

## **Adopt a Student**

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**Information Systems and Computer Engineering**

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*"Não queiras saber tudo. Deixa um espaço livre para te seres a ti." - Vergílio Ferreira*



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## Resumo

Diversas aplicações de partilha de boleias estão disponíveis no mundo inteiro com os mais variados objectivos, no entanto em Portugal a existência deste tipo de sistemas é raro e ainda não é visto com confiança. Esta tese foca-se num nicho, formado por estudantes e empresas, onde foi considerado que a sua utilidade terá diversos ganhos, não só os mais óbvios como poupança monetária e diminuição da pegada ambiental, mas também a construção de uma rede entre os estudantes e empresas.

Foram estudadas diferentes aplicações disponíveis no mercado, para desta forma concluir-se quais os requisitos e preocupações essenciais a ter neste tipo de sistemas. Foi também efectuado, numa fase inicial, um inquérito a ambos os tipos de utilizadores para desta forma se concluir quais as características que eles desejavam ver disponíveis e a importância dos perfis de utilizador.

Tendo em consideração as preocupações advindas das ferramentas estudadas bem como dos dados recolhidos foram concebidas fórmulas para cálculo de avaliação dos utilizadores e da compatibilidade entre os mesmos, e também toda a lógica de garantia da privacidade e da segurança dos dados dos utilizadores.

Relativamente ao desenho de arquitectura da aplicação, foram ponderados diversos modelos de desenvolvimento, assim como tecnologias de implementação, tendo sido concluído que a plataforma OutSystems, baseada no modelo de desenvolvimento ágil, seria a que melhor se adaptaria.

Por fim foi implementada a aplicação de forma a garantir os requisitos e características identificadas, sendo depois testada pela área de qualidade da empresa NOESIS. Os resultados da avaliação da aplicação foram de encontro aos nossos objectivos já que revelaram o cumprimento dos diversos requisitos e a simplicidade de utilização da mesma.

**Palavras-chave:** Boleias, Estudantes, Empresas, Compatibilidade, Privacidade, Segurança.





## Abstract

Several car-sharing applications are available worldwide however in Portugal their presence is almost non-existent and the general society does not trust in this kind of systems. This dissertation is focused on building an application to match students and workers, where the gains are not only related to reduce the environmental footprint and save money, but also to establish a good network to facilitate the communication between companies that need new employees and students that in a near future will need to work.

To conclude what are the main requirements and concerns to have in this kind of applications some existing car-sharing systems were studied. The features that should be available and the profiles importance were detected via an initial survey made to the both types of users.

The logic to guarantee the privacy and security of the user's data and the formulas to calculate the rate of users and the compatibility between them were designed based on the studies and questionnaire mentioned above.

This application was conceived using OutSystems that is an agile based platform taking into consideration the identified requirements and features, and also after proper consideration and comparison between the diverse existing platforms and development methods.

Tests were performed by NOESIS Quality Management area to guarantee the quality of the developed application. The evaluation results show that the goals of this dissertation were accomplished since they revealed that all requirements were fulfilled and that the application is simple to use.

**Keywords:** Car-sharing, Students, Companies, Compatibility, Privacy, Security.



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# Chapter 1

## Introduction

A variety of carpooling systems are available worldwide allowing people to arrange car journeys between themselves. While some of these applications have only one requirement, the possibility to connect citizens that want to share their car, other ones provide the option to match some characteristics of the passengers and driver. Why these systems have become so popular in the last few years? Some advantages for the success of these applications are:

- Reduce transportation expenses;
- Reduce environmental impact;
- Reduce traffic congestion and parking needs;
- Increase social help between citizens.

What about networking? Networking should be started in University, allowing students to have an inside opinion about the companies that surround them. One of the major concerns nowadays in recruitment is not only the knowledge that students bring, but also the capability to work in teams and to relate with one another. Carpooling can also serve this kind of purpose, giving the opportunity to share experiences and knowledge about an industry or more in detail a company. The biggest pool of hires in enterprises is the recently graduates, and not only thinking about costs but also because they bring knowledge of emerging technologies and techniques. So why not share travels between students and workers two of the foremost stakeholders in all lines of business?

In Portugal these kinds of applications are rare and the ones that exist are not widely used, but on the other hand car sharing is very popular in smaller communities. We can take Lisbon workers that live in the suburbs as an example. In this group carpooling is accepted and commonly used, people know each other and the increase in fuel price and decrease in salary was a great motivator. What about students? In this case they don't have any stable income and they are obligated to travel to the university. Another thought, usually when an economy crisis occurs, social support rises. Why not take in advantage of this support and use it on people that are not remembered such as students or elders? These concerns allied with technology innovation lead us to the idea of a system that can help people in an organised and simplified way.

The focus of this dissertation is the sharing of a personal car between students and workers from the surrounding companies and will also consider the different groups of students who should be taken into consideration such as:

- Erasmus students;
- Students from other Portugal districts;
- Students from the same district;
- Students that live nearby.

And why should we divide students in these groups? Due to the fact that each individual group have some characteristics and perspectives that are not usually shared among them. If we take for example, Erasmus students and nearby students we can automatically associate different needs for each one. Typically Erasmus students are open minded, they are searching for different perspectives and knowledge and they want to experience and discover other countries and cultures. So this group should be targeted as important and most likely to use this kind of social applications. But what about the students that live nearby? In this set it is expected a minor adhesion to these initiatives, because usually public transportation is available with reduced costs due to proximity. Nevertheless, there are some exceptions and IST Taguspark location is one them. Oeiras has a lot of transportation problems, because public transports have a restricted time schedule with a long waiting period between buses. The route of buses is also an issue, since they don't cover all neighbourhoods, and the ticket price applied for trips with such a short distance is overwhelming.

## **1.1 Motivation**

The main motivation behind this dissertation is to develop a car sharing application to be used by IST Taguspark students and workers from the companies nearby. To accomplish this goal it was crucial to make a requirement analysis taking into consideration the features of the previous car sharing applications and some new relevant add-ons. But, will the add-ons be enough to bring some innovation to this application? Which add-ons should be implemented? These concerns were considered and investigated in order to obtain a successful application.

Nowadays, users value some general characteristics like design and usability and almost no one wants to use the application help to be able to perform a task. They look for something simple to use that with a few clicks can accomplished what they are seeking to do. Once the usability issue is overcome, privacy concerns rise and the question "Who can access my data?" brings the topic of secure information into the investigation. Security on software applications continues to be widely studied and although it was not a topic extensively investigated within this thesis it had to be examined in order to choose which algorithm/protocol was going to be implemented.

As already mentioned, some new features were implemented that are rare or non-existing in this type of applications. To discover which features were important to offer, an initial survey was constructed and

distributed to the target population. Consequently the application remained simple but gathering the opinions and suggestions of the end users, leading to the success of usability concern discussed above. The applications previously available also gave an important input in this investigation since most of them is rated in platforms like Apple Store and Google Play. Analysing the rate score and user comments of these applications we can, by induction, withdraw some common characteristics valid for any application of this kind.

Another theme addressed in this dissertation was the motivation behind the usage of car sharing applications. Is it purely economic? Everyone heard about the impact of an economic crisis in the number of students that have access to university or even in student's lifestyle, but we also embraced the transportation problems, like routes and prices, and networking incentives. Are the students concerned about where and what to do after graduation? Economic crisis surfaces again with some known outcomes: not enough job offers, low payment in some companies, etc.. Will it not be beneficial to have an inside opinion about enterprise market and good companies to work at before facing the problem? Hopefully it will.

## **1.2 Structure**

This document is divided in seven chapters. In Chapter Two we present an overview of carpooling history, the impact of the economic crisis in students and the benefits of networking in work and university worlds. Chapter Three covers our research in related works, carpooling tools that already exist, and what we could conclude from them. The result of the two previous research chapters is used in Chapter Four, where we define what our application will consist of, which are its requirements and how we intend to implement it. After all investigation was done and the initial architecture was set, in Chapter Five we describe the implementation of our application, as well as the logic used to guarantee the fulfilment of the requirements set in the previous section. In Chapter Six we discuss the evaluation and results of our application and lastly, in Chapter Seven, we conclude all the work developed in this dissertation and what can be done as future work.



# Chapter 2

## Background

### 2.1 Carpooling

The main motivation behind the first car sharing experience was economic, because some citizens could not afford to buy a car and for that reason they started to share one. The organisation behind this experience, dated back to 1948, it was a Swiss cooperative known as Sefage (Selbstfahrgemeinschaft). Afterwards, some other experiments have arisen but with no major impact and with a short duration: Procotip (France, 1971 to 1973); Witkar (Amsterdam, Netherlands, 1974 to 1988), Green Cars (Great Britain, 1977 to 1984); Bilpoolen (Lund, Sweden, 1976 to 1979); Vivallabil (Orebro, Sweden, 1983 to 1998); Bilkooperativ (Gothenburg, Sweden, 1985 to 1990); Mobility Enterprise (Purdue University, North America, 1983 to 1986); and Short-Term Auto Rental demonstration (San Francisco, North America, 1983 to 1985). Experiences continued and were observed in Sweden, France, United Kingdom, United States and Japan, but successful car sharing operations only began in the latest 80's at Switzerland and Germany [38].

We can notice a relationship between car sharing growth and the evolution and new arisen of markets worldwide, the expansion of carpooling to Australia, Asia and Northern Europe and the maturity on the markets identified earlier shows that this kind of operations are helpful and it is expected that they will continue to grow. The most common markets to car sharing are the neighbourhood residential and enterprises, since the proximity factor withdraws some organisational problems of the rides and carpooling among acquaintances does not bring so many security risks [38].

Based on the definition of carpooler as anyone who shares transportation to work in a private vehicle with another worker [20] and ridesharing as the transportation of two or more individuals in a motor vehicle with a capacity not exceeding 15 passengers, when such transportation is incidental to the principal purpose of the driver, which is to reach a destination, and when such transportation does not seek to transport persons for profit [1], this project defines carpooling as the activity performed by any worker who shares transportation in a private vehicle with one student without taking any profit of it. This description is aligned with the three guidelines to define ridesharing: it must be possible to distinguish public transportation and carpooling, the driver establishes the route and profit should not be a motive

[1].

The motivation behind carpooling usage continues to be extensively studied and some common benefits were identified with these investigations. Consensually the advantages identified are the self-centric ones, for instance, cost reduction and the convenience of a car journey. Other benefits were identified but their importance varies depending on the target population. For instance in University of California environmental impact and networking are considered as main advantages [16], opposing to Budapest where these characteristics are a minor concern [41].

Through technology innovation some gaps related to the organisation of car sharing were exceeded. In the related work chapter we will give and analyse some examples of applications developed with the objective of fulfilling these gaps and also applications that have taken into consideration other features like profile matching or routes suggestion.

## 2.2 Economy Crisis

It is well-known worldwide that an individual with a university degree usually earns more than one with just a college degree and Portugal is not an exception. A worker that has a university degree increases to nearly 3% the value of household income [26]. But does any person have the opportunity to attend the university?

With the years passing by the number of university students is increasing and it is expected that these numbers continue to grow and more qualified people enter the business world. But are students confident about their future? No they are not. We can take as example a study made in Coimbra University where we can find out that 88,5% of the students are apprehensive about their future, but why? If we think that 87,2% of those who were enquired state that the economy crisis had quite an impact on their life, with most of them indicating that had 4 negative influences, within a pool of choices like not going away on vacations or not going to see a movie. Add to this evaluation, 34,6% of the students have at least one relative that is unemployed, extrapolating this analyses to the entire country it seems to be comprehensive the afraid that they feel [29].

Although it is expected that the number of students degrees increases over time, the costs of education can become, if they are not already, a major obstruction to the achievement of university degrees. Portugal, in the European context, has one of the last positions in terms of comparison the medium household income with costs with education (11<sup>o</sup>) and life costs of the students (12<sup>o</sup>). In 2008 the percentage of net total costs with education and median income was nearly 65, so with all extra austerity measures implemented after 2008 we can perceive that it is becoming more difficult to study in Portugal. In Europe is always pointed out that the educational charges in U.S. are huge, but do they look at Portugal? We have the same difference of total costs against median income between United Kingdom and United States [10].

This dissertation does not aims to give a solution to all these problems, but we can reduce one of the greatest expenses of the students. Taking out the expenses related to home maintenance, the transportation is identified as a major cost in household income [26]. The Instituto Superior Técnico

Taguspark has a privileged location since it has many companies in the surrounding area, but has major constraint too because the only option to arrive at university is by university shuttle free of charge but with a tight schedule and by bus with a shocking schedule when comparing with the city center bus schedules. In terms of pricing the students face here another problem, the Portuguese state does not hold the company that offers this service so a private transportation company establishes prices in this area. A travel from Monte Abraão to Taguspark (nearly 8 Km) costs €3,25 [42] and a journey from Monte Abraão to almost any point at city center (for instance with a distance of 16km), considering train and subway, companies at this moment hold by Portuguese government, costs a total of €2,95 [14] [15]. This kind of problems can be addressed with a carpooling program and represents one of the goals of this project.

## 2.3 Network

Nowadays networking is commonly associated with social web sites namely Facebook, Twitter or LinkedIn. In this project our goal is not only networking itself, which its major concern is about establishing a connection between two strangers, but also some social networking based on the assumption that an individual has to create his profile and a list of connections established with the users must be managed by the application [8].

Just a few years ago, the roadmap to follow by anyone who wanted to change job was to find in specific webpages the open positions, update the curriculum vitae and send it to the company accompanied by a presentation letter. Other method used was for a specific job offer ask to friends and co-workers if they know anyone that can be interested in that position. But this kind of process is becoming outdated and currently it is expected that you have a profile created in LinkedIn with a summary (presentation letter), curriculum vitae information and areas of expertise. This process evolution brings many advantages namely the decreasing costs and increasing the speed of talent discover and recruitment, because it is easier to find out individuals that have the pretended skills by simply introducing the keywords in LinkedIn and reading the results for this search within our network. The goal to use LinkedIn should not be only the provision of our curriculum worldwide, but also the constant expansion of our network by adding colleagues and friends to it. Enlarging our network facilitates the process of being found by headhunters and access some trainings advertised in certain groups, giving us more opportunities to grow in our professional path [21].

We can also establish a connection between network and innovation, taking as example a U.K. research about the effects of this link, in six high-tech industries. With this study several advantages in innovation of companies using networking were identified, for instance risk sharing; access to new markets and technologies; high speed in release products to market (nearly 20% increase on product improvements and 7% to 10% increase on the development of new products); finding and merging complementary skills; safeguarding property rights or contingent plans and contracts; simplifying access to external knowledge [17].

Although some people can think that networking is part of our daily activities we are surrounded by

it, typical any person belongs to at least three networks, commonly named communities. Our family, friends and neighbours play an important role in our life and give us the support and help to better live in this world. Another example of how can be beneficial the sense of community is in natural disasters or political problems, in the first case networking is essential for the buildings reconstruction and in both cases to provide roof, food, first care and support to all affected people [19].

In summary, networking is an essential part in our life since the beginning of times and now towards technological evolution the empowerment of communities and networking growth is simplified, both in personal and professional life. This project aims to collaborate in this vision through the development of an application in which all members can help each other's.



# Chapter 3

## Related Work

This chapter will be divided in subsections according to the study or application to be evaluated and the analysis will be based in the features provided by the application and evaluations of users in the case of a research relevant findings or conclusions will be referred. The choice of applications and researches to be presented was based in the relevance to the project, availability in Portuguese market, success and innovation brought to the market.

### 3.1 BlaBlaCar

BlaBlaCar was born a few years ago in France to materialise an idea by Frédéric Mazzella who studied in Stanford University and one day wanted to go on a Christmas holidays, did not have a car and all public transports were full. He wanted to start producing this application not only to provide another option to travels but also to improve road transport, reduce congestion problems and make travel affordable and social [4].

