

Information Visibility in Public Transportation Smart Card Ticket Systems

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Abstract—This paper discusses the role of information visibility in public transportation ticket systems. The case is the replacement of paper tickets with smart card tickets in the Oslo region in Norway. By contrasting the visibility of ticket information to users of paper tickets and smart card tickets, this paper describes the move from local information on paper tickets to distributed information on smart cards. We used a qualitative content analysis of reader comments to an online opinion article on the new smart card system to analyse the effect of the loss of ticket information. Using the concept of ‘networked visibility’, this paper argues that the move from paper to smart card ticket resulted in less informed travelers and more informed providers. We discuss issues around the visibility of ticket information and present diverse design solutions, including an augmented reality application, which may address the ticket information needs of public transportation users.

Keywords—Information Visibility; Smart Card; Ticket Information; Public Transportation; Mobile Apps

I. INTRODUCTION

In 2009, Ruter, the public transportation company in the Oslo region in Norway, began to replace the paper tickets with a contactless smart card [1]. By February 2013, Ruter stopped the sale of the last of the paper tickets, the coupon card. This prompted a former user of the coupon card to send a letter to the editor to one of Norway’s national newspapers. In *We don’t want this!*, the user expresses her frustration with the new smart card system [2]. She argues that the new ticket system leaves her permanently insecure about the validity of her ticket.

This user was not alone in her critique. Ruter has experienced a high level of user dissatisfaction with the new system, as well as critique for the way the company dealt with it. We identify information visibility as an important factor contributing to the wide spread dissatisfaction. In design of information systems and usability studies, the visibility of information is related to the visibility of a system’s status. Being informed about a system’s status is one of the ways in which users receive feedback on a system’s use or performance. Studies of the visibility of information on smart cards have been implemented in several sectors, such as supply chain management, the automotive industry, and the healthcare sector [3]–[6]. In public transportation studies, information visibility is discussed as part of radio-frequency identification (RFID) applications for identifying and tracking vehicles, e.g., [7].

We are not aware of information visibility studies of ticketing systems in the public transportation sector, although some other interesting and related issues have been reported in [8]–[10].

Rust and Kannan [6] consider ubiquitous computation to offer a great opportunity towards enhancement of user experience. How could a smart card enhance user experience? A smart card is a credit card size plastic card containing a microchip with antenna for contactless communication with a card reader; see Fig. 1 for the card and Fig. 2 for card readers. The embedded sensor technology provides an opportunity to use the card for several purposes, integrating diverse systems into one, e.g., transportation and event services, or the annual subscription to a museum. It also enables service providers to store information about user’s behavior on the card, in order to offer better one-to-one services.

When moving from paper-based practices [11] to practices where computing and communications technologies are embedded into everyday objects, there are many ways “to capitalize on our familiarity, skill and experience in dealing with the everyday world around us” writes Dourish [12]. New values, new possibilities, but also new concerns may emerge when interacting with these familiar objects with and without embedded technology. In the case of the RFID-enhanced transportation ticket, we could not capitalize on familiarity, because, one major characteristic of the ticket was lost: the visibility of information.

In this paper, we investigate the role of information visibility in the use of the smart card ticket. Our study was guided by two questions:

1. What is the role of information visibility in a public transportation ticketing system?
2. What design solutions are possible to increase information visibility in the smart card ticket?

Our case is the ‘Reisekort’, the smart card ticket used in the public transportation system in the Oslo region. Our focus is on the basic information that is needed to use the smart card as a valid transportation ticket. We identified three basic ticket information needs of public transportation users: the type of the ticket, the value of the ticket, and the duration of the ticket (see Table I). There are other ticket information needs, such as the price of one trip, an overview or log of implemented trips, and an overview of past travel expenses, but they do not add significantly to our argument.

In *We don't want this!*, the author proposes one solution to the lack of information visibility of the smart card: "receive a receipt every time you use the card". The rationale behind this solution is that one will always have a visual confirmation of basic ticket information: what type of card is used and how much money and time are left on the card.

Many readers responded to *We don't want this!*. In this paper, we analyze the reader comments and discuss new proposals for design. We start with a discussion of ticket information needs, comparing paper tickets and smart card tickets. In Section III, we discuss our method and present our analysis of reader comments. In Section IV, we discuss our findings and in Section V, we use the analysis to propose or discuss some design interventions.

