

FACULDADE DE ENGENHARIA DA UNIVERSIDADE DO PORTO

Journata - Designing the interface of a mobile application for exchanging public transport information among travellers

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Mestrado Integrado em Engenharia Informática e Computação

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Abstract

The advent of smartphones and the massification of Internet connections allowed easy access and sharing of real-time information between people. That contributed to the success of several social networks and location-based services developed for mobile devices. The change of paradigm to accessing and sharing information may be explored in order to solve mobility problems, through improvements on public transport services and their use experience, promoting the use of public transport in urban areas.

In these terms, a proposal was made in order to create a mobile application, with social network features, allowing real time sharing of public transport information between travellers, with such information being related to several aspects of the service. Sharing that sort of information can be useful to a better informed decision making by the users about their own journeys, and form a way that public transport operators can use in order to gather information about their service quality and, therefore, to improve it. Simultaneously, a good structure and organization of the shared information maximizes its utility to the users of the platform. The previous work resulted in a functional prototype with several limitations concerning the usability and user interaction with the application, conditioning the application's engagement and mass adherence by potential users.

This dissertation aims to develop a functional prototype to said application, applying user-centred design processed in order to produce a new iteration that overcomes the referred limitations, improving user experience and focusing in the interaction between the final user and the application. Initially, it was performed the elicitation of the limitations of the previous iteration of the application, along with some research in order to understand the usability requirements among potential users. After the prototype development (through an iterative process with evolution and validation of the designed interface and interaction), usability tests were performed among experts in the field of mobile applications development to public transport systems, which allowed to gather feedback about the work carried out and the potential range of an application such as this.

This work can be seen as an evolution of the base concept behind this application, based upon user engagement in the development process phases, serving as a starting point to the integration of the addressed concepts in larger scale projects related to mobility.

Resumo

O advento dos smartphones e a massificação das conexões à Internet possibilitou às pessoas o acesso e partilha de informação em tempo real com facilidade. Tal contribuiu para o sucesso de várias redes sociais e outros serviços baseados na localização do utilizador de dispositivos móveis. A alteração desse paradigma de acesso e partilha de informação poderá ser explorada no intuito de resolver problemas associados à mobilidade, através da melhoria dos serviços de transporte público e da sua experiência de utilização, promovendo a utilização desse tipo de transporte.

Nesse sentido, foi proposta anteriormente a criação de uma aplicação móvel com características de rede social com vista à troca de informações de transportes públicos entre os seus passageiros, em tempo real, sendo essas informações referentes a vários aspectos do serviço. A partilha desse tipo de informações poderá ser útil para uma tomada de decisão mais informada acerca das suas viagens, por parte dos utilizadores, e constituir uma forma através da qual os operadores de transporte público poderão recolher informação sobre o seu serviço com vista a melhorar a qualidade do mesmo. Simultaneamente, a estruturação e organização da informação partilhada maximiza a utilidade da mesma para os utilizadores da plataforma. Esse trabalho anterior resultou num protótipo funcional com severas limitações na óptica de usabilidade e interacção com o utilizador, o que condiciona uma adesão da mesma em larga escala por parte de potenciais utilizadores.

Esta dissertação tem como objectivo o desenvolvimento de um protótipo funcional para a dita aplicação, aplicando os processos de design centrado no utilizador de modo a produzir uma nova iteração dessa aplicação que ultrapasse essas limitações, melhorando a experiência de utilização e dando foco à interacção entre a aplicação e o utilizador final. Inicialmente, foi feito o levantamento das limitações da iteração anterior da aplicação móvel, tendo sido igualmente feita alguma pesquisa no sentido de perceber quais os requisitos de usabilidade de potenciais utilizadores. Após o desenvolvimento do referido protótipo (através de um processo iterativo com evolução e validação da interface e interacção concebidas), foram realizados testes de usabilidade, junto de experts na área do desenvolvimento de aplicações móveis para transportes públicos, o que permitiu recolher feedback acerca do trabalho realizado e do possível alcance de uma aplicação deste tipo. Este trabalho pode ser visto como uma evolução do conceito base desta aplicação, tendo por base o envolvimento dos utilizadores nas fases do processo de desenvolvimento, servindo de ponto de partida para a integração dos conceitos aqui abordados em projectos de maior escala ligados à mobilidade.

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Marco Amador

“The brick walls are there for a reason. The brick walls are not there to keep us out. The brick walls are there to give us a chance to show how badly we want something. The brick walls are there to stop the people who don’t want it badly enough.”

Randy Pausch

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Abbreviations

ADT	Abstract Data Type
ANDF	Architecture-Neutral Distribution Format
API	Application Programming Interface
CAD	Computer-Aided Design
CASE	Computer-Aided Software Engineering
CORBA	Common Object Request Broker Architecture
UNCOL	UNiversal Compiler-oriented Language
Loren	Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Sed vehicula lorem commodo dui
WWW	<i>World Wide Web</i>

Chapter 1

Introduction

This initial chapter aims to give a general overview about this thesis and the themes it addresses. We will start by explaining the context in which it is inserted, as well as the motivation beneath the proposal.

The main objectives of this thesis work, as well as the methods that will be employed in order to achieve them, will also be described.

1.1 Context

In the last few years, we have seen the speed of evolution and innovation regarding technology reach levels we never thought before, and applied to several fields. One of these fields, and probably the one where we, as human beings, felt that evolution was communication. Some of the big changes we perceived was for instance, the massification of the e-mail usage to communicate, the rise (and posterior fall) of instant messaging applications, the boost of the number of mobile phones and Internet connections worldwide [?].

Some recent studies related to the "Six Degrees of Separation theory", which defends that every person in the Earth is only separated, by way of introduction, by six steps to any other person, have shown that this value has been decreasing in the last few years. Microsoft itself performed a study with data from Messenger application, that revealed, only using that application, the mean path between Messenger users is 6.6 [?].

The advent of social networks, platforms that allow information sharing and interaction between people in several ways, had (and still has) a great contribute in approximating people and, along with the growth of Internet connections worldwide and the easiness of internet access, allows people to be constantly connected and communicating.

Mobile devices, in the last few years, have evolved as well, along with technology, developing capabilities of internet access and allowing that connection and communication to be done even when people are not at home or at work.

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As this evolution happens, we witness as well an increasing migration from people to larger cities, promoting an increment on the worldwide population living in urban areas. Recent data on this migration show that this migration is happening in both well developed and less developed regions around the globe [?].

This is contributing to generate chaos on our cities, making the task of reaching our destinations quickly increasingly harder (due to the increasing number of vehicles and people).

Public transport, however, has a vital role on promoting urban mobility and helping us avoid those problems. Encouraging its use reduces the number of cars, thus reducing traffic levels and the likelihood of traffic jams, increasing the efficiency of transport inside the cities and the efficiency of public transport itself [?].

As an attempt to promote public transport usage, some companies publicize their services and try to reach their customers through social networks, particularly the most widely used, such as *Facebook* or *Twitter*, taking advantage of their popularity.

The concept that supports this thesis is based upon this phenomenon, and tries to explore social network's abilities to act as information vehicle between people, and the willingness of people to share information in the first place. However, the kind of information we intend to see shared between people with this project is information concerning public transport, in such way that both users and operators can benefit from that information.

This concept has been proposed in the article *Using social networks for exchanging valuable real time public transport information between travellers* [?], and its implementation is in course at the *IBM Center for Advanced Studies* at FEUP. That implementation has been the subject of previous master thesis works from MIEIC, and resulted on a prototype for an Android mobile application [?].

This thesis aims to provide a redesigned and intuitive interface to the project, in order to make the new iteration a more efficient way for travellers to help each other and contribute to a better public transport service, ultimately leading to an increasing use of public transport (and possibly more efficient public transport and cities).

1.2 Motivation

Time is the most precious resource nowadays, specially for those who live in a city. We waste some of that time on our daily travels, such as performing home-to-work course and the reverse. Often, journeys that should last 10 minutes end up lasting much more than that, due to delays, traffic jams and so on.

Those factors generate some unpredictability on public transport behaviour that, allied with the lack of information about the routes, delays and unexpected problems, frequently leads people to try to avoid them when possible, in order to keep up to their schedule [?].

Providing travellers with real-time status information about public transport is something that can lead people to use them. This way, we can help people making informed travel decisions,

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while possibly reducing the number of private vehicles circulating in our cities, thus reducing traffic and saving time.

Social networks have been used in the recent times by some public transport companies in order to get closer to their customers and to provide them some real-time information about their services. Using social networks, those companies are establishing a two-way communication street with their customers, generating feedback that can be used to improve the quality of the offered services.