This application is one of the most complete ones in the market, mixing important characteristics that are spread through other tools. These features include [5] [6]:

- Profile creation, filling out information like interests, occupation, spoken languages, smoker type, allergies and level of chattiness. In this profile, if you are a driver some information regarding the car is also necessary to clarify the type and level of comfort available;
- To assist travel organisation, meeting points are shown to be chosen, price is automatically suggested by the tool but can be adjusted if the driver does not agree. An internal messaging system is also available to simplify communication between the two parts involved in the journey;
- It is available a search for travels depending on departure and arrival and it is possible to rate a journey within a 5 rate score;
- An experience level is given to the users based on the following factors: email and mobile number verification, completion of profile, positive ratings given by other users and membership time.

According to Google Play and Apple Store nearly 40,000 users are satisfied with this application and rated it as 4+. Regarding functionalities some comments were very interesting to take into consideration when developing mobile applications like permissions, performance, design, multiple languages and time zones [34] [24] [25].

The features available in this application are great and were taken into consideration in this dissertation since some of the features presented are align with ours. The profile creation will be very helpful in the process of matching users but for us, since it is a free ride application the car profile is not necessary, because if you pay for something you should choose where to travel, but in this case networking and helping are the focal point. Regarding communication among users, internal messaging is a interesting choice but will not the users prefer other ones that they are more familiarised with like email, cellphone or even Facebook chat? One of the most interesting features available is the rating system, providing the users the opportunity to recommend or not a driver. In the other hand the experience level make us a little uncomfortable about using this service, since email and number verification and profile photo should always be guarantee for security reasons and completion of profile in our case should be mandatory to able to address the matching profile goal.

## **3.2 boleia.net**

The first thing that anyone will notice entering boleia.net website is the poor design, but that was not one of the concerns of its creators. These three friends worked far from home and searched for a carpooling tool in Portugal, however there was none [31]. The goal was to address the absence of available tools in the market for carpooling and that was achieved and compensates the lack of design.

Some features are not a surprise since they are common in this kind of applications like adding offers or requests of travels and notification services. Nevertheless some other characteristics draw our attention and will be discussed in detail below [30].

The homepage of boleia.net shows traffic information pullout from Brisa and other websites of that kind, this is an innovative idea but will not be considered, since on one side the users can find it on other applications available designed only with that purpose and on the other side it will overload the user with information that may not be required. Another interesting detail that we can find in this tool is the search option that after the insertion of departure and arrival point gives the option to choose the radius where the catching or dropping can be set.

When offering a ride one of the options is to add more lift up points, this is a great idea and should be tied in all car sharing applications, since some of them just take into consideration the departure and arrival spots. In our opinion the appliance of this characteristic in BlaBlaCar will improve it, in this case with the possibility to select more than one public collecting location. We can think that if the driver specifies the circuit that he usually follows the outcome will be the same, but in this case the driver will be stuck to the obligation of follow that circuit to pick up the other individuals, however with the extra locations he can choose those that are not bind to a specific route.

Overall boleia.net is not an appealing website, but its owners have created great features and with

details that are not seen in some other most used applications worldwide. Finally, fuel, time, environment and network gains are not forgotten with advertisement in the homepage.

### 3.3 Carpooling

Carpooling is a ridesharing application available in Europe, that offers its users some great features and a clean design. One of the characteristics that called our attention is the possibility to use this application on a computer, mobile device and Facebook [9]. Nowadays almost every tool has authentication via Facebook, but in this kind of application that can be very important to identify a driver or a rider, however it can bring privacy issues since this social network is targeted by hackers and constantly raises judicial problems.

This carpooling application divided its features into three groups [9]:

- **Reliability:** This cluster includes the following characteristics: response rate, response time, punctuality score and activity score. From this group we want to emphasise punctuality and response time. The first one is essential in this type of applications since it can lead to delays that are harmful to both driver and rider. This rate let us know in advance that if we are with short time to the travel maybe we should not select the person with a low score. About response time let's think about this scenario: I choose a travel that have a departure time in half an hour and the user that offered that ride has a high response time. The probability of not getting an answer in time is high and in this case we should pick up another available trip in which the driver has a low response time, so we can not run in a tight schedule;
- **Safety:** In this group we would like to pointing out the user validation by Facebook connection, Mobile Validation and ID/Passport authentication. This tools provides a wide offer in profile validation, although we think that it should be possible to filter an user by the type of validation chosen. Some individuals do not use this kind of transportation due to security issues, and taking this concerns into consideration Facebook profiles can be fake and mobile phones do not have to be registered so the only validation that can be presented in order to establish trust inside this segment is the ID/Passport validation that in fact is an amazing idea;
- **Fun/Social:** In this group we are introduced to the concepts of picking drivers/passengers and car, once again picking the car is one characteristic that we are not interested in but within this context it is valid one. Concerning the picking up of driver/passengers we think that it can be optimised towards a sorting of the hit list by a matching algorithm between our preferences and the ones of the person we are looking for.

The users rates are good [32] [33] [22] [23] however with not so many ratings as BlaBlaCar. Looking for this information one thing did not make sense to us, there is not one application but one for each country. So if we use this application in Spain and then we go on vacations or work trip to France we have to download and configure a new application to use this service. In our opinion this is a major flaw, with

technology evolution and an average architecture it is not difficult to show different options dependent of a country selection made by the user. Since this is a free application we were not expecting something really fancy like the identification of user localisation to automatically redirection, because typically if an application is developed in a native language this can be easy to do but if an hybrid architecture is used it can be complicated to access some libraries and control elements, however a country selection should have been implemented.

Overall this is a good application and could be great if we did not have to download and install a new application in each country and since it is expected that with the global market relocations are a constantly event in our lives, this flaw is a show stopper to use it.

### **3.4 TwoGo**

TwoGo offers three ways to use it: by web browser, mobile applications and Blackberry email. The Blackberry email is not common to see in such applications, but considering that this tool was designed to provide a carpooling system to enterprises, cities and institutions this feature is essential since Blackberry cellphones are common in this market [36].

Another feature offered in this system is the simplification of the matching algorithm. In the earlier systems the user can choose some characteristics of the person and after selecting the departure and arrival time and location a list of matching travels will be presented to be chosen. In this application this process is automatic and if no matching is found some advices to adjust the ride to be able discover a suitable one will be given [36]. This is a innovative feature and it was implemented with one twist, in our application a list of users is displayed sorted by compatibility, but also with distance and rate information so that the user can choose whom to travel with.

Some security issues are also prevented when using this tool by only allowing the application registry throw corporate email [36]. In enterprise segment this restriction will allow to verify the user identification and combined with automatic matching will not bring problems on response time of travel confirmation. But will this registry limitation bring problems in university scenario? Working users have constantly access to email, but students usually do not pay so much attention to it. Will this bring more problems than solutions? Maybe not, since it will establish trust between users, because no fake profiles will be authorised and it will reduce the risk of taking a ride with a stranger.

Some benefits of using TwoGo in companies are also presented by SAP [36]:

- Finance: reduces travel and parking costs;
- Human Resources: strength company brand to attract new talents, improves networking, collaboration, information exchange and integration of new employees;
- Responsibility and Sustainability: improves travel safety, external company brand and helps environment.

Unfortunately the number of ratings present in Google Play and Apple Store are not enough to be considered, but from our point of view this is a great tool to be used in a scenario like Lisbon district

or Oeiras municipality. However at this time, we do not think that Portugal is prepared to this kind of incentives, since for instance we currently do not have major pollution problems comparing with London or Paris where these ideas could have a different acceptance. Some other government incentives programs were studied and already applied and will be analysed in the Carpool Incentive Programs subsection.

### **3.5 Aventones**

Aventones is set in Peru, Chile, Mexico and Colombia and we should notice that in Latin America the offer of carpooling systems is limited and the governments do not have so many concerns about environment comparing with European countries. For that reason Aventones was already distinguished with some awards related to startup companies, innovation and green applications [3].

This tool does not bring any innovative feature comparing with the ones above, but in terms of services some interesting concerns were taken into consideration. Since it is an application designed for organisations, it is not only important the goals based on the available features but also the list of services offered play an important role.

In terms of marketing, it was the first tool that referenced that these kind of initiatives increases the number of points necessary to obtain the Leadership in Energy & Environmental Design (LEED) certification [2]. This certification is part of U.S. Green Building Council and recognises worldwide achievements in green building that brings gains related to performance, costs and continuous improvement due to the reduce of energy and water expenses and use of cutting-edge technology [13].

There are two other important services advertised and offered when implementing this tool: internal communication campaign and training and awareness workshops [2]. And why are these important? One of the greatest barriers when introducing a new corporate software are the users and their resistance to change, this topic was widely investigated and one of the advices to reduce this kind of impact is the deliver of several workshops explaining the benefits of using that software and the implementation of trainings to the end-users demonstrating how to use the new system. These guidelines of Change Management help to avoid problems on the transition to new software, teams or leaders and improves the support of the employees by explaining the advantages and the reasons behind these changes [27].

### **3.6 TravelRole**

TravelRole research was conducted by Selker and Saphir [37] they considered that face-to-face interaction is the main key for communication. The value of communication by means of technology such as computers is illustrated frequently by calendar scheduling, dating and many other applications. Technology gives us the opportunity to meet more people online, however, it has taken three main directions: social networks that do not physically bring people together, dating systems that strive only to create romantic relationships and professional recruiting that help people get or change jobs. The possibilities for getting people together over everyday interests or educational needs have not yet been fully addressed.

The idea behind it is that users will not take a ride to a total stranger but instead they will ride with someone that have something in common with them, since the main incentive to carpooling is costs saving this way Selker and Saphir [37] tried to give another incentive based on personal growth. However one of the characteristics that has captured our attention is that users do not have to be registered and they remain anonymous for a certain amount of time for security issues. We really do not understand why is this a security improvement, an individual who is apprehensive about riding with a stranger will become more settled if he knows that is not so easy to create a fake profile and not the opposite.

TravelRole is available via web browser to allow both computer and smart phones access and it is based on the following motivations:

- Fill educational gaps;
- Choose compatible riding partners;
- Help the environment;
- Schedule or improvise a ride;
- Decrease government expenses with road maintenance.

We see the fulfil of educational gaps as an excellent marketing topic, typically when a user sees an option for languages spoken they associate it with a way to avoid riding with someone that it is impossible to communicate with, since no language is common between them. But this option also allows that an user who is trying to learn a new language can train it on daily basis, and being able to practice verbal communication on a daily basis is one of the foremost difficulties when someone is willing to invest on a language skill. These kind of requirement is align with the future of education that is evolving to online trainings and remote classes, so this feature should be considered in our project.

To evaluate this project two applications were developed, one with matching profiles component and other without it. The users should test both and evaluate if there is any additional value when a social component is added in a carpooling tool. With this questionnaire some interesting points were unveil, the population that took part of this study is more willing to use carpooling than mass transportation to go work and the major percentage never used carpooling. The preference demonstrated by carpooling allied with economic problems brings some hope that this kind of initiatives have a market to evolve, also we should not forget that this is a great tool to individuals that like to meet new people.

There were identified some improvement topics in this article, like cellphone coordination approaches and integration with social networks to simplify preferences feature. The integration with social networks with this purpose was not address in any application, leading us to think that it is not easy to implement or even that social networks do not allow to get any information from them, and that kind of restriction will not be strange since some security issues can arise, but further investigation should be made in order to understand if it is possible to embedded Facebook information in our application. Finally cellphone coordination approaches to improve convenience and security can be resolved with vehicle information and mandatory profile photos, that in this application did not make sense because no registration was necessary but in our project will be and in that case no such problems will emerge.

### **3.7 Rental Car Companies and Automakers**

Since 2001 we can observe changes in the business model of some rental car companies due to the introduction of car sharing services. Previously its services were based on three main markets: home city locations, airport locations and moving and storing services [39]. Nowadays this industry is moving forward with some differentiated offers align with market needs.

The first company to offer this kind of service was Avis Europe with several initiatives being the CARvenience the most successful one. Rental car companies had to adjust the price model to a hourly-based one but this effort had paid out, since so many other companies had been following this example [39]. The boom on this offering as became notable from 2007/2008, dates also important in financial markets worldwide, nothing to be shocked with since economic crisis are not only related to the raise of unemployment and market contraction but also with the growing on innovative ideas and start-ups creation.

With the car sharing services market entrance by rental car companies, some technology innovation arise with the need of car integration with some kind of authentication and billing mechanisms. But who provided these systems? Automakers were almost obliged to follow the innovation that was surrounding them, and many of this companies became partners or even created their own car sharing branches, for example Volkswagen partnered with StreetCar and provided Polo BlueMotion Diesel in 2011, also in 2011 Mitsubishi added i-MiEV electric city car to Hertz on Demand fleet, Ford is now providing vehicles to Zipcar and GoCar and Honda was the first automaker to create their own car sharing program named Honda Diracc in Singapore. However one of the most important automakers associated with these emerging services is Suzuki that not only was one of the earliest providers of factory equipped vehicles with telematics for car sharing use, but has also introduced on Suzuki Ever car radio-frequency identification (RFID) readers to identify users and communicate with management systems. General Motors in the latest years is also providing cutting-edge technology in OnStar by the integration of P2P in car sharing software [39]. These kind of initiatives are very important because besides the fact that they are supporting the reduction of cars in lanes which also causes community awareness, they try to provide in this services alternative fuel vehicles, and all together bring an incredible reduction of human environmental footprint.

If so many stable and strong companies have considered these services as a growing and expanding market and for that reason have been investing on it, the success of this kind of applications is almost granted. We should not forget that these kinds of investments are traditionally based on a deep market study to prove that it will be a good bet, and with the years passing by the initiatives that cover the reduction of environmental impact on daily activities are expected to be widely supported and used.

### **3.8 Government Incentive Programs**

Among others, studies made by Robert Clavel and Enoch [35], Consulting and Group [11] and Enoch [18] have been investigating which type of initiatives could be implemented in order to improve carpooling

usage. Governments play an important role in these incentives and studies have concluded some interesting options about which kind of measures should be developed, the topics can be divided into three groups:

- Information: intellectual banking, political support and marketing campaigns;
- Regulation: parking slots for carpooling and high-occupancy vehicle (HOV) lanes;
- Fiscal mechanisms: tax breaks for carpooling users and operators and funds to help carpooling companies to buy and run their vehicles.

In our opinion, one of the most interesting purposes is the implementation of HOV lanes described as specific corridors in roads to be used by buses, vanpools and passenger vehicles that transport a certain number of people [43]. In Lisbon city center corridors for buses are already available and could be adapt in order to cover this suggestion, unfortunately in highways BUS lines are not available and their implementation may cause some public dissatisfaction, due to the reduction of lanes for the general public which may cause increasing traffic, but on the other hand it may lead to an increase on carpooling usage to be able to access those lanes.

Parking slots specific for carpooling users are also an excellent idea, since nowadays parking space in Lisbon is explored by private companies that practice expensive rates. Although in city center this can be explain due to the efforts towards the diminish of car traffic in Lisbon, in Oeiras it is not so clear the reason for that. However with this incentive the traffic will also be reduced since one car will transport more than one person and we get another economic incentive for people to carpool.

### **3.9 Matching Algorithms**

Several studies were carried out in order to understand how a carpooling system should match driver and rider and provide an available input about some options and considerations that must be taken when developing such a tool.

Masabumi Furuata study[28] provides a list of primary search criteria options and necessary inputs by the users:

- Inserting departure and arrival location and time the systems suggests the route and schedule more indicated to satisfy both driver and passenger needs;
- After users provide a detailed route and time, the system suggests potential partnerships based on geographic similarities;
- Users select a location on a predefined list and the matching process will be made based on this selection;
- Predetermined locations are available and users must choose one of them, no further arrangement is supported.