Although our case is a local phenomenon, our findings may contribute to the study of networked near field communication (NFC) services in general. Information visibility, we argue, is an important aspect in user satisfaction and for guiding the (re-) design of smart card tickets.

II. FROM PAPER TICKET TO SMART CARD

In *We don't want this!*, the author compares the paper coupon card with the pay-as-you-go smart card. Since the author is a pensioner, she used to have a discount coupon card, recognizable by a different color than the regular coupon card. The card was unregistered and could be used by several people traveling together. The monetary value of the ticket was printed on the card and the empty spots on the card visualized how many trips could still be made with the card. Once the coupon card was stamped in a ticket machine on board the bus or tram, or on the platform of the train or metro, the validity of the ticket could be read on the timestamp.



Figure 1. A smart card ticket used in public transportation in Norway.

In terms of information visibility, the user had the following information available at all times and without the use of extra technology (see Table I):

- The type of ticket: shape, color, name of ticket
- The value of the ticket: printed on the ticket
- The duration of the ticket: date and timestamp on the ticket

This information has become invisible in the smart card ticket. All smart cards, be it a pay-as-you-go card, a weekly,

monthly or day-pass, a regular or discount card, have the same shape, color, and name (see Fig. 1). The type of ticket, value of the ticket, and duration of the ticket can only become visible when an external reader is used (see Fig. 2).

TABLE I. BASIC TICKET INFORMATION NEEDS OF PUBLIC TRANSPORTATION USERS

Type of ticket

The type of the ticket refers to the different kinds of tickets available. We can differentiate between types of tickets based on the number of trips and types of tickets based on the particular period they cover independent of the number of trips (day, week, month, and year). Other types are registered or unregistered (anonymous) tickets, and regular and discount tickets (for children and people over 65 years old).

- A popular paper ticket in Oslo was the unregistered 8 trip-ticket, the so-called *Flexicard*, which was available as a regular ticket and a discount ticket. The Flexicard could be used by more than one traveler at the same time. There is no smart card variation of this ticket.
- A popular smart card ticket is the pay-as-you-go card, which can be topped up when needed. This ticket can only be used by one traveler at the time. There is no paper variation of this ticket.

Value of ticket

The type of ticket decides the monetary value of the ticket. In the case of the pay-as-you-go card, the value of the ticket depends on how much money the user has put on the card. The monetary value of all tickets diminishes with use. A ticket has zero value when the duration of the ticket has expired or when the monetary value is below the price of a ticket. In the case of pay-as-you-go cards, any amount less than the value of a single ticket may be left on the card. Paper tickets did not have this characteristic.

Duration of ticket

The duration of the ticket is decided by the date and time stamp of a ticket and varies for the different ticket types. Registered monthly paper tickets were sent automatically by mail to the user before the monthly ticket expired. Registered smart cards can be automatically topped up (in case of a pay-as-you-go card) or extended (in case of the 30 days card).



Figure 2. Smart card ticket readers at metro stations and on the bus.

How does this affect the use of the smart ticket? In this section, we look at information visibility in three activities public transportation usually users engage in: purchasing a ticket, using a valid ticket and having an expired ticket.

A. Purchasing a ticket

When a ticket is purchased, the three pieces of basic information (type of the ticket, value of the ticket and duration of the ticket) are given by the user to a sales person or are selected by the user on a vending machine or on the public transportation website. In addition, public transportation users also have the choice between a registered and an unregistered ticket. ‘Registered’ means that the name and date of birth of the user is registered with the public transportation provider. ‘Unregistered’ means that the user is anonymous and that the age of the user is unknown.

The information provided when the ticket is purchased is at all times visible on the paper ticket in the form of printed text (type, value, duration), the size of the ticket (type), the color of the ticket (type), and the shape of the ticket (type). For example, the Flexicard, the 8-trip ticket (see Fig. 3), was the only folded paper ticket. It had a pre-printed text to indicate the value of the ticket (kr.180) and the word ‘voksne’ (adults) to indicate that it was a regular ticket. Also the color of the ticket informed the traveler that it was a regular ticket. Discount tickets have a different color. The printed text on a strip is a timestamp, indicating the time when the one-hour validity of the ticket ends. This timestamp is added to the ticket when a traveler enters a metro platform or a bus or tram and inserts the card in a ticket stamp machine (see Fig. 3).



Figure 3. A paper ticket (left) and a ticket stamp machine (right).