However, recent studies have shown that, despite the notorious advantages that arise from this kind of approach, the information provided is not fully exploited sometimes, leading users to perceive it as useless and to underestimate it [?].

The existence of a social network designed to provide structured information in real-time to the right people (people that would perceive that information as highly useful), through a mobile application, could help improving the public transport' perceived experience. Moreover, if the information shared inside this social network had origin in the users themselves, the transport operators wouldn't have charges related to the maintenance of those services, while receiving a constant source of feedback they can use to improve the quality and efficiency of their services.

This social network could also contribute to other kinds of benefits (apart from the economical ones to the transport operators). For instance, it could lead to decreasing levels of stress suffered by passengers of public transport, by increasing their well-being, and also, as an ultimate consequence, to the reduction of the ecological footprint generated by the widespread use of private vehicles on home-to-work travels.

However, providing structured information to the right people in real-time is not enough. Being this social network fed by information generated by and shared between its users, it must have as many users as possible, in order to generate a large volume of information, so that users can receive information useful for them.

That said, the user interface (UI) of the social network, in this case, a mobile application, must be intuitive and attractive to the passengers, captivating them to use it daily and to contribute to the information flow inside the social network.

1.3 Goals

One of the most innovative aspects of the concept referred in the last section is the creation of dynamic community networks, in time and space. For instance, in a social network such as *Facebook*, we have a list of friends and acquaintances that does not change a lot over time (thus, forming static networks). In the proposed concept [?], is discussed the creation of dynamic networks, representative of travellers on a specific line, vehicle, or inside vehicles from different lines that share part of its course between them. That way, a traveller would only receive information from another travellers in the same networks, maximizing the utility of the received information. The main goal of this thesis is to develop a user interface for the mentioned system, while performing the following:

- Create and analyse appropriate metaphors for the interaction with dynamic social networks.
- Design and test innovative visual affordance for the concept of dynamic social networks.
- Apply state-of-the-art concepts related with Human-Computer Interaction in order to maximize the usability of the application by its final users, while addressing usability problems identified on the previous existing prototype.
- Develop a functional prototype for an Android mobile application based on the obtained from the goals already mentioned.
- Perform a pilot test alongside potential users of the system, and evaluate the obtained results.

1.4 Structure of the Report

Besides the Introduction chapter, this document contains six additional chapters, with the following structure: Chapter 2, *State-of-the-Art*, presents the definition, explanation and related works in the fields of the concepts in which the project is based upon. It will also present examples of several mobile applications with social network features and/or related to public transport information.

Chapter 3, *Problem Description and Approach*, explains more in detail what is meant to achieve with this work and the problem that is discussed in it, as well as the chosen approach to reach the proposed goals.

Chapter 4, *Requirements Elicitation*, describes the work performed in the initial phase of the process, having the previous state of the project as a starting point to some new design proposals, and the realization of a focus group to perceive user needs and usability requirements.

Chapter 5, *Application*, presents the architecture of the application, and describes the evolution of each main design concept of it, from the first sketches to the implementation phase.

All the performed tests and subsequent results are presented in Chapter 6, *Tests and Results*.

Finally, Chapter 7 presents the conclusions taken from this thesis, as well as suggestions about future work to be done in the project and ways it can evolve in order to maximize its reach, and be integrated with bigger scale solutions.

Chapter 2

State-of-the-Art

Social networks are changing the paradigm of communication between people. We have seen an increasing growth of the number of people using them in the past few years, and the same applies for the amount of time spent by people in these communities. This popularity brings a huge potential to these platforms, for instance, for promoting or marketing of products, sharing various kinds of information, and stimulating the collaboration among its users. Using this strong sharing component, and with the help of some other features for communication between people, such as chat, instant messaging, video-conferencing and so on, these platforms develop some features of collaborative environments, making them attractive to implement the concept of Collective Intelligence [?].

The fact that we can use a communication network everywhere these days had an impact on the social networks growth, popularity, and volume of information shared. To be online anywhere and at any moment, has become an habit for millions of human beings, and the smartphones' expansion had a great contribution to that. However, their increasing popularity does not exactly mean that people are easily driven or compelled to use new ones. Instead, they usually get bored faster and their acceptance of different networks and environments diminishes.

So, in order to succeed, a new player, in this case, a new social network or platform, has to find new ways in order to keep people addicted to their services, and attract even more people. We will start by clarifying some concepts that are in some way related with the project.

2.1 Online Collaboration Tools

Nowadays, we have a wide range of tools we can use to perform some kind of online collaboration, such as real-time collaborative text editors (Google Drive, for instance), wikis, Q&A websites (*StackOverflow* and *SuperUser* have an enormous success inside the IT community, allowing people to ask questions and to say problems they're facing and see them answered by someone with expertise on the field), and so on.

Most of these platforms, and their success, rely heavily on their number of users, on their features, and on the information flow generated and shared by them. In cases where the shared information is made public (Q&A websites, for instance), the "community sense" perceived by the user, along with the value of the existing information, is fundamental to the acceptance of the platform.

That kind of collaboration lies deeply within the concept of Collective Intelligence, emerged from the debates held by Pierre Lévi [?], where it is assumed that the intelligences of each individual are added and shared by the society.

"What is collective intelligence? It is a form of universally distributed intelligence, constantly enhanced, coordinated in real-time, and resulting in the effective mobilization of skills... My initial premise is based on the notion of a universally distributed intelligence. No one knows everything, everyone knows something, all knowledge resides in humanity."

This is something meant to be explored deeply in this thesis and the concept behind it, due to the functionality and usability the application aims to give to the passengers, in order to keep them generating useful information for other users.

The growth of online collaboration lead also to the growth of a new business model, called *crowdsourcing*, where people submit problems to a community , instead of solving them on their own, hoping for the community to reply with better and/or more creative solutions.

That business model has also evolved into several sub-types, such as *crowdfunding*, where someone prompts the community with a solution for a problem and asks the members of the community for funding, in order to develop and launch said solution, if the said members think the solution is viable, creative and/or necessary.

2.2 Mobile Environment Overview

As said before. we live in an era where smartphones allowed us to take advantages of the massification of wireless networks in order to be online, anywhere and at any given time.

They also allowed us to perform tasks we didn't imagine ourselves performing from a mobile phone twenty years ago, such as:

- Reading our e-mail account and send new e-mails.
- Navigating on websites.
- Share photos with friends via messages or social networks.
- 'Check-in' at restaurants, clubs, museums, etc.
- Use native applications to fetch several types of information: news, weather information, football scores, and even *public transport information*, such as schedules.

The appearance of mobile operating systems with high number of default functionalities, such as Android ¹ (maintained by Google) or iOS ² (from Apple Company), allied to the easy development of native applications for those OS's, lead to an exponential growth in the number of that type of devices worldwide and thus, their native applications.

Android is, by far, the mobile operating system with most devices sold and has a steep growing trend. It is known for being an open source Linux-based system, suitable for both smartphones and tablets and very flexible concerning to hardware configurations.

It has been well received by third-party phone manufacturers, and it has a large community of developers, as well as millions of native applications available for download. Users can find these application in their official store, *Google Play Store*, the largest app store worldwide [?], or through third-party websites.

Apple's iOS, however, is a closed-source system, for installation on Apple's devices only. It was originally developed for Apple's smartphones, iPhone, but it has since then been extended to other devices from the company, such as tablets (iPad) or portable music players (iPod Touch). Its application store is the most profitable worldwide.

Both Android and iOS have evolved since their first versions, not only adding functionality and features, but also providing developers with new methods to make their applications more usable, efficient and aesthetically attractive.

Mobile devices who have these operative systems are also equipped with a lot of embedded sensors, that provide help and data to some features of applications. Some of these sensors are:

- Motion Sensors (accelerometers, gyroscopes, gravity sensors);
- Environmental Sensors (barometers, thermometers);
- Position Sensors (orientation sensors, magnetometer);
- Location Sensors (GPS sensors).

The last type of referred sensors, that allow the device and therefore its applications to detect and use information related to the users location, using GPS (*Global Positioning System*), resulted in the creation of new types of services, that can be inserted in the Location-based Services category.

2.3 Location-Based Services

According to Kupper [?], there is no common definition or terminology for location-based services. Schiller and Voisar [?], however, define location-based services as "services that integrate a mobile device's location or position with other information so as to provide added value to a user".

¹<http://www.android.com/meet-android/>

²<https://www.apple.com/ios/>

GSM Association's definition is a little bit more abstract, and defines those services as "services that use the location of a client for adding value to the service".

In this context, the referred client is understood as any entity whose location is relevant, and not necessarily a mobile device or the user of the service.