In our vision a mix between two of this options is the best fit for an carpooling application when we take into consideration the ratio between implementation costs and requirement fulfilment. If the user is asked to input not only the departure and arrival information but also the possible pick-ups and drop-off points no major algorithm is necessary and the requirement is met.

To address the matching schedule necessary in this kind of applications, Correia and Viegas [12] presented some conclusions about the necessary inputs from to user to be able to discover who is compatible with whom:

- How much driving time are you willing to spend to pick-up a passenger?
- What is your minimum time to leave home?
- What is your maximum time to arrive at work?
- What is your minimum time to leave work?
- What is your maximum time to arrive at home?
- How many people are you willing to give a ride?

This model simplifies and summarises which are the necessary inputs from user concerning time schedule matches. These mechanisms have been implemented in almost all applications previously analysed, but none of them presented all of these questions, which should be carried out in order to fully map the driver and rider needs.

### 3.10 Summary

Wrapping up, with the exception of boleia.net, all analysed applications provide the most important features for this kind of systems (Table 3.1). However the solutions presented in each application are different from the others and can be improved, for instance, gathering some concepts of the other applications. From our analysis the best free application is BlaBlaCar and the best corporate one is TwoGo, since they have the best design and simplified process.

We should not forget the importance of government support and technological changes associated with this kind of initiatives that help to diminish the number of sceptic and/or fearful individuals worldwide.

	BlaBlaCar	boleia.net	Carpooling	TwoGo	Aventones	TravelRole
Profile	X		X	X	X	X
Travel Search	X	X	X	X	X	X
Score Rate	X		X	X	X	
Design	X		X	X	X	X

Table 3.1: Applications versus Features

# Chapter 4

## Development

This chapter will be divided in three sections, the first one is the analysis of the survey replied by students and employees of companies nearby, after that in the second chapter we defined the requirements according to the conclusions of the previous chapters and the questionnaire analysis. The third section is the design of the database model, main logic blocks, compatibility and rates formulas, and mockups necessary to support the identified requirements.

### 4.1 Questionnaire Analysis

A questionnaire was made (Appendix A) in order to understand which features should be implemented in this project based on the future users opinions. This survey was answer by 79 employees of companies nearby and 44 students of Instituto Superior Técnico. To qualify these students, two initial questions were introduced, how do the students usually go to University and how much money is spent *per* month in transportation. We have concluded that the majority of the students go to the campus by car, however some other transports are also used (Figure 4.1). Another important aspect, since students do not have their own source of income, is that they spend an average of nearly €60 *per* month in this travels. This suggests that an application of this kind will be very useful to students, because not only diminishes the time spent to arrive at university, comparing with public transportation that usually have an indirect route, but also eliminates expenses with transportation.

To help us decide which technology should be used to develop this application we asked which devices the users would most commonly use (Figure 4.2), since nowadays with the growth of smartphones usage, computers have been suffering with a substantial usage decrease, so a question has to be raised: is it relevant to prepare an application to be used by desktops? From this analysis we concluded that this application must be prepared to be accessed by mobile devices and computers, for that reason no native mobile development should be considered. In addition, we must also take into consideration that the application must adapt automatically to the device that is being utilised in order to increase usability.

One of the most important requirements is the preference matching and how can this be implemented. It was expected that users considered important this kind of preferences since they allow to

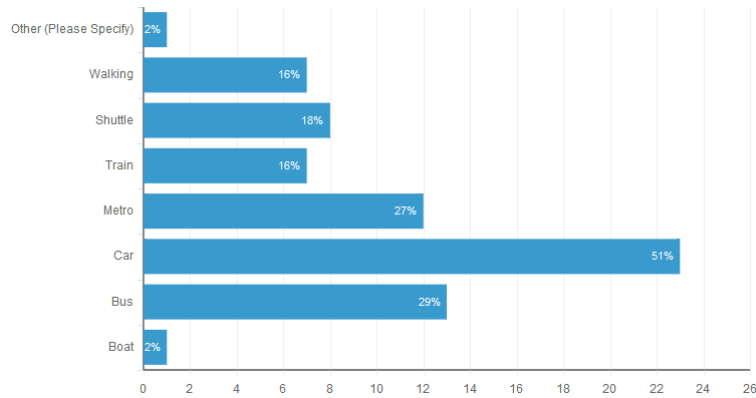


Figure 4.1: [Student] Usually, how do you get to the University?

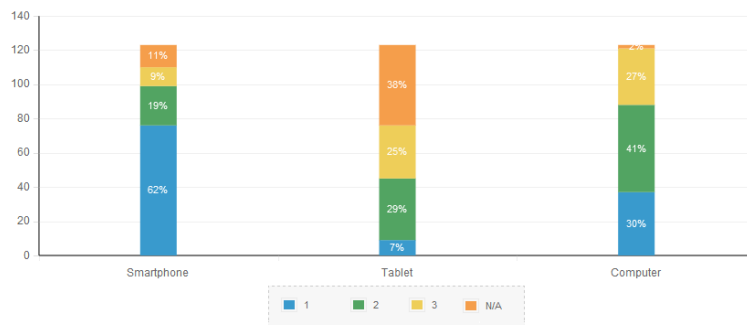


Figure 4.2: Please rank the type of device that you would use to access this application

know a little better the other user, but the results have shown that preferences related to hobbies are not the most important to them. However it is possible to identify two important characteristics: smoker and languages, opposed with birthplace that should not be considered at all to the matching, since it's rating is very low. In order to understand the future users opinion we asked them which preferences do they consider as the important ones (Table 4.1).

	Strongly Dis-agree	Disagree	Agree	Strongly Agree
Gender	23.58%	27.64%	37.4%	11.38%
Smoker	9.76%	17.89%	37.4%	34.96%
Birthplace	45.53%	34.15%	16.26%	4.07%
Languages	11.38%	17.07%	51.22%	20.33%
Music	22.76%	35.77%	36.59%	4.88%
Books	32.52%	44.72%	18.7%	4.07%
Gadgets	33.33%	47.15%	17.89%	1.63%
Profession/Course	18.7%	23.58%	39.02%	18.7%
Films	34.15%	39.84%	25.2%	0.81%
Series	34.96%	39.02%	23.58%	2.44%

Table 4.1: Do you think that it is important to take into consideration the following characteristics when matching profiles?

Related to the security topic, an overwhelming percentage of the inquiries state that it is important to know the identity of the other person before the ride, this topic should be address with profile creation and optional linkages to Facebook and LinkedIn. However, these answers gave us an idea why Portugal

is on the bottom of carpooling usage list, but it is expected to evolve over the years. On top of that, since the majority of the users considered email and cellphone as viable communication mechanisms (Figure 4.3), unlike our first thought that users would want to use Facebook chat, a verification process to these information should be considered.

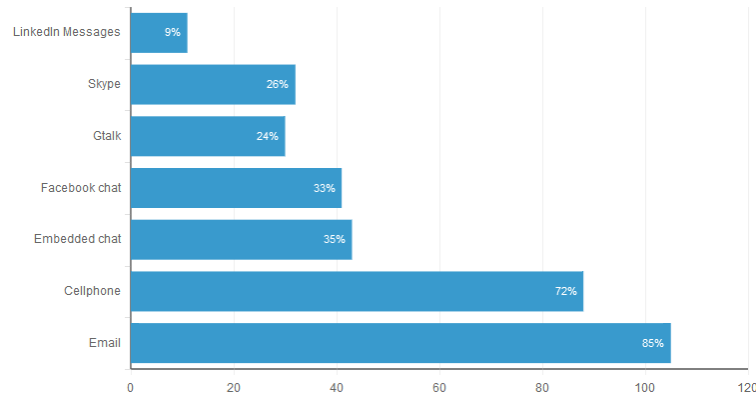


Figure 4.3: Which type of communication you will like to use to arrange the sharing?

Users highly valued having the system available in multiple languages (63.41%) and not only in English (36.59%), which should be taken into consideration since it lead us to a multi-language system. 96% of the users considered the score system as a very important feature to be implemented, so associated with the user profile, the rates given by other users must be saved and shown in the application. This topic will improve the security in users mind, because if someone else rated this user as a good one the chance of something bad happens decrease.

## 4.2 Requirements

In this section we identified all major requirements needed to reach our goals and distribute them by several categories according to their purposes.

### 4.2.1 Administrator

- As an administrator I must be able to block a user;
- As an administrator I must notify the user that he has been blocked and why did it happen;
- As an administrator I must be able to unlock a user;
- As an administrator I must be able to see all users, their profile and reviews;
- As an administrator I must be able to change the email or/and cellphone of a user;
- As an administrator I must be able to create companies;
- As an administrator I must be able to use the application as a user.

#### **4.2.2 User List**

- As a user I will belong to the blacklist if the administrator has blocked my account;
- As a user I will belong to the red list if my account is locked by login failure attempts;
- As a user I will belong to the yellow list if my account is not activated;
- As a user I will belong to the green if my account is activated but my profile information is missing;
- As a user I will belong to the whitelist if my account is activated and my profile info is fulfilled.

#### **4.2.3 User Sign Up**

- As a user I must fill my name, email and password to create an account;
- As a user I must receive an email to activate my account;
- As a user I must activate my account to be able to login in the application.

#### **4.2.4 User Login**

- As a user I must fill my email and password to be able to access my account;
- As a user if I fail my password three consecutive times my account must be locked.

#### **4.2.5 User Reset Password / Unlock Account**

- As a user I must fill my email to reset my password;
- As a user I must fill my new password to reset my account;
- As a user I must receive an email to confirm password reset;
- As a user I must activate my account to be able to login in the application.

#### **4.2.6 User Profile**

- As a user I must be able to choose my gender;
- As a user I must be able to choose if I am a smoker;
- As a user I must be able to fill/choose my profession;
- As a user I must be able to fill/choose my profession area;
- As a user I must be able to fill/choose the company that I work for (with the exception of students);
- As a user I must be able to fill my address;
- As a user I must be able to choose the languages that I speak;

- As a user I must be able to choose my preferred tv show genres;
- As a user I must be able to choose my preferred movie genres;
- As a user I must be able to choose my preferred music genres;
- As a user I must be able to choose my preferred books genres;
- As a user I should fill my profile the first time I login in the application;
- As a user I must be able to change my email and receive an email confirming this change;
- As a user I must fill my profile to have access to request a new travel.

#### **4.2.7 User Driver and Rider**

- As a user I must be able to review another user, but only the one that I have driven with;
- As a rider/driver I will have a list order by percentage of compatibility and distance between rider and driver;
- As a rider/driver I can only see email and cellphone of the driver/rider once the trip is accepted.

#### **4.2.8 Application**

- Recorded user data must respect the principles of security and privacy;
- To recognise the companies that have the more and better users adopting a student a top 3 company rank must be shown.

### **4.3 Design Decisions**

After the requirements identification we defined the architecture to be used in the application applying the model (database model), view (mockups), controller (logic and formulas) pattern. This way the application components will be well divided simplifying the implementation and future changes or maintenance of the system.

#### **4.3.1 Database Model**

In order to support the user requirements we identified some tables that we needed to create. First we establish that we needed a user table to save all profile information and also some auxiliary tables with the fixed values that the user can choose like languages or tv shows genres.

One of the decisions that we took was about the administrator, should we create a different table for it or not? We decided that since the administrator can have the behaviour of a normal user with the addition of some actions a different table did not make sense so we opted to distinguish it by using a flag

in the user table. As a result of the possibility that the administrator has to lock/unlock and block/unblock a user, two additional flags were also added to the user table.

Regarding the different states that the user can have and taking into consideration that they are fixed (yellow, green, white, black, red) we considered that a table containing these static values was the best approach.

Since the user belongs to a company and also considering the fact that we must show the top three companies a company table must be created with the necessary data for the users to know more about it.

So, it is a car-sharing application certainly we must need to save the travel information, like who rides with whom, date and time of the travel, is the ride approved by both users for me to be able to see his information?, what is the rate that the users gave to each other?.

These conclusions lead us to the model presented below in which we cover all the data that needs to be saved.

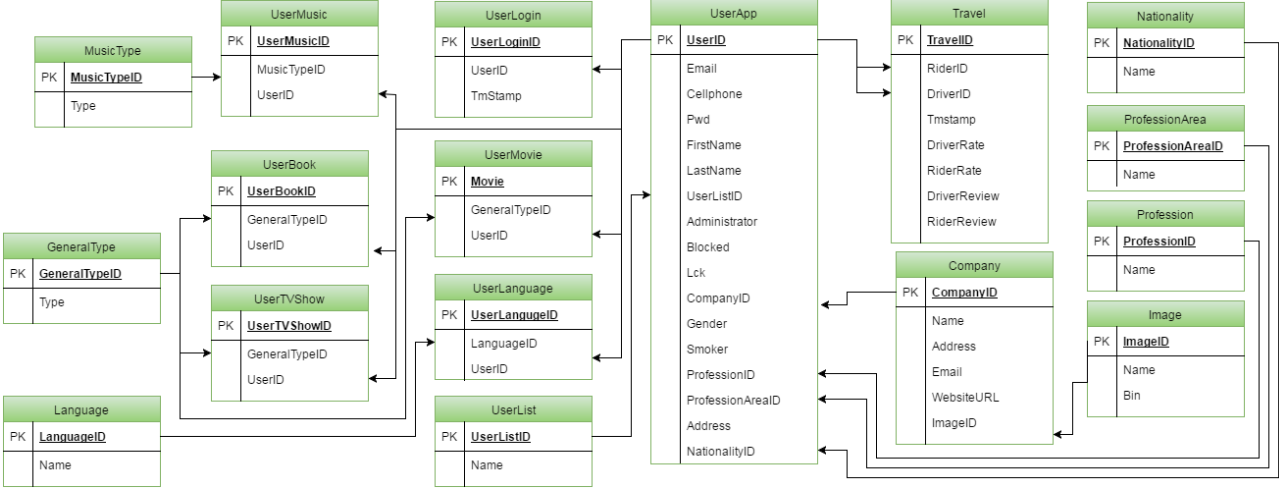


Figure 4.4: Database Model

**4.3.2 Logic**

We identified six major blocks that must be properly implemented since they are the base of the security, privacy and operation of the application.

The first thing the user needs to do before starting to use the application is to register in it. This is an important step since some security issues can arise due to fake profiles. To prevent that kind of situations after his registration the user must confirm the email (Figure 4.5).

After the user email confirmation he will try to login into the application. From this point two different paths can happen, the first one is the correct sign in and the user starts using the application. But the other option is the locking of the user due to more than three failed attempts to login (Figure 4.6).

