

Adopt a Student

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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 paper 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 users 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 NOE-SIS Quality Management area to guarantee the quality of the developed application. The evaluation results show that the goals of this paper 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

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, others 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 the reduce of transportation expenses, environmental impact, traffic congestion and parking needs and the increase of 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 detailed 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 line of businesses?

The main motivation behind this paper 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 is 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 must be considered and investigated in order to obtain a successful application.

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, what are its requirements and how we intend to implement it. After all investigation was done, 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 paper and what can be done as future work.

2. BACKGROUND

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 (Selbstfahrergemeinschaft). Based on the definition of carpooler as anyone who shares transportation to work in a private vehicle with another worker [16] 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 [12], opposing to Budapest where these characteristics are a minor concern [27].

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 [20]. 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 median household income with costs with education (11°) and life costs of the students (12°). 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 [8]. This project does not aim 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 [18]. 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 [28] 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 [10] [11]. This kind of problems can be addressed with a carpooling program and represents one of the goals of this project.

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 [17]. 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 [13]. 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 [15].

3. RELATED WORK

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 and didn't 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 [5]. This application is one of the most complete ones in the market, mixing important characteristics that are spread through other tools. These features include [4] [3]: profile creation, filling out information like interests, occupation, spoken languages, among others; to assist travel organisation 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; 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. The features available in this application are great and were taken into consideration in this project since some of the features presented are align with ours.

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 [21]. 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 there is one innovative idea, since the homepage of boleia.net shows traffic information pullout from Brisa and other websites of that kind, However this feature will not be considered, since on one side the users can find it on other applications designed for this purpose and on the other side it will overload the user with information that may not be required.

Carpooling is a ridesharing application available in Europe, that offers to its users some great features and a clean design. One of characteristics that called our attention is the possibility to use this application on a computer, mobile device and Facebook [7]. 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 [7]: reliability (response rate, response time, punctuality score and activity score), safety (user validation by Facebook connection, Mobile Validation and ID/Passport authentication), fun/social (picking drivers/passengers and car). 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.

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 [23]. 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 [23]. 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. One of the benefits that SAP presents picked our attention, since we want to capture company's workers, which is strength company brand to attract new talents, improves networking, collaboration, information exchange and integration of new employees.

Aventones 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. There are two 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 [19].

The idea behind TravelRole 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 [24] 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. 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 unveiled, 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.

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 [25]. Nowadays this industry is moving forward with some differentiated offers align with market needs. Rental car companies had to adjust the price model to a hourly-based one but this effort has paid out, as we can see since so many other companies had been following this example [25]. The boom on this offering as became notable from 2007/2008, dates also important in financial markets worldwide, nothing to 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 provide 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 On-Star by the integration of P2P in car sharing software [25]. 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 these services alternative fuel vehicles, and all together bring an incredible reduction of human environmental footprint.

Among others, studies made by Robert Clavel and Enoch [22], Consulting and Group [9] and Enoch [14] 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 [29]. 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.

4. DEVELOPMENT

A questionnaire was made 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 help us decide which technology should be used to develop this application we asked which devices the users would most commonly use and 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. Related to the security topic, an overwhelming percentage of the respondents 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, unlike our first thought that users would want to use Facebook chat, a verification process to these information should be considered. 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.

Based on the survey analysis and existing applications in the market, we identified all major requirements needed to reach our goals: as an administrator I must be able to block/unlock a user, see all users and change their email or/and cellphone, create companies and use the application as a user; as a user I will belong to the blacklist if the administrator has blocked my account, to the red list if my account is locked by login failure attempts, to the yellow list if my account is not activated, to the green if my account is activated but my profile information is missing, to the whitelist if my account is activated and my profile info is fulfilled; as a user I must fill my name, email and password to create an account, then receive an email to activate my account and activate it to be able to login in the application; as a user I must fill my email and new password to reset my password, receive an email to confirm password reset and then activate my account to be able to login in the application; as a user I must fill my email and password to be able to access my account and if I fail my password three consecutive times my account must be locked; as a user I must be able to choose my gender, profession, profession area, company that I work for (with the exception of students), languages that I speak, preferred tv show genres, preferred movie genres, preferred music genres, preferred books genres and if I am a smoker; 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; 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; as a rider/driver I will have a list order by percentage of compatibility and distance between rider and driver, I can only see email and cellphone of the driver/rider once the trip is accepted and I must be able to review another user, but only the one that I have driven with.