This concept of location-based services, as it is known today, was first studied by Timo Rantalainen, in his master thesis in Electronical Engineering for Helsinki University of Technology, in 1994. In a posterior article [?], he wrote about possible methods to determine users' location.

These services were created due to a set of particular questions that web developers faced with the growth of the Internet. For instance, how to adapt the contents of a website to a particular reader? Knowing their location (the country they were visiting the page from), it was made possible to display the website information in that country's language. In similar ways, results from a search engine could be customized to the user's country, as well as the advertisement shown [?].

The appearance of mobile computation brought new challenges to this area, and new strengths to these services - it is far more interesting to use the location of a mobile device than the location of a desktop computer, for instance.

Some of the biggest challenges were related to the way the location data was stored and handled (due to being from a mobile device and the data being dynamic, because the location is changing and the gathered data is continuous).

2.4 Social Networks

In the definition provided by James Clyde Mitchell [?], a social network is a set of specific links between a group of people, with the additional property that the characteristics of these connections as a whole can be used to interpret the social behaviour of the involved individuals. Of course, this is the general definition of a social network, but nowadays we associate it to the phenomenon of online social networks, that according to the definition given by Nicole B. Ellison [?], consist in Web services that allow an individual to:

- Create a public or semi-public profile within a bounded system;
- Articulate a list of other users with whom they share a connection;
- View and go through their list of connections and those made by others within the system.

However, most of these online platforms evolved beyond that definition, providing features to their users allowing them to upload content (for instance, photos, music or videos), send instant messages to other users and use small applications or play games [?].

Online social networks have grown in such a way that has provided them a tremendous power (especially the most used platforms, such as *Facebook* or *Twitter*, that have a huge popularity). Some proofs of this power are the recent developments in the political world, where cases like the revolt in Tunisia [?], Egypt [?], and most recently, Syria [?], were made possible in part due to the

massive mobilization of people that occurred through these networks, showing their influence on the world.

This phenomenon led also to some academic work that aimed to analyse the content shared on those social networks during the conflicts, in order to provide knowledge about the forces and the supporters from different factions [?]. Political and religious leaders all around the world have also realized the importance of online social networks, and have themselves created profiles in those networks, that allow them to disseminate messages, that are then replicated by the media. Catholic Church, for instance, created a *Twitter* account to be used by their religious leader, the Pope (first used by Pope Benedict XVI and now by Pope Francis)³. That account has more than 3.6 million followers, apart from more than 400 000 followers in other related accounts (that translate the messages from the original account to other languages, such as Spanish, Portuguese, German and Latin).

Google+, for instance, has provided several live forums with the President of the United States of America, Barack Obama. Using the *Hangouts* functionality, the President can answer to questions from some of the users of the platform. The last debate, held at 31st January 2014, intended to be a discussion about the new US national health system program, commonly known as *Obamacare*, where users could see some of their doubts or questions about the program answered by Barack Obama. Those live forums can often be reviewed on *Youtube*.

Another example of the power of social networks is all the content generated in those networks by athletes and journalists about the 2014 Winter Olympics, hosted in Sochi, Russia. Some photos shared by those people questioned the preparation of the country to host the event, and revealed negative aspects that were conveniently ignored by the Russian media, such as lack of potable water, bad commodities to accommodate athletes, planned infra-structures that were not built, etc. That has led to an imposition by the International Olympic Committee to the athletes, forbidding them to use professional recording material to take photos and videos and put them on social networks such as *Instagram* [?].

On the 18th of May of 2012, *Facebook* became the first online social network to get into the stock market [?], and was followed by *Twitter* on the 7th of November 2013 [?], which is another example of the popularity, success and potential of this type of platforms.

Some of these platforms are meant for general use (*Facebook*, *Twitter*, for instance), but there are also 'themed' online social networks, designed to target part of the population making the platform focused on sharing particular types of information, related to the users' interests or hobbies. *LinkedIn* is an example of a network of that kind, having a focus on professional informations that can help people by sharing their curriculum information, recommending people they work or used to work with, share their set of skills or recommending a certain skill of an acquaintance.

³<https://twitter.com/Pontifex>

2.5 Gamification

Gamification can be defined as the use of game play mechanics for non-game applications, particularly consumer-oriented web and mobile sites, in order to encourage people to adopt the applications, or, in the words of Gabe Zichermann and Christopher Cunningham, authors of the book "Gamification by Design", "the process of game-thinking and game mechanics to engage users and solve problems".

The term gamification only came into widespread use in February 2010, when Jesse Schell, a game designer and professor from Carnegie Mellon University, gave a presentation on the DICE 2010 conference, where he claimed that elements of games will invade every part of our daily lives [?].

The term gained more importance through several recent published books, such as "Game Based Marketing", by Gabe Zichermann, who advocated the use of game mechanics in marketing, and Baron Reeves's "Total Engagement", where it is said that games and virtual worlds will change the way people work. At the South by Southwest annual conference of 2011 (in short, SXSW 2011), entrepreneur Seth Priebatsch talked about games as the new layer that, similarly to the social layer, "will change the world" [?].

Gartner, an IT research company, predicts that by 2015, more than half of companies managing innovation processes will employ gamification of some sort in their products [?]. Another company, M2 Research, predicts that, also by 2015, game mechanics production will generate 1.6 billion dollars in revenues and will account for 23% of social media marketing budgets.

As of today, gamification is employed in applications across many areas, including productivity, finance, news, health, user-generated content and e-learning. Several companies offer gamification in their products as a layer of reward and reputation systems to their users, using points, badges, levels and leader boards as some examples of that use.

In the 2011 Gartner Hype Cycle report, gamification is listed as rising onto the stage of "peak of inflated expectation". After reaching that peak, it is said that one technology reaches the hype and the mainstream adoption. Gamification was then said to have between 2 and 5 years until reaching that peak.

Despite being a term commonly referred, there is already criticism of gamification in the media. Some say that the term is a mere buzzword, applied as a simple "pointification", and often missing game elements such as storytelling and experiences, that are fundamental to the effectiveness of games.

2.6 Existing work

This section aims to introduce and analyse some existing services and applications related in some way to the concepts defined and explained in the previous sections of this chapter. This is particularly relevant because those concepts are behind the work meant to be developed in this thesis work and the project in which it is inserted.

State-of-the-Art

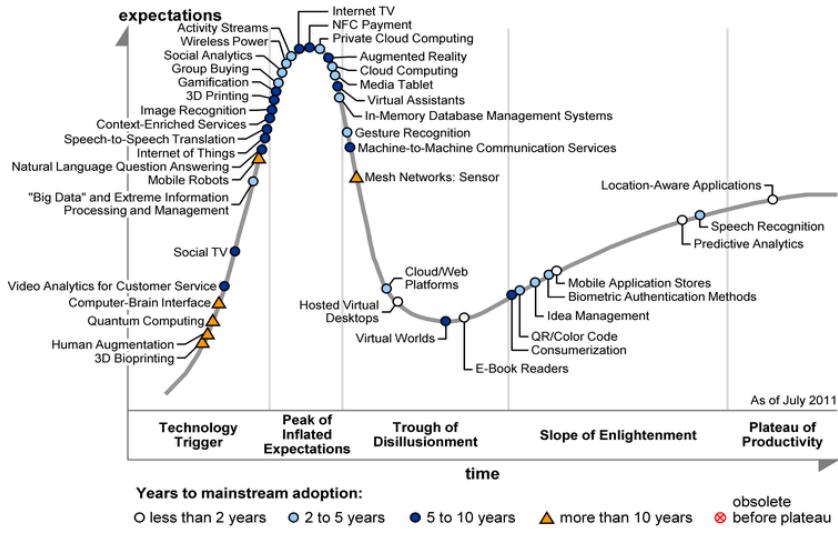


Figure 2.1: Gartner Hype Cycle 2011 graphic

2.6.1 Social Networks for travellers

In this chapter, it was already mentioned that there are 'themed' social networks, directed towards people with particular interests or hobbies. There are also several online social networks aiming to promote the sharing of information between travellers. These platforms try to become a must see for those who are thinking of travelling, planning a particular trip, or want to find places to see in a particular journey or a comfortable place to spend the night during that journey.

Some examples of those platforms are *WAYN*⁴, *Tripatini*⁵, *Gogobot*⁶ and *IgoUgo*⁷. They try to connect travellers and tour operators, using social networks.

However, these platforms have many disadvantages and do not represent what the implementation of the concept presented in [?]. To start, these platforms aim to share information about long distance trips, in contrary to what is aimed to achieve (short-duration trips in a context of urban mobility). Also, after a brief utilization and registration on some of those platforms, anyone can conclude that there is a strong presence of travel operators, filling up user's email accounts with messages, deals and offers to some destinations.