An important difference between the paper ticket and the smart card ticket is that ticket information is never visible on the smart card ticket itself; information becomes visible when the smart card ticket is networked with other devices. This can happen in four different ways: via stationary ticket readers positioned at the entrances of stations and platforms of the metro and train and inside buses and trams, scanners handheld by human ticket controllers, smart card terminals at the point of purchase, and the Internet (only for registered smart card holders, see Fig. 4).

Travelers can always buy more than one ticket. For example, a user of the 30-day ticket may buy a new 30-day ticket before the old one has expired. The smart card ticket can also contain several tickets of the same type, e.g., two 30-day tickets or several different types of tickets



Figure 4. Accessing the internet the information from the smart card.

B. Using a Ticket

When one is traveling, the value and duration of the ticket change. On the paper ticket this information is at all times visible, while travelers with a smart card need to use ticket readers to access this information on their card. The smart card readers are also used to validate a ticket and give information about the type of card, expiration date or remaining value of the card, and expiration time. This information is visible for two seconds at the time of validation. This is often too short. If the user tries to scan the card again, an error message is displayed. The user has to wait 2 minutes after validation in order to display the information again. The fact that the type of ticket is not visible without scanning it, presents the risk of traveling with a wrong card, e.g., a parent can use a child ticket without knowing it. This becomes possible because travelers with a week, 30-days, or year smart card ticket are not obliged to validate their ticket every time they use the public transportation system.

When a traveler validates a ticket, the ticket reader can provide the wrong information. For example, an 11-year-old girl, who travels alone on a tram to her dance school, uses her pay-as-you-go smart card twice a week. Incidentally, her mother accompanies her one-day and notices that the child pays the adult fee instead of the discounted fee for children. The child’s birthday was recorded at the time of the purchase of the smart card ticket and the card has been working well over a long period of time. The mother and the daughter walk into the public transportation service centre. The customer representative scans the card. All the trips, and the fees paid for them, appear on the screen. It becomes apparent that somehow the discount child’s smart card was read as a regular card. The customer representative counts the number of wrongly charged trips, fills a paper based refund form, and issues the overcharged amount in cash.

Because a smart card user can have several tickets stored on the card, the ticket reader will also give information about the type of ticket being in use. However, there has been a lot of confusion over the validation of period tickets, such as the 7 or 30-days ticket. No user would stamp such a paper ticket

before the old ticket was expired, but many smart card ticket users assumed they had validated their new period smart card ticket before the old one was expired. They thus assumed that they were traveling with a valid ticket after their old ticket had expired. Many of these travelers were fined for traveling without a valid ticket.

C. The Expired Ticket

A paper ticket is expired when the timestamp on a ticket has expired. The user of a smart card will not be able to see if the ticket is still valid. The ticket has to be read (see above). If the ticket is a registered smart card (only 10% of all smart card tickets are registered [22]), the validity of the ticket can also be checked by logging onto the public transportation system's website.

At the moment, travelers have no way of checking the validity of their smart card ticket when they leave their home or office or when they are inside a metro train or regular train, unless they have a registered card and Internet access. Smart card users taking the bus or tram find out if their ticket has expired or not by using a card reading located inside the bus or tram. Our observations with smart card readers located with the bus driver (regional buses) made clear that many travelers are surprised to find out that they have not enough funds on their card and that they were attempting to travel with an expired card (see Fig. 5). In that case the user needs to buy an expensive one-time paper ticket from the bus driver or has to leave the bus.



Figure 5. Validating a smart card ticket on the bus.

III. WHAT SMART CARD TICKET USERS SAY

A. Methodology

The Norwegian news media (newspapers and online editions) have covered the transition from paper tickets to smart card tickets extensively. From the introduction of the smart card ticket (Reisekort) in 2009 until September 2013, 392 articles were published [13]. These articles usually triggered many comments from readers, e.g., [14], [15]. Studies in reader comments take largely place in journalism and media studies. Research has shown that news that covers public affairs, that have high social impact, and that is negative, receives the most reader comments [16]. Readers are more willing to comment when they are involved in the issue under discussion [17].

One of the news stories and commentaries we read, the *We don't want this!* article, attracted our attention. It

generated many reader comments in short period of time. Secondly, because the author proposed a solution for the lack of basic ticket information, some readers contributed with their own ideas for the design of information visibility in the public transportation ticket. The article plus reader comments provided us with a rich body of use experiences, plus design ideas based on these experiences.

