Codesign of a Mobile Ticketing Service Solution Based on BLE

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***Abstract*—Complex transport networks and lack of seamless options are barriers to the use of public transport services. Modern mobile ticketing services allow to travel in a convenient and smooth way, enhancing the customer experience. The successful design of mobile ticketing solutions requires action from complex ecosystem of organizations. This paper presents the codesign of a mobile ticketing service solution based on Bluetooth Low Energy (BLE) technology, resulting from close collaboration between different stakeholders of the ecosystem. The solution is based in a check-in/be-out scheme, requiring an intentional user action when entering the vehicle, being the alight station automatically detected by the system. The mobile phone interact with BLE beacons installed in metro and train stations and inside buses, allowing to locate the customer along the transport network. Different contributions and perspectives of each actor to the design of each activity of the customer experience as well as the final decisions that have been taken are also presented.**

***Index Terms*—mobile ticketing, public transport, BLE, codesign**

I. Introduction

We are requesting that you follow these guidelines as closely as possible. The main barrier for multimodal travelling is a lack of seamless options and the highly complex transport networks [1]. The attractiveness of public transport therefore increases as it becomes easier to use. Modern mobile ticketing service solutions are able to free customers from difficult purchase decisions, allowing easier access to services.

This paper presents the design of a mobile ticketing service solution based on Bluetooth Low Energy (BLE) technology that was developed under a research project involving the university and transport operators of the city of Porto, Portugal. The main goal of the proposed service solution is to facilitate and promote the use of public transport services, by leveraging personal mobile devices for the dematerialization of travel tickets.

The design of the service solution results from the interaction between different stakeholders of the mobile ticketing ecosystem: transport operators, technology companies, customers and researchers. The objective was to promote multiple actor engagement in the design process in order to develop a successful new service solution. Therefore, the proposed mobile ticketing solution is innovative in the urban transport field, and results from a well-functioning cooperation during the design process between all stakeholders involved.

The paper is organized as follows: the next section presents the related work concerning mobile ticketing service solutions, BLE technology, mobile ticketing ecosystems and codesign. Section 3 describes the methodology followed during the design process. Section 4 presents the public transport network of the Metropolitan Area of Porto (MAP) and the main challenges in designing the service solution, followed by the presentation of the proposed mobile ticketing solution. Finally, section 5 presents the conclusions and future work.

II. Related Work

A. Mobile Ticketing

Mobile ticketing in public transport can be defined as the use of a mobile device to purchase and/or validate a travel ticket or to initiate and/or end a journey. Early mobile data technologies, despite their low data throughput, were the first to support simple mobile tickets purchases, by sending SMS or making phone calls. Ring&Ride is a mobile ticketing solution, where the customers dial a toll-free number at the beginning and at the end of the journey, and receive the ticket through SMS [2]. Paybox in Austria, Proximus SMS-Pay in Belgium and Mobipay in Spain are also examples of mobile ticketing systems based on SMS that have been implemented. While SMS can be considered a simple and easy to use technology, it has limitations when used to make payments. SMS uses store and forward technology, does not use any encryption method and there is no proof of delivery within the SMS protocol [3]. Message formats are often complicated and slow to key in, and the existence of various payment codes and premium service numbers make them difficult to remember and to find instructions [4].

The evolution of mobile phones to smartphones has broadened the range of payment possibilities especially when technologies like Near Field Communications (NFC) are added to smartphones. Touch&Travel service in Germany allows passengers to make mobile payments by tapping their NFC-enabled mobile phone to the Touchpoint device at the departing station and at the destination. The length of the journey and the ticket price are calculated at the end of the journey, and the customer

Manuscript received July 17, 2018; revised November 8, 2018.

doi: 10.18178/jtle.7.1.10-17

receives, each month, a statement with all travel data and an attached invoice [5]. Other mobile ticketing systems for urban transport based on NFC technology are presented by [6] and [7]. Despite the initiatives, NFC is failing in get critical mass: there is a limited number of NFC-enabled smartphones available on the market [8] and NFC mobile ticketing schemes require huge investments from the transport operators on NFC ticket machines and ticket readers [9].

