Mobiganha - Innovative Services for Public Transportation Based in Mobile Payments

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Abstract

In the last few years, society has witnessed the massification of mobile devices. The possibility to access a large amount of information at any time has brought new ways to interact with the world around us and new manners to accomplish our daily tasks. This has forced many companies to reinvent themselves and to evolve, and transportation companies are not an exception to the phenomenon.

In a society facing many environmental and economic changes in a fast succession, public transportation is starting to be regarded as the most intelligent way for solving one’s transportation needs.

This project wants to contribute to a better junction of the technological and transportation worlds. Mobiganha is the second iteration of the Mobipag project which consisted in the creation of a mobile payments application to substitute the traditional travel tickets in the Metropolitan Area of Porto, and will evolve the existing prototype one step further, by the addition of new functionalities.

Combining the concept of a voucher market with a system of miles, Mobiganha uses this Android application as a technological base to unite the transportation system of a region and its economical activity. Users gain points in result of their spending in travel tickets, and can exchange them for additional tickets or vouchers to spend in spaces scattered throughout the Metropolitan Area of Porto. Apart from all the advantages a mobile payments solution presents, one advantage of this system compared to existing solutions is the freedom conceded to the business owners: through a Web backoffice, they have the liberty to create their own offers when they feel appropriate. Other advantage is the reunion of already existing partnerships between the operators and entities in a single place, reaching therefore a higher audience.

Since location based services are gaining some importance in the mobile software field, the application emits notifications to the user when he is in the vicinity of a local business he possesses a voucher for, keeping the user interested in the use of the application and, indirectly, in the use of public transportation.

This concept results of the analysis of the city’s own necessities. Starting as a blank page, the voucher market solution emerged from a focus group with potential users and meetings with transport operators and people connected to local businesses of the city. This way, a balanced business model, approved by all parts, was achieved. The evaluation of the developed prototype, through some questionnaires and scripts, proved this. The testing sample members regarded Mobiganha as a solution with potential to gather new users for public transportation and engaging the existing ones. Yet, the main conclusion of this project is that, whether it is a voucher market or any other of the proposed services, technology can provide a mean to improve the quality of life of a city and the sustainability of public transportation systems.
Resumo

Nos últimos anos, a sociedade tem assistido à massificação dos dispositivos móveis. A possibilidade de aceder a uma grande quantidade de informação a qualquer momento trouxe consigo novas maneiras de interagir com o mundo que nos rodeia e novos modos de realizar as tarefas diárias. Isto obrigou muitas empresas a reinventarem-se e evoluírem, fenômeno ao qual as empresas de transporte não são exceção.

Numa sociedade que enfrenta muitas mudanças económicas e ambientais em rápida sucessão, os transportes públicos começam a ser encarados como a forma mais inteligente de resolver os nossos problemas de mobilidade.

Este projeto pretende contribuir para uma melhor junção dos mundos dos transportes e tecnológico. Mobiganha é a segunda iteração do projeto Mobipag, que por sua vez culminou na criação de uma aplicação de pagamentos móveis para a desmaterialização dos títulos de viagem tradicionais na Área Metropolitana do Porto. Aqui, através da adição de novas funcionalidades, pretende-se evoluir o protótipo mais um passo.

Combinando o conceito de um mercado de vouchers com um sistema de milhas, o projeto Mobiganha usa a aplicação Android existente como base tecnológica para unir o sistema de transportes de uma região com a sua atividade económica. Os utilizadores são recompensados com pontos fruto dos seus gastos em títulos de viagem, pontos esses que poderão ser posteriormente trocados por títulos adicionais ou vouchers de descontos em diversos sítios espalhados pela cidade. Para além de todas as vantagens que os pagamentos móveis apresentam, uma das vantagens deste sistema comparado com soluções semelhantes é a liberdade concedida aos representantes dos negócios locais: através de um backoffice web, têm a liberdade as suas promoções assim o achem achem proporcionado. Outra vantagem e a união de diversas iniciativas já existentes entre operadores e negócios ou entidades num único local, alcançando assim uma audiência potencialmente maior.

Uma vez que os serviços baseados em localização estão a ganhar importância no campo do software móvel, a aplicação emite notificações ao utilizador quando este se encontra na vizinhança de um estabelecimento para o qual tenha vouchers, mantendo-o assim interessado no uso da aplicação e, indiretamente, no uso de transportes públicos.

Este conceito resulta de uma análise das necessidades da cidade. Começando com uma folha vazia, a solução baseada num mercado de vouchers emergiu a partir de um focus group com potenciais utilizadores e reuniões com operadores de transporte e pessoas ligadas aos negócios locais. Deste modo, um modelo de negócio equilibrado, aprovado por todos os intervenientes, foi alcançado. A avaliação do protótipo desenvolvido, através de questionários e guiões, prova isto mesmo. Os membros da amostra de teste consideram o projeto Mobiganha como uma solução com potencial para atrair novos utilizadores para os transportes públicos e manter os existentes fiéis. Ainda assim, a principal conclusão deste projeto é que, independentemente de ser um mercado de vouchers ou qualquer um dos outros serviços propostos, a tecnologia providencia um meio para melhorar a qualidade de vida de uma cidade e a sustentabilidade dos transportes públicos.
Acknowledgements

This project marks the culmination of my academic journey.

As someone far better with words than myself once said, what matters is the journey and not the destination. I do not know the reasoning behind this statement, but if I had to guess, I would say that the people we meet, the things we learn and the moments we live are what make the journey so worthwhile. This little space is dedicated to all the people who shared this journey with me.

First of all, I want to thank my advisor, Prof. Teresa Galvão, for always making me think one step ahead and giving me the resources to look for solutions for my problems.

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To all my family, for giving me the strength to endure the most stressful moments and believing in me when my hope threatened to leave. To all my friends, for all the moments, and helping me become who I am.

Last but not least, to all the nice folks in stackoverflow, for creating a community so big and so complete that it became truly essential for anyone working in software.

Vítor Hugo Coelho Santos
“The best way to get a project done faster is to start sooner”

Jim Highsmith
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Abbreviations

BLE Bluetooth Low Energy
FEUP Faculdade de Engenharia da Universidade do Porto
GPS Global Positioning System
MVC Model View Controller
NFC Near Field Communication
PDA Personal Digital Assistant
QR Quick Response
RFID Radio-Frequency IDentification
SMS Short Message Service
USSD Unstructured Supplementary Service Data
Chapter 1

Introduction

The goal of this dissertation is to provide the reader with a detailed overview of all the work
done throughout this project, focusing on the problem at hand and the solution created to solve it.
To make this document clear to the broadest set of people possible, it is intended to provide an
explanation of the concepts presented, depending on the context they appear and, in a later chapter,
a brief description of the different technologies involved in the development phase of the project.
In this chapter, and to better contextualize this dissertation, the motivations that led to the choice
of this theme are presented, along with a framing of the theme itself. In the end of this chapter, it
is presented a structure of this document.

1.1 Context

Starting with a brief analysis of the title of this dissertation, it is already possible to extract some
information about the areas it is inserted in. In first place, it is important to state the importance
of the mobile payments, which in this case appear in a public transportation environment. Mobile
payment is the act of using a mobile device, as a smartphone or a tablet, to pay for goods or ser-
vices [AK08]. Limiting this concept to public transportation, a mobile payment implies the use of
the mobile device to perform the necessary payments for a person to be able to use the transportation
service, whether it is to buy of a single-use ticket or a subscription of the service for a limited
amount of time. In fact, public transportation is of major importance for the modern society, not
only because it drives huge investments, but because the state of the public transportation infra-
structure of a region is a sign of its own development [Dey01]. Public transportation is one of the
existing solutions to some of the economic, social and environmental problems the modern society
faces and, as such, should be a target of constant evolution and innovation. One of the possible
paths for this evolution, and the one targeted by this dissertation, is the resort to the functionalities
provided by the aforementioned mobile devices and to services that can bring value to the parties
involved.
Introduction

The use of mobile devices, besides the steady growth in terms of number of users, becoming almost ubiquitous, has been registering some changes in the methods of usage per se. Indeed, the valences provided by current mobile devices, whether in terms of raw processing power, whether in the presence of several sensors, open new possibilities for the creation of revolutionary services. A mobile device, until now mainly used to allow the communication of two users, by sending of text messages or via voice calls, evolved into an authentic personal assistant, where the presence of cameras, a GPS sensor, Internet connectivity and a huge number of other sensors are already commonplace and shape the using experience itself. With this, it is possible to say that we are experiencing the advent of the context based services, another area in which this dissertation is framed. In short, context based services are services that use the context of a user, as the location it is in (location based services are a big subset of context based services), the air temperature, specific body signs, or, generalizing, all the information that helps defining a user in a specific moment, to provide advantages tailored to that specific user and moment [Dey01]. If, from an Engineering point of view, this represents a more or less new focus to be increasingly explored in the future, the same can be said for areas such as Marketing, which, in its mobile facet, seeks to use the mobile devices for the promotion of goods and services tailored to each client.

In this project, it was intended that all these areas were explored and innovative mobile services, which use mobile payment functionalities already available created, always with public transportation as background. The resulting services, to be detailed further in a later chapter, were then implemented in a prototype Android application. Coming as a follow-up to the Mobipag [Moba] project, this project was developed with the close collaboration of several entities, namely STCP - Sociedade de Transportes Colectivos do Porto, SA and Metro do Porto, important not only for the validation of the final results but to the shaping of a solution as well, and OPT – Optimização e Planeamento de Transportes, SA, company responsible for several products related to the operational planning of public transportation systems [OPT].

1.2 Motivation and Goals

The first big goal for this project is to potentiate the usage of mobile payment solutions in public transportation. Solutions of this kind have several advantages to the users. Queues to make a payment are reduced, and, since the cellphone is an essential accessory to many people, loss of the device or forgetfulness become a minor issue comparing with a traditional transportation title. On the other hand, there is a big number of public transportation users in Porto Metropolitan Area, and recent studies show that the trend is for that number to grow [DM13]. During the first semester of 2013, about twenty eight million journeys were made using the Porto Metropolitan [dE13a, dE13b], and, for the STCP buses, the number of validations grows to forty one million [dMdVM13]. To increase these numbers, and be a viable alternative to private transportation, operators need to keep innovating, providing services that make users shift their habits.

So, if for these almost seventy million people public transportation is already a solution for
their mobility problem, it is important that the companies which provide the service keep innovating so that their services could be seen by many other potential users a solution for their mobility problem, becoming more and more a viable solution to the personal mean of transportation.

In a more technological point of view, we keep watching an increase of the diffusion of modern mobile devices. In fact, in the second trimester of 2013, and for the first time ever, the sales of smartphones surpassed the sales of conventional cellphones, and the creation of new, cheaper, data plans allow more people to access the Internet in any place using their new devices. Also in 2013, the Android operative system passed the one thousand millions device activations mark [Yar13].