A large percentage of the websites are also covered with those offers, turning the navigation and understanding of the platform very difficult and tiring, in what can be considered as a bad example of marketing utilization on online social networks, due to the excessive information that is presented.

Another problem of these platforms lies on the reliability of the information. In the end of 2009, a journalist named Arianne Cohen, tested the limits of these platforms by travelling to a foreign and unknown destination for her (in the particular case, Istanbul), using only mobile

⁴<http://wayn.com>

⁵<http://tripatini.com>

⁶<http://gogobot.com>

⁷<http://igougo.com>

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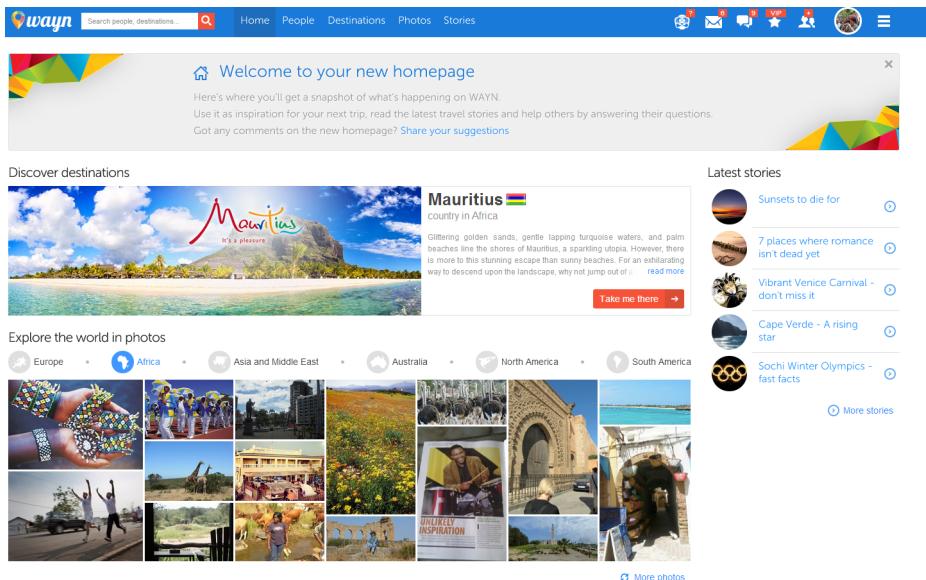


Figure 2.2: Screenshot of WAYN desktop interface

applications and social media to receive information about places to see and where to spend the night. The resulting experience was disappoint in what concerns to these travel-themed platforms, as Arianne obtained most part of her positive experiences from contacting people through general-use platforms, such as *Twitter*, *Facebook* and *Google+* [?].

Tripatini presents us with yet another problem: usability and appearance. The platform's interface looks outdated and the existing information is not well-structured.

In addition to this social networks designed for travellers, some information about public transport can be found on general-use platforms, because public transport companies have realized about the potential the networks have to act as a way to get closer to their customers and daily users, communicating with them. Nowadays, it is fairly common to find *Facebook* and *Twitter* pages from the companies, used to disseminate information about their services and interact more directly with the customers. For instance, *Metro do Porto* is present on both *Facebook*⁸ and *Twitter*⁹, as well as *STCP*^{10 11}.

2.6.2 Mobile Applications using Location-Based Services

As said before, the increasing use of smartphones lead to the appearance of new and richer location-based services (concerning the amount of information they gather about users' location). Some successful online social networks based their business model or main features precisely on the capacity to track the location of their users.

⁸<http://www.facebook.com/MetroPorto?sk=wall>

⁹<https://twitter.com/#!/metroporto>

¹⁰<http://www.facebook.com/STCPSPA?sk=wall>

¹¹<https://twitter.com/#!/STCPServicos>

Perhaps the most successful example of this kind is *Foursquare*¹², who allows the 'check-in' of users at several locations (bars, restaurants, clubs, etc.), employing gamification techniques (badges) to improve user engagement with the network. The mobile application of the platform gathers the user location, giving him information about the nearest interest points, and allowing him to perform manual check-in at one of these locations. A user earns a badge for completing tasks, such as checking-in for the first time at a new place, checking-in at a wide number of places in the same area, or several times in the same place. The platform also allows searching for particular categories of points of interest, and check the places visited by an user acquaintance.

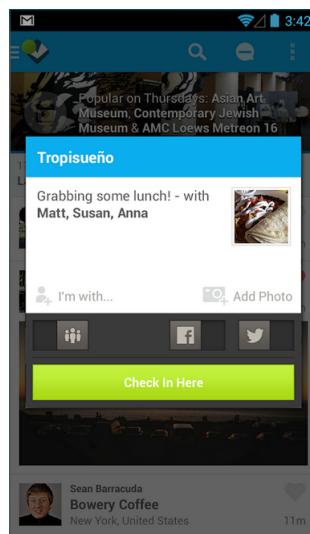


Figure 2.3: Screenshot of *Foursquare* Android mobile application interface

Foursquare had, as of February 2013, more than 40 million registered users, with several millions of check-ins registered in a daily basis.

Some other examples of successful online social networks that take advantage of the location of their users are *Blindr*¹³ and *Tinder*¹⁴. Their main goal is to, using that location, search for people nearby in order to arrange online dates between users.

Tinder, for instance, provides users with a sort of catalog from other users nearby, prompting them with a choice: marking them as a possible interest or not. Then, if the other person does the same thing, communication between the two users is enabled.

These two social networks, along with similar applications, demonstrate how a location-based service can be used in a context where the location of nearby users is deeply explored, and the number of existing users a critical factor for their success.

¹²<http://pt.foursquare.com/>

¹³<http://blindr.com/>

¹⁴<http://www.gotinder.com/>

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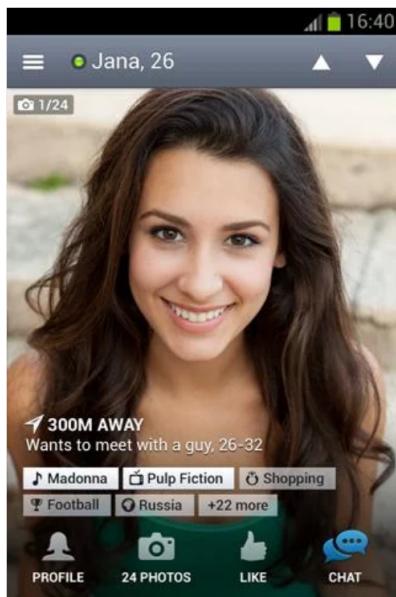


Figure 2.4: Screenshot of *Blendr* Android mobile application interface



Figure 2.5: Workflow of *Tinder* application interface

2.6.3 Route Planners

Route planning services consist in one of the most used services for those who want to plan a trip using the Internet, whether it is short or medium duration trips. These services are usually free of charge, and allow their users to view Earth's maps and satellite images, offering route planning features using several types of transportation (walking, by public transport or by private car). They are particularly useful to find the shortest or fastest route between two given points. The most known service of this type is *Google Maps*, but there are some alternatives, such as *MapQuest* or *Bing Maps*.

Given their features, these services normally have a simple and intuitive interface, making them easy to interact with.

2.6.4 Mobile Applications for Public Transport

In the last few years, some public transport companies tried to provide their users some valuable information about their services. That resulted in several applications, spread by a lot of countries and cities.

Some of those applications are: *London Underground*¹⁵, *Catch that Bus!*¹⁶, *National Rail Enquiries*¹⁷, *iMetroPorto*¹⁸ and *MOVE-ME*¹⁹.

