

More formally known as the Tri-County Metropolitan Transportation District of Oregon, is a public agency that operates mass transit in a region that spans most of the Portland metropolitan. Transit type, Local bus, Light rail, Commuter rail, Streetcar.

Lines: Bus: 78, MAX Light Rail: 5, Commuter Rail: 1, Portland Streetcar: 2

Stations: Light rail: 97, Commuter rail: 5

Ridership: 319,700 riders per day

TriMet Tickets

Self ticketing QR

The App lets you purchase and use tickets and passes instantly on your phone—anywhere, anytime. Register your debit/credit card in our secure system, and you're ready to go.

Services:

• Buy and use fares instantly using a debit/credit card.
• Store multiple tickets on your phone for future use.
• Pay a single fare or multiple fares for a group of riders.
• Register your debit/credit card(s) in our secure system.
• Purchase tickets on your phone or on any computer via our website.

Technology:

You should activate your mobile ticket immediately before boarding, QR for inspectors

Google Play - Android

Update: June 17, 2016
Installs: 100,000 - 500,000

3,2
★★★
▲ 1.715 Insgesamt

★ 5	539
★ 4	332
★ 3	238
★ 2	199
★ 1	407
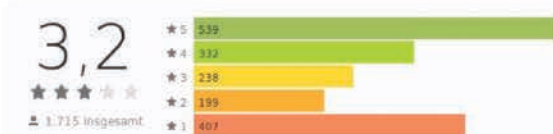
App store - iOs

Update: May 09, 2016

Current version: ★ ★
33 Ratings

All versions: ★ ★ ✦
389 Ratings
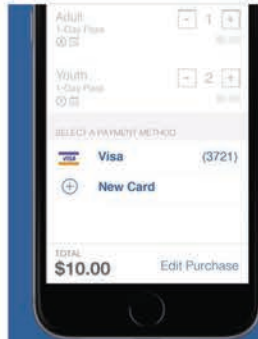
Purchase quickly.
Store your debit/credit card and pay with one tap.
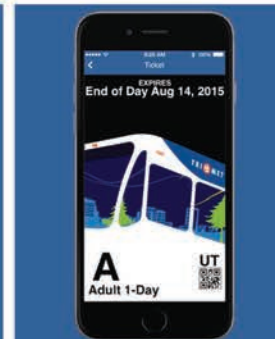
Show us your ticket.
Ready to board? Launch your ticket, sit, and relax.

Video URL: https://www.youtube.com/watch?v=Xji1bhIaIb0
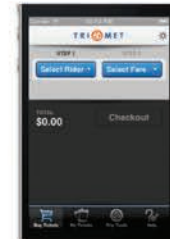
3. METRORail

Houston

METRORail is the 15.2-mile (24.5 km) light rail system in Houston, Texas (USA). After Dallas' DART Light Rail, METRORail ranks as the second most-traveled light rail system in the Southern United States and the 12th most-traveled light rail system in the United States.

Lines: 3 (5 planned)

Stations: 37 open 2 under construction

Ridership: 43,900 per week day, 11.3 million year

Q-Ticketing

Self ticketing QR

Ticketing app that lets you purchase and use your METRO fares and passes instantly on your phone. Mobile tickets can only be used on local bus & rail at this time.

Services:

• Buy and use fares instantly using a debit/credit card or PayPal.
• Store multiple tickets on your phone for future use.
• Pay a single fare or multiple fares for a group of riders.
• Register your debit/credit card(s) in our secure system.
• Purchase tickets on your phone or on any computer via our website.

Technology:

Show the activated ticket to a bus operator, ticket inspector or METRO Police Officer when asked to present your ticket.

Google Play - Android

Update: May 31, 2016
Installs: 5,000 - 10,000

3,9
★★★★☆
👤 29 insgesamt

★ 5	17
★ 4	3
★ 3	3
★ 2	1
★ 1	5

App store - iOs

Update: Sep 10, 2015

All versions: ★ ★★
11 Ratings

Transform your phone into a ticket vending machine
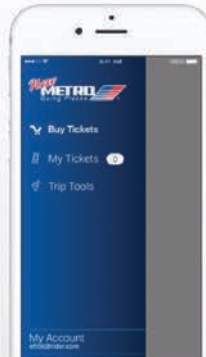
Activate your tickets in seconds!

Feb 24, 2016 12:41 PM

Full Fare

Video URL: https://www.youtube.com/watch?v=FIQOmqecJLc
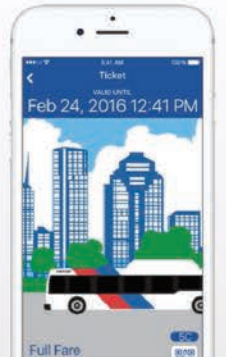
4. MTA LIRR / MNR

New york area

Long Island Rail Road Company is a commuter rail system in southeastern New York, stretching from Manhattan to the eastern tip of Suffolk County on Long Island.
Metro-North, is a suburbancommuter rail service of the state of New York.

Lines: LIRR: 2 lines / MNR: 5 lines

Stations: LIRR: 124 / MNR: 124

Ridership: LIRR 337,800 riders per weekday
MNR 298,900 riders per weekday

Google Play - Android

Update: July 27, 2016
Installs: 10,000 - 50,000

2.8
★★★
👤 91 total

★5	29
★4	5
★3	9
★2	11
★1	37

App store - iOs

Update: Sep 10, 2015

Current version: ★↙
9 Ratings

All versions: ★★
59 Ratings

MTAeTix

Self ticketing QR

The MTA eTix app currently supports only the MNR Hudson and Harlem Lines and the LIRR Port Washington Branch. Additional lines on both railroads will be made available in August

Services:

- Take your ticket with you when you upgrade your phone
get a refund for unused mobile tickets, request receipts and manage payment information.
- Check train schedules and service statuses
- Tickets can be one-way, 10-trip, weekly or monthly. The ticket is saved in an electronic ticket wallet in the app.

Technology:

- 'Punch' your own ticket just before you board
- Riders should have the ticket displayed on their phone when the conductor comes to ask for tickets. Conductors will use a handheld device to scan mobile tickets.