Device manufacturers have the idea that the creation and use of context based services is one of the trends that will define the future of computation assimilated, and therefore they are beginning to include that possibility when conceiving their devices.

In its Iphone 5S, Apple introduced for the first time a co-processor solely responsible for receiving data from the different sensors of the device and providing them to the different applications, liberating some of the load from the main processor and providing new possibilities for the app developers [Kah13]. On the other hand, Motorola, within their X8 platform, includes an always active processor core exclusively dedicated to voice and context processing [Mot13].

Creating new services to foment the growth of mobile payment usage, and at the same time researching and developing in innovative areas as context based services and mobile marketing are also a big personal motivator.

In short, with this project, it is intended to:

• Create innovative services in the mobile computation area, using a mobile payments application as a base, and having those services tailored to each user;

• Evolve the prototype of an already existent Android application with mobile payments functionalities, implementing the aforementioned services and testing them in a real world environment;

• Write recommendations about the usage of this kind of services by the transport operators according to the results of the tests;

• Center already existing services and initiatives in a single place;

• Increase the quality of service of the public transports and the loyalty of customers using services provided by their own devices.

1.3 Structure of the dissertation

Apart from this introductory chapter, this document contains an additional six chapters. In chapter 2, dubbed Literature Review, the existing knowledge about the areas framing this project is elicited, and some relevant projects for the development of a solution for the problem are presented.
Introduction

Following this, chapter 3, presents the Mobipag project, which serves as a base for Mobiganha, and some necessary knowledge to comprehend the system, as the functioning of the Andante system.

In chapter 4, the process that led to the planning of a solution is described, as well as the solution itself, from a business model and technological point of view. This includes a presentation of the architecture of the system.

Chapter 5 gives all the necessary details about the implementation phase of the project. The chapter starts with a list of the found requirements, and, after an explanation of how all the relevant concepts for this project relate among themselves, the chapter finishes with the listing of the main screens of the system and the functionalities present in each one, functioning as a use guide for the system.

In chapter 6, the evaluation methodology and results are detailed and discussed, finishing this document in chapter 7 with all the conclusions taken and an overview of the future work.
Chapter 2

Literature Review

2.1 Introduction

In this chapter it is intended to, in first place, provide a brief literature review relative to the fields inside which this dissertation is framed. Besides this, some already existing mobile applications, relevant for this project are presented, either due to their innovative usage of mobile payments, for bringing value in the transportation area, or even because they represent advancements in the mobile marketing or context based services field.

2.2 Mobile Payments

The use of mobile devices to perform payments is an idea that, albeit not completely engrained in most people’s quotidian, exists for almost twenty years now. Its appearance occurred originally in Finland, with two distinct actions occurred in 1997. The Merita bank launched in that year the first Mobile Banking service but, by then, the two giants Nokia and Coca Cola had already allied to allow the payment of drinks in a small number of machines dispersed by Helsinki through the sending of text messages. The following year, and still in Finland, it was launched the first service to allow the download of multimedia content for cellphones, marking the beginning of mobile content stores.

The mobile payment concept and, by consequence, the mobile commerce concept have, since then, spread around the world. Yet, it is still in the northernmost countries of Europe, where they were first introduced, that they find the most adhesion, being commonplace in several applications, from parking lots to public transportation [nea].

One of the most important characteristics of the mobile payment technology is that it always kept up with the advancements of connectivity methods in mobile devices, or, in other words, the method they use to communicate and send data between themselves. This has led to the appearance of several distinct modalities of mobile payments. The original method consisted in sending text messages using SMS or USSD codes to a pre-determined number, with the respective amount of money being deducted from the user’s balance a posteriori. Once verified the validity
of the transfer, the service provider would perform their part of the deal, usually sending some kind of content. This system has later evolved to a subscription based system, very popular in Portugal which, at predetermined intervals of time, would automatically draw an amount from the subscriber’s balance, sending the content afterwards [Ble03]. Although this method is still practiced nowadays, it is falling into disuse due to the disadvantages associated with a text message based system. The biggest disadvantage is a matter of infrastructural costs, which have to be supported by either the customers or the service providers. On the other hand, the quality of service is very dependent on the amount of users using the system at a given moment. Finally, there are security issues associated with the SMS protocol, namely at the data encryption level.

More recently, the possibility of accessing the Internet from a mobile device fomented some innovations in the mobile payment field. From that moment, it became possible for companies to introduce forms in their webpages for the customers to introduce their credit card data, in a similar way they could already do in a traditional computer. However, doing this from a mobile device did not turn out as an option, since data entry became more difficult, increasing the amount of mistakes and damaging the user experience. This flaw was hugely mitigated by one of the biggest advancements in the electronic payments field: the invention of virtual wallets. Created in 1998, but only becoming popular a few years later due to its relationship with the e-commerce page eBay, the PayPal service is a pioneering example of this technology. Here, a user can register, creating therefore a virtual account which can be linked to an account in a real bank or a credit card [Pay]. Hereupon, the user who wants to make a payment for a good or service can do it with only a few clicks and without memorizing more than a password or PIN, as long as the company website supports Paypal payments.

Later, it appeared some other virtual wallets from competing companies, namely Google Wallet and Square Wallet, described later in this chapter, but none of them caught the interest and market share of the first one. For being the more widespread method of connectivity, the wireless access to the Internet is many times the most effective solution for mobile payment applications [FND13, FCN12].

With the introduction of new sensors in mobile devices, and with the main goal of eliminating Internet access costs, new mobile payment methods started to surface, backed by various different technologies. From all the alternatives, three stand out: QR codes, NFC and BLE. The first one consists in the reading of a special barcode from the device’s camera, like the one presented in Figure 2.1, and in which all the payment related information can be built-in [Wav]. This system has many advantages, like the facility to code and decode the information and the speed of transfer. In contrast, it demands that the device used to capture the code is close to the code itself. This characteristics make this a very viable solution, for instance, to validate a ticket in a turniquet, whether to watch a spectacle or to enter a public transport [GKR09].

NFC, or Near Field Communication is, alternatively, a technology for communication via radio waves [nea]. Comparing this with the use of QR codes, NFC has the advantage of being inherently bi-directional, decreasing the need for interaction between the involved parts, and also for allowing
the sending of bigger amounts of data at high speed. It is, then, an interesting alternative for multimedia content transfer, usually activated by NFC tags scattered by public spaces [OP07]. However, the fact that this technology is only effective at short distances, and specially the fact that NFC is not a widely accepted standard are delaying its growing.

Finally, the BLE technology, or Bluetooth Low Energy, is widely considered the technology with the highest potential for mobile payments usage. Based in Bluetooth, it solves its biggest issue, the huge power drain it causes, while keeping its advantages, such as the possibility of communicating at higher distances and the amount of devise that already support this technology [Gooa]. Possibly the more widely known BLE implementation is in the iBeacon application, developed by Apple.

Outside the technology scope, some studies were led about the factors that drive a determined individual to accept or reject mobile payments. The conclusions found by those studies helped shaping new solutions that increase the satisfaction rate of the users [Mal07].

### 2.3 Context Based Services

One of the consequences of last decade’s adoption smart mobile devices was that, until then stagnated research areas regained their status as potential future of technology. Context based computing is one of those areas.

In truth, the concept of having context allied to computation exists since 1994, yet, only in year 2000 the first true definition of context appeared. According to Dey, context is “any information which can be used to define the situation of an entity. An entity is a person, place or object considered relevant for the interaction between a user and an application, including the user and application themselves” [Dey01].
In the following years, this theme was a target of many researchers, with the main focus regarding the creation of frameworks that allowed the construction of context based services and applications, making the link between the user interface layer and data access layer [BDR07, Bra07]. However, these frameworks ended up introducing some difficulties in the design of these kind of services because business logic would often end up intertwined with context logic [Cho07]. To adapt to this reality and facilitate the architecture of these systems, the requirements engineering process also suffered some advancements. One of the proposals suggested the division of the context concept in three sub-types: computing context, related to the characteristics of the device where the application is running; user context, related to the information about the user of the application and finally, physical context, related to the information about the external environment, as the temperature [HCS05].

With the appearance of the so-called modern PDAs, or, more generally, with the ability to access the Internet with touch screens, it started to surface the first implementations of context based services in mobile devices. Amongst those forerunners it can be found a set of applications developed in Finland by the Rotuaari research project [Oja10]. These applications, like the one that can be seen in Figure 2.2, are fundamentally examples of location based services, a subset of context based services that use the location of the user to adequate their response. The reason for this is simple. By the time, many of the sensors available today weren’t yet existent, or were not present in the devices, making these applications an example of distributed systems as well, with all their inherent difficulties. In fact, location based is still the most common subtype of context based applications [Dia12].

![Image of TimeMachine Oulu application]

Figure 2.2: TimeMachine Oulu application, which enabled the users to see a three dimensional model of the city of Oulu, including building burned down in the nineteenth century

More recently, new sensors started shipping integrated on the mobile devices. This has facilitated the development of context based systems, since all the necessary data is now available through the operative system API’s, losing the need to access several servers. This has led to an indirect increase of the popularity of this kind of programs and fomented the surging of new building techniques of application and services [PO11].
2.4 Mobile Marketing

With the appearance of mobile payments, location and context based services and mobile commerce, it was a matter of time until mobile marketing, i.e., the promotion of goods and services adjusted to each customer, using his mobile device, started to receive a bigger importance. In fact, it was during the year of 2005 that a sudden increase of research around this issue happened. This is a theme that transverses many fields of study, from engineering and information technologies to management. However, the main focus of the research is related to the acceptance of mobile marketing by the users and its diverse approaches [VT10].

In a first phase, in the beginning of last decade, mobile marketing was primarily done by sending text messages to the users. However, since those messages were not adapted to each user, the degree of satisfaction was variable. In fact, studies showed that the first impression caused by this services was mainly negative. Though, for customized offers, this impression inverted. To this satisfaction also contributed if that publicity was authorized or not [THL04, SDM05].

With the appearance of modern mobile devices and specially of the app markets, the preferential diffusion method stopped being the text messages, since ad frameworks, like Google Ads, until then exclusively used in web pages started supporting mobile applications [Goob]. With this, the diffusion of marketing campaigns stopped being dependent on the user authorization, since a big part of the developers adopted frameworks like this in their applications to obtain higher revenues. However, since offers started being adapted to each user, user satisfaction has actually increased [SB09].

2.5 Related Work

By the time this study of the diverse mobile markets was finished, it was concluded that, at least as far as the obtained knowledge goes, there is not any application that solves the proposed problem. Usually, existing apps only solve one part of the problem. There are several mobile payments applications, applications focused only on public transportation users and finally applications implementing context based services, yet, none of them combines these three factors. So, the application that will be proposed by this project can be considered an innovative proposal. Anyway, for presenting interesting solutions for their own problems, providing important information to solve this problem as a whole, some existing programs will now be presented.