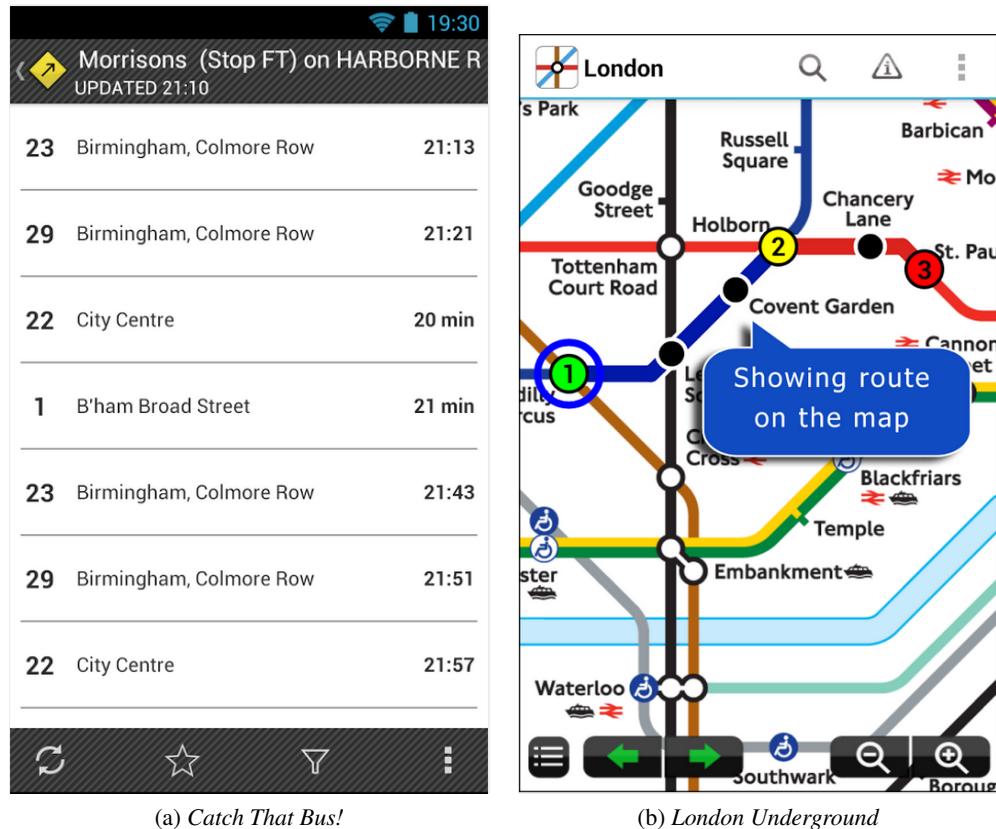


Figure 2.6: Interfaces of mobile applications for public transport information - Example 1

In the range of features provided by these applications, it is possible to find:

- Information about schedules, lines and upcoming vehicles in real time.
- Journey planner features.
- Current location and nearest train/underground stations or bus stops.

¹⁵https://play.google.com/store/apps/details?id=com.visualit.tubeLondonCity&hl=pt_PT

¹⁶<https://play.google.com/store/apps/details?id=uk.co.ashtonbrsc.catchthatbus>

¹⁷<https://play.google.com/store/apps/details?id=uk.co.nationalrail.google>

¹⁸https://play.google.com/store/apps/details?id=pt.edgelabs.metro_porto

¹⁹<https://play.google.com/store/apps/details?id=com.moveme>

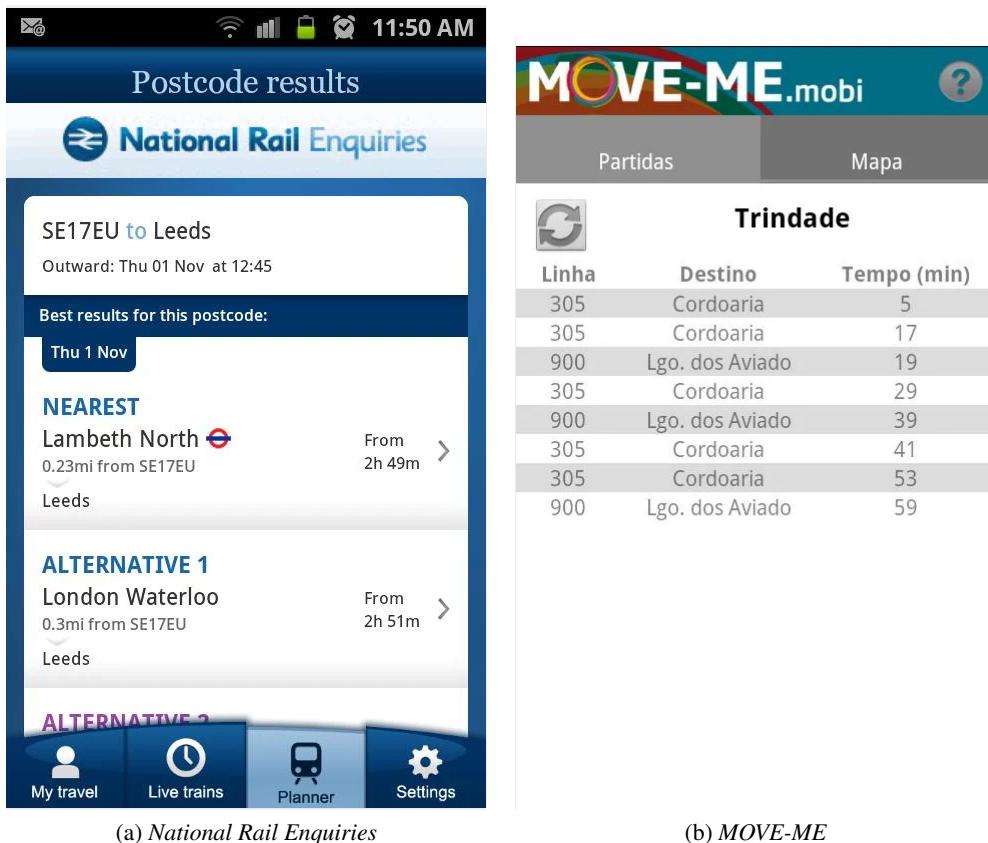


Figure 2.7: Interfaces of mobile applications for public transport information - Example 2

There are, however, some disadvantages to this sort of mobile applications. They are usually limited to a city or urban area, or even to a specific method of transport, constraining their usage and potential. The existing journey planner features, are in most cases pretty limited, not showing warnings or notifications to the users about delays or other events in the planned journey (only *National Rail Enquiries* informs travellers about delays or cancelled trains).

Another downside of these applications, however not visible to the travellers, is that they rely on an existing API in the company's servers. To provide information of this kind to their clients, a public transport company must support the costs of developing and maintaining such solution, costs that can be avoided if an application using crowdsourcing (where the information originates in the users themselves) is available in the said urban areas.

2.6.5 Mobile Applications with Crowdsourcing

Starting from the last constraint mentioned in the last set of existing applications, there has been developments in recent years in order to launch new solutions based on crowdsourcing, where users can access detailed information that were previously generated by other users. The potential of this type of applications is tremendous, specially in areas where there are many users constantly

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using the application, receiving and submitting information possibly useful to other people with the same intentions. Obviously, transportation in urban areas is a field where this potential can be explored, giving the amount of people using private or public transport in a daily basis and sharing travel intentions.

That has lead to the appearance of platforms such as *Tiramisu*²⁰, *Waze*²¹ and *Moovit*²², that are the closest existing applications compared to the project in which this thesis work is inserted. *Waze* is directed towards private transportation, feeding users with information about traffic and navigation provided by other users of the platform. Drivers can also report traffic issues, such as traffic jams or accidents, in order to warn other drivers, giving them the possibility to act accordingly with the situation.

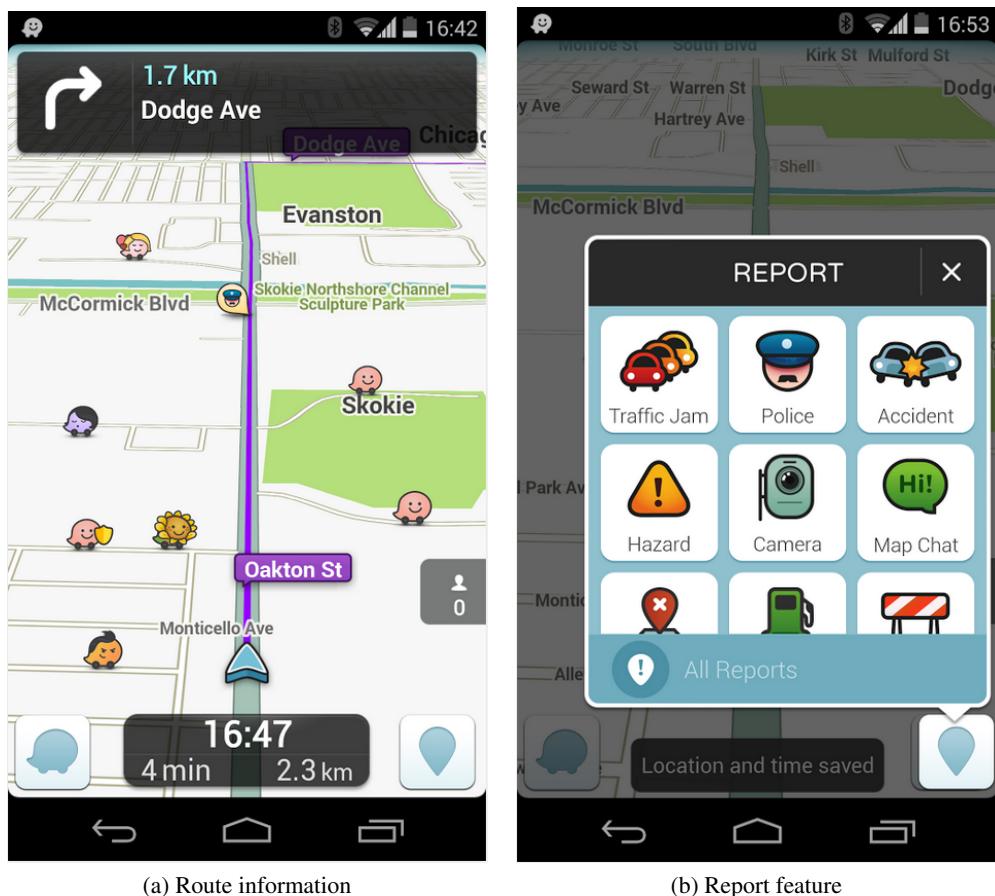


Figure 2.8: Captions of *Waze* mobile application interface.

