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Research and Development of a Mobile Application Interface for Ridesharing for a University Campus in Amazonas

Pesquisa e Desenvolvimento de Interface de Aplicativo Móbile para *Ridesharing* para um Campus Universitário no Amazonas

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Abstract: The worsening in the last two decades of the conditions of urban mobility in the world has aroused in contemporary societies the need to face barriers and inefficiencies in mobility in cities. With the advent of information technology in the last decade, favorable conditions have emerged for the feasibility of some mobility alternatives. In this context, there is the ridesharing method, integrating drivers and hitchhikers by the application that presents specific boarding and disembarkation routes and points associated with different gains for both and society in general. This paper presents the development of the mobile application interface design for integration between members of a university in northern Brazil. Usability guidelines applied in application interface design guided the methodology used for application development.

Keyword: Interface design, Mobile interaction, Mobile interface design, Tool integration, Urban navigation, User interaction

Resumo: O agravamento nas últimas duas décadas das condições de mobilidade urbana no mundo tem despertado nas sociedades contemporâneas a necessidade de enfrentar barreiras e ineficiências na mobilidade nas cidades. Com o advento da tecnologia da informação na última década, surgiram condições favoráveis para a viabilização de algumas alternativas de mobilidade. Neste contexto, destaca-se o método de caronas, integrando motoristas e passageiros pelo aplicativo que apresenta rotas específicas de embarque e desembarque e pontos associados a ganhos diferenciados para ambos e para a sociedade em geral. Este artigo apresenta o desenvolvimento do design de interface de aplicativo móvel para integração entre membros de uma universidade no norte do Brasil. Diretrizes de usabilidade aplicadas no design da interface do aplicativo orientaram a metodologia usada para o desenvolvimento do aplicativo.

Palavras-chaves: Design de interface, interação móvel, design de interface móvel, integração de ferramentas, navegação urbana, interação com o usuário

1. INTRODUCTION

One of the major problems facing humanity since the end of the last century is the unfavorable condition of urban mobility. In cities that favor motorized individual transport the problem is aggravated.

There is a natural imbalance between the capacity of the government to expand its road network and the rapid increase in the fleet of private motor vehicles. Advanced societies face the problem by fostering mobility alternatives and disincentives to individual self-propelled transportation. Unfortunately in underdeveloped nations with no history of adopting technical instruments and planning for urban mobility, there are problems of congestion and chaos in the daily traffic of cities. At the same time, it should be noted that the increase of the road network does not translate into an efficient and definitive solution to the transportation problems in cities.

The traffic conditions of the city of Manaus (state of Amazonas, Brazil) exemplify the previous discussion. At peak times the current setting results in locking and retention at various points in the city's road system. Any accident with full or even partial closure of a single lane impacts almost all major roads in the city. And even with the construction of new interconnection and retention-reducing infrastructures such as overpasses and level crossings, no significant advantages were noticed for efficient traffic flow.

The problem of congestion is not exclusively related to the upsetting and restlessness of citizens who are trapped in the urban traffic jams. The inefficiency in transporting people and cargo in a city also results in additional greenhouse gas emissions, high and inefficient fuel consumption, wasting of time, damage to various businesses, generation of insecurity, and so on. It is notorious and widely discussed in the technical and scientific field the problems and alternatives related to individual motorized transport. Nevertheless, some barriers imply an unfavorable environment for the adoption and implementation of resolute measures. Among these measures is a mobility procedure the practice of ridesharing, made possible today by the evolution of communication through mobile devices (smartphones).

Ridesharing is a socially sustainable mobility alternative, as it allows people to travel in rides without financial remuneration and allows riders to get access to exclusive lanes and “privileged” parking and may even represent a reduction in “swellings” on public transport systems (especially during peak hours). In addition, it can also make possible the reduction of vehicles in traffic, and ultimately reduce the economic pressure on the public power that may fail to increase its resources in the expansion of the road system and in the public transport fleet, equipment and agents. It was evident in the study of mobility of the Federal University of Amazonas - UFAM and other universities in Brazil that the lack of technical resources, in addition to the lack of knowledge on the part of the university communities, represents one of the central elements for the practice of this mobility alternative put into practice.

UFAM and society in general already have the necessary and sufficient Information Technology resources to enable the insertion of ridesharing as a mobility alternative. However, there are still no specific efforts to actually develop a specific tool to meet their specific needs. Given the scenario described earlier this article presents the process of developing the ridesharing tool's interface design to be used by the UFAM community.