2.5.1 Passbook

Passbook is developed by Apple and it is the company’s bet in the mobile wallet concept [App].

Available for iOS mobile operative system from its sixth version, this application has the goal to store several types of passes, such as discount vouchers for certain establishments, flight tickets or tickets for a show.
Although it does not intrinsically possess mobile payment capabilities, Passbook was projected to receive passes from many sources, including mobile payment applications. Users can afterwards use their passes in appropriate locals, since the application supports their validation. Besides, the application is location aware, or in other words, if the user is entering a place he/she has a pass to, Passbook alerts the user for that fact.

It is, by the time of writing, an application already used by service companies of various areas, including transportation companies as British Airways and SNCF, the French railroad company [SNC].

2.5.2 Square Wallet

Square Wallet, currently available for Android and iOS, although exclusively in the United Stated of America, is a mobile payments application that presents some characteristics to detach from its competitors. In first place, it has an automatic admission, or check-in, mechanism, i.e., each time a client enters an establishment, as long as an employee clicks in the application to confirm the users identity, all the payment process is done automatically. It is also possible to use the application as a QR code reader. The QR code contains all the payment details, which is then realized from a card associated to the user's bank account, just like in a common mobile payments app.

Where this application sets itself apart is in the effort put on by the development team to minimize the distance between an electronic payment method and a conventional method, in this case, a credit card. With this application, users can also acquire a micro card reader which connects to the device, which then retains automatically the necessary card information to make the necessary payments in a fast and safe way [Squ].

2.5.3 Gett – Taxi & Black Car Service

The Gett app [Get], previously called Get Taxi, is currently available for a few operative systems, as Android, iOS and Blackberry, and has the main goal to reduce the waiting time for a taxi. Its concept is simple: a user can select a place of his choice in a map, and the application signals the closest free taxi, which then goes to the agreed location. It is possible for the user to see how long it will take for the taxi driver to reach the designated local, and it is also possible to make appointments for a desired date and hour.

Besides this, the application possesses a reward system like the mile system implemented by some air companies, with a user's travelled distance being accumulated, translating into discounts and access to special events. Another relevant functionality of this app is that a user can pay the service using the credit card data attached to the app. For this, the user has to sign up using an email address, to where all the billings will be sent. The app is free, however, the service has a fixed rate of fifteen percent of the value fixed on the taximeter, plus another five percent going directly to the driver.
2.5.4 Groupon

Started in 2008, this American company has registered one of the biggest growths ever registered, finishing the year 2010 valued at more than one thousand million dollars. Groupon’s business revolves around making partnerships with local businesses and selling vouchers for those businesses at a discounted price [Gro]. For this, the business owners contact Groupon which then assign one of their partners to build the campaign strategy with the business owner. In the end, the value of the voucher gets divided by the business owner and Groupon itself. Hopefully, the business will gather enough clients to make the campaign profitable, either via direct earnings or via publicity.

To give the business owners more security, Groupon starts by revealing the promo to a limited number of clients. If, in that small set, exists enough interest in the promotion, it gets revealed to all Groupon users. Otherwise, the promotion gets delayed to a later day.

Although it is now available in almost fifty countries, the Groupon business model started to receive criticism by some analysts, yet, it is still one of the most recognized companies for users wanting to get vouchers and promotions. A screen-shot of the Android application, featuring some available promotions at the time of writing, can be seen in Figure 2.3.
Literature Review
Chapter 3

Background - The Mobipag Project

This chapter is a resume of all the work done previously in the Mobipag project, the base where Mobiganha lies upon [Mobb]. This project was a national initiative towards the growth in the adoption of mobile payments. In this particular case, it represented the creation of a mobile application to replace physical cards in the public transportation system of Porto Metropolitan Area (for simplification purposes, it will from now on be referred solely as Porto).

3.1 The Andante System

For traveling via public transportation in Porto’s extensive network, it is necessary to know how the service is structured and how ticketing works. In fact, one of the main complaints about the service relates to its complexity, which this section intends to clarify.

In first place, it is important to say that this is a network composed by several operators, public and private, that share one common point between them: the Andante.

Andante [And] is the name of the ticketing system used in Porto’s public transportation network. In this system, the price is based on the journey and on user characteristics (child, adult, senior or pensioner), rather than on the transportation type. For instance, if a user wants to take a direct route from Aliados Avenue to Gaia Municipal Council, it is the same, price wise, whether he uses a bus or the light rail.

This journey-based pricing is possible due to a division of the geographical area covered by the network into several zones, as pictured in Figure 3.1. These zones share a flat rate. Therefore, the total price for a journey is calculated having into account the number of zones the user wishes to travel.

The Andante ticketing system is composed by a few ticket types. In first place, there is the occasional ticket. This ticket is defined by the number of zones it covers and only allows for a single use. The naming for this type of ticket follows a zX pattern, where X is the number of zones, from a minimum of two to a maximum of twelve. For instance, a z2 occasional ticket
allows the user to make a journey through a maximum of two zones, while a z12 ticket allows the user to travel through a maximum of twelve zones.

After the occasional, there is the Andante 24. Like the name suggests, it is valid for one day. The user can accumulate more than one ticket in a single card, as long as they have the same number of zones, and when one buys 10 tickets of the same kind in a single operation, he is automatically rewarded with another one for free.

Next, and aiming towards tourists, there is Andante Tour. It can be valid for one or three days, and allows the user to travel through all the different zones.

Finally, there is the possibility to subscribe specific zones on a monthly basis. This subscription allows for unlimited use of the transportation network during that month. For users using the system regularly for their commute, monthly subscriptions are the best option economically. Instead of a blue paper card, the user of a monthly subscription receives a golden plastic card.

The system is based in a open (without gates) architecture, something that requires a big technological investment. In fact, all Andantes are contactless cards with RFID capabilities, that must be validated whenever a user wants to use the service. Since several operators have their stake in the system, when the user changes the mean of transportation or line, the ticket must be validated again. It should be noticed that, once validated for the first time, the ticket has a timespan of 1 hour. Therefore, the user will not be charged again for this change of line or mean of transportation.

Figure 3.1: Division of Porto Metropolitan Area into zones
3.2 Mobipag

The application [Dia13], conceived for Android devices with version number 2.2 or newer, implements almost every functionality provided by an Andante card, but in a digital form.

When the application is started for the first time, the user is prompted with a signup form, where some personal data is required. The user is also asked for a four digit PIN, a security measure necessary when the application returns to execution from a pause state. Afterwards, in the application’s main menu, which can be seen in Picture 3.2, some options are presented, being the first two the more important ones. Starting by the second button of the menu, Comprar, the user is presented with some possible options, which represent the buy of one or more single use titles, valid for a predetermined number of zones. It is also possible to acquire Andante 24 titles, similar to the previous ones except that these are valid throughout a day. Finally, it is possible to acquire a monthly subscription. When subscribing, the user needs to explicitly state which zones he/she will be traveling in, unlike what happens in a regular ticket.

When the titles are bought, the user needs to validate them, using for that matter the first option of the main menu. Here, as it can be seen in Picture ref:vali, the user first needs to input the entry stop, line and title he/she wants to validate. For selecting the entry stop, the user is prompted with a help menu, where one can input the transport company and line, and, after confirmation, a list of all available stops is presented. One possible alternative to this would be using GPS to locate the user, but that alternative was dropped given the plethora of different mobile devices and
Background - The Mobipag Project

Figure 3.3: Title validation menu

consequently, GPS sensors with different sensitivity, would majorly affect the user experience in a critical stage as this, especially in areas with more than one stop close to each other.

Apart from these two essential functionalities, some usage statistics are available to the user in the menu’s third option, Consultar. Here a user can have an overview over his transactions and an historic of ticket usage.

All the connectivity in the application is made through the Internet, being all the data present at an external server. This happens for several reasons:

- Data plan prices are progressively dropping;
- NFC is not an universal technology and has problems with use at bigger distances;
- BLE only started being supported in Android from version 4.3, which a big part of the total devices still lack.

3.3 Testing period

Given the importance of a system of this kind, it was decided that a testing program in real use conditions should be executed. For this, during about three weeks, some potential users used the application prototype in their smartphones and used it during their commutes.
Background - The Mobipag Project

The selection process was led by STCP with the goal of gathering an heterogeneous set of users and, to facilitate communication between these users, a Facebook group was created where they could share experiences, opinions and doubts.

This testing phase was a success, with about 600 validations performed, in about one hundred different routes and more than 200 stops. The involved users were very enthusiastic about the project, and gave very important feedback, not only for bug fixing, but for getting some insight about what the users value most in this kind of applications.

3.4 Conclusion

The Mobipag project was the first stepping stone into building a more sustainable public transportation infrastructure in Porto. Mobiganha is the second step, by using the application capabilities, and extending them into other areas through the incorporation of other services, to better provide a quality service for the existing and future public transportation users.
Background - The Mobipag Project
Chapter 4

Mobiganha

4.1 Introduction

In this chapter, the process that led to a solution for the proposed problem, as well as the solution itself are detailed. In the first section, the research approach, in the form of a focus group, is presented. After this, there is a description of the system and its business model in the second section. Then, the architecture of the system is detailed, finishing this chapter with one section about relevant technologies to be used in the development stage and another for a resume of the chapter and conclusions.

4.2 Focus Group

Taking another brief look at the problem, it is possible to say that there are several possible ways of improving the relationship between public transportation users and the public transportation operators. However, it is not trivial to say which of those several solutions provide the most benefits at a short term or which is the most balanced to both users and public transport operators.

To help solving this issue, a focus group was organized, with the goal of gathering some insights from potential users about their feelings towards public transportation and mobile payments. A focus group is an informal technique to assess user needs and opinions towards a particular theme. This technique entails the realization of a session, usually about two hours long, with a group consisting of ideally six to nine users. The number and characteristics of users are of major importance: on one hand, there should be enough users to provide a wide array of different opinions regarding a particular matter; on the other, this number should not be so big that it jeopardizes the organization of the session. Apart from the selected users, a focus group needs a moderator. This moderator is responsible for keeping the discussion focused on the problem at hand, without inhibiting the free flow of ideas, and for setting a number of goals to be completed by the end of the session [Nie93].
For this second iteration of the project (being the Mobipag project, described in the previous chapter, the first) it was logical to select some users already involved in the project. Henceforth, for this initial session, some participants of the Mobipag project testing phase were selected. In first place, the participants were given a small questionnaire, available in Appendix A, with some questions about their online spending habits, their use of public transportation and general relationship with mobile devices. This way, it was possible to assess the validity of the problem at hand, or if there was enough interest in its resolution.