Moovit, however, is directed towards public transportation, feeding users with information about schedules in real time, re-routing in case of delays, and also about crowding level of the vehicle. The information provided is generated by and shared between other users, thus making

²⁰<http://www.tiramisutransit.com/>

²¹<https://www.waze.com/>

²²<http://www.moovitapp.com/>

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Moovit the most similar platform to this project's concept (however, it still does not take into account other aspects of the trip that we aim to see shared between users).

Moovit is available in several countries and cities all across the world, with relative success. In Portugal, however, it is not available yet. As of 8th of June 2014, the mapping of the public transport lines and schedules for the city of Porto was started by the community, but the lack of users acts as a constraint to the availability of the application for this city's public transport users (still plenty of work to be done in that field), and to its success (with few users, most of the lines would not have information at all, even during the day, because all the information in this application is supplied by its users).

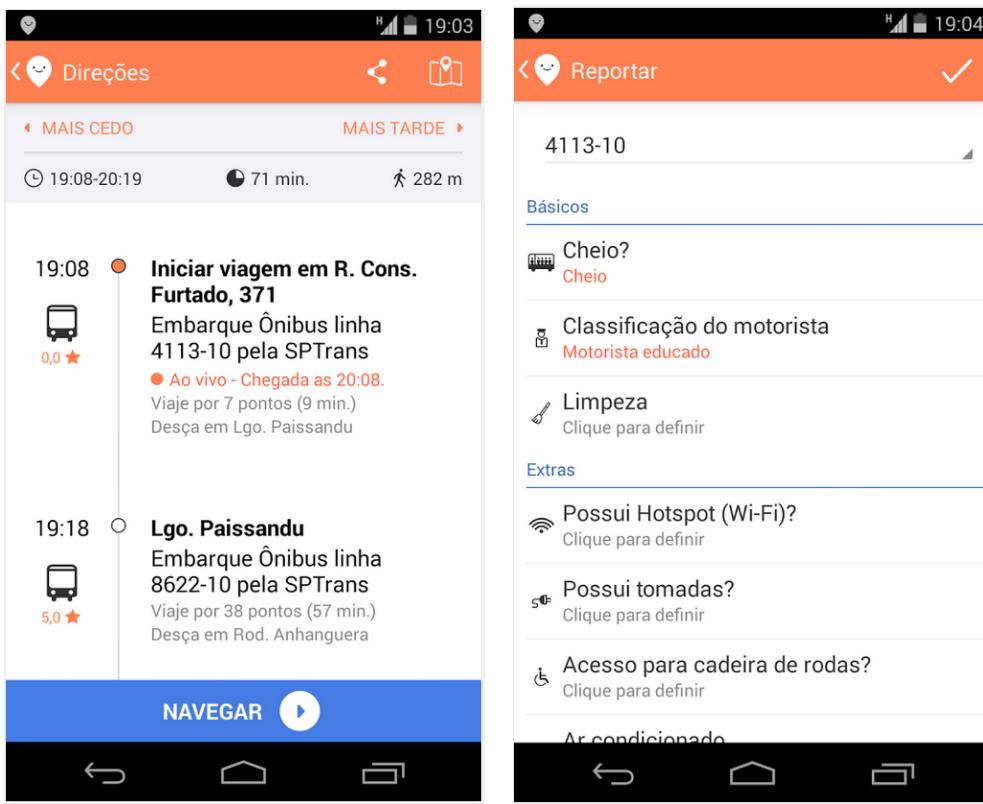


Figure 2.9: Captions of *Moovit* mobile application interface.

Tiramisu is also directed towards public transportation, being focused only on buses. However, it takes advantage from the users GPS location (during a bus trip) in order to predict the bus arrival time and present it to other users. In addition, a user travelling on a bus can report to the application if the bus is full or if there are seats left.

For buses that have no users of the application inside (thus, not recording their location), the application displays the official schedule from the transport operator (not in real time, but the same as the printed scheduled arrive time). *Tiramisu* is only available for a few number of cities and operators in the United States of America.

A final note about the interface of *Waze* and *Moovit*: after a brief use, the interfaces seemed very attractive, but not exactly clear to the user in what the buttons in the interface are meant to do or show.

2.7 Summary

After the literature review and a study of existing applications, it is concluded that there are good examples of services that use location of users and gamification techniques to improve user engagement, and that some of those aspects can be used in the interface meant to be developed in this thesis work.

Concerning applications directed for public transport information, besides the limitations already mentioned, there are no applications feeding users with the information this project desires to provide them with. Also, because the final desired prototype is not limited to show information to the users, but also to make the task of sharing and submitting information as simple as possible, the usability of the application gains much more importance compared to the other existing applications in the field.

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Chapter 3

Problem Description and Approach

As described on the section 1.3 of the introduction, the project encompasses the creation of a functional prototype for an *Android* mobile application for a platform that uses dynamic social networks and intends to use gamification techniques to improve user engagement. The platform is designed to share information about public transport between travellers. Before the implementation of the functional prototype, the creation and testing of interface designs is required. The usability and interaction of that interface is fundamental to the platform, because it might make the difference between its success or failure, given that it might attract or repel several users and facilitate or make more difficult the submission of information through the platform.

According to a study performed by Robert Pessagno [?], "[social networks] acceptance is determined by how easy it is to use them", and that has even more importance in the scope of the project, given that the necessity of having a large base of users feeding the platform with a huge volume of information in real time at any given moment. If that does not happen, there is a risk of having lines that have no information. For instance, low transport frequency time periods or lines may lead to nonexistent information in those lines or during those periods. Having a greater user base mitigates that risk, though it can still happen.

Given the innovation introduced by the main feature of the project, the dynamic social networks, it is necessary to develop suitable metaphors and create user visual affordance to enable the understanding of that feature by travellers, in a familiar or intuitive way for them. In the first iteration of the project [?], usability tests were performed in order to capture possible usability problems with the previously developed interface. Those tests resulted in a set of conclusions that encompassed usability issues to be addressed and aspects to improve in this new iteration, and it is aimed to use those conclusions as a starting point to this work (see 4.2).

Problem Description and Approach

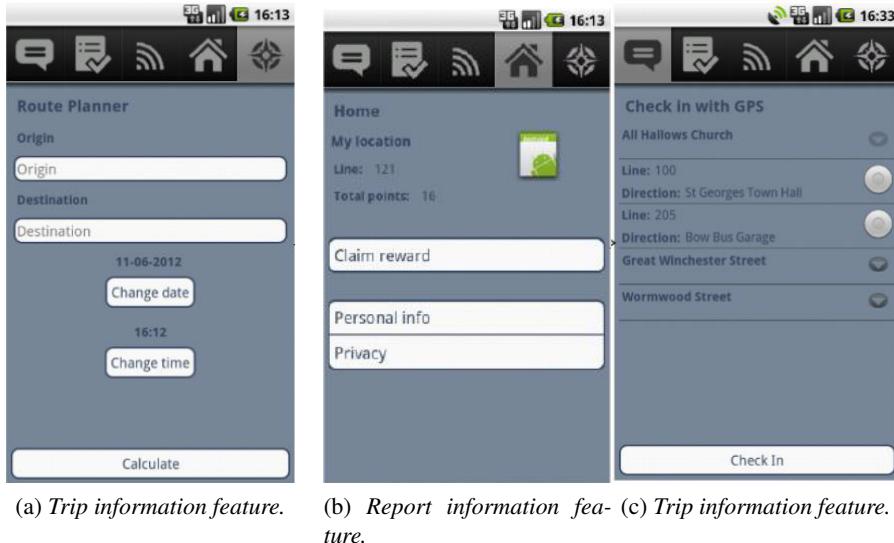


Figure 3.1: Screenshots of the previously implemented interface.