To perform his unlock the user must go to the reset password page and insert the new pretended password. To prevent user profile thefts an email is sent to the user and only after the confirmation of reset password request through the link sent in the email the authorisation to login is granted (Figure

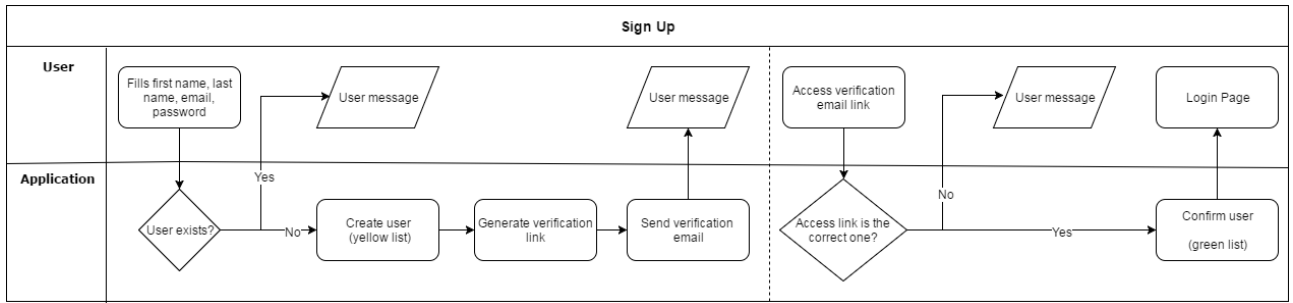


Figure 4.5: Register Logic

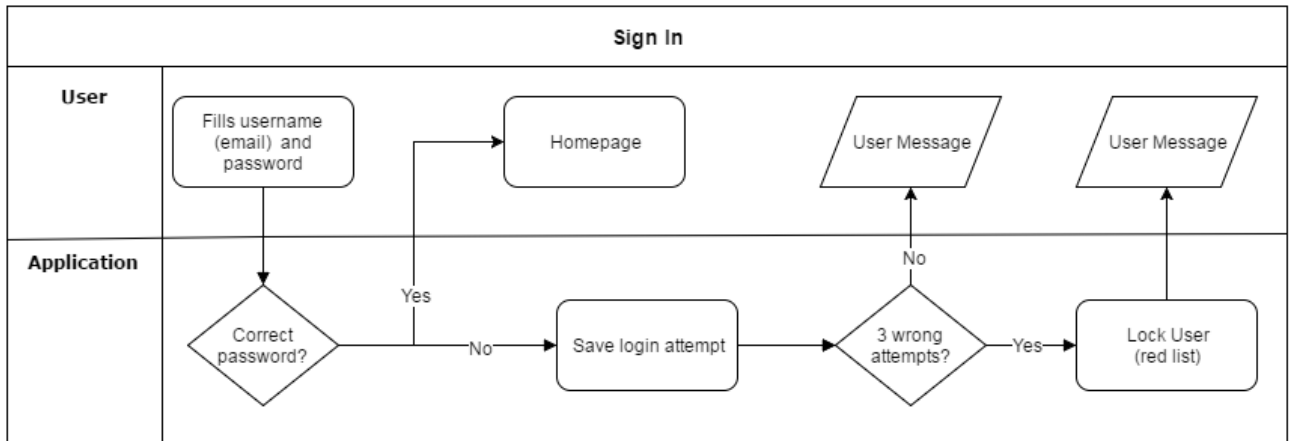


Figure 4.6: Login Logic

4.7). The same mechanism is applied when the user is locked by the administrator due to suspicious of user profile appropriation.

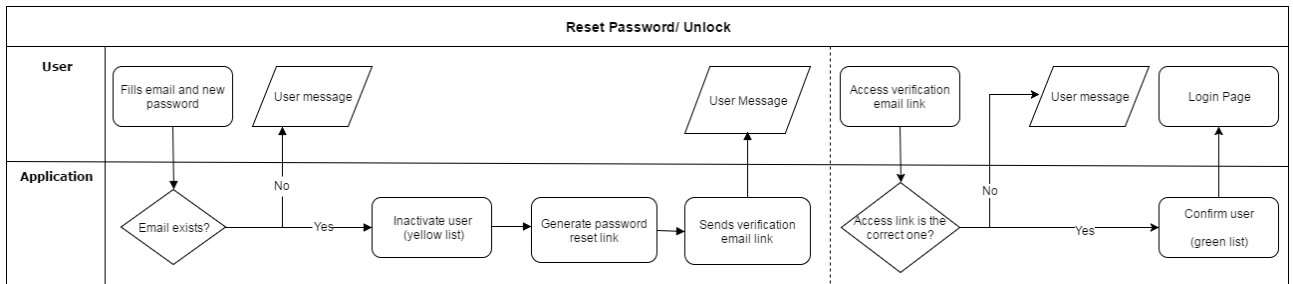


Figure 4.7: Reset Password and Unlock Logic

Nowadays users privacy is widely discussed, since some websites do not allow a real user deletion. Even if the user deletes his account some remnants are maintained which already led to several lawsuits. So, in order to guarantee user privacy we must allow the user profile deletion (Figure 4.8), but once again if someone steals others account the profile can be deleted when it was not intended by the owner of that profile. To improve the security of this action an email is sent to the user's email and only after his confirmation the profile is going to be deleted.

Now the main goal of this application is to provide travel journeys between students and employees of nearby companies but always taking into consideration that the users can choose whom to go with.

A user can approve a travel request (Figure 4.9) or reject it (Figure 4.10), also it can be ignored until



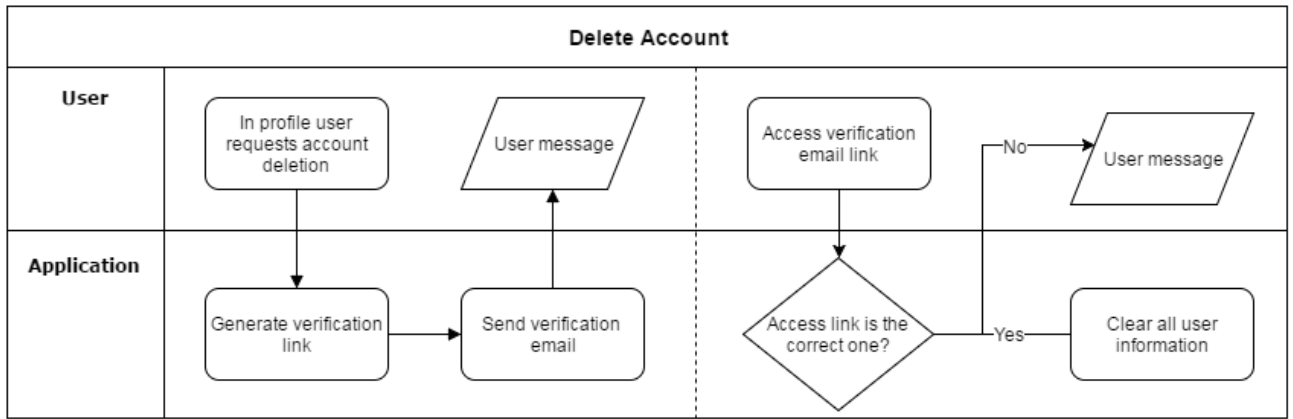


Figure 4.8: Delete Account Logic

the time of the travel goes by. We classified the travels in four states:

- Missing approval: as a user I requested a travel and I am waiting for the other user approval;
- Waiting for approval: as a user I received a travel request and I did not approved or rejected it;
- Upcoming: travel is approved by both driver and rider and it did not happen yet, from this state on the users can see the email and cellphone of each order to allow the arrangement of the travel;
- Missing Rate: as a user I took a travel but did not classified my partner.

When the final state is reached either by the logic above or because it is an outdated ride the travel will be available on the travels history.

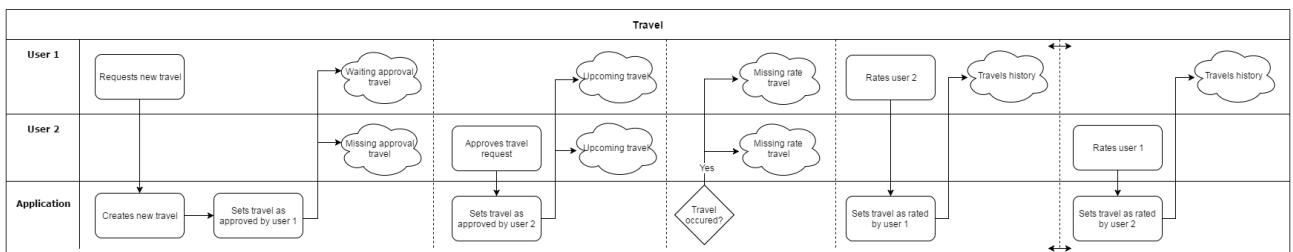


Figure 4.9: Approved Travel Logic

### 4.3.3 Formulas

With Formula 4.1 we were able to rate a given user through the total number of travels made and the rate that was given for each of them  $(u_t, t = 1, ..n)$ . As mentioned, this final rate is very important to establish some initial trust between the two users that want to travel together. Assuming that the users do not know each other, we had to conceive a mechanism for users to rely on before taking a ride with a stranger, so if this stranger has taken other rides and it's well quoted the probability of something go wrong decreases.

$$R = n * \sum_{t=1}^n u_t \tag{4.1}$$

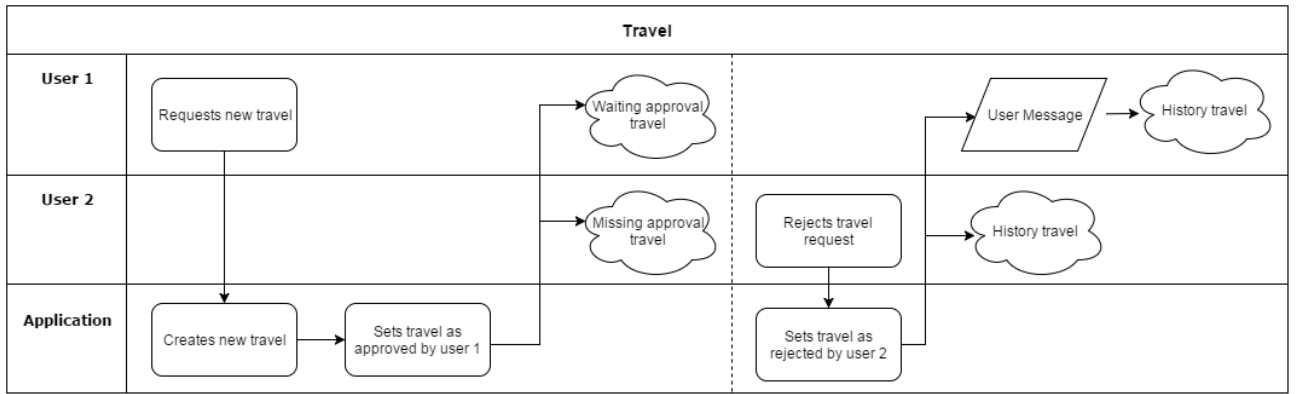


Figure 4.10: Rejected Travel Logic

Regarding top three companies the initial idea was to rate them according to the number of registered users, but this will not be fair since an employee can register himself but never use the application. So we reach the conclusion that the most reasonable option was to calculate the companies rank (Formula 4.2) using not only the number of registered users ( $u$ ), but also the number of travels made by these users and respective travel rates which corresponds to the sum of the total user rate ( $R$ ) calculated in Formula 4.1.

$$C = u + \sum_{u=1}^n R_u \quad (4.2)$$

According to the questionnaire analysis a user profile could be very helpful, taking as example one of the most important characteristics identified if a student hates the tobacco smell probably he does not want to take a ride with a person that smokes, since the odds of his partner light up a cigarette in the car is high.

Based on the answers of the questionnaire and after analysing which characteristics were more important we calculated for almost each of them its rating average ( $r$ ), that can be transformed in an average weight ( $w$ ) using  $w = \frac{r+2}{4}$ . The results of these calculations are presented in Table 4.2. Some important components were not considered for this calculation since the formulation of the survey did not take into consideration how that characteristic should be considered in the compatibility calculation like gender and profession, but they have to be considered on the implementation side.

We should now have to consider that between two users for the same characteristic they can only have some options in common, considering books I can like dramas and adventure and the other user adventure and comedy. To calculate the matching rate between user A and user B, we take into consideration the number of options selected by user A ( $O_A$ ) and the number of common options between the two users ( $O_{com}$ ), which results on  $M = \frac{O_{com}}{O_A}$ .

Considering the existence of  $n$  preference criteria, we have equation 4.3 where  $m_i$  is the matching

	Strongly Disagree (-2)	Disagree (-1)	Agree (1)	Strongly Agree (2)	Rating Average	Weight Average
Smoker	9.76%	17.89%	37.4%	34.96%	0.7	1.20
Languages	11.38%	17.07%	51.22%	20.33%	0.52	1.02
Music	22.76%	35.77%	36.59%	4.88%	-0.35	0.15
Books	32.52%	44.72%	18.7%	4.07%	-0.83	0.29
Films	34.15%	39.84%	25.2%	0.81%	-0.81	0.30
Series	34.96%	39.02%	23.58%	2.44%	-0.8	0.30

Table 4.2: Rating and weight average of relevant profile characteristics

rate of item  $i$  and  $w_i$  is the normalised weight for the same item. This weight is calculated based on the weight average  $W_i$  for item  $i$  (formula 4.4).

$$S = \sum_{i=1}^n m_i * w_i \quad (4.3)$$

$$w_i = \frac{W_i}{\sum_{k=1}^n W_k} \quad (4.4)$$

#### 4.3.4 Mockups

The answers to the survey have shown us that we must design an application that runs on several devices and operating systems, so the first decision was how to make this possible? The best approach was to design a responsive web page because if on one hand dropping this requirement will hamper his adoption, on the other hand the costs of maintaining at least three different proprietary source codes was very high. After this decision some mockups were designed to be used as a basis for the final application (these sketches can be found in Appendix B).

The principle that we wanted to follow was to have clean and sober pages with a modern look and feel. Why? Users feel really lost when they go to some web pages that contain a huge amount of information. However the user may also quit if he has to click in too many buttons or links until he finally finds the information that he really wants.

For instance in the home page (Figure 4.11) we show a summary of the most important notifications regarding travels, but for more details the user must navigate to another submenu. This way we prevent an overload of information in the same page displaying only a summary of the latest actions. On the other hand the users menu (Figure 4.12) is a good example of a simple webpage where the user do not have to press to much buttons or links to access the relevant information that he needs to decide his companionship, since the name of the user, compatibility and distance between them are immediately shown with a link to automatically select who to schedule a travel with.

Finally some concerns were taken regarding application flow:

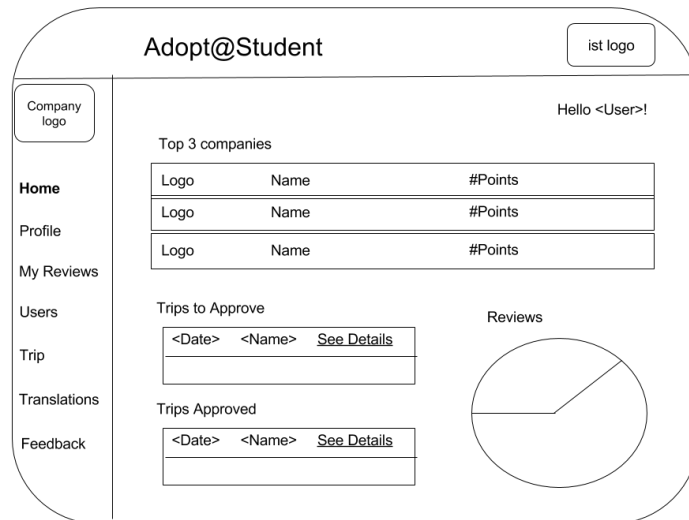


Figure 4.11: User Home Mockup

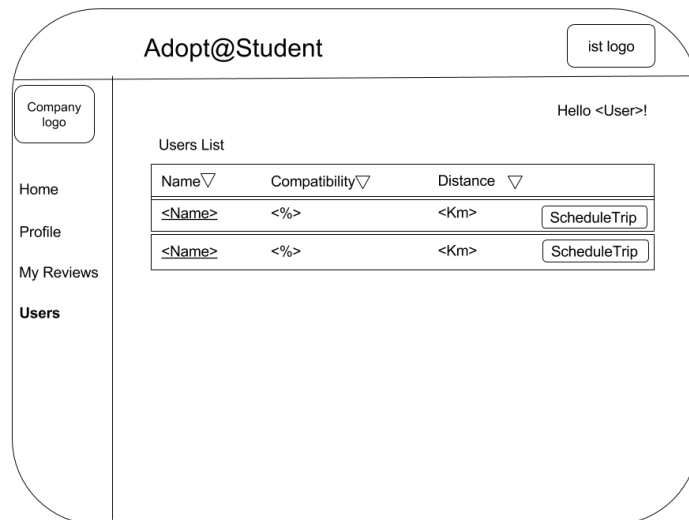


Figure 4.12: Users Mockup

- User must always know where he are in order to not feel lost;
- In a web page that contains a save button it must also contain a cancel button, because the user can regret the changes he made;
- A details web page must always contain a back button to the main one and vice-versa in order to improve the application navigation;
- All kind of user messages should have detailed information instead of generic one like "Error" if not the user does not know what went wrong and how to correct it;
- When logging in into the application the error presented must not define if the user does not exists or if the password is incorrect to prevent brute force attacks;

- Explicit menu options, otherwise the user will have doubts where to go to perform a given action;
- The menu should be organised by priority, the user should not get annoyed when looking for what he wants;
- The navigation flow must respect the operating system that it is running on, in other words the layout of the web pages must be consistent in all devices.