On a second phase of the focus group, the participants were asked some open questions about what features would propel them to use public transports more often and how they could be integrated in a mobile application. The participants suggested several alternatives.

In first place, the users suggested the creation of an incentive for the use of public transportation, to be given by companies to their workers. This could be embedded in the application, and would likely replace already existing subsidies.

After this, users complained that one of the main reasons for not using public transportation was that, for people with family, it was cheaper to use private transportation. They suggested the creation of partnerships with entities like museums that could benefit families using public transportation and therefore reduce spending. In fact, partnerships and reward were probably the key words for the whole session, gathering support from everyone present. For this fact, and since a system like this could be seamlessly translated into the existing application, it was the base concept for Mobiganha.

However, other topics were raised by the users. In first place, the topic of security: specially during weekends, public transportation is more scarce and, given the smaller influx of people in some stops, the sense of security is damaged. The suggestion presented was the creation of an app (or, in this case, the inclusion of a module in the existing app) where users can evaluate the security of a given stop in real time, providing important information to other users and even the security agents. Lastly, the topic of environment: common sense tells us that using public transportation is more environmentally friendly than using private transportation, but it is sometimes hard to quantify that difference. Through the concept of gamification, the participants suggested that the app started presenting ecological information to the user during the course of the trip. This would not be a service per se, but an add-on.

4.2.0.1 Sociodemographic distribution of the users

In this session, apart from the moderators, other eight people were present. From this eight users, five said they owned a smartphone for two to six months at the time, with the remaining three saying they owned a smartphone for more than two years now. The big majority also stated Games, Social Networks and Weather as the main types of applications they used in their device, with Navigation and Transportation apps close behind.

Regarding their consumer habits, all the users except one said they make online purchases but, with "between 1 and 10 times a year" being the most common answer, it is possible to conclude that
this reality is not very present in their lives. As for promotion vouchers, the results were bipartite. A group of users said they rarely use them while the other stated they use them frequently. In both cases, as a result of many marketing campaigns, supermarkets and petrol stations were the areas where vouchers are mostly used.

Almost all users, more precisely six out of eight, consider themselves as regular user of public transportation for their daily commute to work or school and for leisure, using either bus or light rail. Only one user stated the train as the principal mean of public transportation. Going out on weekends seems to be the main reason for the users to use their private vehicles.

Finally, five of the users are between 20 and 35 years old, with the remaining being between 35 and 50 years old. The gender distribution was six male users and the remaining two female. All users reside near Porto, although one of the users has Brazilian nationality and another has Romanian nationality. Two of the users have high school (twelfth grade) as their last finished education, with the remaining users having a college degree.

### 4.3 Voucher Market

According to the results of the focus group, rewarding users for using public transportation and using the available mobile payments app would be the best way not only to keep the existing client base loyal, but also to gather new clients.

For this project, a voucher market was developed and added as a new functionality to the existing application. However, given that this voucher market appears inserted in a special context (mobile payments for public transportation) there are some restrictions and particularities that make this system different from a system like Groupon. A summarized view of the business model is present in Figure 4.1

#### 4.3.1 Points

One thing to focus about this project is that it intends to provide new functionalities to support the adhesion to mobile payments in public transportation, and not be the main calling point to the application. This has led to a small discussion about whether the existing vouchers should be bought with real money, like in Groupon for instance, or should there be another mean of acquiring them. The conclusion was that the latter option would make more sense. This way the users would feel a bigger sense of accomplishment when acquiring a new voucher, would feel more committed to travel in order to be able to acquire that voucher and finally the whole system would feel more cohesive.

So, a user, alongside the balance needed to acquire tickets will now have a points balance. These points are awarded when the user buys a travel ticket or subscribes the service for a period of time. The attribution of these points is linear. For instance, if a user buys a ticket that values one euro, the user will be rewarded with one hundred points; for a twenty euro ticket, two thousand points are awarded.
The points can be later exchanged not only for vouchers, each with a predefined value, but also to acquire other single use tickets. In this case, for a one euro ticket, the user would have to spend one thousand points, and so on. This way, the aforementioned “buy ten, receive one free” promotion gets seamlessly translated into the application.

4.3.2 Promotion Creation and Associated Fee

Another way to differentiate this system from other voucher markets, with Groupon being the prime example, relates to the freedom given to local business owners, and possibly transport operators, for creating their own vouchers and promotions. For this, it was designed a simple web backoffice system where the entity owner (local business or operator) can register and then, through the filling of some forms, create the desired promotion. This backoffice system will be detailed further in a later chapter.

Since there are maintenance costs associated with a system like this, a monthly fee would have to be paid by the entity owners to the organization that will manage the whole system. This fee would function in a usage base, for instance, if a business owner is not planning to launch a promotion in a given month, the fee for that month would be zero.

Also, to prevent flooding of the market voucher by some business owners, the creation would be limited by time, that is, a business owner would only be able to launch a new promotion a given set of time after launching the last.
4.3.3 Entity Advantages

From a local business point of view, a system like this is interesting mainly because of the publicity it generates. Porto’s touristic interest has been steadily rising in the last few years, and with that, there are many stores, restaurants and bars opening every month. Using an application like this to publicize a business might give the business owners the edge they need to surpass the competition and be a first mean of contact of foreigners visiting the city.

As stated in chapter two, one of the goals for this system is also to unite all the diverse campaigns created by public entities, as museums and venues, in a single place. Through this system, they can pass some of the bureaucracy in this kind of partnerships and quickly reach the desired potential clients.

4.3.4 Transport Operator Advantages

Although not directly, transport service providers also benefit from a system of this kind. In fact, ticketing represents the main part of these companies budget and, in order to cut costs, it is of their interest the use of solutions that do not use physical tickets. So, while the Mobipag project allowed the operators to save money over traditional tickets, the inclusion of the voucher market in the Mobiganha project is a step towards a bigger user base that will take those savings further.

Besides this, and as already mentioned, operators usually have their own promotions and campaigns with venues and music festivals. While designing this solution, some people responsible by different transport operators were asked for feedback. The general opinion was very positive, stating that this solution can prove very useful to transport operators at a short term.

4.3.5 Promo Highlight

As an added functionality of the system, and an additional mean of income for the entity managing the system, entity owners will be able to highlight their own promotions for a limited period of time. To do this, they need to spend one specific amount of credits. All the operation, from the acquisition of credits to the highlighting of a promo is done via the web office.

4.4 Architecture

The system can be divided in two big areas: the client area, which consists on the Android application and the business area, composed by the web backoffice. Another option that was considered in the first stage of this project was developing a standalone Android app for the business owners or embedding the necessary functionalities in an extra menu of the existing app. However, since Portuguese laws mandate every business to have now a dedicated machine for tax purposes, the probability of a business owner having access to a regular computer with Internet access is higher than having a mobile device with a data plan. Also, for the sake of simplicity, it was concluded that a true separation of the business and client part was also desirable. Outside of these two areas, there is a web service, responsible for accessing the central database and responsible for
tying the whole system. This way, it is possible to say that this whole system follows a classical Client/Server architecture. See Figure 4.2

4.4.1 Web Backoffice

This component will act as an interface for the business owners (including the transport operators) to create and manage their own promotions. The only necessary equipment to do this is the access to a browser, preferably in a desktop/laptop. Other functionalities include:

- Signing up for an account, which will have to be verified by the system’s manager;
- Edit an existing promotion. To ensure no clients are misled into buying a voucher for a promotion that is later changed, business owners only have a limited time frame to edit a given promotion;
- Highlight a promotion, using credits;
- Edit the user’s profile;
- See more info about a given promotion, including the number of vouchers sold;
- See the business’s history, consulting already expired promotions;
- Validate client’s vouchers.

4.4.2 Android Application

This application is the only way the system users can explore the system features. To do this, they should have access to an Android device running version 2.2 or newer. This project’s added functionalities include:

- Possibility to buy new vouchers;
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- See vouchers already in possession, consult their details and validate them;
- Search for promotions;
- Possibility to buy tickets using points;
- History of already used vouchers;
- Location Based notifications.

4.4.3 Web Service

The web service, accessible through an API to be described in a later chapter, is responsible for managing the data inside the database, only available locally, and it’s crucial for the Android app’s functioning. It was developed using the CodeIgniter framework, as the Web Backoffice, with an added external library.

4.5 Technologies

4.5.1 Android

Having now surpassed iOS as the most popular mobile operative system in the world, using Android in this project was more or less a requirements, since the Mobipag project was developed in this platform. Even so, there are other characteristics that make Android the preferred choice for this kind of projects. In first place, there are no admission fees or conditions, unlike for iOS, where the developers have to use a specific operative system and pay an annual fee to access the development tools. Besides this, the application development in Android is largely based in the Java language, widely known for having a low learning curve due to the simple syntax.

Finally, Google provides several services with a very mature state of development. The Google Maps API for instance is a very important tool for location based services and even for applications that do not have maps or navigation as their main functionality.

4.5.2 SQLite

To save data traffic in the usage of this application, instead of making requests to the web service whenever is needed, a support database was created in the application. The application pre-fetches the relevant data for the current user using the web service and stores it in this support database for later usage.

SQLite technology proved to be the best option for this local database. SQLite is a library that implements an SQL database engine. Since it is self-contained, it requires no other additional libraries to function, making this kind of databases suited for applications working in a large array of different devices. Other pluses reside in the fact that SQLite does not require any kind of installation, being completely plug and play, and the fact it does not run in a separate server process, unlike many other database engines, using only local disk files for read and write.
This “lite” philosophy goes even further, since the library, even with all functionalities active and for a 64 bit processor (the code is bigger than for 32 bit), is usually under 500kB of space.

All of this is why SQLite is the official database type for usage in Android applications. Due to this, there is a lot of documentation to facilitate the use of this technology.

4.5.3 MySQL

Despite being a very good alternative to use inside an application, SQLite databases are not always the best option when it comes to a server side implementation, compared with other kinds of database. Because of this, to back the entire system, the choice was a MySQL database.

MySQL is one of the most popular open-source database engines and, compared to SQLite, has a better handling of concurrency, or in other words, performs better when more than one device tries to connect to the database at the same time, has better scalability and it can manage users with different permissions. Finally, there is a better support from Codeigniter to MySQL than to SQLite.

Obviously there’s a tradeoff, since MySQL databases are not plug and play and therefore harder to configure, but it is still the best option weighting the pros and cons.

4.5.4 CodeIgniter

CodeIgniter is a PHP framework based in the MVC principle meant for the creation of complete web applications with as little effort as possible. MVC means Model View Controller and is an architectural software pattern that divides a piece of software in three parts: the model, where all the access to data (databases, files, . . . ) is made, view where all the interaction with the user is done (usually the interface) and finally the controller to provide a middle ground between the model and the views. This pattern allows for more organized and readable software.