Other mobile ticketing solutions are based on internet connection and on QR Codes. [10] propose a mobile ticketing solution for public transport that uses passengers' smartphones to purchase and validate travel tickets via Internet connection. The Indian Railway Catering and Tourism Corporation Limited (IRCTC) developed a mobile application through which registered passengers can book railway tickets and confirm the payment using the 3G/4G mobile data from their phone network providers [11]. Justride [12] is a cloud-based ticketing solution implemented in several transport operators such as New York MTA, Las Vegas RTC and LA Metrolink. Passengers access to the transport services by presenting the QR Code on their smartphone to the reader, which enables the identification of the passenger. [13] and [14] present a mobile ticketing solution based on a check-in/check-out concept requiring the reading of the corresponding QR Code station. This application was tested by users in real environment, in the city of Porto, Portugal. The results show that users considered the system extremely useful and convenient. However, the use of the QR Codes to perform the payment has shown to be one of the main challenges to be addressed, since lighting conditions, position and distance to the QR Code influences the reading process. Other technologies, such as Bluetooth Low Energy (BLE) have not been much explored in the public transport field. This technology is presented in detail in the next subsection.

B. BLE

Bluetooth Low Energy (BLE) was integrated in the Bluetooth 4.0 Specification introduced in 2010 by the Bluetooth Special Interest Group [15]. The main feature of BLE, and that differentiates it from the standard Bluetooth specification, is the low power consumption it allows, making BLE ideal to be used in Bluetooth beacons. In addition to this, the vast majority of smartphones now being manufactured support BLE [16], which makes them a perfect counterpart for the BLE beacons.

A beacon in wireless technology is the concept of broadcasting small pieces of information. Different beacons may transmit different types of information, either static, such as simple identification data, or dynamic, such as information coming from sensors (temperature, humidity, location, orientation, or others). BLE beacons implement this by using BLE technology. The signal broadcasted by the BLE beacon can be picked by any Bluetooth enabled device within the emission range of the beacon (50m to 70m).

There are many studies focusing on the use of BLE technology for various Location-Based Services [17] and [18]. By deploying several beacons in a limited space, any Bluetooth enabled device can calculate its position based solely on the signals from them, by using adequate algorithms. Although beacons are mainly used for location tracking, it is important to note that the tracking is not done by the beacons themselves, but the user's application/device. Beacons act only as broadcasters of a signal, and usually don't even connect with other devices. [19] conducted a series of experiments to measure the interference between environment conditions and BLE signal. They concluded that the presence of human bodies and metal near a BLE-enabled smartphone (approximately 20cm) have a significant shielding effect, affecting communication and distance calculations.

The use of BLE technology to support mobile ticketing services is recent and the studies about the topic are scarce. [20] propose a be-in/be-out ticketing system for public transport using BLE technology. Passengers carry a BLE beacon or BLE-enabled smartphone, which advertises a unique ID via a broadcast. This signal is received by an on-board system (OBS), in this case a Raspberry Pi, placed inside each vehicle. The information regarding the passenger ID and route details are processed remotely on a decoupled system, which calculates the price to pay for the journey. Another mobile ticketing pilot test using BLE technology was carried out in Soest, Germany, in 2016 [21]. This pilot consisted on testing a check-in/be-out solution, through which the passenger checks-in in the vehicle by selecting the bus detected by the mobile application and when the passenger leaves the vehicle, the mobile application loses connection to the bus and the app closes the journey. The next subsection describes the mobile ticketing ecosystem.

C. Mobile Ticketing Ecosystem and Codesign

Markets in developed countries have witnessed the launch of a number of mobile payment initiatives over the last years. Even though the emergence of mobile payments may still hold high promises, most of these initiatives have seen stagnation or failure [22]. The widespread deployment and adoption of mobile payment solutions requires action from complex ecosystem of organizations (e.g. passengers, transport operators, transport authorities, banks, mobile network operators, third parties and others) to create a mobile payments service solution [23]. Each entity desires to have the leading place in the mobile payments ecosystem and dominant role in the value chain. Mobile payments entail a complex, system-interdependent ecosystem players whose success is dependent on joint action by all the players together at the same time. However, the struggle for these inter-dependent firms to form coalitions just hindered the emergence of successful mobile payment platforms.