2. BIBLIOGRAPHIC REVIEW

2.1. EVOLUTION OF INFORMATION AND COMMUNICATION TECHNOLOGIES (ICTS)

According to Cury (2011), in his article on the History of Information and Communication Technologies, the evolution of ICTs generates significant cultural impact resulting in social, economic, scientific and political changes. The invention of the Gutemberg printing press, the telegraph, photography, the

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telephone, the computer, the internet and later wireless communication, among others, were technological milestones that established new paradigms in human life.

The contemporary technological and cultural scene stems from the popularization of the world wide web, the Internet, and related instruments. Cury (2011) explains that the precursor of the internet, ARPANET, was established in the mid-early 70's with the purpose of integrating academic and military research to generate new technological projects. Due to the growing complexity of the network, caused by the establishment of communication protocols and programming language and the expansion to the telephone and satellite networks, ARPANET was replaced by the internet and started to connect computers and allow the exchange and processing of data and information among them. In the late 1980s, the World Wide Web (WWW) emerged in parallel with the popularization of personal computers, enabling ordinary people to access a massive amount of information and facilitating the most diverse communication processes. Given the complexity of contemporary society, ICTs have become a permanent and indispensable part of the human way of life, being the cause and consequence of economic and social change. According to Moran (2012). ICTs can be understood as technological tools to facilitate communication. Such tools are therefore omnipresent, as we live in the so-called Information Age.

In a simple task of making a purchase one notices a significant amount of ICTs involved in the process. For example, in a store purchase, product barcodes are read by a scanner connected to the store's inventory system and payment can be made by credit card allowing access to the user's banking system. Barcodes, the scanner, the inventory system, the credit card and the banking system are tools designed to facilitate customer communication with the services needed to make a purchase. There is therefore a tendency to further facilitate communicative processes by converging tools and simplifying systems. In this context, the most popular tool today is the smartphone, a mobile communication device with high data processing capacity that accumulates functions, besides the telephone, through service-providing software called applications or apps. It's important to note that both apps and smatphones are ICTs. According to Silva et al. (2015), applications are products that can be downloaded from an online store through a mobile internet connection to perform various types of services.

2.2. Mobile Application Development

There are several ways to build mobile applications, as there are a variety of development and usage platforms, as well as a multitude of interface design methodology and different models of mobile devices with different operating systems. Silva et al. (2015) discusses the difference between developing web apps, native apps, and hybrid apps for Apple's iOS system. Mattje (2014) presents hybrid applications which develop mobile applications for various platforms using single programming. This enables the generation of smartphone applications that integrate with other employee communication tools, making them accessible on Android and iOS devices.

From these studies, it is inferred that, in order to make the application broader in terms of audience reach, the developer must design them so that they can be used on the various smartphones (or tablets), be they IOS System, Android or any other system, aiming also not to make significant differences in their use.

Application Development Patterns (Neil, 2012) lists several successful models of interface design elements and their most common uses, presenting options usable on both iOs and Android platforms.

2.3. Ergonomics and Usability

The mobile application interface, because they are virtual environments targeted at people of different ages and levels of familiarity with technological devices, require caution on the part of the designer at the

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moment of its development. In this context, knowledge of the principles of Ergonomics focusing on Usability of Digital Interfaces is indispensable and present itself as a defining factor of the success of a mobile application project. Therefore, several academic researches about this subject are being carried out in the last years. Zaidem (2015) compares the usability of applications of the IOs and Android operating systems and concludes that the latter has superior personalization and individualization characteristics than the main competitor, which in turn stands out for ease of operation and security. Gonçalves (2014) establishes usability guidelines for mobile application design, summarized in the Table 1.

Table 1: Categories of usability guidelines for application design

1 - Context		
2 - Content		
3 - Information Architecture	3.1 - Organization	
	3.2 Navigation	3.2.1 - Workflow
		3.2.2 - Navigation Affordances
	3.3 - Labeling	
	3.4 - Search, Sorting and Filtering	
4 - Screen Layout	4.1 - Screen Orientation	
	4.2 - Screen Size	
	4.3 - Screen Design	4.3.1 - *Chrome* Elements
		4.3.2 - Diagramming
		4.3.3 - Aesthetic Value
		4.3.4 - Viewing Patterns
		4.3.5 - Color and Typography
5 - Graphics		
6 - Forms		
7 - Dialogues	7.1 - Language	
	7.2 - Messages, Notifications and Alerts	
	7.3 - Errors	
	7.4 - Help	
	7.5 - Animation	7.5.1 - *Loader*
		7.5.1 - Transitions
	7.6 - Sound	
8 - Input Methods	8.1 - Typing / Keyboard	
	8.2 - Selection	
	8.3 - Controls	
	8.4 -*Touch Targets*	
	8.5 - Gestures	
9 - System Functions	9.1 - Saving	
	9.2 - Customization and *Settings*	
	9.3 - Connectivity and Sharing	
	9.4 - Device Features	

Source: GONÇALVES, 2014.