CodeIgniter provides several libraries to make php development easier and less boring. Database accesses are facilitated through the Active Record, another software pattern that transforms a table row into an object (the table is now a class), making it easier to work with, while preserving the usual features found in the SQL language, like the insert, delete and update verbs. On the other hand, form validation is now a much faster task since there are many pre-built rules which are automatically checked when a form is submitted, with more rules being defined by the developer if need be.

4.6 Resume and Conclusions

In resume, one of the interesting things about this project is that it started as a blank page. It was necessary to gather potential users of the system to see what factors compelled them to use public transports for their commutes and what would engage them to if they were not regular users. Most answers lead to a reward system.

Using already existent solutions at a starting point, but always remembering the public transportation and mobile payments as a background, the created system provides rewards related to
the travels the user performs, and, at the same time, engages the local businesses and entities to engage themselves in the act of maintaining the public transportation system sustainability while gathering benefits of it.

The system is divided in three main architectural packages: the Android application, focused on the end user, the web backoffice, for the local businesses and entities, and the webservice, that provides a bridge between the other two. It uses some different technologies, thought out to be the best choice for the development of a system like this and with the constraints it presents.
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Chapter 5

Implementation

5.1 Introduction

The present chapter provides a detailed description of the development phase of this project. For this, it will be provided an elicitation of the different requirements, the use cases for the two big parts that compose the system (web backoffice and application), the conceptual model and finally, the artifacts themselves.

The implementation of this system follows a spiral process or, more precisely, an iterative and incremental process. Considering four main phases in the creation of a software system (planning, coding, testing and releasing), the main characteristic of this process is having these four activities in a cycle, that can be repeated as many times as necessary. The first time this cycle is completed, an initial prototype with very few functionalities is released. The next iterations add new functionalities to the prototype, ultimately converging into the completed software. This kind of process is very useful when requirements are bound to change a lot during the development of the system, giving the developer the ability to react quickly and, therefore, minimizing the cost to implement the changes. Since the testing phase is spread across the implementation stage, this process also gives the developer a higher sense of security that the developed code is correct, i.e., it does what it is supposed to do.

5.2 Requirements Specification

5.2.1 Functional Requirements

To develop a system of this kind, and one that can be useful not only to the users but also to transport operators and local business owners, it was necessary to analyze the similar options already available, while keeping enough distance from those solutions to better adequate the system to the problem’s context.

Due to time constraints, all the possible functionalities were prioritized, but only the most important were implemented. These functionalities are now listed, following the MoSCoW notation.
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(Must, Should, Could, Won’t). More details can be consulted in Appendix D

**Android Application**

- A user must be able to search for vouchers;
- The system must be able to handle some search parameters;
- A user must be able to see vouchers already in his/her possession;
- A user should be able to see how many points are in his/her account;
- A user must be able to acquire a desired voucher using points;
- A user should be able to buy a single use ticket using points;
- A user must receive points when buying transport tickets;
- A user should be able to see the history of his/her already used vouchers;
- A user could be able to see more details about a promotion;
- A user could be able to see more details about the entity that created the promotion;
- A user must be reminded he/she is close to a given business, provided the user has an unused voucher to that business.

**Web Backoffice**

- A user must be able to register his/her business in the system;
- A user must be able to sign-in and access his/her personal area;
- A user, if an administrator, must be able to accept or reject a registration;
- A user should be able to see and edit the business’s personal data;
- A user must be able to create a new promotion;
- A user must be able to delete a given promotion;
- A user should be able to edit a given promotion, provided it was created no longer than a given timeframe;
- A user should be able to highlight a promotion, given that he/she has the necessary amount of credits;
- A user must be able to validate a voucher;
- A user could be able to see a history of expired promotions.
5.2.1.1 Non-Functional Requirements

For any piece of software to be usable by possible target users, even if in a prototype stage, like in this case, there are some quality requirements that need to be met. The most important quality, or non-functional, requirements are listed below.

- **Integrity** - The system must be built in such a way that a user should not be able to access data not relevant to his/her operations (meaning, data that belong to other users).
- **Availability** - The system should have as little down time as possible.
- **Performance** - Though this application is a prototype, it should be fast enough to give the users a pleasant experience, and not to mislead them by showing incorrect information.
- **Scalability** - The system should be built to allow for future improvements.
- **Usability** - The application should be easy to use, with simple interfaces and easy to interpret text elements.

5.3 Conceptual Data Model

Throughout this document, some concepts, like Promotion, Voucher, Entity, have been mentioned several times. In this section, it is intended to explain how these concepts relate with each other, and what do they mean specifically and which data they enclose. This is done via two diagrams, the first one is the conceptual model for the Mobipag project, in the Figure 5.1, and the second one, more relevant to this project, shows the conceptual model for the Mobiganha project, Figure 5.2. The final system integrates a hybrid of the two conceptual data models, with the points of contact between the two being the User (Utilizador) and the Ticket (Bilhete) concept.

5.3.1 User

Relative to Mobipag, the User as an object does not suffer much alterations. The essential data, as the email, which serves as identifying element, name, NIF, money balance and others were already stored pieces of information. For Mobiganha, there is only one one additional field, which is the number of points a User has in its possession.

5.3.2 Promotion

The Promotion element can be seen, in this project, as the cogwheel that makes the system tick. It is through a created promotion that an entity can gather new clients; users only buy vouchers for promotions they are interested in, and so on. Apart from this, it is important that there’s as little a chance as possible for the users to get tricked into buying a voucher they in fact do not want due to lack of information. Therefore, it is important to register as much information as necessary to explain all the details about an information. This is why there are many fields of data
that sometimes seem to overlap each other, as the Horário (Schedule) Condições (Conditions) Poupança (Discount), to ensure that, when a user has any doubt about a given promotion, the information is already available. The other fields of data are already expected in a system of this kind, as the beginning and end dates and how much a Voucher for that Promotion would cost. It is also relevant to register if the Promotion has a relationship with another concept of the system, in this case the Ticket (Bilhete).
5.3.3 Entity

The Entity object is another type of user of the system, in this case it represents the local businesses, transport operators and public entities (venues, museums, and so on). As such, and like it happens for the User object, there are three types of data that need to be registered: the personal data, as the name of the entity and name of the owner, or fiscal identification number (NIF); the account data, in this case the email and password; and finally, information relevant to the system functioning, as the number of credits.

5.3.4 Voucher

The Voucher represents a transaction inside the system, meaning, a Voucher is only created when the User has enough interest in a Promotion to spend the necessary amount of points to buy the access to that promotion. Therefore, the first two defining pieces of information of the Voucher concept is something that represents the Promotion and something that represents the User. This however would not be enough to characterize the Voucher, since a User can have more than one Voucher for the same Promotion. Therefore, additional data is necessary. The most important one is the Validation Key (Código Validação), created automatically by the system and that could uniquely identify a Voucher. Other fields of data, as the Buy or Validation date serve only to provide more info to the User about a specific Voucher.
5.4 Web Backoffice

In this section, the main screens of the Web Backoffice will be shown, with a brief explanation of all the elements present in each one. This way, the reader gets a better idea of the system’s navigation and all the current functionalities.

5.4.1 Main Menu

When the user enters the website, the Figure 5.3 the first screen shown. The text displayed in this page serves as a brief introduction to the whole Mobiganha system. Looking at the navigation bar at the top, some options are visible. The ones in the left add a little more detail about this project, specifically the advantages for the local businesses and operators and a contact form in case any doubt appears. The ones in the right are much more important, since they are the Register button and the Sign In button respectively. Clicking in the Register button will lead the user into the next screen.

![Figure 5.3: Main Menu for the Web Backoffice](image)

5.4.2 New Register

The screen displayed in Figure 5.4 is the registration form for the local businesses and operators that want to take part in the system. All fields are mandatory since some of the information will be displayed to the potential clients. After inserting the address, the system, using the Google Maps API, will display a map centered in the address location. The user should check that this is the correct place, since the coordinates provided by the API will be used to trigger location based notifications via the Android application.
5.4.3 Login

After having a validated account (meaning, after creating an account and having that account accepted by the system’s administrator), the user can access the personal area by signing in with the account’s credentials in the menu displayed in Figure reffig:login. If already logged in, the user can find a link for the personal area by clicking in the rightmost button of the navigation bar, and clicking in the first option of the menu. The second option terminates the session. It should be noticed that a user will only be able to access his/her personal area after the account is validated by the system’s administrator.
5.4.4 Personal Area - The Profile

After accessing the personal area, the first thing a user sees is an overview of the account details (see Figure 5.6). In the bottom of this information there are two buttons: **Editar Perfil** and **Adquirir Créditos**. The first one leads to the profile editing menu, while the second one is used to acquire credits to later highlight promotions. Since this project is just a prototype for proof of concept purposes, clicking in this button will only give the user automatically one hundred points.

5.4.5 Edit Profile

This screen, represented in Figure 5.7, is very similar to the already mentioned Registration Form. However, in this case only a part of the fields can be changed, being the others more critical to the potential clients security and therefore, only changeable by contacting the administrator to do so (after verification).
5.4.6 Personal Area - The Promotions

Going back into the Personal Area and scrolling the mouse down, the user faces a new container, which might contain the resumed information about his/her active promotions, and, at the top the container, three buttons. The first one is for validating a client’s vouchers, the second to create a new promotion, and the final one for checking the user’s history. Inside each promotion’s block, there are three more buttons: one for expanding the information, the second for editing the promotion and the last one for eliminating it. See Figure 5.8

5.4.7 Create a Promotion

Entering this option will load a form (Figure 5.9) for the user to complete with information about the promotion. In the end of this form there are two special fields that provide more possibilities for the users. The first, *Em conjunto com...* is for the user to insert the name of the other entity in case of a collaboration. This is specially useful for the operators and public entities. The other one,
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Figure 5.8: Lower part of the personal area, concerning active promotions

*Inclui Bilhete*, takes advantage of this being a mobile payments application for public transports and allows the entity to offer travel tickets in their promotions. If the entity wants to do so, they have to insert the ticket type in the respective field.

### 5.4.8 See More Information

The screen shown in Figure 5.10 provides more information about a certain promotion, including the number of vouchers sold for a promotion. At the top of the container, the user can find a button that redirects to the voucher validation menu. This button is repeated for usability reasons. Since the voucher validation is the most common operation for the web backoffice, it makes sense that it becomes more ubiquitous than the remaining features.

In the end of the container, there are two more buttons. The first goes back into the personal area, and the other one highlights the current promotion. The reason why this button is more “hidden” than the rest is because one of the main ideas for this system is to provide the business owners freedom while creating their own promotions. Having this button more visible would create a compelling force to spend money when it is not needed, even if this represents a source of income for the company that would supervise the system.