In order to support some of the requirements defined above we created a set of formulas. With Formula 1 we were able to rate a given user through the total number of 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.

$$R = n * \sum_{t=1}^n u_t \quad (1)$$

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 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 1.

$$C = u + \sum_{u=1}^n R_u \quad (2)$$

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 doesn't 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 1 in which Strongly Disagree corresponds to (-2), Disagree to (-1), Agree to (1) and Strongly Agree to (2). Some important components were not considered for this calculation since the formulation of the survey didn't 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.

	-2 (%)	-1 (%)	1 (%)	2 (%)	Rating Avg	Weight Avg
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 1: Rating and weight average of relevant profile characteristics

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 3 where m_i is the matching 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).

$$S = \sum_{i=1}^n m_i * w_i \quad (3)$$

$$w_i = \frac{W_i}{\sum_{k=1}^n W_k} \quad (4)$$

5. IMPLEMENTATION

We decided to use OutSystems as our development tool, since it is designed with the only purpose of conceive web based applications, has a low learning curve, several integrations with external systems already available, direct integration with C# where we are able to go further if we want to programme something out of the box and a cloud option, which leads to almost zero preoccupations regarding system maintenance, and last but not least allows an easy and fast deployment.

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.

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 we needed in our application.

Data tier was implemented as a module in the Service Studio and contains the schema of our application. 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 like (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 users' wrong login attempts to automatically lock their account so a UserLogin table was set and as defined in the requirements the user has a UserList associated that give us the state of their account in the system, this values are constant so a static entity is the right call to have them. If any error occurs in the application or any doubts emerges in the

user's mind they must be able to contact the administrator so a Report entity was created to save those communication and 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.

In the Application tier module we have implemented the business logic necessary to make our application work as expected (an example of OutSystems implementation can be seen in Figure 1) and in the Presentation tier module we can find the screens that support our application.

The first thing the user needs to do when he wants to use our application is to register himself. 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. 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, we need to check if the user can use the application and if not he must comprehend why not, like sending a message saying "Your account is not activated, please activate it through the link sent by email".

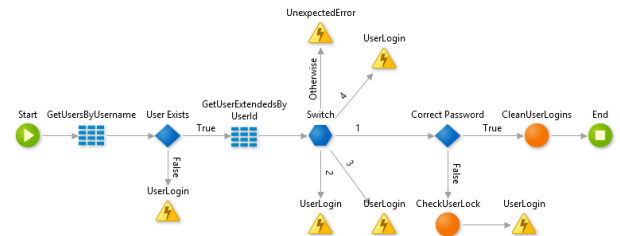


Figure 1: Login Logic

The login process checks if the user is registered, locked, blocked, inactive or exceed the number of wrong attempts, before allowing the usage of the application. After a successful login the user is redirected to the home page (Figure 2) 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.