From a service-dominant logic, value is co-created collaboratively, being an "interactive process that takes place in the context of a unique set of multiple exchange relationships" [24]. Value creation is mutual and reciprocal, since "not only does the firm provide inputs for the customer's value-creating activities but the customer does the same for the firm" [24]. Codesign is a collective creativity between designers and non-designers that work together in the design development process [25]. Therefore, codesign is a specific instance of cocreation [25]. In this paper, we focus in codesign as a creative cooperation during the design process, rather than cocreation as a creative cooperation during service delivery and usage. Codesign is tightly connected with the tradition of participatory design, and is built on a mind-set based on collaboration and is a team approach [25]. In codesign, diverse experts come together, such as researchers, designers or developers, and (potential) customers to cooperate creatively.

Recent studies [26] and [27] have focused on the importance of user involvement in codesign, as they are also "experts of their experiences" [28]. When addressing more complex service systems, such as public services, service design engages not only customers but also other networks actors [29]. Codesign in this context seeks to create better solutions and to promote more inclusive processes to enhance multiple actor engagement [29]. Different perspectives are needed in order to understand both a service's demand side, i.e. users' and customers' needs, and its supply side, i.e. technologies and processes, in order to develop successful services [30]. Sanders and Stappers [25] anticipated that "Future codesigning will be a close collaboration between all the stakeholders in the design development process together with a variety of professionals having hybrid design/research skills."

III. Methodology

As methodology to design the new mobile ticketing service, we adopted a codesign perspective with a participatory mindset. The objective was to promote multiple actor engagement in the design process in order to develop a successful new service solution. Therefore, in the complex mobile ticketing service ecosystem, we advocate not only the importance of involving customers, end-users of the services, but also involving all other stakeholders (transport operators, transport authorities, technology companies, banks, mobile phone operators and manufacturers), as codesigners of the final service. Since multiple partners are involved in the mobile payment ecosystem, it requires a well-functioning cooperation during the design process.

Four different stakeholders collaborated in the codesign of the solution: transport operators, technology companies, customers, and researchers. All of them bring different perspectives and contributions to the design. The main objective of transport operators is to design a mobile ticketing solution that enhances the customers' travel experience and reduces the complexity of purchasing and validating travel tickets. They represent the supply-side and are important contributors as they know how the operation works, which systems are already implemented and what are the main constraints. The technology companies have the know-how regarding the hardware and software development and technology restrictions. Customers are the end-users of the solution and the experts of their experience. It is important to understand their needs, the challenges they face every day and what is important from their point-of-view. Finally, researchers play a facilitating and knowledgeable role. Researchers are independent and agnostic to any interests, therefore act as facilitators among stakeholders by bringing together different, and sometimes conflicting, perspectives into a new service solution. They also bring methodologies and tools for the ideation and expression of the new ideas, as well as the knowledge and experience of past mobile ticketing projects.

The design phase consisted of weekly meetings between transport operators, technology companies and researchers and focus group with customers. The main aim of the meetings was to set the objectives, explore the concept, and make the first decisions regarding the technologies, functionalities and requirements of the solution. The mobile ticketing customer experience was defined, as well as the corresponding activities elicited. After a number of meetings several doubts arose and it was necessary to draw upon the experience of the customers. Initial mockups of the service solution were designed using a web tool (Proto.io), which were then presented by researchers to the customers in a focus group session. The purpose of the prototypes were not to test complete solutions but to explore optimal user experiences and how users cognitively and emotionally engage with service elements, processes, and experiences.

The focus group was done with 6 potential customers ([31] suggest between 6 and 10), 2 female and 4 male, aged between 22 and 34 years-old, from which 4 are frequent users of public transport and 3 have already paid with the mobile phone. The session lasted about 2:30h, was audio recorded, fully transcribed and then analyzed following qualitative methods [32]. First, a questionnaire was applied to characterize the sample, followed by a brief presentation of the project. They were then asked about their perception regarding the concept of paying their journeys with the mobile phone, the interaction with the BLE technology and the concept of optimizing the fares to be paid. Then, each journey stage – start of journey, travelling and end of journey – was explored, with the help of prototypes, post-its and pens. The idea was to understand the customers' needs at each stage and what kind of information and feedback they expected the service to provide.

IV. Proposed Mobile Ticketing Service Solution

The proposed mobile ticketing service solution is the result of a project involving the University and the Transportes Intermodais do Porto (TIP). The main goal is to facilitate and promote the use of public transport services, by leveraging personal mobile devices for the dematerialization of travel tickets. The following sub-sections describe the context of the public transport network of the Metropolitan Area of Porto (MAP) and the main challenges in designing the service solution, followed by the codesign process of the mobile ticketing solution.