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2.4. RIDESHARING

Sousa (2014) describes that, during the period of World War II, the basic principle of carpooling emerges in the United States. This phenomenon was due to the need to reduce fuel consumption by society. Then there were incentives and determinations for employees to share their vehicles with co-workers on the same commute. Later, during the period of the oil crisis in the 1970s, the number of entities with programs to promote sharing increased. An example of these incentives was the creation of exclusive lanes for vehicles that performed a mode of carpooling, which eventually became slugging.

Shaheen et al (2016) refer and argue that casual carpooling represents a ridesharing operationalization mechanism. In ridesharing there is no direct division or sharing of costs between those who offer or who ride. In addition, the ridesharing practitioner's gain lies in the benefit of using "privileged" lanes (e.g. Manaus' blue lane) and / or a reduction in toll rates.

It should be understood that ridesharing does not need the requirement to "ride in solidarity" with participants residing close to each other, but rather between participants connecting routes with participants' departure or arrival points. Thus, the term can be interpreted as a dynamic carpooling, as it does not require commuting, i.e. home-work-home.

One of the difficulties encountered in the effective operation of ridesharing from birth to the last decade was the lack of information technology mechanisms and instruments. However, in the current decade, with the popularization of the use of smartphones with internet access and the development of new applications, there is an opening and establishment of the main conditions for achieving successful ridesharing.

Byonl et al (2013) indicate that the current advancement of computing, communication and social networking tools, especially due to the high availability of smartphone devices, enable the practice of carpooling - and consequently ridesharing.

Siuhi, Mwakalonge (2016) present and discuss the viability and opportunity generated by smartphones, which benefited different sectors of society, including transportation, enabling practices such as ridesharing, carpooling and vanpooling, using the following applications for these modes of transport: Uber, Avego, SideCar, Car2go, Podorozhniki Smart Ridesharing, RideShare4Less, Tifandi-Share Your Taxi Ride, Zebigo, Share-E-Ride, Southwest Carpool V2, Adelaide Carpool, Carma Carpooling.

Nale et al (2016) point out that the Carpooling Application for Android Platform tool, which provides sharing in passenger car travel, enables fuel cost savings and CO2 emissions.

Dimitrijević et AL (2013) show the adoption of web and app tools for carpooling and ridesharing, such as Lyft, SideCar and Waze.

Despite the "good" conditions for the diffusion of the new modes of transport mentioned, countless other variables cause barriers to their evolution, namely: distrust and insecurity in relation to people who join the sharing program; the relative loss of intimacy of the individual and / or family environment; the affinity of different dimensions between participants; and the loss of freedom to perform other routes and at varying times.

Other issues are the absence of legislation that ensures the practice and distrust of the taxi segment, which could regard ridesharing practices as a possibility of competition, as some users could unduly institute a paid ride procedure.

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2.5. "SOLIDARITY RIDE" LAW

The search for regulation of the “solidarity ride” is new in Brazil. It is being processed in the federal chamber through Bill No. 8.074 / 2014, which aims to establish the "Legal Ride System" nationwide regulating carpooling and ridesharing as solidarity transport.

In fact, the simple regulation of ridesharing is not enough for such a shared transport model to be effectively adopted by society. A simple regulation does not solve the barriers indicated above, such as safety, habits changes and so on. Certainly there must be the basic and necessary conditions for such barriers to be circumvented, and potential users foresee effective gains.

Below are concrete examples in progress or to be implemented:

a) Public Office creates solidarity ride application for servers: Sustainable mobility project of the House of Representatives, known as MOB-Carona Solidaria, wants to make better use of car spaces around the Public Office. Running since December 15, the program works through an online application, where servers and outsourced Public Office staff can request and offer rides. Those who adopt the project will have access to vacancies closer to the Public Office. In addition to saving on fuel and car parts, the participant will also be contributing to the reduction of emissions of polluting gases into the atmosphere. The only requirement to participate in the program is for the car to have at least three people (City staff), counting the driver. The application can be accessed through the intranet. One of the Carona Solidária users, Daniel Carvalho, a resident of Águas Lindas de Goiás (GO), a municipality near the Federal District, was able to reduce his expenses with the solidarity transport initiative. “I'm spending a quarter of what I spent monthly on gasoline. I used to spend R$ 600 and now only spend R$ 150, so it's very viable for me", he said.

b) Viaduct in São Paulo is allowed for cars with more than one person: The route was only allowed for buses and taxis. Measure aims to encourage shared use of the car.

c) Bill intends to exempt from the toll those who practice solidarity ride: The text is under analysis of the technical areas of the Government of the State of São Paulo.