### 5.4.9 Highlight a Promotion

When the user clicks the button to highlight promo, the pop-up at Figure 5.11 appears. This serves as a final confirmation for the operation. When highlighting a promotion, it stays highlighted for a week costing 50 credits. If the promotion is already highlighted, 50 credits will accumulate another week to the highlight termination date.
5.4.10 Validate a Voucher

Although simple, the screen at Figure 5.12 is the most important at the web backoffice. When a client acquires a voucher through the Android application, it automatically generate a random code, composed by ten characters. This code can now be inserted in this menu for validation of the voucher. In case the voucher gets successfully validated, a new screen will appear with the client’s email and promo description.
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Figure 5.10: Screen displayed extended information for a given promotion

Figure 5.11: Confirmation popup for highlighting a given promotion

Figure 5.12: Voucher Validation form
Implementation

5.4.11 Promotion History

Accessing the user’s history menu, a container with all the expired promotions will be displayed. This menu will only display the resumed information for each promotion, but the complete information can be requested by clicking the button inside each sub-container. See Figure 5.13

![Screen with the history of user’s promotions.](image)

Figure 5.13: Screen with the history of user’s promotions.

5.5 Android Application

5.5.1 Main Market Menu

Entering the Vouchers e Promoções option in the main menu, Figure 5.14, of the application, the user is presented with the screen visible in Figure 5.15. Here, there are three main blocks: the upper one features the title string and especially the user’s points. The middle one, is a scrollable list featuring all the highlighted promotions available to the user. In the bottom of the screen there is a block with two buttons. The upper one redirects the user to the promotion search form and the bottom one to the voucher wallet.

5.5.2 Promotion Search

The form displayed in Figure 5.16 is a form for the user to search for desired promotions. The form has various fields, from the promotions name to the amount of points necessary. If none of the fields is inserted, the results are all the available promotions.

5.5.3 Promotion Details

Clicking in any promotion, the user is presented with all the information about it. This menu features a map with the approximate location of the entity and the value of the voucher. In the bottom
of the screen there is a button to buy the voucher, operation that needs a confirmation by the user. See Figure 5.17.

5.5.4 Entity Details

Another of the option in the Promotion details screen is to check additional data about the promotion’s creator. This information can be seen in Figure 5.18.

5.5.5 Voucher Details

The most relevant details about a voucher is the validation code and the validation state. These can be seen in the Figure 5.19. The sequence of operations for validating a voucher will be detailed in a future section of this chapter.

5.5.6 History

This screen, seen in Figure 5.20 displays a list of the already used vouchers.
5.5.7 Notifications

One of the features of this system is having notifications activated by the location of the user. Considering that the user possesses a voucher for a given promotion still not used, in case he/she gets closer than a threshold distance, an alert is displayed in the notification area of the mobile device. This event is only triggered after a specific time after the last notification was emitted.
5.6 Webservice

The webservice used in this system caters specifically to the needs of the Android application since all database accesses from the web backoffice are realized from the created models. In this section, the API is briefly described, with more details being included in Appendix C.

1 - promo_get

This service, receiving the id of a promotion, returns the desired promotion’s information.

2 - promos_get

This service returns the information for all the active promotions.

3 - highlightedpromos_get

This service returns the information for all the active highlighted promotions. This is primarily a backup service, since that the promos_get method should return the necessary information to
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4 - entities_get

This service returns the information about the all the entities. Useful for pre-fetching data, if necessary.

5 - entity_get

This service receives the id of an entity (local business or operator), and returns the information about that entity. Used when the user wants to see more information about a promo. Since in this prototype it is necessary an active Internet connection most of the time, the entities_get() service was substituted by this one, which only fetches the data necessary at a given moment.

6 - userpoints_get

This service receives the email of the current logged in user and returns the amount of points the user has in his/her wallet.

Figure 5.18: Screen showing the details of an entity
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Figure 5.19: Details of a voucher

7 - updatepoints

This service is used to update the points balance in the central database. It is used every time a transaction using points occurs. Even if for the normal operation of the application, the points amount used comes from the local database, the values across databases need to be synchronized.

8 - voucher_get

This service receives the id of a voucher and returns the voucher’s information.

9 - uservouchers_get

This service receives the email of an user and returns all the vouchers present in the user’s wallet. It is performed when the user logs in in the application.

10 - userhistory_get
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This service receives the already validated vouchers in the user’s wallet, receiving the user’s email.

11 - promosbycat_get

This service receives a string of a given category and returns the information about all the promotions of that category. Used for filtering information when searching promotions.

12 - buyvoucher_get

This service receives the email of an user and the id of a promotion, adding another voucher to the user’s wallet. The points balance is also re-calculated when this service is used.

Figure 5.20: List of all the expended vouchers of a user
Figure 5.21: Example of a notification
Chapter 6

Evaluation and Validation

6.1 Evaluation planning

Unlike what happened in Mobipag, for Mobiganha the evaluation strategy was not based in a real world simulation program. The reason for this is that the needs of both projects are very different: Mobipag started as a concrete idea for the creation of a mobile payment application. Mobiganha started as a solid goal with a vague solution. Given the process that led to that solution, it makes sense that this evaluation phase is more focused on validating the solution’s concept through the developed application.

It is possible to say that the meetings that happened throughout the development phase served this same purpose, yet, for a more scientific approach, and during the course of approximately one week, some people were selected and asked to test the application in a controlled environment and give their feedback.

For this, a script, available in Appendix B, was presented to the users. This scrip was divided in two main sections, one for the Android application and other for the Web backoffice, and contained specific tasks that the users had to solve while being timed. The users were asked to “think out loud” [VSBS+94], so that it was possible to retrieve some information about the thought process invested into each task that might got lost otherwise.

6.1.1 Sociodemographic distribution of the users

Like in the focus group, the script included an initial questionnaire about the usage of smartphones and public transportation, as well as the relationship of users with vouchers and promotions and other generic demographic questions.

The user sample for this evaluation phase was composed by fifteen users, twelve male and three female, all with ages comprehended within 20 and 35 years old. The fact that this test was mostly conducted within FEUP made it hard to have a more heterogeneous sample.
Education wise, one of the users had secondary school as the highest finished degree, with all the rest being either undergraduate, graduate or masters. All of the users had Portuguese nationality, with one of the users having Brazilian nationality as well, and all of the users reside in the Porto Metropolitan Area.

Regarding the ownership of smartphones and their use, all of the users possess smartphones, with the vast majority using Android and only one user with iOS operative system. As for their preferred applications, Facebook, email (whether Gmail or other equivalent), and Feedly, a RSS news reader, were the most common answers.

All of the users declared being regular public transportation users. For this, thirteen out of fifteen users stated the bus as a preferential mean of transportation. For the light rail and train, the number drops to ten and four respectively.

Finally, half of the users stated they rarely use discount vouchers but might consider changing their daily routine of the voucher is worth it. One of the users said he ignored the vouchers, and the rest said they use them regularly and change their routine to get the best promotions.

6.2 Android Application Evaluation

The application related part of the script consisted of eight simple tasks to be completed by the user.

The first one, registering for an account, was already tested during Mobipag, but it was necessary to enable the use of the application. The general perception of the difficulty of the task was that it was very simple, with an average score of 4.8 out of 5. However, some of the users showed a tendency to insert the email and password in the login form at first, and only then clicking in the register button and finishing the process. The average completion time for the task was 65 seconds.

The second task was buying a monthly signature for five different zones. For this, the users had to select the right option in the main menu, the right type of ticket and then completing the process. This would give them enough points to complete the rest of the script. Once again, users thought that the process was really easy, scoring a perfect 5 out of 5, with an average completion time of 25 seconds.

Thirdly, users were asked to state how many points existed in their wallet. This was, by far, the most confusing task of the test. Since there is a menu "Consultar" in the application, where users can see their tickets and money transactions, the would instinctively go to this menu to see points information, only available in the "Vouchers e Promoções" option. Upon realization of this fact, users could successfully locate the desired information.

Therefore, the average score for this task was of 3.4, and the average completion time of about 23 seconds.
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The fourth activity was to simply buy a voucher for an highlighted promotion. Since these promotions appear in the first screen where the users can check their points, this activity was also considered really easy, with a 5 out of 5. Some users used this task to also explore some information about the promotions and entities, taking a bigger time to complete the task. Even so, the average completion time was of 25 seconds.

In fifth place, users had to reach the screen detailing a voucher’s details. As it happened in task number three, users first thought process told them to go to the "Consultar" menu in the main screen, however, even before doing so, most of them concluded that all the information for points, vouchers and promotions was actually in the "Vouchers e Promoções" option, so, seeing the button leading to the voucher wallet, they concluded the task without major problems. This led to an average score of 4.6 and conclusion time of 22 seconds on average.

Next, users had to buy a voucher for a specific promotion. They were given the parameters which they needed to input into the search form, and easily completed the task. The fact there is a button that explicitly points to the search form was helpful according to the testers.

Also considered very easy by the users was the act of buying a travel ticket with points. Even with the button to complete the task being hidden due to screen size, the scrolled until finding it. The only complaint about this task was the lack of information about the points balance of the user. The task achieved an average score of 4.9, and a completion time of 18 seconds.

In the final task, users had to validate a previously bought voucher, that granted them a travel ticket, and finally checking the existence of that ticket in their wallet. Some users didn't notice that the voucher included a ticket and asked for that information to be more visible, but even so they found the task to be simple.

6.3 Web Backoffice Evaluation

This part of the test was not directed at regular users, but due to the difficulty of finding business owners to test the application, they ended up doing the test themselves. It was shorter than the application test since for this part of the system, having suggestions for new functionalities was more important that testing the stability of the prototype.

The first task to be completed was the registration in the system. The users found it to be very easy, but, given the amount of fields in the form, the average time was longer than for the similar task in the Android application.

After this, the users had to create a new promotion. First they had to access the personal area, and then scroll until the correct button was shown. Once again, they found the task very easy and
intuitive.

The third task was the theoretically most difficult one. Users simply had to highlight a single promotion. The users however, found this activity very straightforward and stated that, given it is an extra functionality and not a core one, it made perfect sense that the button was more hardly accessible.

To wrap this test up, users had to simply change their password. Since the button to do this is immediately visible in the personal area, all the users completed the task in a matter of few seconds.

6.4 General Evaluation and Suggestions

The final stage of the evaluation process was a set of questions about the market voucher concept and the application in general.

The general consensus, even for people that do not use vouchers regularly, was that this is a really useful addition to the application, and something that could boost the public transportation adoption.