3.1 Usability

Usability can be defined as a measurement for how easy it is to use an interface. Typically, the evaluation or measurement of usability is kept separate from discussions of utility, a characteristic often more influenced by what the interface is connected to (if we're talking about a mobile application, that can be for instance an existing API retrieving data existing in an external server) than the interface itself. Jakob Nielsen, one of the most prominent authors and experts on usability, defines usability as having the following components [?]

- **Learnability** - How easy it is to users to accomplish basic tasks in the first time they are introduced to the design?
- **Efficiency** - Once the users have passed the learning phase, how quickly can they perform tasks?
- **Memorability** - After a period of not using the interface, how quickly can users remember it and be proficient in the accomplishment of tasks?
- **Errors** - How many errors do the users make while using the interface? What is the severity of those errors and can they recover from them?
- **Satisfaction** - How pleasant is it to use the design?

Following Nielsen's approach, only actual performance by users is worth measuring. However, there are other approaches, for instance the one defined by Patrick Jordan, that include the theoretical performance level achieved when the system being measured is used to its full potential [?].

Despite the several definitions and approaches, the goal of (improving) usability, that aims to be accomplished in this thesis work, is to make it faster and easier to users of an interface to achieve their goals and accomplish the desired tasks.

3.2 User-Centered Design

In the recent years, the attempt of several institutions to integrate design with technology has become a regular behaviour in the development of their products. In 1999, it was established an international standard, *ISO 13407*, that aimed to provide "guidance on achieving quality in use by incorporating user centred design activities throughout the life cycle of interactive computer-based systems."

That standard established four activities that had to be started at the earlier stages of a project:

- Understand and specify the context of use for the product - Collect relevant contextual information from the environment where the system is going to be used;
- Specify the user and organisational requirements - Formulate and build the user-centered requirements for the new software.
- Produce design solutions - Simulate design solutions using paper or computer-based mock-ups and get feedback of real users;
- Evaluate designs against requirements. Last but not least, is indispensable to evaluate the design work performed previously. In this phase anomalies, defects, bugs, failures are detected in order to select the best solution for the system.

These activities were meant to be performed according to the following work flow.

This standard has since then been revised and re-issued as *ISO 9241-210*, that describes six key principles to apply in a user-centered design process [?]:

- The design is based upon an explicit understanding of users, tasks and environments. This means that is necessary to understand your users, understand what they want to do with the system and understand the environment in which the system is used.
- Users are involved throughout design and development - Users must be involved in all design phases, not just at the start and at the end of the design.
- The design is driven and refined by user-centred evaluation - Usability testing should be carried out throughout the design process. Initially, to test preliminary designs such as paper prototypes, and after that, not just at the end of the process.
- The process is iterative - It is difficult, if not impossible, for users to explain what they want or need from a system. So, in order to find out what people want, it is necessary to show them something that they probably don't want (first designs) and then discover how

Problem Description and Approach

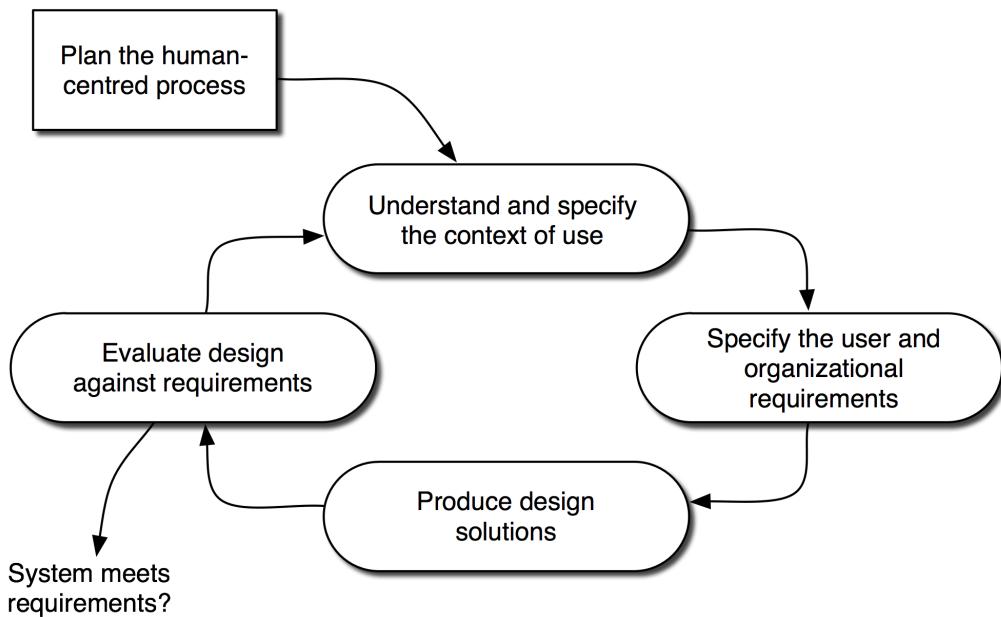


Figure 3.2: Workflow of the process described in ISO 13407.

to improve it. This means that if a waterfall methodology is used the design process will struggle to be user-centered.

- The design addresses the whole user experience - Usability (and a good user experience) is about a lot more than making things simple, including the perceptual and emotional aspects typically associated with user experience.
- The design team includes multidisciplinary skills and perspectives - The design team should include a range of views, including the voices of accessibility experts, end users, domain experts, etc.

Given those recommendations and the referred importance of making the users part of the development process (thus increasing the chance of success of the application among a wider audience), the chosen process in order to achieve the expected results has four phases:

- **Requirements Elicitation phase** - As an initial step, it should include an analysis of what went wrong or what were the perceived disadvantages in the interface previously conceived, followed by additional usability requirements elicitation (assembling a focus group with potential users of the application and regular public transport users);
- **Design phase** - consists in the creation of alternative low-level designs, along with the usability tests and studies in order to maximize their quality and relevance.
- **Prototyping phase** - Implementation of a chosen design, previously done, as an *Android* mobile application.

- **Evaluation phase** - Realization of usability evaluation and analysis of the evaluation results, as the name suggests.

It is worth referring that this process is an adaptation encompassing the iterative process described in *ISO 13407*, where the mentioned Requirements Elicitation phase serves as the first iteration that allows the gathering of a vast amount of information regarding usability requirements, that will result in the production of an initial design, that will be checked against additional requirements.

The following design phase will act as several iterations of the process, constantly evolving the interface and trying to improve the quality of the solution. That phase will end with a usability test with potential users, that will serve as validation of the evolved design in order to pass to the implementation phase.

Finally, the implementation and evaluation phases will act as a final (and long duration, due to the duration of the implementation) iteration of the process.

3.3 Usability Evaluation

The usual approaches to perform usability evaluation are the following:

1. **Usability testing** - Involves measuring typical user's performance on task accomplishment.
2. **Field studies** - Performed in a natural environment (real case scenario)
3. **Analytical evaluation** - Does not involve end-users. Two main methods are usually used, heuristic evaluation and/or predictive evaluation. While heuristic evaluation involves the use heuristics (sets of guidelines and standards) and walkthroughs with experts through scenarios of the application prototypes, predictive evaluation is based on theoretical models, in order to predict user performance.

In this project, usability testing, through potential user observation and questioning, will be employed during the development process (as a tool to help with the validation of the interface), while heuristic evaluation with experts will be employed in a final phase, to evaluate the functional prototype and serve as validation of the implemented interface and serve as a base to possible future improvements.

3.4 Usability Studies

In order to measure and improve usability of a given project, usability studies are often performed. A usability study serves as an important tool for the evaluation of an User Interface, in which the effectiveness of the User Interface itself is analysed. Based on the results of that evaluation, changes can be made to improve the interface and the interaction of the said project.

Problem Description and Approach

These studies often consist in observing users accomplishing a given set of tasks in the application, or even looking at a User Interface and checking it against common design rules and guidelines [?] and identifying the origin of possible unexpected/unwanted behaviours in its utilization.

In the scope of this project, usability studies will be performed through the design phase, promoting the correction and improvement of the designed interface and crossing those studies with the results of performed usability tests.

Chapter 4

Requirements Elicitation

This chapter will present in detail the first stage on the development process of this thesis, covering the initial usability requirements elicitation.

The following sections provide an analysis of the previously existing work on the project and conclusions drawn from that work, as well as the process that lead to a first redesign, based on those conclusions.

In the last section, the referred redesign, consisting in several alternative solutions, will act as a discussion material in a focus group performed with potential users of the application, in order to elicit usability requirements. All the process of the focus group, as well as all the data gathered from it, is detailed there.