Planning to install readers in the future
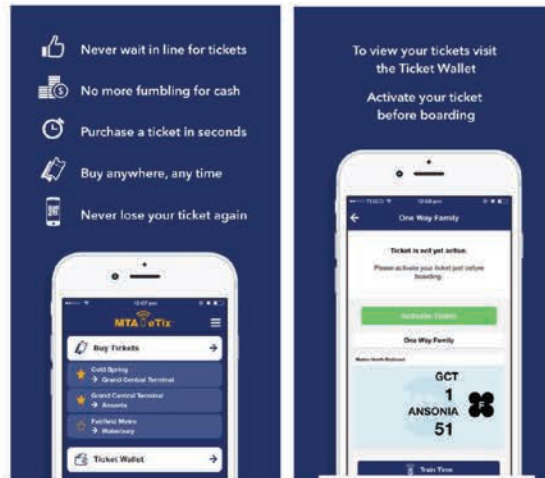
5. Ruter

Oslo and Akershus

Ruter provides services for: Oslo Metro, Tramway, Commuter rail, Bus, and Ferry.

Lines: Metro 6, Tram 6, commuter rail 8

Stations: Metro: 101, tramway 99, commuter rail 128

RuterBillett

Self ticketing QR

Ruter's mobile app lets you buy your ticket before you get on board. The ticket is valid on the Metro, buses, trams, ferries and trains in Oslo and Akershus.

Services:

- You can buy a ticket just for yourself or for a group travelling together.
- You can buy tickets in advance, and you can change the start time for your ticket
- For additional security, you can change the fare limit for which a password is required when buying tickets.
- Your receipt will be sent via e-mail.

Technology:

Activate the QR ticket before boarding

Google Play - Android

Update: June 27, 2016
Installs: 500,000 - 1,000,000

3.7
★★★★☆
👤 1.661 total

★ 5	714
★ 4	388
★ 3	183
★ 2	108
★ 1	268
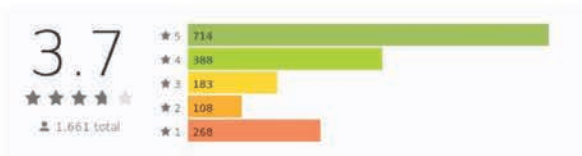
App store - iOs

Update: Jun 27, 2016

All versions: -
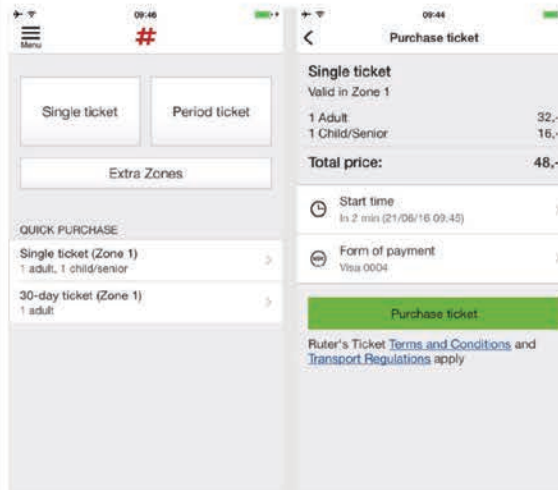
Video URL: https://www.youtube.com/watch?v=_8qdNS3x3uM

6. SFMuni

San Francisco

The San Francisco Municipal Railway (SF Muni or Muni) is the public transit system for the city and county of San Francisco, California.In ridership Muni is the seventh largest transit system in the United States. Transit type Bus, trolleybus, light rail,streetcar, cable cars

Lines: 82

Ridership: 679,800 per day

Google Play - Android

Update: May 20, 2016
Installs: 10,000- 50,000

2.9
★★★☆☆
👤 58 total

★ 5	11
★ 4	12
★ 3	12
★ 2	8
★ 1	15

App store - iOs

Update: May 20, 2016

Current version: ★ ★
10 Ratings

All versions: ★ ★ ↲
48 Ratings

MuniMobile

Self ticketing QR

MuniMobile lets you buy tickets instantly through a credit/debit card or PayPal account. Buy Muni tickets and passes in advance or for the whole family from one smartphone.

Services:

Ability to purchase, store and use single or multiple Muni fares on one mobile device
Ability to pay for single-ride fares, cable car rides, and one-day, three-day and seven-day passports
Industry-leading security to protect personal information and payment
Trip planner integration

Technology:

Riders should purchase and activate their tickets before or while on the boarding platform, Inspector personnel have been trained in verifying these tickets.
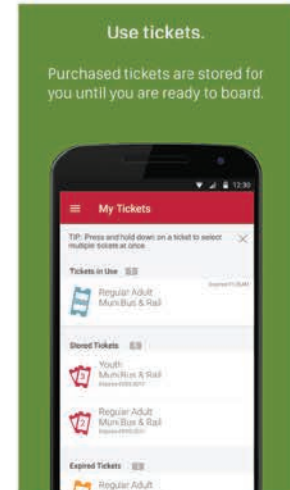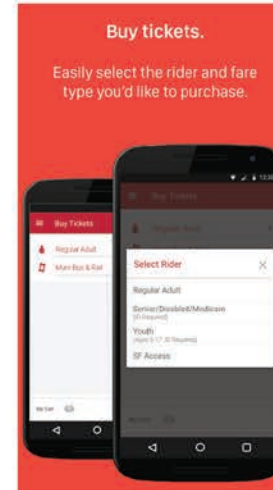
7. BVG

Berlin

The Berliner Verkehrsbetriebe (German for Berlin Transport Company) is the main public transport company of Berlin, the capital city of Germany. It manages the city's U-Bahn underground railway, tram, bus, replacement services (EV) and ferry networks, but not the S-Bahn urban rail system.

System	Stations/ Lines/ Net length	Passengers per year
U-Bahn	170 / 9 / 145 km	457 million
S-Bahn	166 / 15 / 331 km	376 million
Tram	398 / 22 / 192 km	171 million
Bus	2627 / 147 / 1,626 km	407 million
Ferry	14 / 6 / -	-

Google Play - Android

Update: May 13, 2016
Installs: 1.000.000-5.000.000

3,8
★★★★☆
⛹ 7.449 insgesamt

★ 5	3.435
★ 4	1.818
★ 3	775
★ 2	461
★ 1	960

App store - iOs

Updated: Aug 01, 2016

All versions: ★★★✰
59 Ratings

BVG FahrInfo Plus App

Self ticketing QR

It allows you to use your mobile phone as a ticket and find out about connections or save favourite routes and call them up at the tap of a finger. In addition, you can display the locations of available car club vehicles from Car2go with an interactive area view.