2.6. COMMUNITY SPECIFIC RIDESHARING AND CARPOOLING

Both the contents of Bill N. 8.074/2014 and other publications and experiences show that carpooling and ridesharing are initially successful when applied to specific communities, such as companies, agencies, universities, etc.

In the specific case of universities there is a high universe of recorded experiences, for example:

a) Proposed *carpooling* and *ridesharing* system to enable UTFPR community mobility (MARTINS and LARA, 2016);
b) Identity development process and identification of hitchhiking application used for the community of Universidade Federal do Rio Grande do Norte – UFRN. (Cricket, et al, 2016);
c) Impacts of different modes of transport at Instituto Politécnico de Leiria (Ferreira, et al, 2016);
d) Mobility study at the University of Minho (Meireles, 2014);
e) Carpooling web service at Universidade Complutense de Madri (Esteban, et al, 2012);
f) The use of *carpooling* at Faculdade de Engenharia da Universidade do Porto (Sousa, 2014);
g) Hitchhiking study at Universidade Federal de Pernambuco (Silva e Andrade, 2016).

In addition, it is noteworthy that university experiences in carpooling and ridesharing are a phenomenon that is gaining momentum today, as the publications on this subject are recent.

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Kuwahara, et al (2008) present results of the extension project carried out in 2008 of "Evaluation and Proposition of Mobility Management at UFAM Campus: Analysis of the Introduction of Carpools and Cycling as Transport Alternatives", being found receptive by the university community to adoption of such mobility alternatives, despite the need for some measures.

One advantage of implementing ridesharing in a restricted community over hitchhiking combined through groups of strangers made in messaging or social networking applications is the security provided by the identification tools of the group of individuals involved, as noted at the Federal University of Maranhão - UFMA and the Federal Rural University of Pernambuco - UFRPE, which uses student records to identify and integrate drivers and rides to reduce the occurrence of robberies and other crimes at campus bus stops.

UFMA students have a group in the Whatsapp messaging application and ask for a screenshot of the practitioner's profile on the university's institutional portal to ensure the individual's link to it.1

UFRPE has its own application called Carona Phone, whose registration can only be done by the institution and the interface allows the application to connect with the user's Facebook, displaying their photo and profile on the social network. 2

Finally, it is reiterated that the practice of solidarity hitching without an adequate tool and without restriction of participants can result in fatal crimes, such as the case occurred in Minas Gerais in November 2017. It was reported that a 22-year-old woman agreed to offer a ride to a stranger through an open application and was eventually killed by the passenger who intended to steal her car.3

3. Methodology

Chammas (2014) lists the main existing methodologies and compares them under the precepts established by ISO 9241-210 / 2010. This standard state that an interactive systems development methodology should follow the following principles:

- The design should be based on explicit understanding of users, tasks and environments;
- Users should be involved in the whole project development process;
- The project must be oriented and refined by user-centered assessment;
- The process must be iterative;
- The project should address the entire user experience;
- The team must have multidisciplinary competencies and skills.

In short, it can be said that the best methodology for developing interactive systems is one that supports the needs of the user while meeting the design requirements and the familiarity of the designer.

Among the listed methodologies - SCRUM, *Elements of User Interface, Lean Ux, Rapid* ContextualDesign*, Goal-Directed Design, Wheel, Design Thinking* and Usability Engineering Cycle - only the last two

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determine user participation to meet the conditions set out in ISO 9241-210 / 2010. Therefore, based on the amount of material available and the complexity of the two methodologies, we chose *Design Thinking*.

The multidisciplinarity suggested by ISO 9241-210 / 2010 was met with interaction with a Computer Engineering researcher responsible for programming the JAVA application for Android devices. This step has consolidated technical programming factors that limit or expand application functionality.

Usability testing through a guided interview at the UFAM Usability and Interfaces Lab, with individuals who are part of the application audience, enabled user involvement in the refinement and validation stages of the prototype.