There were, however, some improvement suggestions to the application:

- More feedback to the user, by the exhibition of toasts or dialogs that provide information about what is happening in the system;
- Providing information about the points balance in the ticket buy and consult menu;
- Re-thinking of the navigation. Sometimes to get back to some menus, many back clicks are necessary;
- Being able to see if a voucher is already existing in the user’s voucher wallet;
- Recommendations of promotions given user’s history;
- The ability of offering vouchers and tickets to other users or trading vouchers with other users;
- Trip planning abilities;
- A dynamic point attribution system instead of a static one;
- More statistics in the web backoffice.
Chapter 7

Conclusions and Future Work

In this chapter, it is presented a review of the performed work, which led to the writing of this document. It is important to see if it solves the proposed objectives and to what degree. It is also important to look ahead, so, in this chapter, some ideas gathered from tests feedback and from the involved people perceptions during the course of the project will be detailed, and hopefully, implemented in a possible future stage of this problem.

7.1 Satisfaction of the Objectives

This report focuses mainly on the last six months of work, the duration of the Dissertation course. However, before that, the foundations for this project started being layered, in the Dissertation Planning - EIC0087 - course. Here, the students were asked to do two presentations about the theme their were engaging in the dissertation, and a final report, mainly consisting of the Literature Review found in Chapter 2. This was a very challenging task, simply because of the nature of the theme itself. There was a clear idea of the problem at hand, the boundaries were known and the fields of study affected were somewhat grasped, but the solution was unknown. This meant that the Literature Review had to be more extensive and many times involving areas not usually related to Computer Engineering, as Marketing or even Sociology. This was the first big challenge to this work, but it was also a very good eye opener to other realities.

Already during the Dissertation period, a new immediate goal appeared: finding a specific solution for this problem, that could serve as a proof that technology can be an important part of modernizing and sustaining public transportation, and a big asset to the evolution of the economy of a system as a whole. The already mentioned focus group was a good first step to see what the final users valued more in a system of this kind, but it was far from being enough to provide a solid solution with real-world use potential as wanted. In order to fine tune this solution, there were a few meetings with people from STCP, Metro do Porto and TIP - Transportes Intermodais do Porto, fundamental to see the perspective of all the technicalities of a transport operator.
Conclusions and Future Work

Implementing this solution was the most familiar stage of this whole project, but it was also faced as another opportunity to improve the knowledge acquired during the course and test unknown technologies, like CodeIgniter.

All these processes, meetings, lines of code, however, are only significant when the interested parties give their approval. This is exactly what happened with the Testing and Evaluation phase. There are always edges to be softened, and the initial tests revealed unknown bugs, promptly resolved, but the received feedback shown that this approach of adding services to enrich the experience of using public transportation is interesting and possible from a technological perspective. For all of this, this project was a success.

In a more personal point of view, this project was a huge opportunity to contact with the big world of public transportation, something that us, users, tend to see as an acquired right, but that in reality is a big machine and where sometimes moving a small cog has a huge repercussion for the service. It was a time to meet new people, that, albeit sometimes not being directly connected with software development or engineering in general, share the same vision of progress as an engineering student as myself, and sometimes even more passionately. So, from this perspective, it is possible to say Mobiganha was also a success.

7.2 Future Work

Despite its merits as a standalone project, Mobiganha is another element in a bigger picture, just like Mobipag. This means that, until those elements exist, there is always a room for improvement. Time is an important factor when developing a project during a dissertation, and that, combined with the factor that this project started without a clear view of the route to follow solution-wise, ultimately meant that some functionalities had to be left out for a later stage. These functionalities might be important factors to drive adoption of a mobile payments solution like this, so they have to be looked upon with great attention, but in an early phase like this one, it is sometimes better to be conservative and do less, but do better.

So, in this section, it will be presented some improvements, ideas and concerns that appeared during development and testing but are not present in the current stage of the application but were somewhat sidelined.

7.2.1 Security

Applications that handle user’s private information and money are usually a big honeypot for malicious persons or entities. Although this application was built with some protections in mind, it is normal for prototypes to lack some security functions that are fundamental in production systems.

Another underlying security concern in the Mobiganha project resides in the resistance to fraud of the validation process. When designing the application, other possibilities were considered for
the validation of vouchers. The conclusion at the time was that, probabilistically it is difficult to generate a code present in the database and get the right email and promotion id for that voucher, but always with the idea that the system is not infallible.

In a future development stage for this project, these two security facets are something that should be addressed, with mechanisms to provide a bigger security for the users, whether from the application or the web backoffice.

7.2.2 Design

One of the main criticisms raised by the users during the test and evaluation was that the application was "ugly" and that some strings were not enough descriptive. In fact, this is a very valid point. In recent years, product design became an important fact in the success of products in general and mobile applications in particular, to the point that users prefer applications with a good appearance over ones with better functionality but not as well presented.

This issue goes further than creating good looking buttons or adopting an easy to read typeface. Given that a trivial mobile payments application will probably reach many different users, all with specific needs, a study would need to be conducted to find a compromise for all those needs. This study would also need to focus on a seamless integration of all the different modules and functionalities, to make the experience easy and enjoyable.

7.2.3 Adapting to different technologies

The necessity of an active data connection throughout the use of the application was one aspect studied in both iterations of the project. Although is safe to assume that we are migrating into a bigger adoption of smart data plans, the fact is that these still represent a cost to the user, something that is desirable to reduce. So, exploring other technologies is something that might be interesting to do in a later stage. From simple QR codes to the use of Bluetooth or NFC, or even a combination of these technologies is something that might reveal itself as a good solution for a more forward-thinking application.

7.2.4 Personalization

The first idea that came to mind when creating the voucher market was to make it as personal as possible, making the system learn about the user’s preferences and mixing that with its location, and other contextual information, to provide the most suitable promotions.

This, however, would imply the building of a recommendation engine and the use of data mining techniques that would take much more time than was available to plan and to implement.
Conclusions and Future Work

7.2.5 Others

There were a few other suggestions from the testing phase that could provide some improvements to the already existing system.

In first place, for the transport operators and local businesses it is important that an application like this is a mean of gathering new clients. It is also important that, after trying the application for the first time, it becomes compelled to keep using it. The items mentioned before (having an evolved design, being secure, and so on) contribute to this, but it is not enough. The solution mentioned by a STCP representative revolved the creation of a website with some of the functionalities of the Android application, making those available for users without smartphones or with smartphones with other operative systems. In addition to this, the inclusion of email reminders, like what already happens with some solutions of vouchers and promotions created by some retailers.

Also from the local business point of view, one of the most asked features to be added to Mobiganha was the inclusion of support statistics to the promotions system. To application already tells how many vouchers from a specific promotion were sold, but there are other metrics that can provide a better estimate of the interest generated. For instance, one specific metric that was asked was the register of clicks in a specific promotion, and how many of those clicks translate into a voucher sale. This would not be trivial to implement in a mobile application, but could provide a good tool for the promoters to adapt their strategy.

For the application users, the desired new functionalities are more or less the same elicited for the Mobipag iteration. The first one is the ability of planning trips, as well as being able to buy the most suitable ticket for that trip.

As it had already happened for the tickets, users think that is important to be able to share vouchers with another users, and also making the application more social. In other words, enabling functionalities from Facebook, Foursquare or other networks into Mobipag/Mobiganha.

Finally, some users mentioned the development of a new dynamic method of gaining points, instead of the existing static "spend x money, gain y points" method.

7.3 Resume

More than implementing an Android application and creating a website, the purpose of this project was to prove that public transports are an interesting and complex area, that can highly benefit from technological improvements and new software solutions. The reaction Mobiganha has provoked in the public transport operators has shown that these kind of solutions were long due. In fact, there are already projects in motion to bring these solutions to real life in Porto.
Conclusions and Future Work

But this evolutionary process must not stop. As stated in this chapter, many other new services could bring a better experience to the users, truly making public transportation a viable alternative to the private transportation.
Conclusions and Future Work
References


REFERENCES


[HCS05] Dan Hong, DKW Chiu, and VY Shen. Requirements elicitation for the design of context-aware applications in a ubiquitous environment. . . of the 7th international conference on . . ., pages 590–596, 2005.


REFERENCES


REFERENCES

Appendix A

Focus Group Initial Questionnaire

A.1 Sociodemographic Questionnaire

A.1.1 Since how long have you been using a smartphone?

- Less than 6 months
- Between 6 months and 2 years
- More than 2 years

A.1.2 Select (up to a maximum of 5) the applications you use more often in your Smartphone.

- Books
- Business / Finance
- Education
- Transportation
- Games
- Health and Fitness
- Lifestyle
- Music
- Navigation
- Magazines and newspapers
- Photos and Video
Focus Group Initial Questionnaire

- Social Networks
- Sports
- Utilities
- Weather

A.1.3 How often do you make online purchases?
- 1 to 5 times per month
- 1 to 10 times per year
- Rarely
- Never

A.1.4 How often do you use discounts?
- 1 to 5 times per week
- 1 to 5 times per month
- 1 to 10 times per year
- Rarely

A.1.5 Where do you use your discount vouchers?
- Supermarket
- Clothing
- Travels
- Cinema / Shows
- Sports
- Food and Drinks
- Petrol

A.1.6 Do you actively seek voucher and promotion?
- Yes
- No
A.1.7 How often do you use public transports?
- 1 to 5 times per week
- 1 to 5 times per month
- 1 to 10 times per year
- Rarely

A.1.8 What kind of traveling do you do using public transports?
- Urban
- Interurban

A.1.9 Which type of public transport do you use more often?
- Bus
- Metropolitan
- Train

A.1.10 Which type of ticket do you buy more frequently?
- Single use
- Daily
- Monthly subscription
- Other. Which one?

A.1.11 To which kind of activity do you prefer to travel using public transportation?
- Work
- Study
- Leisure
- Personal
- Familiar
- None
A.1.12 To which kind of activity do you prefer to travel using private transportation?

A.1.13 Age
- Less than 20 years old
- Between 20 and 35 years old
- Between 36 and 50 years old
- Between 51 and 65 years old
- More than 65 years old

A.1.14 Sex
- Male
- Female

A.1.15 Nationality

A.1.16 Country and City of Residence

A.1.17 Educational Qualifications
- Fourth Grade
- Ninth Grade
- Twelfth Grade
- Bachelors degree, Undergraduate, Graduate
- Masters degree, Doctorate, Postdoctoral

A.1.18 Profession
Appendix B

Evaluation Phase Script

B.1 Sociodemographic Questionnaire

B.1.1 Age
  - Less than 20 years old
  - Between 20 and 35 years old
  - Between 36 and 50 years old
  - Between 51 and 65 years old
  - More than 65 years old

B.1.2 Sex
  - Male
  - Female

B.1.3 Nationality

B.1.4 Country and City of Residence

B.1.5 Educational Qualifications
  - Fourth Grade
  - Ninth Grade
  - Twelfth Grade
  - Bachelors degree, Undergraduate, Graduate
  - Masters degree, Doctorate, Postdoctoral
B.1.6 Profession

B.1.7 How often do you use public transportation?