These concerns and principles were applied in order to retain the users in the first contact otherwise he will never comes back and that is exactly what we do not want to happen.

## **4.4 Summary**

In resume making a questionnaire to discover the prospective users opinion was very important in order to produce well defined requirements. Through these requirements we were able to determine the database model to apply in our application and also the main logic blocks necessary to accomplish the correct operation of our system. After all this analysis we design some mockups to obtain an idea of how should the application look like to correspond to our users expectations.



# Chapter 5

## Implementation

In this chapter we explain which tool was used to implement this application and why. After we show how is the development organised and what was made. We also reveal some decisions and assumptions that were taken during the implementation and based on what groundings.

### 5.1 Platform Choice

The first decision that we had to took was what should we use to do it, should it be Python, Ruby, Java or other one? In the beginning since Instituto Superior Técnico has all configurations set to use Postgres, Java and PHP which covered all our architecture we started to design our database and main classes. However at a given point of time we started to think why do not we use a web based platform that could simplify the development leaving time to implement more features? We decided to pursuit that idea and after this decision we investigated some platforms but the one that catch our attention that had some interesting characteristics:

- Designed with the only purpose of conceive web based applications;
- Low learning curve;
- Easy and fast deployment;
- Several integrations with external systems already available;
- Cloud option, that leads to almost zero preoccupations regarding system maintenance;
- Direct integration with C# where we are able to go further if we want to programme something out of the box.

These aspects made us believe that OutSystems was a great fit for our goals so we went on that direction.

## 5.2 OutSystems Context

OutSystems platform is composed by Integration Studio that allows the creation of custom components in .Net or JAVA programming languages, Lifetime to manage all information technology tasks and the applications lifecycle, Service Center that allows all kind of management operations and Service Studio the development environment.

### 5.2.1 Service Center

Service Center is the administrator web page where we can see the applications developed, monitoring their behaviour, perform some administration and configuration tasks and export all kind of reports. Below we are going to explain the options used in our application.

To notify the users of operations related to their account, Adopt a Student application demands email sending functionality but, how can I configure the sender's account? Service Center (Figure 5.1) offers a centralised place to add this configuration, in Administration Email tab, which allows the manager to change the sender's email whenever he needs avoiding source code changes in all spots where this feature is used.

In our application we also need to use some patterns to validate the input fields and to configure the distance allowed between two users, these kind of values never change or do not changed very often. In OutSystems this kind of variables, similar to the static variables in other programming languages, are called Site Properties and can be configured inside Factory eSpace tab, allowing changes in configuration without the need to republish the application.

The screenshot displays the 'Administration' tab within the 'Environment Configuration' section of the OutSystems Service Center. The interface includes a navigation bar with 'Factory', 'Monitoring', 'Administration', and 'Analytics'. Below the navigation bar, the 'Environment Configuration' page is shown, featuring a breadcrumb trail: 'Development > Users > Roles > Environment Configuration > Environment Security > Zones > Database Catalogs > Database Connections > Email > Certificates > SEO URLs > Li'. The main content area is titled 'Environment Configuration' and includes a link for 'Export Configuration for OutSystems Support'. The configuration fields are as follows:

- Environment Name:** Development
- Hostname:** istapps.outsystemscloud.com
- Running Mode:** Development (dropdown menu)
- Date Format:** YYYY-MM-DD (dropdown menu)
- Administration Email:** (text input field)
- Show Email on login screen:**
- Timer Execution Attempts:** 3 retries
- Enable 2-Stage Deploy:**
- Enable Daily Activity Reports:**
- Enable Weekly Reports:**

Footnote: (\*) Your OutSystems subscription doesn't support this feature.

Figure 5.1: Outsystems Service Center



## 5.2.2 Service Studio

Service Studio is the development environment of OutSystems platform that allow us to create modules that can be reused by other modules, each of them containing Data, Logic, Interface and Processes divisions as can be behold in Figure 5.2.

Regarding the Data section we can define Entities, which can be tables (Entities) or enumerators (Static Entities) with a set of methods to perform CRUD operations (create, read, update and delete), Structures that define a set of non persistent attributes, Session Variables which are variables written in the database for a given period of time and Site Properties that are global variables saved in the memory cache.

In Logic division we can define Actions that are methods that can have input, output and local variables and perform a given programming logic, Roles where we can define distinct user groups to later on assign different privileges and Exceptions to define the type of errors that can occur in the application.

Interface is where we conceive the web screens that are shown to the final user. Each screen can be composed by interface design, local variables and actions, where we want to highlight the preparation action that runs before the screen presentation. Each web screen is created under a web flow, which is basically a folder to aggregate web screens and web blocks, that are pieces of interfaces that can be reused inside other blocks or screens, like for example footer or header.

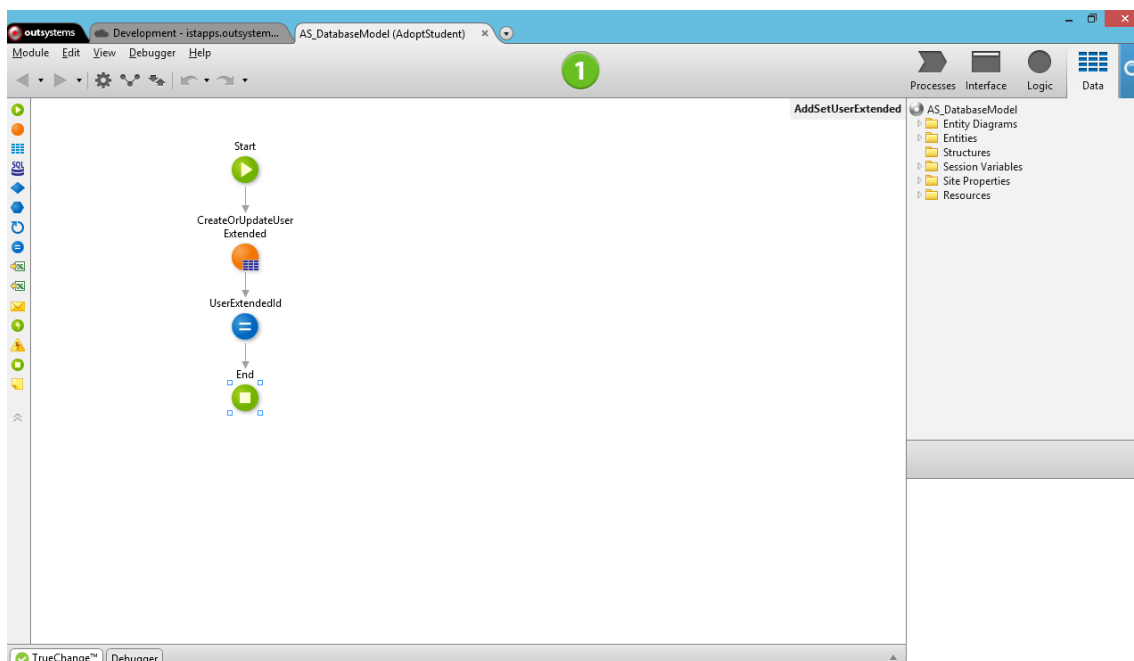


Figure 5.2: Outsystems Service Studio

## 5.3 Adopt a Student Modules

Despite the fact that the development environment already has different sections to define data, logic and interface, OutSystems best practices advise us to separate database schema, program logic and

interfaces for a better and more easier reuse of each of them. Following that guidance we conceived three different modules each of them containing several actions to be called in the layer above, resulting in a three-tier architecture that allows the replacement of one individual module without affecting the remaining ones. We also reuse some extensions, modules designed by OutSystems or their community, to add or simplify features that were needed in our application.

In the next subsections we are going to explain each of the implemented modules, their purpose and operations allowed, as well as the used extensions and configurations made.

### **5.3.1 Data Schema**

The data tier was implemented as a module in the Service Studio and contains the schema of our application (Figure 5.3). There are eight static entities that contain values that supposedly never change like the list of nationalities that a user can have or his gender. Users can enjoy more than one music, movie, tv show or book gender and for that purpose we have created several entities that connect the user to the genders that they appreciate (UserMusic, UserMovie, UserTVShow, MusicBook). Also most of our target population knows more than one language which led us to specify an UserLanguage table containing that information.

For security reasons we must save the user's wrong login attempts to automatically lock their account so a UserLogin table was set. As defined in the requirements, the user has a UserList associated that give us the state of their account in the system, these values are constant so a static entity is the right place to define them.

If any error occurs in the application or any doubts emerges in the user's mind he must be able to contact the administrator, so a Report entity was created to save those communication. Following OutSystems guidances an image table was created despite the fact that a company can only have one logo.

Since OutSystems is a rapid development platform a set of actions and tables are already assembled since they are commonly used in all web applications, like User entity table. The system user table should not be directly extended so we have created a new table called UserExtended to save all extra data that we needed like user profession or company.

Last but not least, giving the fact that we are developing a free ride application we need to have an entity to save all Travel data, such us the users and date that they are going to travel.

### **5.3.2 Program Logic**

In this module we have implemented the business logic necessary to make our application work as expected. The application tier is responsible to receive the information from the data tier, treat it and prepare the operations that will be called by the presentation tier. In this section we are going to detail and show some examples of the source code behind the register, login and new travel request functionalities, which are used to deduce the remaining operations available.

The first thing the user needs to do when he wants to use our application is to register himself



Figure 5.3: Outsystems Database Model

(Figure 5.4). On the server side, the first operation executed is the password encryption applying MD5 Salt Hash. Then a token is generated encrypting the user information (user name, encrypted password, username and email) using the same algorithm. To finalise an email is triggered to the user using his user id and the created token. To gain effective privileges to enter in his account the user has to access the link sent by email, we used this logic to decrease the risk of fake identities (Figure 5.5).



Figure 5.4: User Register Logic

Outside the application itself two more operations can be done, login and password reset. The reset password basically uses the same logic as register process, an email is sent to the user to activate his account. Regarding login (Figure 5.6), we need to check if the user can use the application and if not

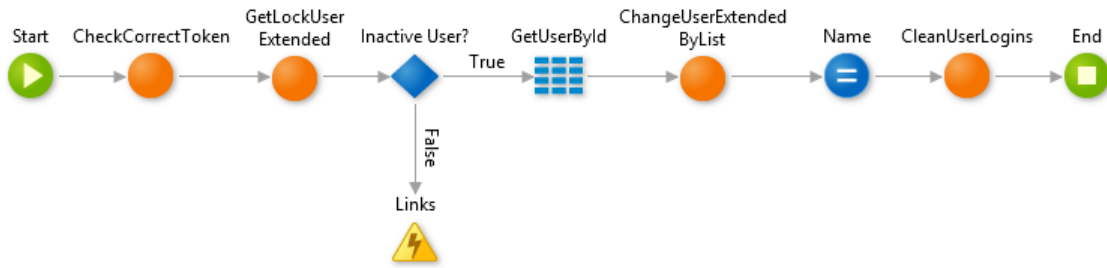


Figure 5.5: User Activation Logic

he must comprehend why not, like sending a message saying "Your account is not activated, please activate it through the link sent by email". The validations made in the login process are the following:

- Is he a registered user?;
- Is the user locked? If that is the case or the user exceeded the number of wrong tentatives to login or the administrator has locked him due to identity thief suspicious;
- Is the user blocked? The block state can only be set by the administrator due to other users complaints or suspicious of fake identity;
- Did the user forgot to activate his account?;
- Is the password correct? If not locks the user at his third attempt, if it is the correct password cleans the number of wrong attempts.

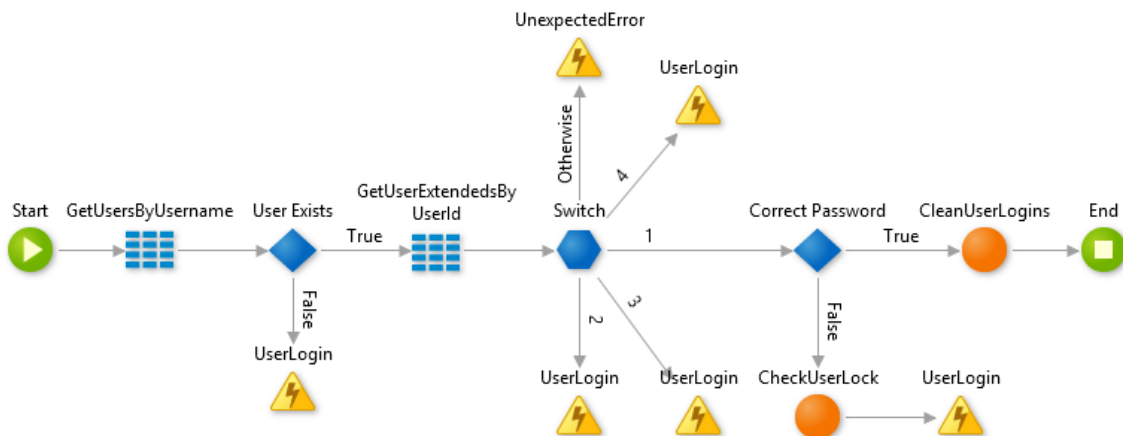


Figure 5.6: User Login Logic

Regarding new travel logic, the user is only allowed to request a new ride once his profile is filled. The user profile is considered filled when his mobile phone, address, gender, nationality, profession, profession area and company (not needed if the user is a student) are set. When the profile is set the user is able to choose is travel companion, but for that he wants to know the compatibility between him and the other users. This matching is calculated implementing formula 4.3 through a complex query (Figure 5.7) that reads smoker and user's tables preferences (UserBook, UserMovie, UserTVShow, UserMusic)