3.1. Design Thinking

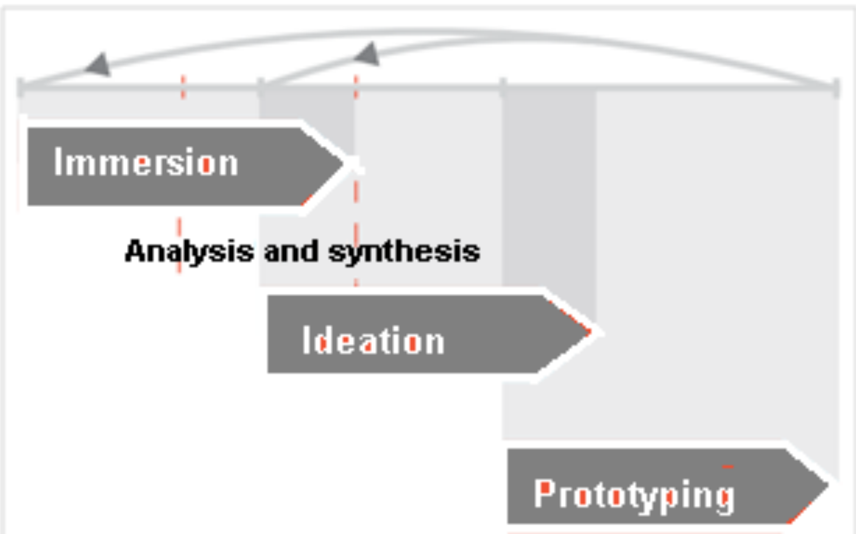
According to Martins et al. (2016) citing Brown (2009), the Design Thinking methodology strikes a balance between three criteria of a project - feasibility, feasibility and desirability -, which are conferred through the approach of individuals (direct or indirect users) related to the system project. In addition the application of Design Thinking generates a number of prototypes that allow the comparison of various projects, inducing improvements and provoking innovation.

Martins et al. (2016) also concludes that Design Thinking proves to be an efficient connection between didactic and academic content with market reality due to its functional and pragmatic nature, focusing mainly on user needs.

According to Vianna el al. (2012), the Design Thinking process is divided into three stages: Inspiration or Immersion, whose goal is to "... define the scope of the project and its boundaries", "… identify extreme behaviors and map patterns and latent needs "of the process actors and analyze / synthesize the information obtained; Ideation, where ideas are generated to solve the observed problems; and Prototyping, where generated ideas are tested and validated.

The methodology is flexible, because the results of the succeeding steps feed the previous phases, generating a kind of cycle as shown in Figure 1.

Figure 1: Representative scheme of the stages of the Design Thinking process



Source: VIANNA, 2012

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Vianna el al. (2012) divides Immersion into Preliminary, where the designer becomes familiar with the scenario and the agents involved in the project, seeking behavioral and situational patterns; and Deep, where the causes and consequences of these patterns are studied. The authors also various techniques for performing such types of immersion.

The Preliminary Immersion process took place by defining all the subjects involved in the action to be performed (ride), which in this case would be the driver and the passenger (direct users of the application) and the individual responsible for the programming and maintenance of the system from which the interface intermediates.

It was decided to focus on direct users to define the requirements and parameters of the visual programming of the interface and we considered the third subject when structuring the informational architecture of the application.

The data collection process was done through three *Design* Thinking techniques: The *Desk* Research, with the analysis of applications similar to the one intended to be developed and the reading and academic work of other universities with similar objectives; Exploratory Research, where the researcher interacts with subjects related to the study; and "A Day in the Life," where the researcher puts himself in the place of those he previously interacted with to define the causes of the reported problems.

The collected data were synthesized in the form of cards with insights about the problem (called *insights*) and flowcharts with the order of actions related to the problem.

Observing all the collected criteria it was possible to create an interface structure, that is, to define the application elements, both technical and visual.

The prototyping phase was performed on paper as low complexity *wireframes* and then developed with the Adobe XD tool, a rapid prototyping *software* for digital interfaces such as applications and *websites.*

3.2. Usability Testing

Usability testing allows you to verify the quality of the mobile application by taking into account the user for which the system was designed.

By performing the test it is possible to identify if the users' needs will be promptly met, if there is any problem in the interaction between the user and the system and finally detect some design errors.

According to PRATES (2003), often the user cannot express his own experience while using the system, therefore, it is essential that the designer carefully plans, guides and observes the usability test, in order to extract the data necessary for the enhancement of your project.

The usability test was performed at the end of the project cycle, in this case being classified by FERREIRA (2002) as Validation Test.

The author explains that the Validation Test aims to "verify how the product fits in with usability standards, performance standards and historical standards".