We used qualitative content analysis [18], [19] to study the content of *We don't want this!* and its reader comments. Generally, it is not clear if reader opinions, such as this one, are presenting the general opinion. American research has shown that such opinions are often written by people who are older, better educated, and more conservative than the general public, but, on the other hand, such letters on controversial topics may reflect public opinion [20]. A second limitation to our approach is that is often difficult to generalize the findings of qualitative methods such as content analysis to the general public at large. Thirdly, we have no way of knowing if our online sample, the article author and the commentators on the article, is representational of the general public.

We dealt with the limitations of the qualitative content analysis by using other methods to supplement our findings. We have used direct observations of people purchasing or validating their tickets and we conducted semi-structured interviews with 20 randomly chosen public transport users. Both observations and interviews, summarized in [1], lead to the same conclusion: the lack of ticket information visibility is problematic for travelers.

The article was published on June 1, 2013 on the Opinion section of the newspaper's website. The article received 232 comments written by 105 unique registered commentators. One hundred and one of the comments contained a negative opinion about the new smart card ticket, 38 comments contained a positive opinion, while 90 comments discussed related aspects of the new ticket system or expressed opinions that did not fall under the category 'positive' or 'negative' or they were deleted (3 comments). The entire discussion (now closed) was coded independently by two researchers and the results were discussed and synthesized. The analysis of the reader comments shows that many public transportation users experience the loss of ticket information as problematic.

B. Analysis

In this section, we present our analysis of the online material. We first describe and present the main themes in the reader comments that emerged in the content analysis related to the design of the system, the lack of user's perspective, validation of the ticket, nostalgia over the paper based solution, cognitive complexity, comparison with other systems and solution proposals. A discussion of these findings in the context of information visibility and the implications for design will be presented in the next section.

1) Design

Several readers comment on the design of the new ticket systems, both the smart card tickets as well as the readers, the placement of the readers:

“We also have small children who need a card. Which card shall we give them? Do we need to go down to one of the stations to find out which is a regular card, which one a children [discount] card, and how much money is left on the card? And sometimes we have guests and we experience the same problems.” (#14: 24 likes)

“Several times a week the system [card readers] doesn’t work when you get on [the bus] and many of the buses have older equipment so you can’t read [the screen] if you don’t bend over to a 1.40 m. height for the one second that the reader gives you information.” (#56: 75 likes/1 dislike)

“What kind of problem is solved with the [smart card ticket]? I used to have a [paper] monthly pass and I could always see its stamp and I was sure that the same date would still be on the ticket when there was ticket control.” (#83: 12 likes)

“I struggle using these validation machines [card readers]. Only seldom I am able to read what is written on them before it disappears. I am often unsure if I have paid or not. Shameful.” (#207: 57 likes)

2) Users’ perspective

Several readers mention that the system is developed without having the interests of the users in mind:

“Don’t understand why they who decide in our little Oslo can’t come down from their prestige horse and actually deliver a system that takes the users’ interests in consideration.” (#73: 71 likes)

“[H]ave made thousands of trips with tram, metro, bus and train, also in other countries, but never experienced problems with paying that come close to being as foolish and user-unfriendly as in Oslo.” (#36: 67 likes)

“The reason for making a new system must be to make it simpler, not for making it more difficult. Ruter [the public transportation company] has made it difficult for many customers. Tried to complain, but they don’t pay attention to the individual customer.” (#15: 22 likes)

3) Validation

Many of the reader comments focused on validation of the ticket. Users experienced that card readers did not work so they couldn’t validate their card. The comments also show that there is confusion about the act of validating a ticket. Although validating a smart card ticket has the same function as stamping a ticket, many readers don’t seem to understand the concept of validating a smart card. Some equate paying for a ticket with validating a ticket, while this is only true for the pay-as-you-go card:

“This is BTW called ‘buy ticket’ too; that’s what is written in the display when you validate a pay-as-you-go card.” (#61)

“After a few days my mother was using the card [a 2-zone card] from zone 2 to zone 1, but then it became clear that I had topped up the card in zone 1 [...] the card couldn’t be validated in zone 2.” (#148: 48 likes)

4) Paper is best

Many readers argue that the paper ticket system was a better system:

“Paper is king. Paper doesn’t need electricity and it is easier to fill the ink cartridge in empty stamp machines than to cruise around town trying to find out where the mistake is when all ticket machines stop working.” (#80: 76 likes/1 dislike)