Services:
* Purchase possibility of following mobile tickets, valid for all transport in VBB by credit card or direct debit for the tariff zones Berlin AB, BC and ABC: see the play store for the details
 *Integrated timetable information for all connections in the VBB
* stops departure board
* Individual settings: travel history, remiders for departures and connectiosn, access to contacts
* connection with Car2go
* Offline maps

Technology:
QR. Show the inspection staff your smartphone with QR.

8. Deutsche Bahn

Germany

Deutsche Bahn AG (abbreviated as DB, DB AG or DBAG) is a German railway company. Headquartered in Berlin. It is the largest railway operator and infrastructure owner in Europe. It carries about two billion passengers each year.
- **ICE** (Intercity-Express) for high-speed rail services between major cities and regions
- **IC** (InterCity) for long-distance trains connecting regions with each other. If the trains cross international boundaries, they are usually called EuroCity (EC).
- **IRE** (Interregio-Express) serves regions and connects cities
- **RE** (Regional-Express) serves regions and connects cities
- **RB** (Regionalbahn) stops at all stations and is the most basic train service
- **S** (S-Bahn) are rapid transit and most of the lines stop at all stations.

Google Play - Android

Update:
Installs:

3,9
★★★★☆
👤 29 insgesamt

★ 5	17
★ 4	3
★ 3	3
★ 2	1
★ 1	5

App store - iOs

Current version:
9 Ratings

All versions: ★ ★★
59 Ratings

DB Navigator

Self ticketing QR

"My journey" contains all of your travel details a glance, such as timely notification of an upcoming train transfer. Push notifications actively provide you with information such as your departure time, when you need to change trains, and what the arrival time is. This section also contains real-time information such as delays and gives you direct access to alternative connections if you need them.

Services:
- My journey: with all of your information at a glance
- Regional offers: can be booked directly
- Travel planning: incl. S-bahn (local trains) and U-Bahn (underground trains), trams and buses
- Real-time information with current departure and arrival times
- Door-to-door route planner including GPS positioning and footpath mapping
- Registration for Delay Notificationas a push message, can also be used by commuters
- Smartphone ticket save function/download, booking, cancellation, management
- Saver fare finderon your smartphone

Technology: QR tickets
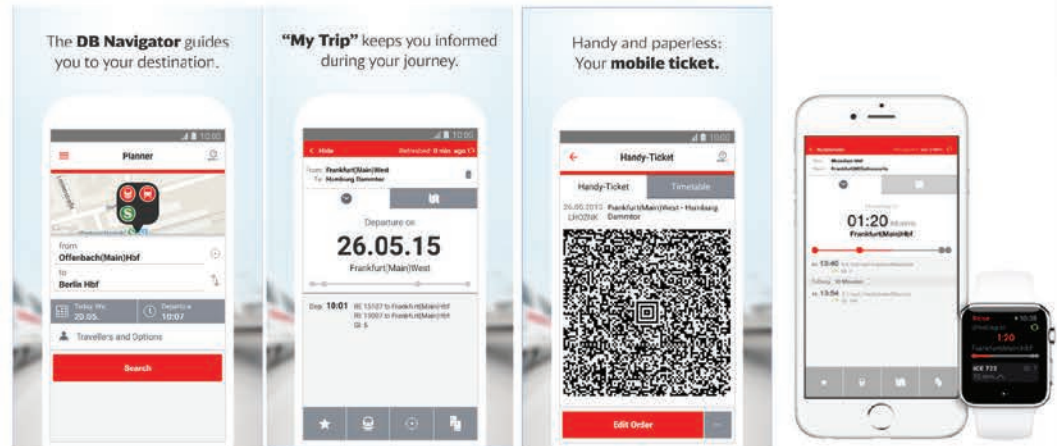
9. Chiltern Railways

London

It is a British train operating company. It operates commuter/regional rail passenger services from its Central London terminus at London Marylebone along the M40 corridor to destinations in Buckinghamshire, Oxfordshire and Warwickshire, as well as long-distance services to the West Midlands along two routes.

Stations called at: 62

Stations operated:32

Chiltern Railways

QR with gate scanners

Use our free app to purchase Chiltern Railways barcode tickets as well as paper tickets for all other train companies to destinations throughout the UK.The Chiltern Railways App has no booking fees and is a quick and easy way to check times and pay for tickets.

Services:
- Get your ticket instantly as a barcode for journeys on Chiltern Railways
- New customers don't need to visit our main website to sign up in the app, you can log in with account details already in use for the main website
- Recent journeys and details are securely maintained in the app for quick and easy repurchasing
- Live departure boards showing platform numbers
- You can buy tickets for any other train company nationwide using this app and collect them at your chosen station with a self service ticket machine.
- Barcodes are stored in the app's ticket wallet and available offline
- If picking up tickets from a ticket machine, reference numbers are stored in the ticket wallet and available offline to view when collecting tickets.

Technology: London Kings Cross, London Marylebone, London Victoria, Gatwick Airport, Cambridge are equiped with barcode gate readers, barcode read-times at 250-500ms

Google Play - Android

Update: 5 July 2016
Installs: 50,000 - 100,000

3.8
★★★★
👤 309 total

★ 5 138
★ 4 75
★ 3 35
★ 2 25
★ 1 36

Video URL: https://www.youtube.com/watch?v=vBm0ppXnOis

Video URL: https://www.youtube.com/watch?v=JCGrOE3uMb8
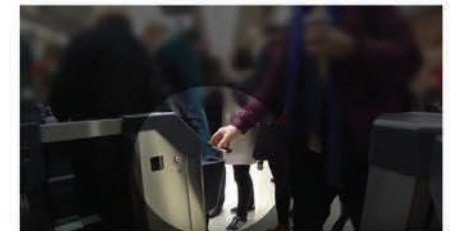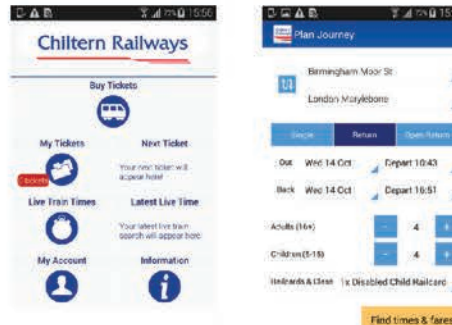
10. Nederlandse Spoorwegen

The Netherlands

The Dutch rail network supports predominantly passenger transport and also most distance travelled on Dutch public transport is done by rail.and Berlin.