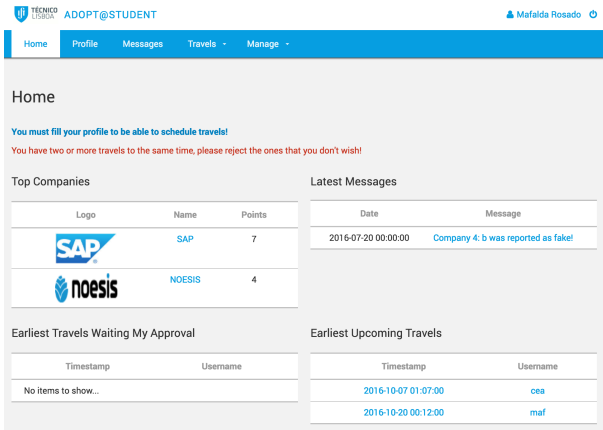


Figure 2: User Home Screen

In the profile, the user is able to fulfil his information, either the mandatory for request a new travel (mobile phone, address, gender, nationality, profession, profession area and company (not needed if the user is a student) 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. On the top of the page 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.

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 3 through a complex query that reads smoker and user's tables preferences 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 would result on a waste of effort to copy all the information from one structure to the other. 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, 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. 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.

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 order to avoid the development of something that already exists we used ImageUtilities to resize the company logotypes, SortRecordList to order the lists shown to the user, Google Maps to indicate where is the address that user had inserted and Google Matrix to calculate the distance between driver and rider. 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.

6. EVALUATION AND RESULTS

Since the result of this dissertation is a car-sharing application, the tests should be done by 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 [26], 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.

The tests were classified according to their scope (functionality, layout, improvements and usability) and severity degree (critical, major, minor and trivial) following the principles of International Software Testing Qualifications Board (ISTQB [6]). Also 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).

During the tests 123 defects were found and separated by their scope (Figure 4) and severity (Figure 3). 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 login (corrected); application crash when deleting some companies (false positive). 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 (solved). Some of the minor errors were considered no issues, since they were related with expected disparities in different web browsers or devices. Respon-

siveness 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 had a message in the home page indicating that the user must fill its profile in order to schedule travels. However the 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 become 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.

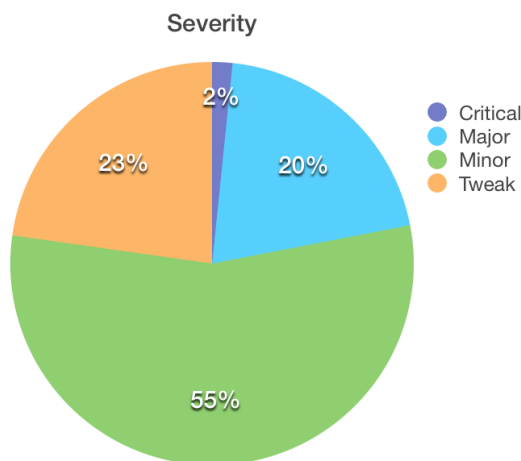


Figure 3: Defects by Severity

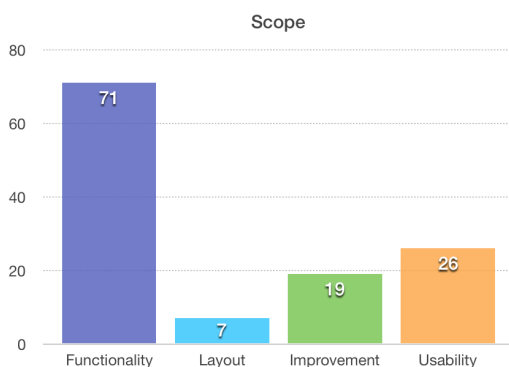


Figure 4: Defects by Scope

7. CONCLUSIONS AND FUTURE WORK

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. We consider that the investigation of existing applications and the survey made to the future users was vital to the success of our application. OutSystems platform was a great fit, but as a down side we had two major problems related to dates, since we were not able to change the timezone (GMT-1) neither the date format on the server. NOESIS company 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 have accomplished the defined objective, nevertheless some adjustments were made based on the testers inputs and defects found.

Although we considered that the application was successfully implemented, some new features or upgrades can be performed in order to increase our application capacities. We had 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. These new features or upgrades are the offer of multi language support, international phone numbers and integration with social networks, like Facebook, LinkedIn, Google Plus) in the registry and login.

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