A. MAP Public Transport Network and Challenge

The public transport network of the Metropolitan Area of Porto covers an area of 1,575 km^2 and serves 1.75

million of inhabitants. The network is composed of 11 operators: 128 bus lines (72 public and 56 private), 81 metro stations and 19 train stations. A total of 137.75 million journeys were recorded in the year of 2015 [33]. The electronic ticketing system is an open (ungated) system, composed by ticket readers along the platforms at each metro/train station and at each bus vehicle, and handheld devices for inspectors. The fare media are contactless travel cards, called Andante, which are accepted by all 11 operators. TIP is the entity responsible for managing the ticketing system, collecting the fares and distributing by the transport operators.

Andante is an entry-only Automated Fare Collection (AFC) system and the fares are defined by a zonal structure. The network is divided into 26 geographic travel zones and the journey fare depends on the number of zones traveled between its origin and destination. There are two types of Andante travel cards: occasional and monthly subscription. Passengers charge the occasional tickets with the numbers of zones they want to cross during a certain journey. In the case of monthly subscriptions they are valid for a set of adjacent zones previously chosen by the passenger. Andante is a time-based system, allowing pay-per-use passengers to make unlimited transfers in a given time period, which increases according to the number of zones that are included in the respective fare. To start a journey, passengers tap the travel card on a reader. This validation must happen at the beginning of the journey and whenever changing vehicles during the journey.

This is a very complex system that requires prior knowledge of the type of ticket that must be purchased to perform a certain journey. Complex transport networks and lack of seamless options have proven to be barriers to the adoption public transport services [34]. Therefore, the main aim of the project is to provide passengers with easier access to services, by introducing personal mobile phones in the service delivery process. The new mobile ticketing service should allow to pay for a journey in a smooth and easy way, regardless of the complexity of the transport network. Thus, two main objectives were defined:

1) The service must be easy to use and require the least possible interaction from the customer.
2) The service should not require any knowledge about fares and transport networks.

Ease of use can be defined as the degree to which a person believes that adopting the system will be free of effort [35]. This lead to the first decision of the project: the choice of the BLE technology as enabler of the payment. Other technologies, such as NFC [36], Wi-Fi [10] and QR Codes [14] have already been tested in MAP. BLE technology is relatively new in the transport field and allows for the implementation of check-in/be-out and be-in/be-out schemes that require little (or no) interaction from customers.

Regardless the complexity of fare structures and transport networks it should be easy for customers to travel along the network and change vehicle and transport operator any time they want. This objective lead to the second decision: the fare to be paid is calculated by the system and not by the customer, freeing him/her from this responsibility.

B. Codesign of the Mobile Ticketing Service Solution

The customer experience is composed by a sequence of moments of contact between customer and company [37]. Each moment of interaction is a design component that needs to be designed into an integrated whole. The customer experience of a mobile ticketing service can be divided in three different moments: 1) Before the journey; 2) During the journey; and 3) After the journey. These are composed by different activities (see Fig. 1), that were codesigned by transport operators, technology companies, researchers and customers. Following this participatory mindset, the perspectives of the different stakeholders in the design of each activity as well as the final decision regarding its design are presented below. Fig. 2, 3 and 4 presents the evolution in the design of the service, from the prototypes, presented to customers during the focus group session, to the final design of the mobile ticketing solution.

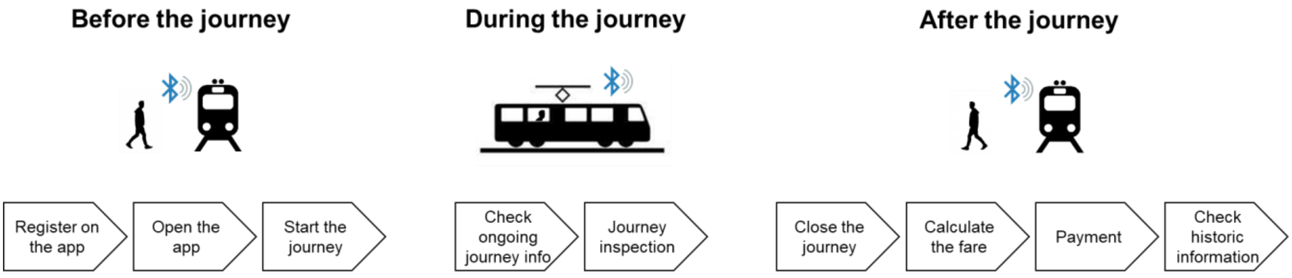

Figure 1. Mobile ticketing customer experience.