Stations: 108

Ridership: 438 million per year

NS Reisplanner Xtra

QR with gate scanners

Reisplanner Xtra is the official planning application for the Dutch Railways.

Services:

- Realtime journey planner
- Timetable of departing trains per station
- Summary of Planned work and disruptions
- Station specific information regarding facilities and shops
- Notifications regarding delays of a saved trip
Purchase a one-way or return ticket online. Order a one way or return ticket online. When you see the delivery option, select 'E-ticket' and you can print it out or download it to the Reisplanner Xtra app.

Technology:

The gates are equipped with scanners for the QR ticket

Google Play - Android

Update: August 10, 2016
Installs: 1,000,000 - 5,000,000

4.1
★★★★☆
👤 13,716 total

★ 5	6,722
★ 4	3,818
★ 3	1,459
★ 2	665
★ 1	1,047

App store - iOs

Updated: 04-08-2016

All versions: ★ ★★
49 Ratings
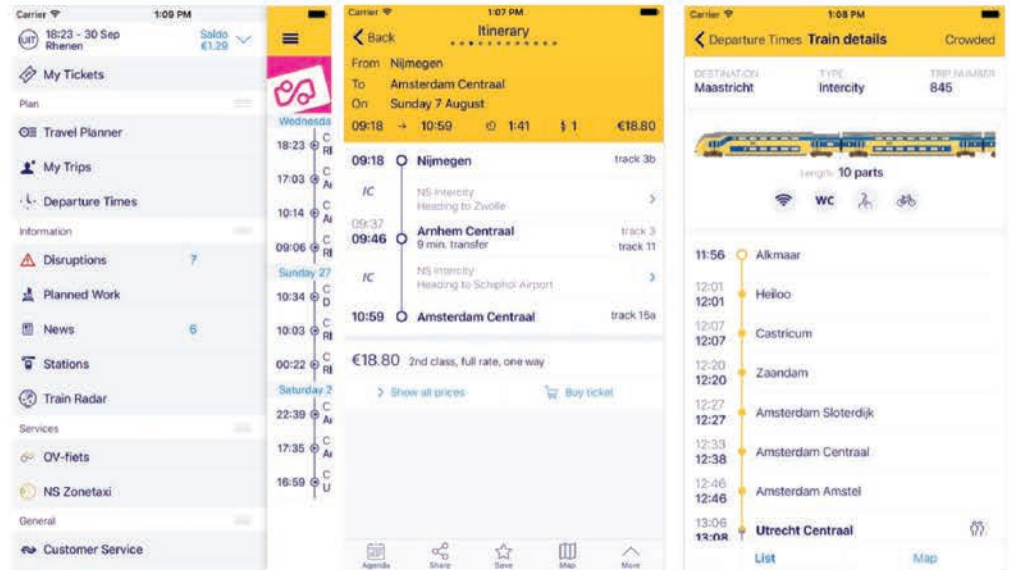
11. NS International

The Netherlands

NS International business makes sure you can travel from any Dutch train station to over 3300 destinations throughout Europe
You may book your tickets for the Thalys, ICE International, Eurostar and TGV high-speed trains, as well as the Intercity trains to Brussels and Berlin.

NS International app

QR with gate scanners

Have your ticket close hand and you will always be informed of the most up-to-date information regarding your trip. The app show the departure and arrival times and will tell you from which platform the train leaves. Moreover, you will be informed of relevant news and interesting deals

Services:
- Fast and easy planning of train trips. A clear overview of connections helps selecting the best trip.
- Trip details have been redesigned, are realtime and now also include ticket prices. Book your ticket through the mobile website.
- Booking in the app.For selected destinations the mobile tickets have been expended with (realtime) trip details.
- An easy to setup monitoring service.

Technology:
You must show the mobile ticket through the NS International App (version 4 or higher). QR with readers only apply in equipped stations

Google Play - Android

Update: May 12, 2016
Installs: 10,000 - 50,000

3,3
★★★☆☆
👤 653 insgesamt

★ 5	204
★ 4	141
★ 3	101
★ 2	63
★ 1	144
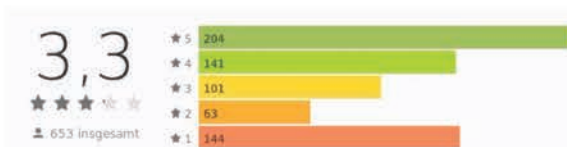
App store - iOs

Updated: 04-08-2016

All versions: ★ ★ ★
107 Ratings

Vergelijk en kies uw reis

Reis met een mobiel ticket
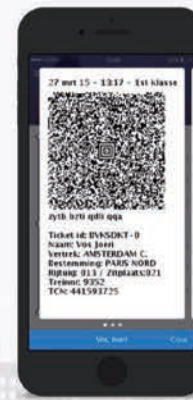
Plan een reis

Selecteer een vertrek- en aankomststation bij van en naar.

Video URL: https://www.youtube.com/watch?v=FIQOmqecJLc

12. Deutsche Bahn

Germany

Deutsche Bahn AG (abbreviated as DB, DB AG or DBAG) is a German railway company. Headquartered in Berlin. It is the largest railway operator and infrastructure owner in Europe. It carries about two billion passengers each year.
- **ICE** (Intercity-Express) for high-speed rail services between major cities and regions
- **IC** (InterCity) for long-distance trains connecting regions with each other. If the trains cross international boundaries, they are usually called EuroCity (EC).
- **IRE** (Interregio-Express) serves regions and connects cities
- **RE** (Regional-Express) serves regions and connects cities
- **RB** (Regionalbahn) stops at all stations and is the most basic train service
- **S** (S-Bahn) are rapid transit and most of the lines stop at all stations.

Touch and Travel

GPS tracking

Touch and travel was an complementary service to DB Navigator, however it has been recently closed because of its lack of use.

Services:

Just one swipe at your departure station is all you need to do before you jump aboard.
You decide when to get off. Check out at your destination station, the Touch&Travel App automatically calculates your price.

Technology:

The user can log in in an specific spot by typing a code, GPS, NFC (only some phones) or scanning a QR. It is required to log out in the final destination. The cost will be displayed and the final bill will arrive home or can be automatically debited.