“I miss the 8-trip ticket. Always overview over remaining trips, the stamp machines at the stations worked. Simple and effective.” (#109: 73 likes)

Not everyone was satisfied with the paper ticket and its stamps:

“And there where different kind of stamps and explanations of what was the line number, the date and time, and the number of zones etc. ... And now we have tickets whose ‘content’ is invisible!:-).” (#172: 4 likes)

5) Cognitive challenges

The new system of smart card, card readers, and buying tickets is perceived as too complex:

“I don’t know how the Ruter system works (the same as for any tourist coming to Oslo), I have no idea where and how to buy a ticket.” (#5: 12 likes)

“I have no idea what I have to do to buy a ticket for the bus/metro/tram. [...] I miss the paper ticket.” (#34: 41 likes)

6) Other places – different smart card ticket systems

Many of the readers mention smart card systems in other countries. They have experienced systems that are simpler because they have only one type of ticket or the traveler pays per distance and checks in and out each time the card is used:

“Seoul, Bussan (both South-Korea), Hong Kong (+ many Chinese cities) Tokyo (+ many Japanese cities), Singapore, most of Europe (this are many cities), Bangkok, Moscow, St. Petersburg (Russia), Kiev (Ukraine), Medellin (Colombia), Rio de Janeiro, Sao Paulo (both Brazil), New York (USA), Sydney (Australia) have all brilliant metro systems, where it is easy to buy a ticket and understandable systems that always work. I have tried all of them and never had any problems. In contrast, I have lots of problems with the system in Oslo.” (#221: 103 likes)

7) Solutions

Several readers propose solutions to deal with the problems they experience with the smart card ticket system. Several propose to stop investing money in an expensive smart card system and ongoing ticket control in order to

provide free public transportation or at least free transportation for senior citizens:

“Wouldn't it be simpler and cheaper for all parties if public transportation was completely free??” (#74: 24 likes)

Based on experiences in other countries, several readers propose a simpler system:

“Let people pay for each time they travel, dependent on the distance. Gladly with plastic card or app. Thus we need only one option in the machines (Put money on).” (#102: 3 likes)

Others have started to use the new mobile phone app, which allows one to order a ticket on the spot:

“On my mobile I can see the whole time how much time I have left again [on my ticket].” (#57: 3 likes/1 dislike)

On the other hand, people with older mobile phones, including older models of smart phones, are unable to use the app and with the app more responsibility is transferred to the user. The user now needs to make sure that the valid ticket can be shown on demand by a ticket controller:

“I prefer the smart card. It is not as vulnerable for mistakes as the phone app, for example something as simple as an empty battery. I don't say that the app is badly made, but it puts more responsibility and risk on the user”. (#178: 9 likes)

Another commentator proposed a smart card with a small ‘ink screen’ that could keep the ticket information visible:

“So can one always see how much one has again ...” (#170: 6 likes)

8) *Responsibility to learn a new system*

Many of the readers who are positive about the smart card system state that users who have problems with the new system are lazy or do not take responsibility for learning something new:

“This is new, not complicated [...]. It doesn't take a long time to learn oneself the new system, not even the elderly. This is just laziness.” (#9: 11 likes/3 dislikes)

“Don't people no longer have responsibility? This case and the other cases that were in the media lately show that people don't want to familiarize themselves with the new system, they don't want to learn and they don't take responsibility.” (#18: 10 likes/8 dislikes)

One reader describes explicitly what it means to take responsibility:

“The only thing I need to remember is to bring my card, to scan it when I go on board, and to make a note when I buy the ticket (I put the alarm on in my mobile phone an hour ahead in case I am not able to go out and back again in one hour).” (#87: 15 likes / 1 dislike)

IV. DISCUSSION: THE VISIBILITY OF TICKET INFORMATION

The majority of reader comments critical of the new smart card system address the issue of loss of basic ticket information. Not only the timestamp is now removed from the ticket, also other visual pointers, such as the shape and color that indicated the type of ticket, have disappeared. The answer to simple questions, such as “is this my child's ticket” or “how many more trips can I make on this ticket” now involve a variety of devices and places. Ticket information, once located on a piece of paper in the hand of the user, is now distributed and networked. Stalder [21] calls this *networked visibility*, which is “created by the capacity to record, store, transmit, access communication, action, and states generated through digital networks”. Stalder presents two types of visibility: *horizontal visibility*, pertaining to information becoming visible to users; and *vertical visibility*, pertaining to what information the service providers can see. While users can often manage their horizontal visibility, e.g., what information about themselves becomes visible to others, they have no control over the vertical visibility of their information. Service providers have access to the information of all users, but this visibility is one way, it is invisible to the users.