Also highlighted is the importance of choosing the right place, the roles of the individuals responsible for the testing steps, the importance of choosing the right participant users, and developing a detailed script / script / to-do list to guide the evaluator during the tests.

In adapting the author's method, the researcher accumulated as an evaluator, information organizer and observer. While the post of record operator (photographic record) was performed by an assistant. In this research the functions of expert and time recorder were not necessary due to the nature of the application.

FERREIRA (2002) also states that the product or prototype validation process with an attempt to expose usability problems can be done in a short period of time with about five participants as long as they match the profile of the target audience. So, since there are two main types of users in the app, it was decided to test it with seven individuals who could use it in a real situation.

4. Results and Discussions

4.1. First Stage (2017/2018)

In the Immersion phase of the Design Thinking methodology, the behavior of the application's target audience was studied in order to raise possible problems in the system operation and propose some partial solutions.

The first concern perceived was the high mistrust of the female public for potential male users, even though they were members of the UFAM community. It was thought that by highlighting the driver's gender in the app during the ride offer process, it would give female passengers the power to opt for a driver who gave her a sense of security.

In addition, with regard to safety, the very condition of UFAM's own ridesharing system being directed to a restricted community and having a participant register contributes to the safe practice of carpool, as opposed to the use of applications. “Open” services that offer hitchhiking between strangers, or simply by combining parties in message groups like Whatsapp. Both of the previous scenarios present a danger to users and because of this the project described here is relevant and different from other similar services.

Another problematic situation considered would be: How would the driver and passenger recognize each other at the time of the ride without causing any embarrassment or difficulty to the users? For this question some ideas came up:

- Use bus stops as ride hotspots as they are recorded in major geolocation applications and tools;
- • Implement in the application a feature for the passenger to provide some information to facilitate their identification, such as the color of clothing or combine some gesture for identification. (Idea was dropped in the prototyping phase as it added more steps to complete the action, compromising usability)
- • Implement in the application one that identifies for both users through a beep that they are nearby; (Such feature lacks existing yet unstable technology)
- • Implement in the app a feature that would display on the smartphone display a flashy image (red screen) for the passenger user to use as a signal to the driver. (Option discarded due to the possibility of theft of the smartphone device).

The use of bus stops as reference points is also justified by the guarantee that the passenger will have to reach his or her destination within the desired timeframe in case the accidental ride does not occur. Enabling this user to use common public transport as a second mobility option.

Later, it was realized that, as UFAM was the main site present in the application, it would be important to include university parking lots in the list of rides, in addition to the already included bus stops.

The type of user was classified based on their role in the institution, and these students, teachers and administrative technicians. Based on this labeling it was possible to establish the adequacy of the interface to the condition of each one.

Research was done on the possibility of integrating UFAM's ecampus data system with the application to ensure the correct identification of users. The response was positive, but with caveats. The ecampus system is programmed with the Groovy language and using the Grails framework, so the application to be designed must be compatible with both. In addition, the authorization of the Dean of Teaching and Graduation of UFAM is required for the personal data of students and servers to be used. User authentication is established through the CPF, such as access to the ecampus portal. It was also informed that there is in the database of the university information about the administrative technicians, but they are outdated, so for the successful implementation of the application in the academic community is necessary to update this data by the administration of the institution.

Regarding the benefits for drivers, it is considered to reserve vacancies that are closest to the UFAM access roads and that are in shaded areas for drivers who practice solidarity ride. The idea came from drivers complaining about concentrated heat in their cars throughout the day and the difficulty of finding shaded parking spaces that minimize this problem.

Another idea of benefit thought was the release of the "blue belt" (fast transit lane for public transport) present in the main roads of the city, in order to reduce travel time and arouse the driver's interest in the solidarity ride.

According to Article 1 of Ordinance N. 033 of February 15, 2016, from MANAUSTRANS, the use of the "blue lane" is authorized for urban mass transit vehicles, taxis, charter vehicles, school transport vehicles, military transport vehicles and winches if these are in exercise of their functions. Therefore, it was informed that, in order to release the use of the special lane by vehicles practicing the solidarity ride, MANAUSTRANS must update the ordinance.

We studied some articles and conclusion papers related to the practice of ridesharing and carpooling in several Brazilian universities and the Iberian Peninsula (Portugal and Spain). The two most informative surveys were the Dissertations called CARONA UNIVATES PROJECT: PROPOSAL OF REDESIGN AND CREATION OF AN INTERFACE FOR MOBILE DEVICES (MÜLLER, 2015) and the article UFMG RIDES: INVESTIGATING RELATIONSHIPS OF EXCHANGES, SAFETY AND REWARDS IN THE DEVELOPMENT OF A MOBILE APPLICATION FOR A COMMUNITY (LEITE et al., 2016).