Google Play - Android

Update: January 19, 2016
Installs: 10,000 - 50,000

3,9
★★★★
👤 29 insgesamt

★5	17
★4	3
★3	3
★2	1
★1	5

App store - iOs

Updated: Sep 10, 2015

Current version: ★ ★ ★ ★
89 Ratings

All versions: ★ ★ ★
595 Ratings
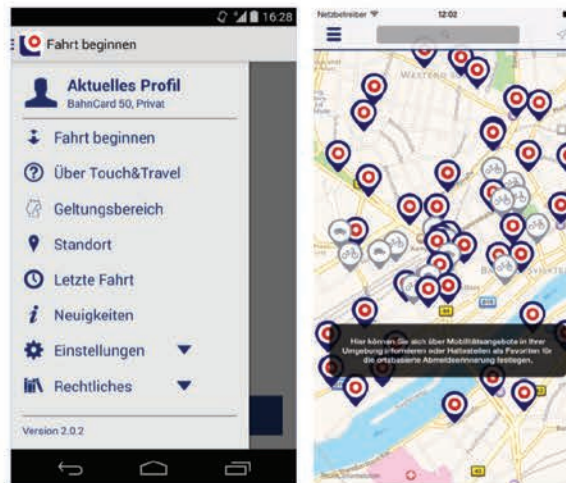
Video URL: https://www.youtube.com/watch?v=iF78QdCn_xQ

13. Opal card

Sydney Area

Opal is a contactless smartcard ticketing system for public transport services in the greater Sydney area of New South Wales, Australia.

Opal is valid on Transport for New South Wales bus, rail, light rail and ferry services that operate in Sydney and the neighbouring Central Coast, Hunter Region, Blue Mountains and Illawarraareas. It is also accepted on train services in the Southern Highlands

Opal travel

NFC for card scan

An app. No tickets. Just pull out. Touch & Travel is the smart, paperless alternative for bus and train.

Services:

• Trip planner with fare estimates
• Top up or set auto top up
• Check your balance, history and Weekly Travel Reward progress
• See public transport service disruptions
• Find nearby Opal retailers

Technology:
If you have a compatible NFC-enabled Android device, you can also scan your Opal card to check your balance, last tap details and Weekly Travel Reward progress.

Google Play - Android

Update: April 17, 2016
Installs: 100,000 - 500,000

3.5
★★★ ½ ☆
👤 1,216 total

★ 5	465
★ 4	269
★ 3	139
★ 2	58
★ 1	285

App store - iOs

Updated: Sep 10, 2015

All versions: ★ ★ ⁄
5 Ratings
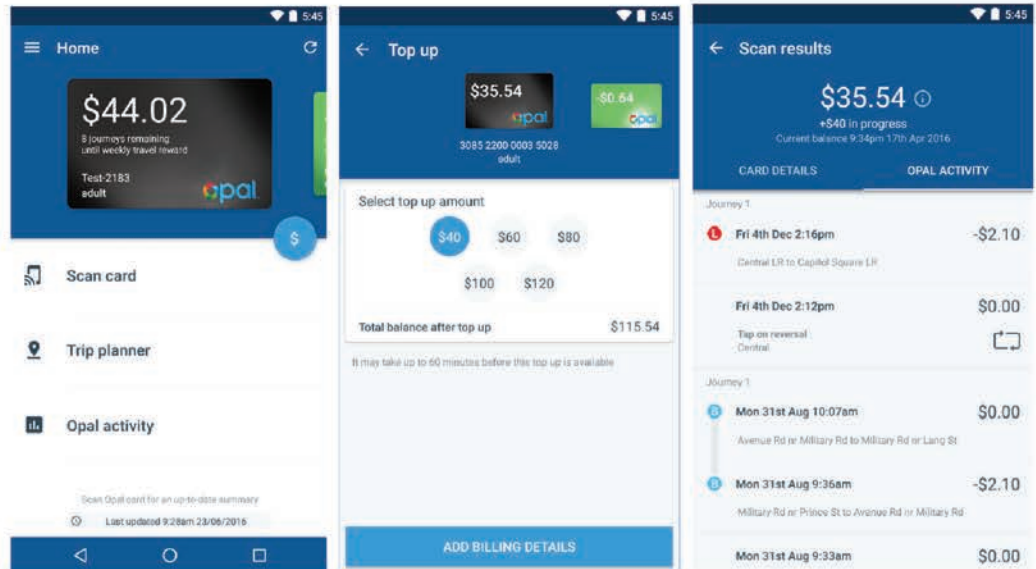
14. Metra, CTA, Pace

Chicago

Metra is a commuter railroad in the Chicago metropolitan area. CTA (Chicago Transit Authority), is the operator of mass transit in Chicago, Illinois and some of its surrounding suburbs, including the trains of the Chicago "L" and CTA bus service. Pace is the bus division to conmuter and paratransit services

Lines: Metra 11, CTA Rail 8 + Bus 140 routes

Stations: Metra 211

Ridership: Metra 292,000 weekday/ CTA Bus: 872,090, Rail: 787,430, per day. Pace 39.925 million riders in 2013.

Ventra

Mobile wallet + Self ticketing QR

Use transit in and around all of Chicago: It's easy to manage and pay your fare on CTA, Metra and Pace buses and trains with the Ventra app. Find all the features you're used to on the Ventra website and more, including mobile ticketing for Metra trains!

Services:
• Check your balance and available passes in your Ventra Card's transit account.
• Instantly load value or passes to your Ventra Card's transit account.
• Switch autoload for transit value or passes on and off.
• Buy and use Metra mobile tickets to ride any Metra train.
• Use transit value you've loaded to buy a Metra ticket.
• Get real-time account notifications so you know when it's time to load more fare
• Get real-time arrival/departure information from CTA, Metra and Pace all in one app—by picking a stop, using favorites or looking at service near where you're standing.

Technology:Ventra payment system includes several options of payment, including a contactless smart card powered by RFID, a single day or use ticket powered by RFID, any personal bank-issued credit card or debit card that has an RFID chip, and a compatible Mobile phone.