4.1 Previous work

As said before, the initial work on this project encompassed the initial implementation of the concept referred on [?], including a first prototype of an *Android* mobile application. This prototype was made using *Android* API level 8, being compatible with mobile devices running at least version 2.2 of the operative system.

This prototype had the following set of features [?]

- Login
- Register Account
- Check-in
- Check-out
- See News Feed
- Check

Requirements Elicitation

- Submit a Comment
- Rate a Comment from Other User
- Plan a Journey

A more detailed explanation of those features, introducing some of the interaction flow of the prototype, is the following:

1. User launched the application, being prompted to login or to register a new account if he had not created one yet. If the user does not have an account, he has to register and then he is guided to the login screen.
2. User had the possibility to check-in on a vehicle by two methods: manual insertion of the public transport stop names (origin and destination), or by GPS, where the user location was used in order to fetch the nearest stops, marking a chosen one as the origin, and choosing the destination from one of the given possibilities, thus marking the journey is making at that given moment.
3. While checked-in (*and only then*) the user could perform actions like submit a new comment for the selected journey (that could be written text comment, to a maximum of 150 characters, or a predefined categorised comment, rating aspects of the vehicle, which was converted to text afterwards), check a news feed with comments from other users made for the same journey, and rate the correctness of comments from other users.
4. User could also perform check-out, in order to mark the end of the journey.
5. User could check his/her profile in order to check their number of points (awarded from submitted comments) and change settings like his nickname or if that nickname will be hidden from other users (in their news feed).
6. Finally, users could plan a journey for the future, setting the origin and destination stops, and choosing a date and time. Ten minutes before the planned journey, the user receives a notification asking if he wants to receive information for that journey (thus checking-in on the journey).

The developed prototype was the subject of a test in the field, performed in London with real bus users. A certain number of tasks, exploring all the features above mentioned, were given to the users, in order to measure the average execution time of each task.

Despite the obtained results (average times for task completion were considered positive), there were tasks that could or should have better accomplishment times, given their importance in the whole user experience and utility. For instance, planning a journey takes more than 80 seconds, on average (despite being referred that happens due to a bug in a auto-complete feature), but there are a lot more features taking more than 30 seconds on average to be accomplished (check-in

Requirements Elicitation

in, whether through the manual method or using GPS location, and rating a comment from other user).

Regarding the check-in functionalities, this can be a problem since it is a feature used on a critical part of the application - check-in is required to access several other main use cases. Making this process too extensive or making those features only accessible to checked-in users may lead to loss of interest by potential users.

One of the possible causes to this unwanted results is the fact that the check-in options are not accessible at a user's view level after logging in with his account - in order to perform check-in, users had to press the *Android* Menu button (which prompts up the context menu to the user, where they would find those options).

The same principle is valid for the check-out feature, as the button who triggers it is also found in the context menu.

Despite the results obtained for this task were much better, that is probably due to the fact that, in order to perform check-out, an user has to check-in in the first place, learning the place where the check-out button is when he's faced with the check-in task.

Still, no visual element whatsoever gives the user the information that the context menu is available to be shown. We should not rely on previous experience that the final user may have with the platform/operative system for which we are designing an interface, specially if that possible experience includes gestures, buttons or other interaction triggers that may be unfamiliar for the user in similar contexts or not visible.

There was another task with average accomplishment time exceeding 30 seconds - submitting a written comment - though it's fair to assume that most of that time consists in writing the desired comment, and it is not necessarily tied to a disadvantage of the interface.

Another measurement taken was a quantitative value (from one to five) representing the appraisal of a given task, concerning its difficulty, so that one represents a very difficult task to execute, and five represents an easy task. Here, the tasks that could have had better results were related to the notification system (informing a user that he has a planned journey soon, asking if he wants to receive information from it and check-in), as well as rating other users comments.

This last concept was perceived as difficult to grasp, suggesting that improvement on this feature or the whole comment validation system, in order to provide more reliable feedback to public transport operators, can and should be made. The less positive appraisal from the rating comment task could also be associated with the fact that this feature has his own tab (the main navigation is composed by tabs), thus getting less visibility when comparing to other tabs (news feed or comment tab, for instance).

A possible solution to this problem could consist in aggregating both the news feed and rate separators, giving this feature more visibility, because one of the goals of the application is to maximize the reliability of the generated information. Thus, having as much users as possible performing ratings (by simplifying that task or the interaction behind it, or by augmenting its visibility) is crucial.

Requirements Elicitation

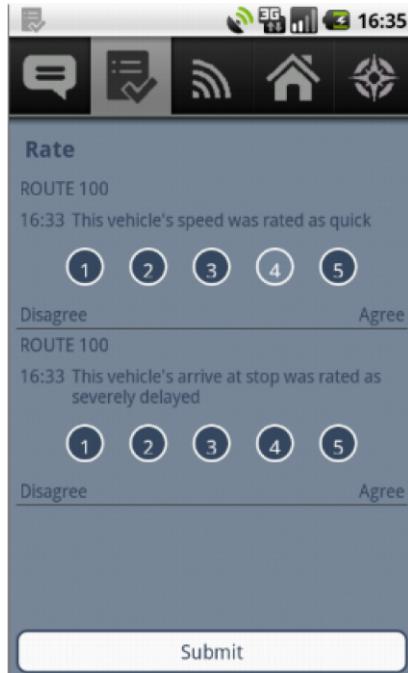


Figure 4.1: Screenshot of the tab where we could find the rate comment feature.

All these questions and conclusions led to the development of a initial interface redesign, presented in the following section.

4.2 Initial Proposals

4.3 Focus Group

Chapter 5

Application

Application

Chapter 6

Tests and Results

Tests and Results

Chapter 7

Conclusions and Future Work

7.1 Data Structure

7.2 Integration with existing social networks

7.3 Integration with existing public transport apps

Conclusions and Future Work

Appendix A

Loren Ipsum

Depois das conclusões e antes das referências bibliográficas, apresenta-se neste anexo numerado o texto usado para preencher a dissertação.

A.1 O que é o *Loren Ipsum*?

Loren Ipsum is simply dummy text of the printing and typesetting industry. Loren Ipsum has been the industry's standard dummy text ever since the 1500s, when an unknown printer took a galley of type and scrambled it to make a type specimen book. It has survived not only five centuries, but also the leap into electronic typesetting, remaining essentially unchanged. It was popularised in the 1960s with the release of Letraset sheets containing Loren Ipsum passages, and more recently with desktop publishing software like Aldus PageMaker including versions of Loren Ipsum [?].

A.2 De onde Vem o Loren?

Contrary to popular belief, Loren Ipsum is not simply random text. It has roots in a piece of classical Latin literature from 45 BC, making it over 2000 years old. Richard McClintonck, a Latin professor at Hampden-Sydney College in Virginia, looked up one of the more obscure Latin words, *consectetur*, from a Loren Ipsum passage, and going through the cites of the word in classical literature, discovered the undoubtable source. Loren Ipsum comes from sections 1.10.32 and 1.10.33 of “*de Finibus Bonorum et Malorum*” (The Extremes of Good and Evil) by Cicero, written in 45 BC. This book is a treatise on the theory of ethics, very popular during the Renaissance. The first line of Loren Ipsum, “*Lorem ipsum dolor sit amet...*”, comes from a line in section 1.10.32.

The standard chunk of Loren Ipsum used since the 1500s is reproduced below for those interested. Sections 1.10.32 and 1.10.33 from “*de Finibus Bonorum et Malorum*” by Cicero are also reproduced in their exact original form, accompanied by English versions from the 1914 translation by H. Rackham.

A.3 Porque se usa o Loren?

It is a long established fact that a reader will be distracted by the readable content of a page when looking at its layout. The point of using Lorem Ipsum is that it has a more-or-less normal distribution of letters, as opposed to using “Content here, content here”, making it look like readable English. Many desktop publishing packages and web page editors now use Lorem Ipsum as their default model text, and a search for “lorem ipsum” will uncover many web sites still in their infancy. Various versions have evolved over the years, sometimes by accident, sometimes on purpose (injected humour and the like).

A.4 Onde se Podem Encontrar Exemplos?

There are many variations of passages of Lorem Ipsum available, but the majority have suffered alteration in some form, by injected humour, or randomised words which don't look even slightly believable. If you are going to use a passage of Lorem Ipsum, you need to be sure there isn't anything embarrassing hidden in the middle of text. All the Lorem Ipsum generators on the Internet tend to repeat predefined chunks as necessary, making this the first true generator on the Internet. It uses a dictionary of over 200 Latin words, combined with a handful of model sentence structures, to generate Lorem Ipsum which looks reasonable. The generated Lorem Ipsum is therefore always free from repetition, injected humour, or non-characteristic words etc.