information and calculates the compatibility percentage. But why did we implemented something so complex? Did not we had any other solution? The reason behind this decision held on reducing performance issues. One of the restrictions of the OutSystems cloud service is that we do not have access to the database, so we could not implement this functionality via stored procedures. What about C#? The mechanism to show the information to the user relies on a list created with all the data. Regarding queries, their output is directly a list so we do not have any lost time in conversions. On the other side if we have used programmatic logic we would need to transform the data into a list format, which will result on a waste of effort to copy all the information from one structure to the other.

```

select
round(((1.2 / (1.2 + case when sum(countLanguage) <> 0 then 1.02 * sum(countLanguage) else 0 end + case when sum(countBook) <> 0 then 0.15 * sum(countBook) else 0 end +
case when sum(countMovie) <> 0 then 0.29 * sum(countMovie) else 0 end + case when sum(countMusic) <> 0 then 0.3 * sum(countMusic) else 0 end +
case when sum(countTVShow) <> 0 then 0.3 * sum(countTVShow) else 0 end)
* sum(smoker)
+ 1.02 / (1.2 + case when sum(countLanguage) <> 0 then 1.02 * sum(countLanguage) else 0 end + case when sum(countBook) <> 0 then 0.15 * sum(countBook) else 0 end +
case when sum(countMovie) <> 0 then 0.29 * sum(countMovie) else 0 end + case when sum(countMusic) <> 0 then 0.3 * sum(countMusic) else 0 end +
case when sum(countTVShow) <> 0 then 0.3 * sum(countTVShow) else 0 end)
* sum(sumLanguage)
+ 0.15 / (1.2 + case when sum(countLanguage) <> 0 then 1.02 * sum(countLanguage) else 0 end + case when sum(countBook) <> 0 then 0.15 * sum(countBook) else 0 end +
case when sum(countMovie) <> 0 then 0.29 * sum(countMovie) else 0 end + case when sum(countMusic) <> 0 then 0.3 * sum(countMusic) else 0 end +
case when sum(countTVShow) <> 0 then 0.3 * sum(countTVShow) else 0 end)
* sum(sumMusic)
+ 0.29 / (1.2 + case when sum(countLanguage) <> 0 then 1.02 * sum(countLanguage) else 0 end + case when sum(countBook) <> 0 then 0.15 * sum(countBook) else 0 end +
case when sum(countMovie) <> 0 then 0.29 * sum(countMovie) else 0 end + case when sum(countMusic) <> 0 then 0.3 * sum(countMusic) else 0 end +
case when sum(countTVShow) <> 0 then 0.3 * sum(countTVShow) else 0 end)
* sum(sumBook)
+ 0.3 / (1.2 + case when sum(countLanguage) <> 0 then 1.02 * sum(countLanguage) else 0 end + case when sum(countBook) <> 0 then 0.15 * sum(countBook) else 0 end +
case when sum(countMovie) <> 0 then 0.29 * sum(countMovie) else 0 end + case when sum(countMusic) <> 0 then 0.3 * sum(countMusic) else 0 end +
case when sum(countTVShow) <> 0 then 0.3 * sum(countTVShow) else 0 end)
* sum(sumMovie)
+ 0.3 / (1.2 + case when sum(countLanguage) <> 0 then 1.02 * sum(countLanguage) else 0 end + case when sum(countBook) <> 0 then 0.15 * sum(countBook) else 0 end +
case when sum(countMovie) <> 0 then 0.29 * sum(countMovie) else 0 end + case when sum(countMusic) <> 0 then 0.3 * sum(countMusic) else 0 end +
case when sum(countTVShow) <> 0 then 0.3 * sum(countTVShow) else 0 end)
* sum(sumTVShow)) + 100),2) as Compatibility
from
(select other.UserId as OtherId, sum(case when usr.smoker = other.smoker then 1 else 0 end) as smoker, 0 as sumLanguage, 0 as countLanguage,
0 as sumBook, 0 as countBook, 0 as sumMovie, 0 as countMovie, 0 as sumTVShow, 0 as countTVShow, 0 as sumMusic, 0 as countMusic
from {UserExtended} usr left join {UserExtended} other
on usr.UserId <> other.UserId
where usr.UserId = @UserId
group by other.UserId
union
SELECT other.Id as OtherId, 0 as smoker,
sum(case when usr.LanguageId = other.LanguageId then 1 else 0 end) as sumLanguage,
count(distinct usr.LanguageId) as countLanguage,
0 as sumBook, 0 as countBook, 0 as sumMovie, 0 as countMovie, 0 as sumTVShow, 0 as countTVShow, 0 as sumMusic, 0 as countMusic
from {UserLanguage} usr left join
(select usr.Id, other.LanguageId from {User} usr
left join {UserLanguage} other on usr.Id = other.UserId
where usr.Id <> @UserId) other
on usr.UserId <> other.UserId
where usr.UserId = @UserId
group by other.Id, usr.UserId
union
SELECT other.Id as OtherId, 0 as smoker, 0 as sumLanguage, 0 as countLanguage,
sum(case when usr.GeneralTypeId = other.GeneralTypeId then 1 else 0 end) as sumBook,
count(distinct usr.GeneralTypeId) as countBook, 0 as sumMovie, 0 as countMovie, 0 as sumTVShow, 0 as countTVShow,
0 as sumMusic, 0 as countMusic
from {UserBook} usr left join
(select usr.Id, other.GeneralTypeId from {User} usr
left join {UserBook} other on usr.Id = other.UserId
where usr.Id <> @UserId) other
on usr.UserId <> other.UserId
where usr.UserId = @UserId
group by other.Id, usr.UserId
union
SELECT other.Id as OtherId, 0 as smoker, 0 as sumLanguage, 0 as countLanguage, 0 as sumBook, 0 as countBook,
sum(case when usr.GeneralTypeId = other.GeneralTypeId then 1 else 0 end) as sumMovie,
count(distinct usr.GeneralTypeId) as countMovie, 0 as sumTVShow, 0 as countTVShow, 0 as sumMusic, 0 as countMusic
from {UserMovie} usr left join
(select usr.Id, other.GeneralTypeId from {User} usr
left join {UserMovie} other on usr.Id = other.UserId
where usr.Id <> @UserId) other
on usr.UserId <> other.UserId
where usr.UserId = @UserId
group by other.Id, usr.UserId
union
SELECT other.Id as OtherId, 0 as smoker, 0 as sumLanguage, 0 as countLanguage, 0 as sumBook, 0 as countBook, 0 as sumMovie, 0 as countMovie,
sum(case when usr.GeneralTypeId = other.GeneralTypeId then 1 else 0 end) as sumTVShow,
count(distinct usr.GeneralTypeId) as countTVShow, 0 as sumMusic, 0 as countMusic
from {UserTVShow} usr left join
(select usr.Id, other.GeneralTypeId from {User} usr
left join {UserTVShow} other on usr.Id = other.UserId
where usr.Id <> @UserId) other
on usr.UserId <> other.UserId
where usr.UserId = @UserId
group by other.Id, usr.UserId
union
SELECT other.Id as OtherId, 0 as smoker, 0 as sumLanguage, 0 as countLanguage, 0 as sumBook, 0 as countBook, 0 as sumMovie, 0 as countMovie, 0 as sumTVShow,
0 as countTVShow, sum(case when usr.MusicTypeId = other.MusicTypeId then 1 else 0 end) as sumMusic,
count(distinct usr.MusicTypeId) as countMusic
from {UserMusic} usr left join
(select usr.Id, other.MusicTypeId from {User} usr
left join {UserMusic} other on usr.Id = other.UserId
where usr.Id <> @UserId) other
on usr.UserId <> other.UserId
where usr.UserId = @UserId
group by other.Id, usr.UserId) as pm
where pm.OtherId = @OtherUserId
group by pm.OtherId

```

Figure 5.7: Compatibility Query

As a user I can only request a new travel if I do not have another one already schedule for the same period, this means approved by both driver and rider (Figures 5.8 and 5.9). But he can request the travels he wants if none of them is approved, because the user does not know who will want or can go with him. The same applies when approving a travel, if I already approved a ride for the same period the application will not allow the operation until the previous travel is rejected (Figures 5.10 and 5.11). One of the scenarios that could not be automatically surpassed was the approval of two different drivers/riders to a travel with the same user in the same period, in this case a message is displayed to the requester user stating that he has two travels for the same time and asking him to reject the one that he does not want.

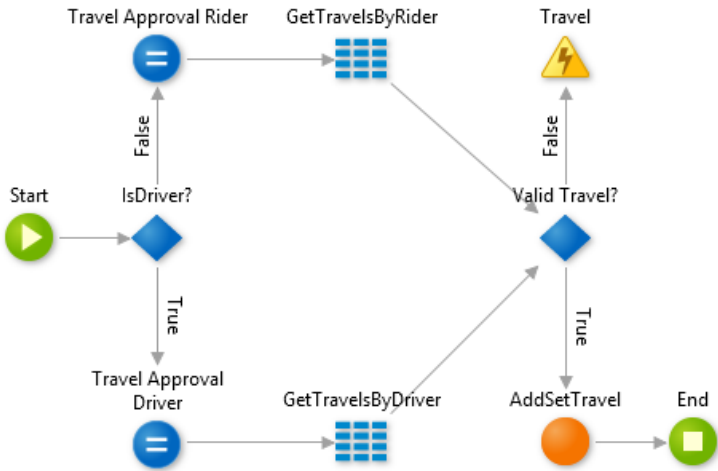


Figure 5.8: Request New Travel Logic

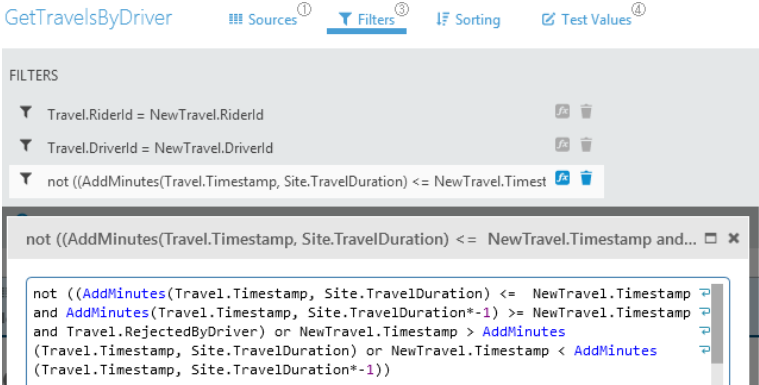


Figure 5.9: Verify travel for the same period logic

In this module we also design the emails that the user receives after his register or whenever he wants to reset password or to receive the information that he was locked or blocked by the administrator, an example of this emails can be seen in Figure 5.12.

**5.3.3 Interface**

In the Presentation tier module we can find the screens that support our application. There are two menus (user and administrator), a common home screen for both kind of users and several main and

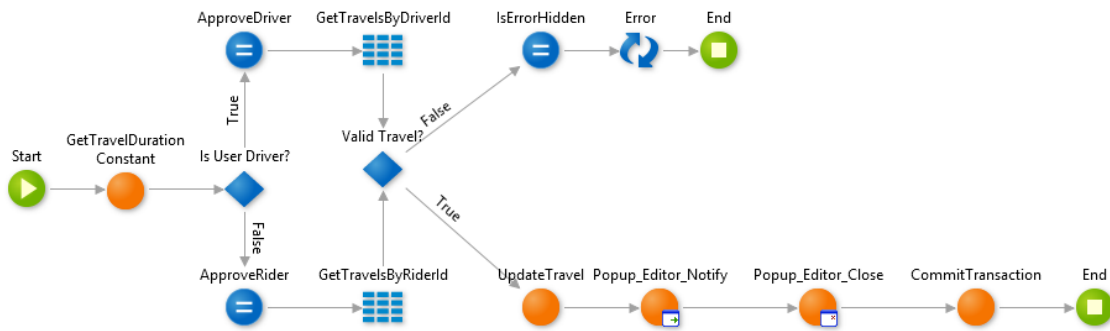


Figure 5.10: Approve Travel Logic

GetTravelsByDriverId Sources Filters Sorting Test Values

FILTERS

- Travel.DriverId = Session.UserId
- Travel.ApprovedByRider = True
- Travel.ApprovedByDriver = True
- Travel.Id <> TravelId
- not (UpdatedTravel.Timestamp > AddMinutes(Travel.Timestamp, GetTravelDur...

```
not (UpdatedTravel.Timestamp > AddMinutes(Travel.Timestamp,
GetTravelDurationConstant.TravelDuration) or
UpdatedTravel.Timestamp < AddMinutes(Travel.Timestamp,
GetTravelDurationConstant.TravelDuration*-1))
```

Figure 5.11: Verify travel approved for the same period logic

Adopt@Student Reset Password! Inbox x

Adopt@Student <istutlapps@gmail.com> 16:53 (4 minutes ago)

to me

Hi msr!

Your have request a reset password in Adopt@Student community, please proceed to the following link to activate your user.  
<https://istapps.outsystemscloud.com/AdoptStudent/AccountActivation.aspx?id=27&token=1852847FED6AED053DE21EA3A6F574FF>

Kind regards,  
 Adopt@Student team

Figure 5.12: Reset Password Email

details pages.

After a successful login the user is redirected to the home page (Figure 5.13) where he can see the top three companies, messages, travels waiting his approval and upcoming travels. In messages and travels dashboards only the latest three messages are shown, in order to view all of them the user must navigate to the corresponding menu. At the top we can also observe two messages, the first one informing the user that his profile is not totally filled and for that reason he will not be able to schedule new travels and an error message indicating that he has travels schedule for the same period and asking

him to reject the ones that we does not want.

The menu shown in Figure 5.13 is the administrator menu where he can create and see all the companies, users and contact messages from the users. But in that case why does he also have a messages submenu? We decided that since the administrator can also travel there should be a separation between administration tasks and car-sharing messages. The difference between the administrator menu and the so called normal user is that for the normal user the Manage submenu is replaced by a Contact Us submenu (Figure 5.14).

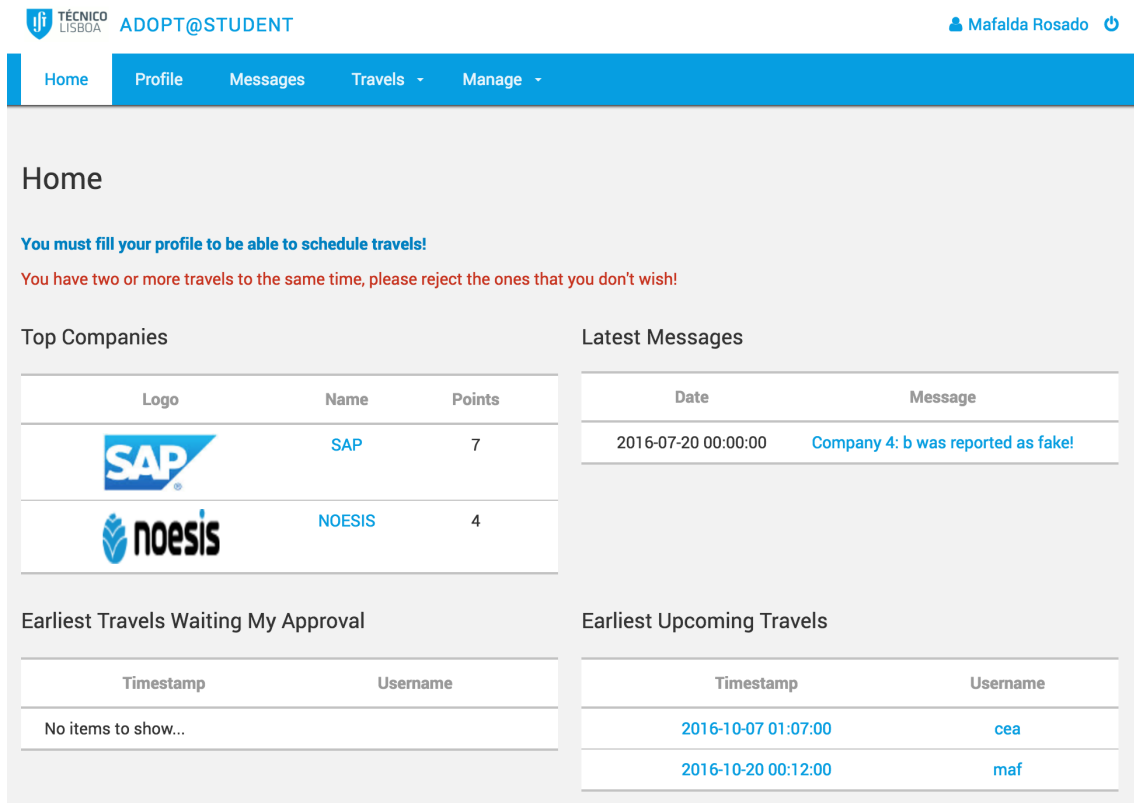


Figure 5.13: Home Page



Figure 5.14: User Menu

In the profile (Figure 5.15) the user is able to fulfil his information, either the mandatory for request a new travel or his hobbies for a better compatibility match. The first thing he sees when accessing the page is the points that he already has, these points represent the number of travels made multiplied by the rates given to him by the other users. Below an information message is shown explaining how to identify the fields that are mandatory to fulfil in order to be able to request new travels. Due to privacy issues the address is only visible to the user and the administrator, that information is mandatory since the distance between him and the other users is calculated based on it, but no one needs to know where each one lives and if they want, they can always provide it when arranging the travel.