Google Play - Android

Update: August 1, 2016
Installs: 100,000 - 500,000

3.4
★★★ 1/
👤 854 total

★5	335
★4	138
★3	97
★2	84
★1	200

App store - iOs

Updated: Aug 02, 2016

Current version: ★★
8 Ratings

All versions: ★★⯪
214 Ratings

CTA/Pace
Pay as you go

SAMSUNG pay   android pay   🍎 Pay

Metra
QR self ticketing

15. Snapper card

New Zeland

The Snapper card is a contactless electronic ticketing card used to pay for bus fares and other everyday items, such as taxis, food and coffee, in New Zealand. Buses of the following operators: CityLink Whangarei, Airport Flyer, GO Wellington, Runcimans, Valley Flyer, mainly in Wellington. New Zeland does not have an integrated card for all the transport system.

There are more than 4000 places you can use your Snapper. Whether you want to , cab across town, commute to work, university or school using the Cable Car or Bus, Snapper's got it covered.

Snapper in retailers
Find your nearest Snapper retailer...
- Hutt Valley & Porirua
- Wellington city
- Wellington suburbs

Snapper your parking
Now there is an easier way to pay for your parking....
- Where can I Snapper my parking?
- How to Snapper your parking
- Snapper your parking FAQs

Snapper on the bus
Does your bus company take Snapper? Find out here...
- CityLink Whangarei
- Airport Flyer
- GO Wellington
- Runcimans
- Valley Flyer

Snapper in taxis
Snapper your taxi ride in any cab displaying the Snapper logo...

Snapper at school
Many schools accept Snapper in their tuckshop and school office...

Google Play - Android

Update: April 20, 2016
Installs: 50,000 - 100,000

4.0
★★★★☆
👤 982 total

| Stars	Count
★ 5	520
★ 4	232
★ 3	60
★ 2	49
★ 1	121

Snapper

NFC for card scan

Using your Android smartphone with near field communication (NFC), the Snapper Mobile app is the essential companion to your Snapper + card or Semble SIM.

Services:

- Log in
- Check your balance
- Top up
- Buy a travel pass
- Check transaction history
- Save payment details
- View card information
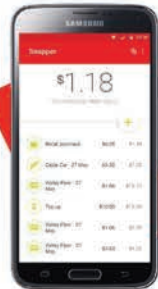
Check your balance and recent transactions on the go.
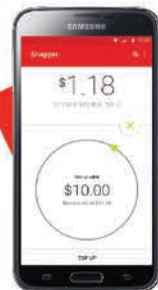
Instantly top up.

Semble

Mobile wallet

To provide mobile payment Snaper made an alliance with Semble a mobile wallet app. The mobile payment was implemented by using a SIM card, it was available during almost a year but now Semble has removed the app, it is possible for the users to use the mobile payment but only for Snaper, not other cards.

Snapper in Semble.
Once you have Snapper in Semble it's easy to start paying with your phone. Your Snapper card will default to ON. You don't even need to open Semble or have your phone turned on to use it.

Just Hold > Beep > Go!
To tag on and off, touch the back of your phone to the middle of the Snapper reader (aim for the fish!), and hold it still until you hear the beep.

The reader will tell you if it has gone through. If you hear 'Please try again', pull your phone away completely, wait for the reader error message to clear, and have another go.

Top up your Snapper.
If the reader tells you to 'Please check your balance', it means you have a balance of less than $12 on your Snapper. Check your balance and top-up via the Snapper Mobile app anytime, anywhere.

What's your Snapper style?
There is a knack to using your phone on the many different readers out there. Most people find they get it right first time, but if you need some help check out our **Snapper FAQ's**.

16. Transport for London

London

TfL has responsibility for London's network of principal road routes, for various rail networks including the London Underground, London Overground, Docklands Light Railway and TfL Rail, for London's trams, buses and taxis, for cycling provision, and for river services.

Lines: Tube 11

Stations: Tube 270

Ridership: Tube 1.3 billions a year

Contactless payment

Mobile wallet

You can use contactless for pay as you go travel on bus, Tube, tram, DLR, London Overground, TfL Rail, Emirates Air Line, River Bus and most National Rail services in London.

Services:

The following methods of contactless payment are currently accepted:
- Android Pay
- Apple Pay
- Barclaycard and Barclays Contactless Mobile
- bPay
- EE Cash on Tap

Technology: The independent mobile wallets load the bank cards and then those can be used for paying.

Video URL: https://www.youtube.com/watch?v=nuyG5yNbutc

17. EZ-Link card

Singapore

The card is commonly used in Singapore as a smartcard for paying transportation fees in the city-state's Mass Rapid Transit (MRT), Light Rail Transit (LRT) and public bus services.
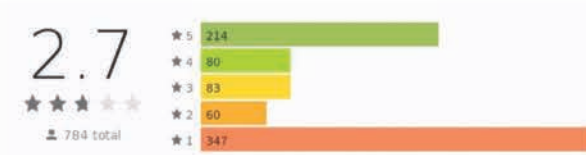
Lines: MRT 8, LRT 3

Stations: MRT 154, LRT 43

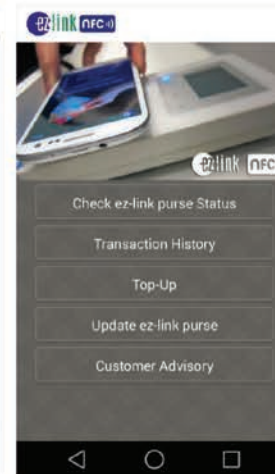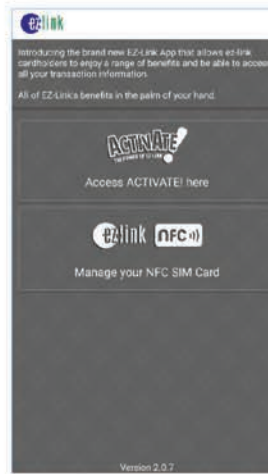Ridership: MRT 2.879 million, LRT 152,000 daily

EZ-Link

NFC for card or SIM card scan

The official EZ-Link app comes with an array of services in one easy to use app; use it to manage your ez-link cards and your EZ-Link NFC SIM with ease.

Services:

- Check transaction history
- Check purse balance value
- Sign up for Activate! card blocking and card protection service
- Register up to 3 cards on Activate!
- Deregister cards on Activate!
- Top-up EZ-Link NFC enabled SIM (for NFC certified mobile only)

Technoloy:

Top-up and manage your EZ-Link NFC SIM with the in-app functions

Google Play - Android

Update: July 12, 2016
Installs: 100,000 - 500,000

2.7
★★★
👤 784 total

★5 214
★4 80
★3 83
★2 60
★1 347

Video URL: https://www.youtube.com/watch?v=oOkHxFAiCAo

Singapore

The card is commonly used in Singapore as a smartcard for paying transportation fees in the city-state's Mass Rapid Transit (MRT), Light Rail Transit (LRT) and public bus services.