1) Register on the app

After downloading the mobile application, the customer registers by entering his/her personal data, such as name, email, address, and bank details. An email is then sent to confirm the registration. Customers suggested to allow the registration using Google or Facebook accounts in order to not have to enter the information manually. They also suggested that the confirmation of the registration was made through SMS and not through email. These two suggestions were not implemented in the final solution.

"I would prefer to confirm the registration through a SMS. It is more comfortable to access a SMS than an email through the smartphone." (Female, 31)

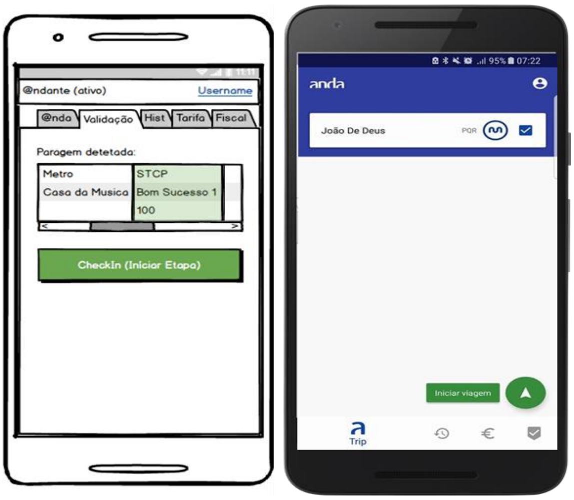

Figure 2. Start journey screen: From prototype to final design.

2) Open the app

When opening the mobile application, customers wanted to see the validation screen, and this was implemented in the final solution.

"I'm going to open the app to validate, this should be the main action. Seeing the historic is secondary, I will not use it every day." (Male, 29)

3) Start the journey

Regarding the way of how the journey starts, two options were discussed: be-in or check-in. Be-in schemes do not require any interaction from the user. The ticketing system recognizes the passenger is inside the vehicle and automatically starts the journey. This type of schemes are really convenient for passengers, since no implicit action is required from them. However it has several implementation challenges. Technology companies argue that such a system would be very intensive in terms of smartphone battery usage, since it would have to be constantly listening to beacons and trying to understand, for example through the accelerometer, whether the person is inside the vehicle or not. It would also be difficult to distinguish a person that is travelling by car, right behind the bus, and those travelling inside the bus. At some point it could be charging the person incorrectly.

Check-in schemes require the passenger to actively register the entrance on the vehicle. This was the most consensual option in terms of implementation. Therefore, two types of solutions were discussed during the focus group: a) the system is constantly sending pop-up messages, when near buses or stations, asking if the passenger is entering that particular vehicle or not (the system has an active role); b) the passenger must intentionally open the mobile application, the app starts to search for nearby stations/buses and the passengers selects the one that he/she is entering on (the passenger has an active role). Between the two option, all participants preferred the second approach, since the first one could become very annoying and be misleading if they say no and wanted to say yes. This second approach was the one considered in the design of the activity.

"I think the pop-up message would not work. If I am waiting at a bus stop, like a terminal stop, there are several buses there waiting 10min. or 15 min. to initiate the service, and I can reject the wrong bus, or change plans, and miss the chance to validate in the right bus." (Male, 29)

"I would not want to be invaded by a rain of pop-ups on my smartphone." (Male, 28)

However, most of them would prefer to validate the entry into the vehicle by reading a QR Code with the mobile phone or swiping it in front of the validator through a NFC connection. This gives a visual feedback to bus drivers allowing them to verify that people are checking-in and prevents people from selecting the wrong beacon.

"It is much easier to tap the validator like the cards" ((Female, 34)

"I am thinking about my mother: if pop-ups started to appear, it would be a mess to her, choose the station would also be a mess. I think the easiest way was to read a QR code." (Male, 29)

Fig. 2 presents the evolution of the design of the start journey screen from the mockup to the final design. The difference is mainly on the navigation: a list of beacons with slide bar were replaced by boxes of beacons navigable through swipe movements, the main menu moved from the top to the bottom of the screen, and the start button was placed at a distance of a thumb.