In the travels menu (Figure 5.16) the user can perform several actions regarding travels. The new



travel submenu (Figure 5.17) allows the user to request a new ride. He must choose the date and time of the travel and he has at his disposal a list of the users that he can travel with. A driver is always a worker and the rider a student so the list is filtered accordingly. In this table we can find the compatibility between the users (by default the table is sorted by this field) and both walking and driving distances among them. The user can always see more information about other users with the exception of address, cellphone and email, becoming the last two available after the approval of both rider and driver. The Waiting My Approval submenu allows the acceptance or rejection of a new travel request (Figure 5.18). At any moment users can reject travels that they already approved in the Upcoming submenu, triggering this way a notification to the other user informing that this travel was rejected. In the Missing Approval menu the user can see the travels that he have requested and the other user did not replied yet, and can reject the travel himself. After the date of the travel the users should rate it (Figure 5.19) through the Missing Rate menu in order to give visibility if the other user is a good company or not, since the rate influences the points of that user. In History (Figure 5.20) we have all travels that already took place with the information if the travel was approved or rejected and the rate average for the travel (sum of the users rate divided by two).

In the manage menu (Figure 5.21) the administrator can perform several tasks: answer user's messages; deactivate, lock and block a user or create and manage companies (Figure 5.22). In order to create a company the administrator must fulfil among others the company website and logotype, these two fields are very important since one of the ways to capture workers attention is to give publicity to their company. The top 3 companies shown in the home page guarantees the publicity and also a web link was added to the logo in order to directly open the company website.

### 5.3.4 Extensions

OutSystem platform offers a set of independent modules that users request over time and a community where developers can provide their own modules. These kind of modules are called extensions since they are not part of the platform itself. In our case we decided to use four of them since it did not make sense to develop something that was already available in the market for free.

ImageUtilities was one of them and we simply use it to resize the company logotypes that the administrator provides, this way he will not have to be worried with the dimension of the image uploaded.

The development environment allow us to sort a table as we want, but if we want to show elements of a list the in-house sort will not work and for that kind of sets we use SortRecordList extension.

One of the most important aspects of our application was to show users whom can they travel with depending on their address, so instead of developing our own algorithm why should we not use one that most of people use and trust? We follow that path and choose Google Matrix which is the one that Google uses in the Maps platform to calculate the distance between two points. Finally, we used Google Maps to allow users the visualisation of the inserted address in order to minimise the number of typos occurrences.

## 5.4 Configurations

We decided to use OutSystems site properties to allow a more efficient and simple change of configurations within the system. In our case these properties are mostly input fields validation patterns but we also defined travel period duration and maximum distance allowed between users that they can travel with using this method. Our variables can be found in AS\_BusinessLogic (Figure 5.23) and AdoptStudent (Figure 5.24) configuration portal.

## Profile (16 points)

 [Change Password](#)

[Delete Account](#)

You must fill all fields marked with (\*) to be able to schedule travels!

Name \*

Email \*

Mobile Phone (\*)

Address (\*)

Your address will only be visible to you and to the administrator!



Gender (\*)

Nationality (\*)

Professional Area (\*)

Profession (\*)

Smoker

Use ctrl key to select or deselect options in the lists below!

Spoken Languages

Books Genres

Movies Genres

Music Genres

TV Shows Genres

Figure 5.15: User Profile

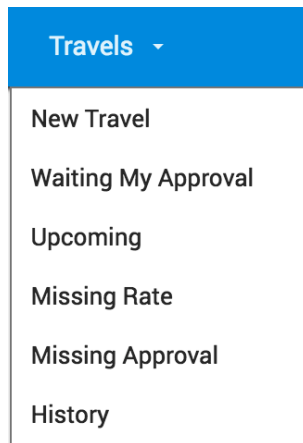


Figure 5.16: Travels Menu

### New Travel

Select the date and time of your travel:

Select the user to travel with:

Username	Gender	Profession	Compability (%)	Walking Distance	Driving Distance
<input type="radio"/> maf	Female	Student	72.8	0.4 km	1.0 km
<input type="radio"/> cea	Female	Student	24.7	1.6 km	1.9 km

2 records

Figure 5.17: New Travel Request

#### Travel Details

Driver: msr

Timestamp: 2016-10-05 21:16:00

Figure 5.18: Approve or Reject New Travel Request Popup

Travel Details
✕

Driver

Timestamp

Rate  1  2  3  4  5

Rate
Cancel

Figure 5.19: Rate Travel

### Travels History

Search
Reset

Timestamp	Username	Name	Approved	Rejected	Rate Average
<a href="#">2016-11-09 13:44:00</a>	<a href="#">cea</a>	ksadh		✔	0
<a href="#">2016-11-09 12:43:00</a>	<a href="#">cea</a>	ksadh		✔	0
<a href="#">2016-10-20 16:55:00</a>	<a href="#">cea</a>	ksadh		✔	0
<a href="#">2016-10-12 16:54:00</a>	<a href="#">cea</a>	ksadh		✔	0
<a href="#">2016-10-07 01:07:00</a>	<a href="#">cea</a>	ksadh		✔	0
<a href="#">2016-09-30 22:22:00</a>	<a href="#">cea</a>	ksadh	✔		4
<a href="#">2016-09-27 00:18:00</a>	<a href="#">maf</a>	name	✔		2.5

Figure 5.20: Travel's History

- Manage ▾
- Companies
  - Messages
  - Users

Figure 5.21: Manage Menu

# New Company

Name \*

Address \*

Map Satellite

O Parque Taguspark

Sacoor Brothers

Taguspark, SA

N249-3

Map data ©2016 Google Terms of Use Report a map error

Email \*

Website URL \*

Image \*  No file chosen

Figure 5.22: New Company

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## eSpace AS\_BusinessLogic

[eSpaces List](#) | [General Log](#) | [Screen Log](#) | [Error Log](#) | [Application Objects](#)

□ An eSpace is an application or part of an application that implements a set of related business services covering a range of ...

Application: [AdoptStudent](#)

Description: (No description available)

Status: The eSpace is OK. No messages to show.

Last Published: 2016-10-01 19:39:31 by IST Apps

Versions Dependencies Single Sign-On Solutions Integrations Tenants Site Properties Timers Operation

Site properties used by the eSpace at runtime. To edit them, select the property name.

**Note:** Multi-tenant Site Properties can be edited in the tenant detail page, under the Tenants tab.

Name	Data Type	Effective Value
<a href="#">AccountActivationPath</a>	Text	https://istapps.outsystemscloud.com/AdoptStudent/AccountActivation.aspx
<a href="#">DeleteAccountPath</a>	Text	https://istapps.outsystemscloud.com/AdoptStudent/DeleteAccount.aspx
<a href="#">TravelDuration</a>	Integer	15

Figure 5.23: Service Center AS\_BusinessLogic site properties







## Chapter 6

# Evaluation and Results

Since the result of this dissertation is a car-sharing application the tests should be done by several persons with different backgrounds in order to prevent future problems. NOESIS company has a Quality Management area responsible among other things to specify and test applications and websites for several companies in the market. One of the techniques that they use is Crowd Testing [40], but what is this? They pick up people that work in different business areas and with the guidance of a quality team, test an application. These type of tests leverage applications since the number of errors that can appear later on are very reduced since most of them are discovered and tackled before its launch.

### 6.1 Evaluation

A brief description was sent to the testers in order to give some context about the application, the requirements were also sent to allow the application verification against them. Since the crowd testing methodology is based on tests made by a group of persons with different backgrounds, NOESIS invited people from different departments: OutSystems, IT Help Desk, Configuration Management and Quality Management. The testing period was from 7:00PM to 00:30AM in the company headquarters in Lisbon with eight testers on-site and four off-site.

The errors were registered on Mantis Bug Tracker software and classified accordingly to the four scopes defined below:

- **Functionality:** verifies the application functionalities against its specific requirements and the expected behaviour of this kind of application;
- **Layout:** checks if web pages that compose the application are perceptible and consistent in all browsers and devices;
- **Improvements:** testers advices for new functionalities and enhancements to the existing features;
- **Usability:** establish if the application is easy to use and their emotional response to it, for instance whether the users can perform an operation in a short period of time.

Following the principles of International Software Testing Qualifications Board (ISTQB [7]) the issues were divided into four different severity degrees:

- Critical: high importance data or operations are compromised and the user does not have any available workaround;
- Major: important data or features are compromised and although a workaround is available its execution is not easy to perform;
- Minor: non-critical data or minor functionalities are affected but a simple workaround is applicable;
- Trivial: no workaround is needed since it does not affect any feature or data. In here the testers normally point out, for instance, improvements, new functionalities, layout inconsistencies or text spelling mistakes.

To guarantee the correct operation of our application NOESIS also used different devices (computers, tablets and cellphones), operating systems (Windows and Macintosh) and web browsers (Google Chrome, Safari, Internet Explorer and Firefox).

## 6.2 Results

During the tests 123 defects were found and classified according to their severities (Figure 6.1) and scopes (Figure 6.2) defined above.

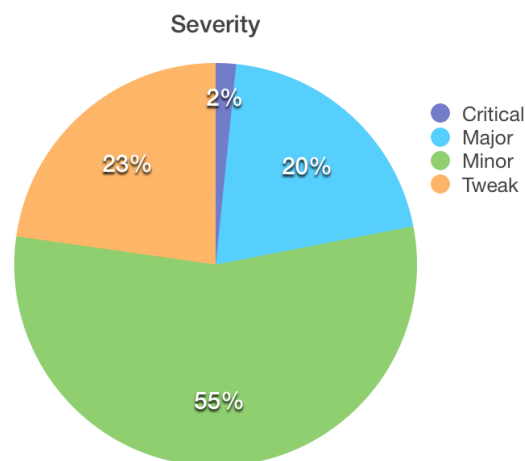


Figure 6.1: Defects by Severity

Regarding their severity only two issues were indicated as critical:

- On register the username is not case sensitive, but then none of the users can logon: this issue was corrected;
- Application crashes when deleting some companies: considered as a false positive, because it was generated by bad data from unit tests (tests performed by developers);

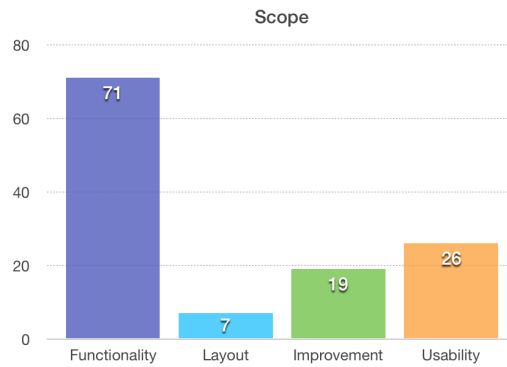


Figure 6.2: Defects by Scope

The preponderance of major defects were related to administrator's tasks. To lock or block a user the administrator had two checkboxes available and also a user list combobox. If he used the checkboxes the user list id will not be updated, generating an unreliable behaviour. This issue was solved removing the flags and changing the combobox options to a more perceptible name, for instance red to lock, yellow to inactive.

Some of the minor errors were considered no issues, since they were related with expected disparities in different web browsers or devices. Responsiveness means that the screen adapts itself to the specific layout of a device, for instance the menu on a web page is visible on the top of the page and in tablets or cellphones the menu is hide on right side. Other minor defects were grouped since they were the same problem, the user could request the same travel the times he wanted. This issue was overcome verifying in the database if, for the same driver, rider and date, a travel was previously created and notifying the user that a similar ride already exists.

The trivial issues made us reach the conclusion that we needed to change and add some information messages. We already had a message in the home page indicating that the user must fill it is profile in order to schedule travels. However this message was small and grey, which proved that it was too much framed into the web page design to be eminent. The message was changed to blue and increased in order to became more visible. Another issue was related with the lack of information regarding the profile information that needed to be filled in order to be able to create new travels. In this case a message was added in the top of the user profile page, with the same format of the user's home message, indicating the user that to be able to schedule travels he needed to fulfil the the fields marked with an asterisk.

### 6.3 Summary

The outcome of the tests allowed us not only to correct some errors that were present in the application, but also increase its quality improving the user experience and reducing the number of missteps to perform an operation.

As stated before, crowd testing is a union of people that have different backgrounds joined to test an application. This option proved to be a perfect fit for us since it was possible to test, at the same time, if the application was set to be used by expert and non expert users. For instance, the expert users were

the ones testing the administrator component, since they are used to be in that position.

## Chapter 7

# Conclusions

As stated in motivation, our main goal was to develop a car-sharing application between the students of Instituto Superior Técnico Taguspark and employees from companies nearby. Besides the environmental and costs benefits we also wanted to fill a gap that we considered that exists, at least in Portugal, which is the proximity between students and companies. Students have access to job prospects information through several platforms, for instance companies websites or even job fairs that normally occur at least once a year in the universities. However the focus of such kind of events, from the companies perspective, is to conquer new employees so only the bright side is shown and for that reason the students do not really acquire the total information that, in most cases, want.

To achieve our objective, in Chapter 3, we investigated the most used and well quoted applications available on market in order to understand which features should be implement. We also considered important to gather our future users opinion to design our application accordingly to their wishes. With that purpose we created a survey and its evaluation, present in chapter 4 section 1, helped us to conceive some conduct lines to take into consideration during the development of our application.

For the development we used OutSystems platform, due to its low learning curve, available integrations and extensions, and guarantee of application responsiveness. The application was built on top of a cloud server managed by OutSystems, considered has a positive speck since it eliminates all the server maintenance concerns. Although we still see it as positive point as downside we cannot change the server date time which originated some problems, since the time zone is set to GMT-1. Other problem regarding date time was its format because if on one hand we have the possibility to change it on the platform on the other hand we are not able to set it in the database, which generated some incongruent behaviour.

In order to evaluate the application, NOESIS company have performed crowd testing tests in order to find the maximum number of errors as possible to guarantee the Adopt a Student quality. During the tests we reach the conclusion that the application accomplish the defined goal allowing the users to create a profile and schedule new travels according to their choice of compatible users. Nevertheless some adjustments were made based on the testers inputs and defects found that were not detected or even thought during the implementation process.

Although the positive outcome of the tests, some adjustments should be made in order to enhance the application usage and some features should also be added to fulfil newly requirements.

## 7.1 Future Work

Although we considered that the application was successfully implemented and have accomplished our defined goals, some new features or upgrades can be performed in order to increase our application capacities. We have identified three of these improvements that we were not able to implement due to time constraints and preference to develop features that we considered more important to the final user.

OutSystems platform offers a multilingual support that allows translation of static elements, like titles and labels, and data stored in database. This kind of feature is a great benefit since some users have a preferred language and in our specific case the target population covers Erasmus students and workers that can be from foreign countries.

When we started the development of this thesis we made the assumption that if someone lives in Portugal he will have a Portuguese cellphone number and for that reason we only allowed +351 indicative. However, taking as example the European Union it is expected that in June 2017 the roaming taxes will end, so there is no motif to have a country dependent number which justifies the implementation of this improvement.

Should be also studied the possibility to introduce the register and login through social network platforms like Google Plus, Facebook and LinkedIn, because nowadays the market is moving towards systems integration in order to reduce the time and effort spent by users when using a tool.