Based on Stalder, we can differentiate between the horizontal and vertical visibility of ticket information. We understand *horizontal visibility* as the visibility of ticket information to the user of the public transportation system. The paper ticket user has immediate horizontal visibility, at all times and places. The ticket information is directly visible on the paper ticket – when the ticket is in use, not in use, or expired. The smart card user's horizontal visibility is limited to particular places: when the ticket is purchased, when it is read or scanned, or when it is checked on the web (only for registered cards). As we saw in the previous section, many travelers are insecure about the validity of their smart card. Travelers taking the bus or metro can only find out if their ticket is still valid after they have boarded, unless they have a registered ticket (only 10% of the smart card ticket holders) or are close to a ticket machine at metro stations and main bus stations.

We understand *vertical visibility* as the visibility of the ticket information to the provider of the public transportation system. The provider has other ticket information needs than the user. The provider is interested in *use information*, such as the users' frequency, time, and destination of travel, and what type of ticket they use. This information is the basis for organizing public transportation schedules, the frequency of departures, and the number of routes. The provider had only limited vertical visibility when the paper tickets were in use and therefore had to implement user surveys to get this information. With the introduction of the smart card, the provider has full access to ticket information.

A. *Networked Visibility*

In our case, the networked visibility created by embedding computing and networking capabilities in a

public transportation ticket has decreased the horizontal visibility of the users and significantly increased the vertical visibility of the provider. The loss of horizontal visibility negatively affects a large number of travelers who are uncomfortable using their smart card. They cannot transfer their familiarity, skill, and experience in using the paper ticket to the smart card. This becomes especially clear in the reader comments on validation. Travelers do not see the similarity between stamping a paper ticket and validating a ticket via a card reader. They experience new problems, such as card readers that do not work or cannot validate a smart card ticket. If they do validate or read their card, the basic ticket information is only visible for 2 seconds. Therefore, many smart card users express their insecurity about the validity of their tickets when they travel and several relate stories of unpleasant experiences during ticket control.

B. Mobile Phone App

None of the travelers, who were positive regarding the new smart card system, addressed the issue of ticket information visibility of the smart card ticket. They had found ‘work arounds’ for the loss of basic ticket information, e.g., setting an alarm on the mobile phone or validating the ticket every time they used public transportation, even if their ticket type did not require this. Many of the positive travelers are now using Ruter’s mobile app, which was launched in December 2012. The app provides all basic ticket information, including a count down function for travelers who bought a single ticket with one-hour validity (see Fig. 6).



Figure 6. An adult single trip ticket: the green zone states: valid and the timer shows the exact amount of validity time left

C. New Concerns

The increase of the vertical visibility of the provider can create new concerns in terms of privacy as the whereabouts of smart card users can be recorded, stored, and transmitted.

These data can be accessed or aggregated for uses not directly related to the public transportation system, such as marketing. This seems less of a concern in Norway. At the introduction of the smart ticket, Ruter wanted all cards to be registered (linked to a person) and required cards to be validated before each trip. These demands soon disappeared after intervention by the Norwegian Data Protection Authority in 2009. At the moment 90% of more than 600.000 smart cards used in public transportation in the Oslo region are not registered and there are strict rules about storage and use of data produced by the 10% registered cards.

V. DESIGN ALTERNATIVES

The design of the smart card ticket builds forth on some of the characteristics of the paper ticket: tickets need to be validated before use and the points of validation can be found at the same locations as the paper tickets. The main difference is the visibility of ticket information. On paper tickets, information was visible at all times and places because it was a *local information*, it was locally stored on the paper ticket. As we have seen in the previous section, there are serious issues with visibility of information on smart card tickets. Can we make this characteristic of the paper ticket available on the smart card ticket and thus capitalize on the familiarity with the paper ticket?

A. ARTick: Augmenting the Smart Ticket

As described in [1], in order to improve the user experience with smart tickets and offer local visibility of the ticketing information, we made a simple prototype: ARTick (Augmented Reality Ticket) (Fig. 7). ARTick turns any smart phone into a mobile smart card reader using NFC standards, see also [10]. NFC is a short-range wireless technology, enabling one-way and two-way communication between smart phones or between smart phones and other wireless devices, in our case the contactless smart card [23].