4) Check ongoing *journey* information

BLE beacons installed in metro and train stations and inside buses are constantly sending information regarding the station or bus stop from where they are placed. These messages are captured by the customers' smartphones through Bluetooth connection, allowing to identify the stop/station where the customer is located. Transport operators, technology companies, and researchers proposed the mobile application to provide information about the stops/stations the customer was going through, during the journey. This feature was implemented (see Fig. 3), but was not consensus among customers. Some stated this information was not useful for frequent passengers, since they already know the sequence of stops, and others claimed it could be more interesting for tourists or occasional passengers.

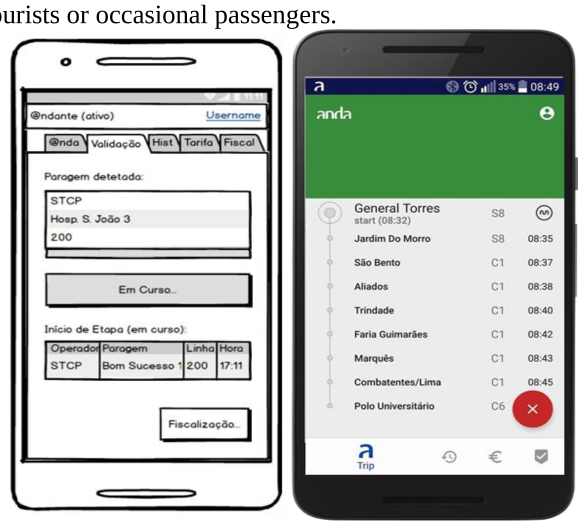

Figure 3. Check ongoing journey information: from prototype to final design.

"During home-work-hone journeys no one will look at the mobile phone to see if they are reaching the destination or not. Maybe in a more occasional trip, which you do not know very well, it can be useful" (Male, 28)

5) Journey inspection

The design of this activity was not considered a priority. Several ideas were discussed, such as visual inspection or use of inspectors' handheld devices to verify the validity of the journey, but no decision was made. From the customers' point-of-view they claimed for a straightforward process, such as clicking on a button when the inspector approaches.

6) Close the journey

Regarding the way of how the journey ends, two options were discussed: be-out or check-out. The main aim of the proposed solution was to require the least possible interaction from the customer. Since the beginning of the journey was difficult to implement without any user interaction, transport operators decided to follow a be-out scheme, with no objection from the technological point-of-view. Therefore, when the customer leaves the vehicle, the mobile phone loses the signal of the beacon. This information, combined with the mobile phone accelerometer, allows to understand the customer left the vehicle and the mobile application closes the journey automatically. The users only point out that a time-out is considered.

"There must be an interval of time that closes the trip even if I stay at the station at the end of the trip." (Male, 29)

7) Calculate the fare

The fare to be paid is calculated by the system and not by the customer. Since the system knows the exact origin and destination, customers suggest to calculate the price according to the km or stops travelled and not based on the zones crossed. They argue this would be a fairer system and would encourage its adoption by passengers.

"Why is it not possible to only pay exactly what you travel? That is, if I enter this stop and leave in another located in the middle of a zone, I could pay only half of the price." (Male, 27)

However, transport operators do not want to change the fares in force. Both ticketing systems (card and mobile) must use the same fare rules. Therefore, it was developed a fare optimization algorithm in order to optimize the fare to be paid by the customers. The algorithm groups the journeys in the cheapest combination of tickets for the customer. For instance, if the customer has made enough trips to reach a monthly subscription, only the monthly subscription is charged. This is one of the biggest advantages of the proposed mobile ticketing service when compared with the traditional ticketing system. Customers only pay what they travel and do not need to have any knowledge about routes and fares.

8) Payment

In order to optimize the price to be paid by the customers, transport operators opted for a post-paid solution. The fare is paid at the end of the month through debit or credit card. The majority of customers (67%) preferred a pre-paid wallet, through which the amount to be paid would be discounted. However, transport operators decided for a post-paid solution linked to the bank account.