Lines: MRT 8, LRT 3

Stations: MRT 154, LRT 43

Ridership: MRT 2.879 million, LRT 152,000 daily

NFC + Sim card

My EZ-Link Mobile is a free mobile application developed for NFC (Near Field Communication) enabled mobile phones. The application allows you to transform your phone into a personal EZ-Link top up terminal for all EZ-Link issued CEPAS cards.

Services:
• Top up ez-link cards* using Visa / MasterCard / American Express Cards
• Activation of EZ-Reload (Auto Top-up)
• View card details and transaction history
• Save credit card details securely for future top ups
• Manage up to 10 ez-link cards

Technoloy:
Since 2012, EZ-Link has offered the EZ-Link NFC SIM via mobile network operators for payments at ez-link retail acceptance points. From 29 March 2016 onwards, EZ-Link is offering the new EZ-Link NFC SIM via mobile network operators for payments for both public transit as well as retail acceptance points.

Google Play - Android

Update: July 27, 2016
Installs: 10,000 - 50,000

3.0
★★★
2,630 total

★ 5	844
★ 4	368
★ 3	269
★ 2	212
★ 1	937

For optimal performance, users should tap their handset at the readers with their handset screen facing upwards (back of handset should be facing the reader).

TO GET STARTED, YOU WILL NEED:

☑ An approved NFC-enabled mobile phone model.

LG
Optimus G • Optimus G Pro

SAMSUNG
GALAXY ACE 3 With LTE • GALAXY Note II LTE • Galaxy Note 5 4G+ • GALAXY Note Edge 4G+ • GALAXY S III • GALAXY S III LTE • Galaxy S6 4G+ • Galaxy S6 edge+ 4G+ • Galaxy S7 4G+ • Galaxy S7 edge 4G+

SONY
Xperia Z • Xperia Z2 • Xperia Z3 • Xperia Z3 Compact • Xperia Z5 • Xperia Z5 Compact • Xperia Z5 Premium

(Handset list updated as of 29 March 2016.)

☑ An EZ-LINK NFC SIM!
Check with your mobile operator on the availability of the EZ-LINK NFC SIM Cards today!

☑ You are now ready to go!
Top-up your EZ-Link NFC SIM at the EZ-Link self service top-up channels.

19. Octopus

Hong Kong

It is a reusable contactless stored value smart card for making electronic payments in online or offline systems in Hong Kong. It is used as payment for all public transport, many retail shops, convenience stores, supermarkets, fast-food restaurants, on-street parking meters, car parks, to other point-of-sale applications such as service stations and vending machines. From 1997

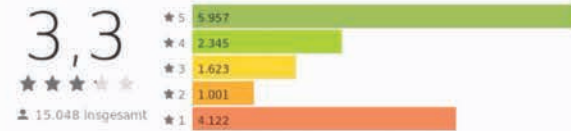Lines: MTR Heavy 10, MTR light 12, Tramways 6

Stations: MTR Heavy 87, MTR light 12, Tramways 120

Ridership: MTR, aprox 5 millions per day, Tramway 180,000 per day.

Google Play - Android

Update: June 29, 2016
Installs: 1,000,000 - 5,000,000

3,3
★★★☆☆
± 15.048 insgesamt

★ 5	5.957
★ 4	2.345
★ 3	1.623
★ 2	1.001
★ 1	4.122

App store - iOs

Updated: 28 July 2016

Current version: ★ ★ ✦
9 Ratings

NFC + SIM card

It is the official application developed by Octopus Cards Limited and is a free application for NFC (Near Field Communication) enabled Android mobile devices and applicable to Octopus with 9-digit Octopus number (including eight digits plus one single digit inside the bracket).

Services:
• Check Octopus' remaining value, latest transaction records and other information
• Make Octopus Online Payment at designated online merchants
• Conduct Incomplete transaction refund enquiry and collection
• Activate Octopus Automatic Add Value Service (AAVS)
• Receive refund and AAVS activation notification, When using Octopus Mobile SIM, you can enjoy the convenience of checking the remaining value using the Home Screen widget.

Technology: The Mobile SIM consists of both Octopus function and mobile telecommunication function for use on NFC (Near Field Communication) enabled mobile phones as tested by Octopus.

Video URL: https://www.youtube.com/watch?v=IWc8VVNo63I
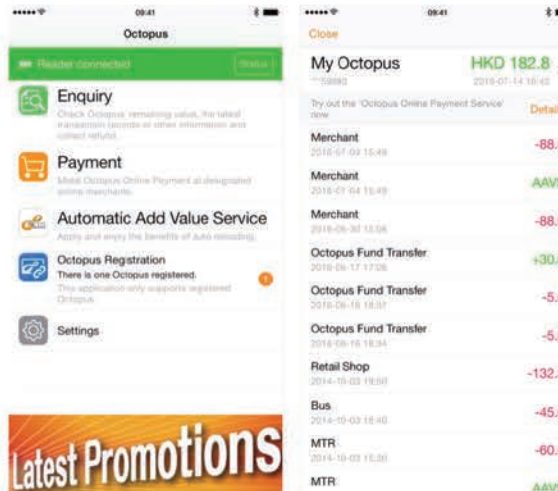
20. HopOn

Israel

The HopOn system is already in use with more than 7 public transport operators in Israel installed on a total of more than 2,000 vehicles, including buses, BRT, LRT and bike rental stations.
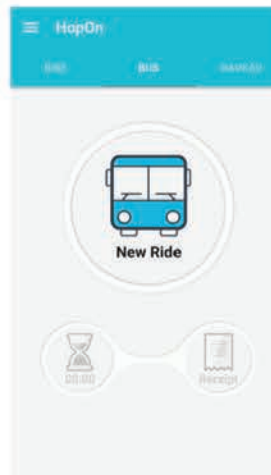
HopOn

HopOn

HopOn is a mobile platform for payment and validations through public transit, that changes the ticketing experience.

Services:
- Take your ticket with you when you upgrade your phone get a refund for unused mobile tickets, request receipts and manage payment information.
- Check train schedules and service statuses
- Tickets can be one-way, 10-trip, weekly or monthly. The ticket is saved in an electronic ticket wallet in the app.