From the first it was observed the creation of application operation flowcharts and examples of interface elements such as menus, layout, among others. In the second, the reputation system implemented, and the concepts of total and partial ride were analyzed.

In addition, three mobility-related applications were analyzed to identify positive and negative points in their visual programming and the stylistic design pattern applied to them. The applications studied were AYA, 99Taxi and Troopool.

From these apps were taken advantage of the menu ideas, predefined locations, user help in the form of questions and answers and presentation of the application on first access.

With the synthesis of all the information obtained and ideas generated, the process of creating the brand, the interfacial system and later the prototype of the screens began.

The application elements were created in the following order:

1. Context;
2. Content;
3. Brand;
4. Navigation;

5. Screen Layout and Design;
6. Dialogues and Notifications;
7. System Functions.

4.2. CONTEXT

The application must enable the action of solidarity ride among members of the UFAM academic community (students, teachers and staff), serving as the main mobility option for those who wish to move from their homes to the university quickly, safely, avoiding the disorders common to public transport users.

The advantage for the driver would be through the right of use of the fast lane present in parts of the city and special spaces on campus, both at the time of the ride.

4.3. CONTENT

The application is equipped with the Home area where the primary actions are performed (offer, request and cancel ride) and a menu with secondary options (Profile, Benefits, History, My Places, Settings, Help, Contact Us and Exit).

Home is designed in two modes: the driver and the passenger. Both are easily interchangeable and have slight differences in their visual programming and language to suit the type of user action. In addition, the menus differ by including the "Benefits" option in driver mode.

4.4. BRAND

The app's branding should consist of symbol and logo, as well as representing the concepts of commute, ride, community, UFAM, and sharing. Therefore, the shape of the icons related to these themes was studied.

The predominant geometric form found was the circle, which refers to movement, technology, the idea of cycles and union. Then the circle shape was deconstructed and a series of graphical recombinations were performed to obtain symbol alternatives.

Among the options generated and their variations, we chose the one that seemed the most visually pleasing and that resembled a pin with a hollow space that resembles a wind rose or a four-pointed star, and has four elements that refer to the UFAM-branded coffee and tobacco leaves and the maximum number of seats available in a popular car normally used for rides.

Regarding the name of the application, RIDESHARING UFAM was chosen because it is straightforward and represents exactly its function.

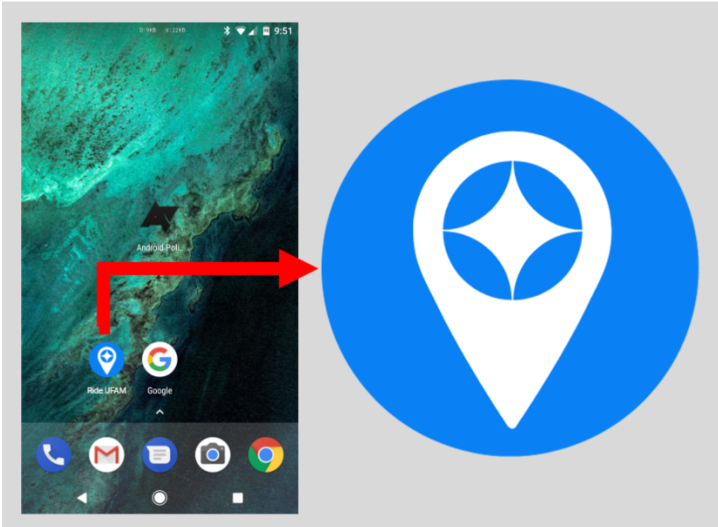
Carpool UFAM was first thought of, but there was already a project called that, and furthermore it could cause confusion by the term to encompass both Carpooling and Ridesharing rides.

For the logo, a font that visually harmonizes with the symbol was chosen. The typography chosen was Baloo Bhai in capital letters. The name RIDESHARING UFAM has a letter 'E' spacing from the symbol.

As for colors, blue and green were considered because they represent technology, trust (blue) and sustainability / community (green). However, during the prototyping phase, it was observed that the use of lighter shades of blue made the application more inviting and enjoyable. Then the secondary color became white. Ridesharing UFAM's first contact with the user is through the app's avatar. That's why it was designed to give you a little idea of the project.