*If the answer is Never, you can pass to question number 9*

- Between one and five times per week
- Between one and five times per month
- Between one and ten times per year
- Never

B.1.8 Which type of public transport do you use more often?

- Bus
- Metropolitan
- Train

B.1.9 Do you own a Smartphone or Tablet?

- Yes
- No

B.1.10 If yes, what is the operative system?

- Android
- iOS
- Windows Phone
- Other. Which one?

B.1.11 What is your relationship with discount vouchers?

- I use them regularly and change my daily routine because of them
- I use them regularly but do not change my daily routine because of them
- I rarely use them and might change my routine because if I find it worth it
- I rarely use them and do not change my daily routine because of them
- I ignore them
B.1.12 What mobile applications do you use more often?

B.2 Testing Script

You should read and think loud while doing the tasks
In the end of each task you should rate them according to its difficulty from 1 to 5, being 1 for very hard tasks and 5 for very easy tasks.

B.2.1 Android Application

1 - Register in the application
To be able to use the application, it is necessary to possess an account in the system. Therefore, for this test, create a new account, selecting the option "Registrar".

2 - Subscribe a signature
Buy a signature to five distinct zones. This process will give you enough points to realize all the tasks in this script.

3 - Consult the points balance
State how many points you have in your account.

4 - Buy a voucher for an highlighted promotion
Access the "Vouchers e Promoções" menu and buy a voucher for any highlighted promotion.

5 - Consult voucher details
Assuming you want to check the recently bought voucher, state how you would do it.

6 - Buy a voucher for a specific promotion
Buy a voucher for a promotion with the following restrictions. To do this, go back at the menu where the highlights appear and select the "Adquirir novos vouchers" option. After inserting the restrictions, buy one voucher for the promotion appearing in the results.

- Category: Fashion
- Points: Between 1000 and 2000

7 - Buy a traveling ticket using points
To spend the remaining points, buy a Z2 ticket.

8 - Validate a voucher with included ticket
Validate the voucher bought in step number 6. With this validation, you have won one Z4 ticket. Verify it’s existence in your ticket wallet.

B.2.2 Web Backoffice

1 - Register in the website
To use the system, you have to possess an account. To create and account click in the "Registrar" button, on the top right of the screen.
Evaluation Phase Script

Note: the account has to be validated by the system administrator

2 - Create a new promotion

Accessing to the personal area, click the "Insert Promotion" button, and insert the necessary data. The promotion will then be created.

3 - Highlight a promotion

If you wanted to highlight a promotion, which steps would you take?

4 - Edit Profile

Assuming there was a security breach in the system, you now have to change your password. Go to your personal area, click in the "Editar Perfil" button and change your password.

B.3 Final Evaluation Questionnaire

B.3.1 What do you think of this concept? Do you believe it is a useful addition to the existing application?

B.3.2 Do you believe the implementation transmits the concept in an adequate manner?

B.3.3 What functionality of the application stands out more?

B.3.4 What did you like less in the application?

B.3.5 Did you find the application difficult to use?

B.3.6 Which functionalities would you like to see added to the voucher market?

B.3.7 Which functionalities would you like to see added to the application in general?
Appendix C

Webservice API

C.1 Methods

C.1.1 promo_get

This service returns a promotion’s information.

Arguments

- id_promo - Id of the promotion

Response Codes

- 200 - Success
- 400 - Missing parameters
- 404 - Promotion could not be found

Usage Example http://localhost/webservice/index.php/api/promo/id_promo/4

C.1.2 promos_get

This service returns the information for all the promotions.

Arguments None

Response Codes

- 200 - Success
- 404 - There are no promotions in the database

Usage Example
http://localhost/webservice/index.php/api/promos
C.1.3  highlightedpromos_get
This service returns the IDs for all the highlighted promotions. This is primarily a backup service, since that the promos_get method should return the necessary information to filter the highlighted promotions, albeit using more data traffic.

Arguments
None

Response Codes

- 200 - Success
- 404 - There are no highlighted promotions in the database

Usage Example
http://localhost/webservice/index.php/api/highlightedpromos

C.1.4  entities_get
This service returns the information about the all the entities. Useful for pre-fetching data, if necessary.

Arguments
None

Response Codes

- 200 - Success
- 404 - There are no highlighted promotions in the database

Usage Example
http://localhost/webservice/index.php/api/entities

C.1.5  entity_get
This service returns the information about one entity. Used when the user wants to see more information about a promo. Since in this prototype it is necessary an active Internet connection most of the time, the entities_get() service was substituted by this one, which only fetches the data necessary at a given moment.

Arguments

- id_entidade - The entity’s id

Response Codes

- 200 - Success
- 400 - Missing parameter
Webservice API

- 404 - There is no matching entity

**Usage Example**
http://localhost/webservice/index.php/api/entity/id_entidade/4

C.1.6 **userpoints_get**

This method returns the amount of points the user has in his/her wallet.

**Arguments**

- email - The user's email

**Response Codes**

- 200 - Success
- 400 - Missing parameter
- 404 - Critical error! Should never happen.

**Usage Example**
http://localhost/webservice/index.php/api/userpoints/email/email@email.com

C.1.7 **updatepoints**

This service is used to update the points balance in the central database. It is used every time a transaction using points occurs. Even if for the normal operation of the application, the points amount used comes from the local database, the values across databases need to be synchronized.

**Arguments**

- email - The user's email
- pontos - The amount of points

**Response Codes**

- 200 - Success
- 300 - Missing parameter
- 404 - Critical error! Should never happen.

**Usage Example**
http://localhost/webservice/index.php/api/updatepoints/email/email@email.com/pontos/5000
C.1.8 voucher_get

This service returns the information for a voucher.

Arguments
- id_voucher - The voucher's ID

Response Codes
- 200 - Success
- 400 - Missing parameter
- 404 - There isn’t any voucher with the given ID.

Usage Example
http://localhost/webservice/index.php/api/voucher/id_voucher/5

C.1.9 uservouchers_get

This service all the vouchers present in the user’s wallet. It is performed when the user logs in the application.

Arguments
- email - The user’s email

Response Codes
- 200 - Success
- 400 - Missing parameter
- 404 - The user does not exist or doesn’t have any voucher.

Usage Example
http://localhost/webservice/index.php/api/uservouchers/email/email@email.com

C.1.10 userhistory_get

This service receives the already validated vouchers in the user’s wallet, receiving the user’s email.

Arguments
- email - The user’s email

Response Codes
- 200 - Success
- 400 - Missing parameter
- 404 - The user does not exist or doesn’t have any voucher.

Usage Example
http://localhost/webservice/index.php/api/userhistory/email/email@email.com
C.1.11 promosbycat_get

This service receives a string of a given category and returns the information about all the promotions of that category. Used for filtering information when searching promotions.

Arguments

- categoria - The desired Category.

Response Codes

- 200 - Success
- 400 - Missing parameter
- 404 - It does not exist any promotion for the given category in the database.

Usage Example

http://localhost/webservice/index.php/api/promosbycat/categoria/Restauração

C.1.12 buyvoucher_get

This service receives the email of an user and the id of a promotion, adding another voucher to the user’s wallet. The points balance is also re-calculated when this service is used.

Arguments

- email - The user’s email
- id_promo - The promotion’s ID

Response Codes

- 200 - Success
- 300 - Missing parameters
- 301 - Not enough points to finish the operation

Usage Example

http://localhost/webservice/index.php/api/buyvoucher/email/email@email.com/id_promo/34
Webservice API
Appendix D

Functional Requirements

In this appendix, it is provided more information about the requirements for the system. They will be divided in two tables: one for the mobile application requirements, and the other for the web backoffice requirements. Since these two components are two parts of the same system it is possible that in the dependency field values of the other table appear.

**Android Application**

<table>
<thead>
<tr>
<th>Description</th>
<th>Priority</th>
<th>Dependencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 - A user must receive points when buying transport tickets</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>A2 - A user should be able to see how many points are in his/her account</td>
<td>Medium</td>
<td>A1</td>
</tr>
<tr>
<td>A3 - A user must be able to acquire a desired voucher using points</td>
<td>High</td>
<td>A1,W5</td>
</tr>
<tr>
<td>A4 - A user must be able to search for vouchers</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>A5 - The system must be able to handle some voucher search parameters</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>A6 - A user must be able to see vouchers already in his/her possession</td>
<td>High</td>
<td>A3</td>
</tr>
<tr>
<td>A7 - A user should be able to buy a single use ticket using points</td>
<td>Medium</td>
<td>A1</td>
</tr>
<tr>
<td>A8 - A user should be able to see the history of his/her already used vouchers</td>
<td>Medium</td>
<td>A3</td>
</tr>
<tr>
<td>A9 - A user must be reminded he/she is close to a given business, provided the user has an unused voucher to that business</td>
<td>High</td>
<td>A3,W1</td>
</tr>
<tr>
<td>A10 - A user could be able to see more details about a promotion</td>
<td>Low</td>
<td>W5</td>
</tr>
<tr>
<td>A11 - A user could be able to see more details about the entity that created the promotion</td>
<td>Low</td>
<td>W1</td>
</tr>
</tbody>
</table>

Table D.1: Table of Priorities and Dependencies of the functional requirements for the Android Application
### Functional Requirements

<table>
<thead>
<tr>
<th>Description</th>
<th>Priority</th>
<th>Dependencies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>W1</strong> - A user must be able to register his/her business in the system</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td><strong>W2</strong> - A user must be able to sign-in and access his/her personal area</td>
<td>High</td>
<td>W1</td>
</tr>
<tr>
<td><strong>W3</strong> - A user, if an administrator, must be able to accept or reject a registration</td>
<td>High</td>
<td>W1</td>
</tr>
<tr>
<td><strong>W4</strong> - A user should be able to see and edit the business’s personal data</td>
<td>Medium</td>
<td>W2</td>
</tr>
<tr>
<td><strong>W5</strong> - A user must be able to create a new promotion</td>
<td>High</td>
<td>W2</td>
</tr>
<tr>
<td><strong>W6</strong> - A user must be able to delete a given promotion</td>
<td>High</td>
<td>W5</td>
</tr>
<tr>
<td><strong>W7</strong> - A user should be able to edit a given promotion, provided it was created no longer than a given timeframe</td>
<td>Medium</td>
<td>W5</td>
</tr>
<tr>
<td><strong>W8</strong> - A user should be able to highlight a promotion, given that he/she has the necessary amount of credits</td>
<td>Medium</td>
<td>W5</td>
</tr>
<tr>
<td><strong>W9</strong> - A user must be able to validate a voucher</td>
<td>High</td>
<td>W5,A3</td>
</tr>
<tr>
<td><strong>W10</strong> - A user could be able to see a history of expired promotions</td>
<td>Low</td>
<td>W5</td>
</tr>
</tbody>
</table>

Table D.2: Table of Priorities and Dependencies of the functional requirements for the Web Back-office