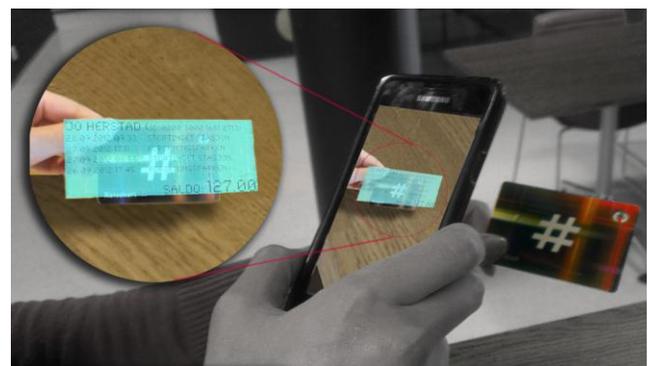


Figure 7. A 3D rendering of smart card ticket information using a NFC-enabled smart phone with ARTick [1].

On NFC-enabled mobile phones, the ARTick application uses NFC to read the information off the card. The application enables the user to check the type of ticket, the value and duration of the ticket, as well as the latest transactions. ARTick enables ticket information to be read

in 2D and 3D, augmented using the camera as shown in Fig. 7, as well as audio for the visual impaired.

Non-NFC-enabled smart phones use the camera to take an image of the card number on the back of the smart card ticket, see lower left corner on Fig. 1, and use Optical Character Recognition (OCR). This card number corresponds with ticket information stored on the website of the public transportation provider. Once the number is recognized, a user can access the same information as the provider.

The addition of audio is particularly interesting for users who have issues with their vision, whether it is related to sight challenges or various forms of dyslexia. ARTick follows universal design principles [24]. ARTick thus enables all mobile phones with camera, smart or not, to check the validity of the smart card ticket. After the launch of the mobile app [25], this solution's appeal diminished. The smart phone Ruter app solves the problem of visibility. ARTick may, however, still be of interest for groups with special needs or travelers without smart phones.

B. Solution Suggestions by Online Commentators

In the Introduction, we stated that the author of *We don't want this!*, proposes one solution: "receive a receipt every time you use the card". She writes:

"The system is not based on legal principles. It does not take into account two important principles:

1. *You must have a receipt each time you pay a commodity.*
2. *This should be so not only when you buy a ticket for some period, or even buy a single ticket or just put money on your card, but also whenever you use your card. I see from other posts that you are referring to the Canary Islands, where this is a practice on their buses. I have spent so much, I have so much left. This principle applies in most other cases in business. When I put my money on the card, I borrow this money to Router until I use it to travel."*

As mentioned in Section IV, a smart phone based ticketing service is now available, see Fig. 10. The app won 'The Best App award' at Mobile Trends conference [25]. However, not everyone owns a smart phone. In the analysis of the customers' comments we found the following conversation, pointing to several issues regarding this solution, e.g., expense related to acquisition of a smart phone, usability issues regarding the purchase of the ticket:

"Mobile app is definitely a future oriented and good solution. Ruter / NSB should enter into an agreement with Telenor [telecommunications provider] as affordable smart phone and subscription to those who lack this. Let those born before 1940 go free, and sell day passes to tourists. And by all means, the app must be working in the whole country as soon as possible." (#54: 8 likes)

"This phone, that the app is attached to, do they send it to you in mail, free of charge?" (#55: 40 likes/1 dislike)

"Of course, but first you must use an order app and an email app on your existing mobile phone, or use password app to receive a password to a website where you can obtain the user name to an app, which provides access to a password that you can use to log onto a website ..." (#56)

Among user commentaries, we find several that propose alternative solutions. Most notably, a solution based on SMS:

"Why can not the ticket be paid through a regular SMS, for those who do not have smart phones? I'm not saying that mobile is the only way to pay, but since there is app-ticket requiring smart phone, it should have been SMS-ticket too! You send an SMS with the typical B [Barn - Norwegian for children] for children, H for seniors [Honor citizens] V for adult [Voksen - adult] and get a code (which ticket controllers can check) with an expiration time and ticket type specification. If you need to have multiple zones, simply send B2, V2 etc - very easy." (#78: 21 likes)

Another design suggestion among commentators is:

"What if you have a small ink display cards that get power from the computer right after you check, just to refresh the ink on the screen and become passive again? So you can always see how much is left." (#86: 6 likes)

"Why not have a solution where I do not have to check or validate. E.g., what about selling 100 trips (more or less) and an optional notification about the number of remaining trips? The more trips you buy the higher discount and flexibility for those who travel infrequently." (#44: 11 likes).