Technology:
"HopOn Beacon" transfers data over ultrasonic sound waves to the passenger's phone, enabling us to support multiple, simultaneous validations and payments. The technology automatically detects all the necessary information in order to generate a valid boarding pass soon as the passenger boards, without any other passenger intervention.

Google Play - Android

Update: July 24, 2016
Installs: 50,000 - 100,000

3,0
★ ★ ★
👤 1.122 insgesamt

★ 5	368
★ 4	121
★ 3	150
★ 2	152
★ 1	331

App store - iOs

Updated: Sep 10, 2015

All versions: ★ ★ ★
33 Ratings

Video URL: https://www.youtube.com/watch?v=ioSEthx8aXs

Table 3, Quantitative selection

	Transport system	Location	App	Technology	App satisfaction		Installs	Modalities	Coverage area	Ridership (per day)	Result
					Android	iOS					
1	MBTA	Massachusets area	MBTA mTicket	Self ticketing QR	4.2 ●●●	2.5 ●●○	100,000 500,000 ●○○	2	Regionwide ●●○	1.3 millions ●●○	10
2	TriMet	Portland	TriMet	Self ticketing QR	3.2	2.5 ●●○	100,000 500,000 ●○○	4 ●○○	Regionwide ●●○	319,700	6
3	METRORail	Houston	Q-ticketing	Self ticketing QR	3.9 ●●○	3 ●●○	5,000 10,000	1	Citywide ●○○	43,900	5
4	MTA LIRR / MNR	New York area	MTA eTix	Self ticketing QR	2.8	2	10,000 50,000 ●○○	4	Regionwide ●●○	637,700 ●○○	4
5	Rutter	Oslo and Akershus/ Norway	RuterBillett	Self ticketing QR	3.7 ●○○	-	500,000 100,000 ●●○	6 ●●●	Regionwide ●●○	300,000	8
6	SFMuni	San Francisco	MuniMobile	Self ticketing QR	2.9	2.5 ●●○	10,000 50,000 ●○○	4 ●○○	Citywide ●○○	679,800 ●○○	4
7	BVG	Berlin	BVG FahrInfo Plus	Self ticketing QR	3.7 ●○○	3.5 ●●●	1.000.000 5.000.000 ●●●	6 ●●●	Regionwide ●●○	1,390,000 U-Bahn ●●●	15
8	Deutsche Bahn	Germay	DB navigator	Self ticketing QR	4 ●●○	4 ●●●	10,000,000 50,000,000 ●●●	6 ●●●	Countrywide ●●●	1.8 millions ●●●	17
9	Chiltern Railways	London	Chiltern Railways	QR with gate scanners	3.8 ●●○	-	50,000 100,000	1	Regionwide ●●○	-	4
10	NS Nederlandse Spoorwegen	The Netherlands	NS Reisplanner Xtra	QR with gate scanners	4.1 ●●●	3 ●●○	1.000.000 5.000.000 ●●●	1	Countrywide ●●●	1,200,000 ●●○	13

11	NS International	The Netherlands	NS International app	QR with gate scanners	3.3	2	10,000 50,000	1	Several countries	-	0
12	Deutsche Bahn	Germany	Touch and Travel	GPS track NFC GPS QR scanning	3.6 ●○○	3.5 ●●●	10,000 50,000	5 ●●○	Regionwide ●●○	-	8
13	Opal Card	Sydney area	Opal travel	NFC for card scan	3.5 ●●○	2.5 ●○○	100,000 500,000 ●●○	4 ●○○	Regionwide ●●○	-	6
14	Metra, CTA, Pace	Chicago	Ventra	NFC QR Apple pay Android pay	3.4 ●●○	2.5 ●○○	100,000 500,000 ●○○	4 ●○○	Citywide ●○○	1,2 millions ●●○	7
15	Snapper card	New Zeland	Semble	NFC card scan. Mobile wallet	4 ●●○	-	50,000 100,000	3	Countrywide ●●●	-	5
16	Transport for London	London	Android Pay ApplePay bPay	Mobile Wallet	4 ●●○	-	50,000,000 100,000,000 ●●●	6 ●●●	Citywide ●○○	3.6 milions ●●●	12
17	EZ-Link Card	Singapore	EZ-Link	NFC to top up and check	2.7	-	100,000 500,000 ●○○	5 ●●○	Countrywide ●●●	3 millions ●●●	9
18	EZ-Link Card	Singapore	My EZ-Link Mobile	NFC + Simcard	3	-	10,000 50,000	5 ●●○	Countrywide ●●●	3 millions ●●●	8
19	Octupus Card	Hong Kong	Octupus Card	NFC + Simcard	3.3	1.5	1.000.000 5.000.000 ●●●	5 ●●○	Countrywide ●●●	5 millions ●●●	11
20	HopOn	Israel	HopOn	HopOn	3 ●●○	3	50,000 100,000	3 ●●○	Regionwide ●●○	-	6

References

"Facts and Figures 2016 | Deutsche Bahn." Accessed May 24, 2017. http://www.deutschebahn.com/en/group/ataglance/facts_figures.html.

Joppien, J., T. Niks, G. Niermeijer and J. v. Kuijk (2013) Exploring new possibilities for user-centred e-ticketing, Delft University of Technology.

Kim, Changsu, Mirsobit Mirusmonov, and In Lee. "An empirical examination of factors influencing the intention to use mobile payment." Computers in Human Behavior 26.3 (2010): 310-322.

Lam, W. H., & Bell, M. G. (Eds.). (2002). Advanced modeling for transit operations and service planning. Emerald Group Publishing Limited.

No author (2008,March). VCD: NFC adoption will be slower than expected. RFID Journal. Retrieved from http://www.rfidjournal.com/articles/view?6930

Cameron Faulkner (2015, November) What is NFC? Everything you need to know. Techradar. Retrieved from http://www.techradar.com/news/phone-and-communications/what-is-nfc-and-why-is-it-in-your-phone-948410

Colophon

Author
Diana Lorena Gonzalez Sanchez did her bachelor in Industrial Design in the National University of Colombia, currently is studing Design for Interaction Master of Science at the Delft University of Technology. This report is part of a research elective project.

Supervisors
Jasper van Kuijk is assistant professor in user-centered innovation at the faculty of Industrial Design Engineering of the Delft University of Technology. He has a PhD and Master's degree in Industrial Design Engineering.