"I prefer pre-paid systems. I have more control over my spending." (Female, 31)

9) Check historic information

Customers can check their travel history at any time. The mockups presented to customers had too much information and were considered confusing (see prototype in Fig. 4). They just want information about the departure and alight station, date and hour (see final design in Fig. 4). They do not want to know the corresponding ticket to perform a certain journey, neither to compare with the optimized fare. Customers want to forget about the complexity of the network and corresponding fare system.

"I would take a lot of information out of here. I just want to know the origin and destination, date and hour. The intermediary stops are not important." (Female, 31)

"Replace the name of the operator with the logo would be better visually." (Male, 22)

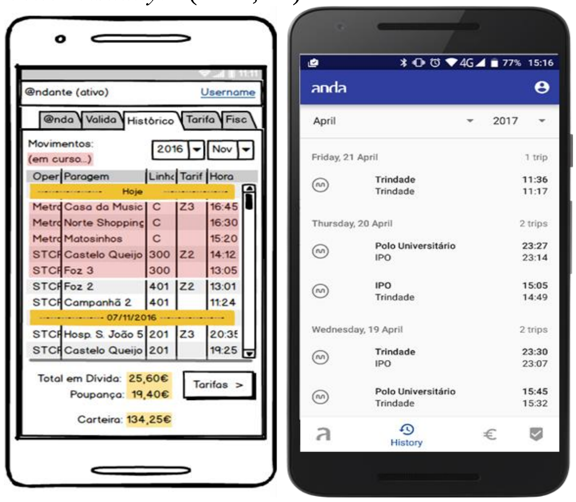

Figure 4. Check historic information: from prototype to final design.

C. Discussion

The design of the mobile ticketing service solution resulted from close interaction between several stakeholders of the mobile ticketing ecosystem. First the problem was identified by local transport authorities and operators: complexity of the fares and of the transport network. The objective was to develop a mobile ticketing service solution easy-to-use, with least interaction possible from passengers and that enables easy access and use of public transport services. Several meetings were held between transport operators, researchers and technological companies to codesign the service and first mockups were produced. These were discussed with customers during focus group sessions in order to collect their opinion regarding the designs and travelling experience. Several issues were addressed: what kind of information they wanted to have access to, how they imagine the check-in process, what kind of payment they would prefer (post-paid vs. pre-paid) and main features and functionalities the service should provide. During the codesign process opposing opinions arose and a consensus had to be established in order to achieve a consistent mobile ticketing service solution.

In the final solution, the passenger downloads de mobile application and registers by introducing personal information: name, email, phone number, password and bank account details. Then the passenger access to the email and confirms the registration. To start a journey, the passenger opens the app and it starts to search for beacons placed in stations and buses. The passengers selects the one that he/she is entering on, having an active role at the beginning of the journey. During the journey, the passenger can check the stations he/she is going through and at the end of the journey the mobile application closes the ongoing trip. Customers stated they wanted few information in the historic screen, the home screen should be the validation one and would like to pay exactly want they travel. Despite its complexity, transport operators did not want to change the fares in force and adapted the solution to automatically calculate the corresponding fare. Due to technological constraints it was not possible to create a be-in/be-out scheme and the choice fell on a check-in/be-out scheme.

V. Conclusions and Future Work

This paper presents the codesigning process of a mobile ticketing service solution based on BLE, that was developed under a research project involving the Faculty of Engineering of the University of Porto and Transportes Intermodais do Porto. The design of the service involved multiple stakeholders of mobile ticketing ecosystem: transport operators, technology companies, customers and researchers. Weekly meetings and focus group were carried out in order to explore the different perspectives of the stakeholders. A final solution covering all customer experience moments – before journey, travelling, and end of journey – was designed taking into consideration stakeholders' contributions.

The final service solution is based on a check-in/be-out scheme, requiring an intentional user action when entering the vehicle and the alight station is automatically detected by the system, as well as intermediary stations along the trip. The mobile phone interact with BLE beacons installed in metro and train stations and inside buses, through Bluetooth connection, to locate the customer along the transport network. The price to be paid by the customer is calculated through a fare optimization algorithm, which minimizes the cost for the passenger. A total of 150 BLE beacons were installed in pre-selected metro and train stations as well as inside buses, in the city of Porto, Portugal. The objective is to run a pilot with real passengers in order to assess the viability of the mobile ticketing solution.

The proposed mobile ticketing service solution is innovative in the urban transport field, resulting from a clear and unequivocal interaction between different stakeholders of the mobile ticketing ecosystem.

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