In conclusion, although our application fulfils the pre establish requirements, such kind of improvements or new functionalities will add value to our application, foremost the consent of international cellphones usage.

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## **Appendix A**

### **Adopt a Student - What do you think?**



## Adopt a Student - What do you think?

### Welcome!

The purpose of this project is to provide a tool to help on social campaigns. The first step will be an application to share trips between students from IST Taguspark and workers from the companies nearby. The employees of these companies will share the car with one or more students helping them to arrive at university. Another goal is to provide an effective tool to increase networking and share experiences while helping another person.

The objective of this survey is to understand the needs and wishes of both students and workers, accomplishing this way an application that best suits all interested parts.

1. Do you wish to use this application as a student or a worker?\*

- Student
- Worker (please jump to question 4)

2. [Student] Usually, how do you get to the University?

- Boat
- Bus
- Car
- Metro
- Train
- Shuttle
- Walking
- Other (Please Specify)

3. [Student] How much do you spend per month in transportation?

4. Please rank the type of device that you would use to access this application:\*

- |                                     |                              |
|-------------------------------------|------------------------------|
| <input type="checkbox"/> Smartphone | <input type="checkbox"/> N/A |
| <input type="checkbox"/> Tablet     | <input type="checkbox"/> N/A |
| <input type="checkbox"/> Computer   | <input type="checkbox"/> N/A |

5. Do you think that it is important the application to be available in multiple languages or English will be enough?\*

- English
- Multiple Languages

6. Do you think that it is important to take into consideration the following characteristics when matching profiles?\*

Figure A.1: Survey - Part 1

	Strongly Disagree	Disagree	Agree	Strongly Agree
Gender	<input type="radio"/> -2	<input type="radio"/> -1	<input type="radio"/> 1	<input type="radio"/> 2
Smoker	<input type="radio"/> -2	<input type="radio"/> -1	<input type="radio"/> 1	<input type="radio"/> 2
Birthplace	<input type="radio"/> -2	<input type="radio"/> -1	<input type="radio"/> 1	<input type="radio"/> 2
Languages	<input type="radio"/> -2	<input type="radio"/> -1	<input type="radio"/> 1	<input type="radio"/> 2
Music	<input type="radio"/> -2	<input type="radio"/> -1	<input type="radio"/> 1	<input type="radio"/> 2
Books	<input type="radio"/> -2	<input type="radio"/> -1	<input type="radio"/> 1	<input type="radio"/> 2
Gadgets	<input type="radio"/> -2	<input type="radio"/> -1	<input type="radio"/> 1	<input type="radio"/> 2
Profession / Course	<input type="radio"/> -2	<input type="radio"/> -1	<input type="radio"/> 1	<input type="radio"/> 2
Movies	<input type="radio"/> -2	<input type="radio"/> -1	<input type="radio"/> 1	<input type="radio"/> 2
Series	<input type="radio"/> -2	<input type="radio"/> -1	<input type="radio"/> 1	<input type="radio"/> 2
Other characteristics:	<input type="text"/>			

---

7. Is it important to know the identity of the other person before the ride?\*

Yes

No

---

8. Is it important to have a score for some attributes of the trip and driver/passenger? (e.g. punctuality)\*

Yes

No

---

9. Which type of communication you will like to use to arrange the sharing?\*

Email

Cellphone

Embedded chat

Facebook chat

Gtalk

Skype

LinkedIn Messages

---

10. If you wish to be a beta tester of this application or be consulted about its features, please leave your email contact.

---

11. This type of application can be very helpful in our society, not only to share rides between students and workers, but also can be apply to several volunteer actions. Do you wish to give us ideas to, in the future, continue this work helping other people?

Figure A.2: Survey - Part 2

# Appendix B

# Mockups



The mockup shows a registration form within a rounded rectangular frame. At the top left is a box labeled 'company logo'. In the center is the text 'Adopt@Student'. At the top right is a box labeled 'ist logo'. Below the title is a '<Messages>' link. The form contains six input fields: 'First Name', 'Last Name', 'Email', 'Cellphone', 'Password', and 'Repeat Password'. At the bottom are two buttons: 'Sign Up' and 'Cancel'.

Figure B.1: Register Mockup

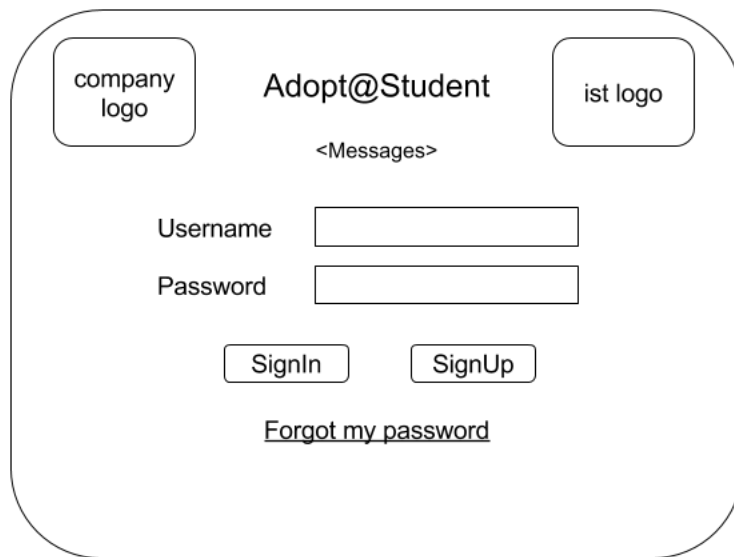


Figure B.2: Login Mockup

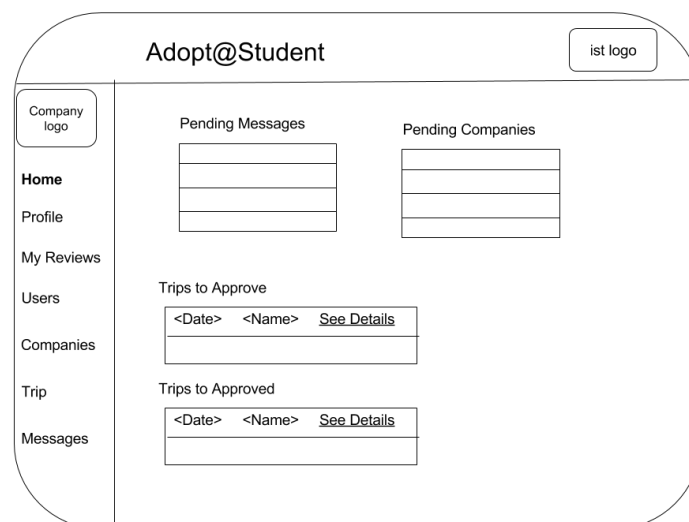


Figure B.3: Administrator Home Mockup

Adopt@Student ist logo

Company logo

Home

**Profile**

▼ Main Save

Old Password

New Password

Repeat Password

Old Email

New Email

Old Cellphone

New Cellphone

▼ General

▼ Hobbies

Figure B.4: Profile Main Mockup

Adopt@Student ist logo

Company logo

Home

**Profile**

▼ Main Save

▼ General

Postal Code  -

Gender  
 M  F

Smoker

Profession  ▼

Area

Company  ▼ New Company

▼ Hobbies

Figure B.5: Profile General Mockup



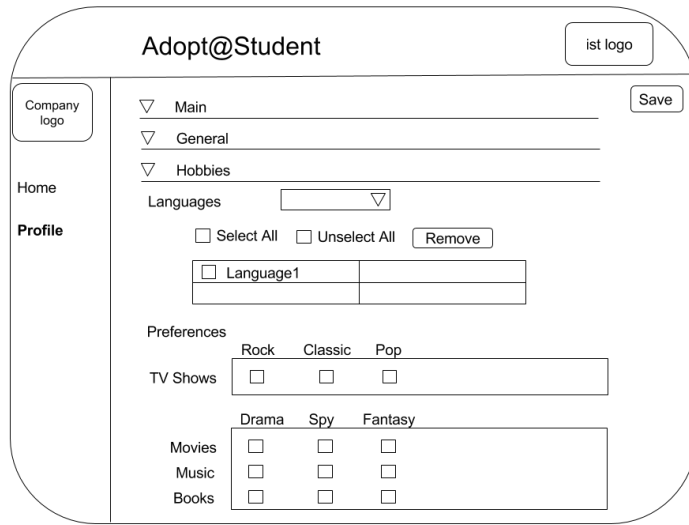


Figure B.6: Profile Hobbies Mockup

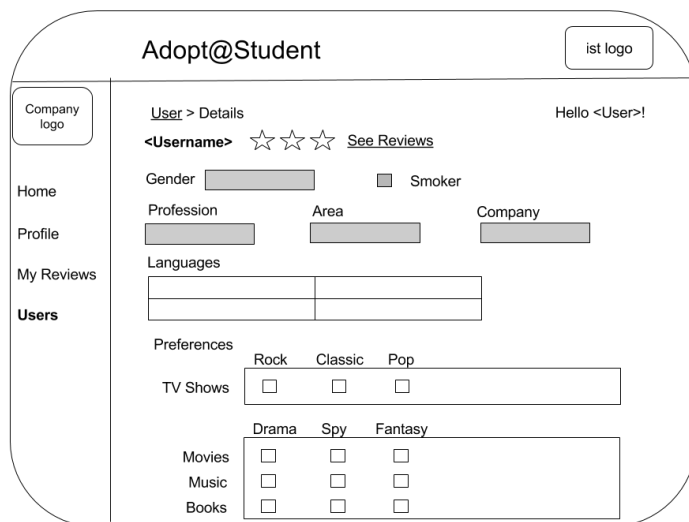


Figure B.7: User Details Mockup

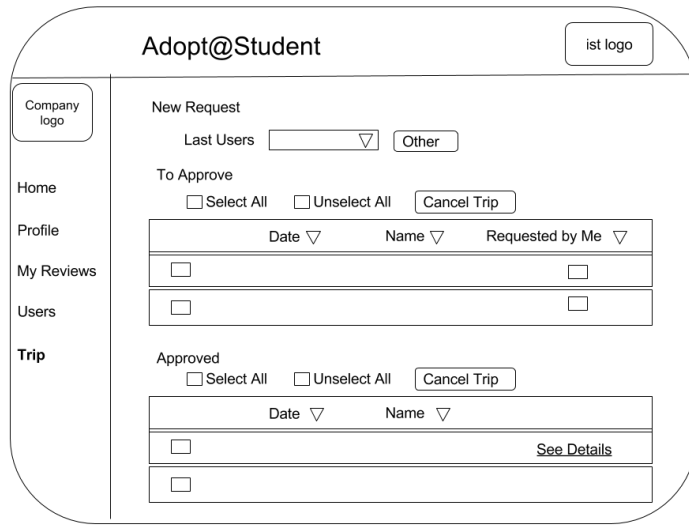


Figure B.8: Travel Mockup

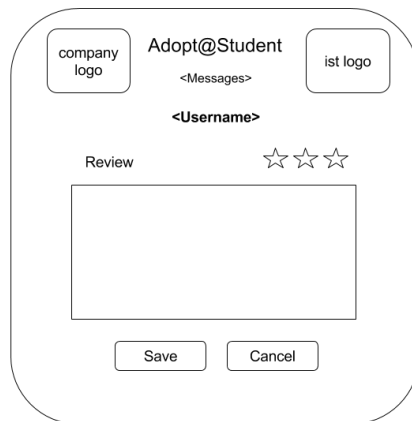


Figure B.9: Review Travel Mockup

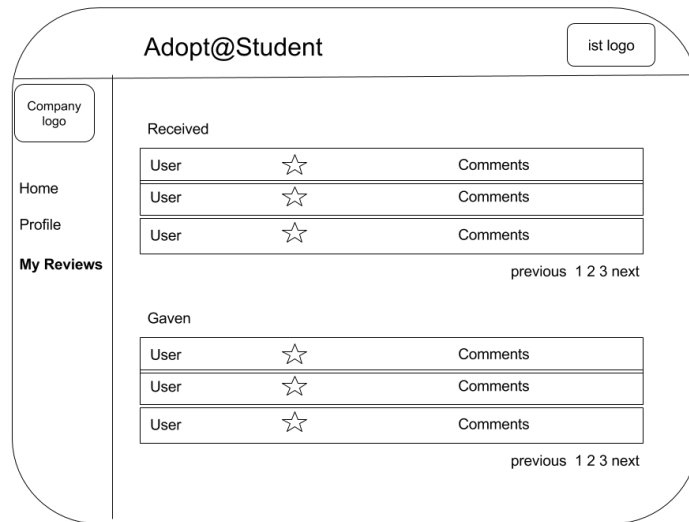


Figure B.10: My Reviews Mockup

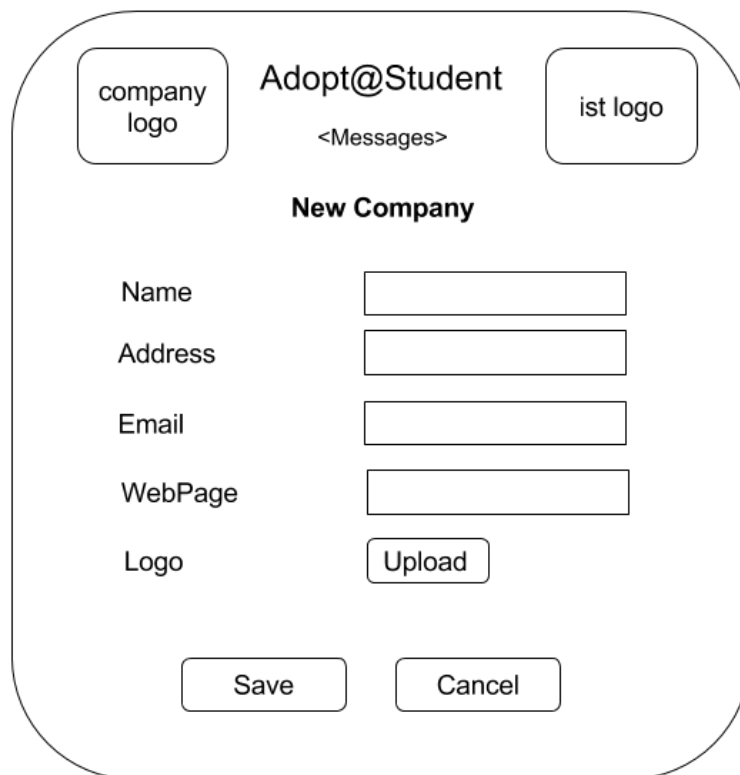


Figure B.11: New Company Mockup

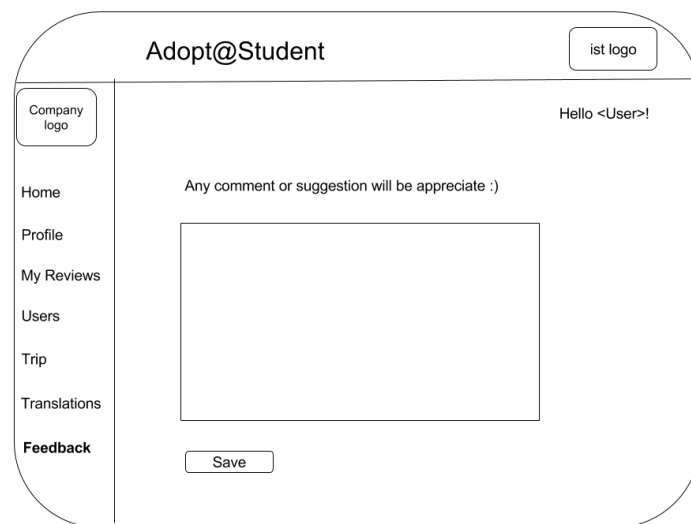


Figure B.12: User Feedback Mockup