"Introduce the city tax, get all ticket controllers fired, as well as everyone who worked on this s... ticket system, and make the collective traffic free." (#58: 3 likes)

All of the above suggestions, explicitly or implicitly, address the visibility of the information. On a mobile app solution, it is already there. The solution by the author of *We don't want this!*, the SMS solution proposed by the commentator #78, as well as the ink display on the ticket suggestion by commentator #86, all have explicit visibility at all times, and build on a familiarity with the old system. In the old system, the stamp in itself was a receipt for transaction. The last two suggestions simply remove the validation, or tickets, and thus address the visibility indirectly.

C. Wearables: an Emerging Trend in Smart Ticketing

Massachusetts based Sesame Ring project, supported by Massachusetts Bay Transportation Authority (MBTA), started in 2013, see [26]. The designers involved in the project managed to reduce the size of the RFID tag and

place it inside a ring, see Fig. 8. Rings are custom sized and users may create their own designs for the front of the ring.



Figure 8. Wearable technology seems to be the direction for transportation solutions. Photo: Kickstarter, [27].

A similar solution has been developed for London's transit smartcard Oyster, see [28]. Fig. 9 shows the card worn as a wrist-band attachment.

The MBTA and London transport services are possibly different than services offered in Oslo, but the wearable tickets offer one possibility to code type of the card: color. One could then instantly and easily identify those carrying monthly, weekly, daily or any other type of ticket offered by Ruter. However, the problems related to visibility of expiration time would still remain unsolved, assuming current rules and regulations around the use of the card.



Figure 9. A wearable solution replacing the plastic smart card is proposed for London transport. Photo: via Yanko Design

Many large smart phone producers, e.g., Samsung, Apple and Sony, see [29], are in a race to push their smart watches on the market. The watches could easily provide visibility of both ticket type, and validity period. As with a smart phone, though, this solution will not fit all travelers. It would involve investment into the device and skills to operate it. For many travelers though, also in Oslo, this could provide a solution scoring high on user satisfaction.

VI. CONCLUSION AND FUTURE WORK

The move from paper-based to smart card-based public transportation tickets did not result in enhanced user experience. Travelers could not use their familiarity with the

paper ticket when the smart card ticket was introduced. Our study showed that the lack of information visibility, the immediate and continuous access to ticket information, is a prerequisite for users to capitalize on their familiarity with the paper ticket.

The loss of this visibility resulted in negative user experiences in the three main ticketing activities: purchasing a ticket, using a ticket, and knowing when a ticket is expired. This became especially clear in the discussion of the notion of the validation of the ticket. The loss of information visibility of the smart card user led to a situation in which the familiarity with stamping a paper ticket could not be transferred to the notion of validating a smart card ticket.

Also new concerns emerged after the move from paper tickets to smart card tickets. Initially, Ruter wanted every traveler to register (personalized) the smart card ticket and to validate the ticket every time the public transportation system was used. In this way, the provider would gain access to user and use information (vertical visibility), creating new concerns about privacy. Ruter could not maximize its vertical information visibility, after intervention by the Norwegian Data Protection Authority, but still has access to more use data than was available when the paper tickets were still in use.

The concepts of networked visibility and horizontal and vertical visibility helped us to understand the emergence of new user experience issues and concerns when computing and networking technology is embedded in a transportation ticket. These concepts were also used to explore solutions, such as how to restore the horizontal visibility of ticket information, the immediate and continuous ticket information to the users. We discussed several solutions that increase the information visibility of the smart card ticket, such as ARTick, an app that turns a smart phone into a smart card reader, a smart card with display, and the addition of a paper receipt every time the smart card is validated. We also discussed wearable smart tickets, which we believe will enhance user experience but not necessarily information visibility. Ruterbillett, Ruter's mobile phone app, fully restores information visibility to the user, but can only be used on latest models mobile phones.

In further research, we will continue studying the role of information visibility in smart technologies.

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Figure 10. The new Ruter mobile app. One can clearly see the type of the ticket and the expiration date/time: 30-day ticket expires in 24 hours. Photo: Ruter.