The avatar model chosen consists of the brand symbol on a background that resembles the paths of digital maps, alluding to the pin image marking the location on these maps, as indicated in Figure 2.

Figure 2: Avatar Ridesharing UFAM



Source: The Authors

4.5. Navigation

It was defined that the first access of the user would have a small presentation of the idea of the application, after the mandatory screens for allowing access to the smartphone device peripherals - which in this case would be the camera, the location service and the storage service, and science of the Terms of Use and Privacy. Then comes the login screen, where the user chooses to start application as a driver or passenger or wants to register in the passenger system.

When clicking register, the user is asked to indicate what their role in UFAM, then he enters his CPF to confirm its existence in the database.

After confirming the user, the database returns the application-relevant data to the application. These are: full name, gender, date of birth, course / position and registration number (for students).

The user then completes the data by entering their mobile phone number, their email address, their home address and a photo, which can be taken on time or imported from the handset gallery.

Then, the application asks the user to confirm the same password used in the ecampus system (students and teachers) or create a new password (for the administrative technicians, since they do not have any type of password registered).

When completing the profile registration, you are asked if the user is a driver or passenger. If you indicate the first option, the vehicle registration screen starts, which gives the options immediate registration or not.

The registration of the vehicle requires a picture of the same taken in a horizontal position where you can see the license plate and its appearance, according to the example presented. Then ask for the license plate, model and color of the car. Then the registration is completed, and the user is redirected to the

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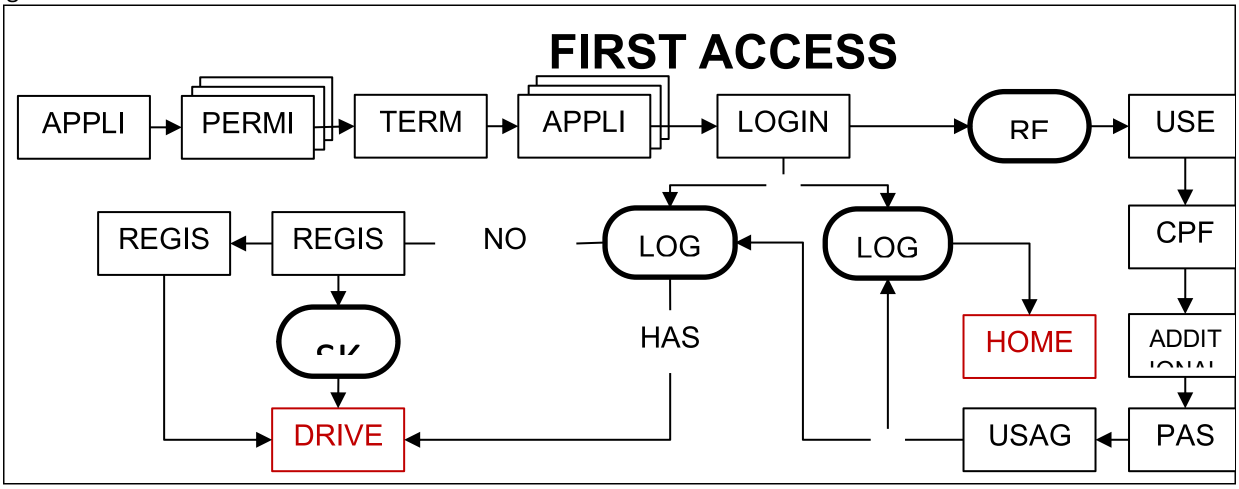
driver's Home screen. If the user, at the end of the profile registration, indicates being a passenger, he / she is immediately redirected to the passenger Home screen. Figure 3 presents the operational organization chart of this application, with first access visualization.

Figure 3: Flowchart of the first access



Source: The Authors

In other accesses the application starts at the login screen. The user fills in the CPF and the password and enters the Home of the chosen mode.

The driver ride offer process proceeds as follows: the user enters his final destination in the "Destination" bar; The app calculates the arrival time and shows on the map the hitchhiking points on the route; The user clicks the "Offer Ride" button, indicates the number of seats available and awaits requests for a ride.

Passenger hitchhiking happens as follows: Once the user is near a ride point (bus stop or UFAM parking lots), he clicks on the pin representing that point and the "Destination" tab becomes valid and one enters where they want to go; The application calculates and displays how many drivers who offered a ride have the same route as the user; the user clicks "Ask for a ride" and chooses the desired driver from the profile options presented; finally, the app sends a notification with the passenger profile to the vehicle owner.

Once both parties agree on the ride, the app displays both their position and the time for ridesharing.

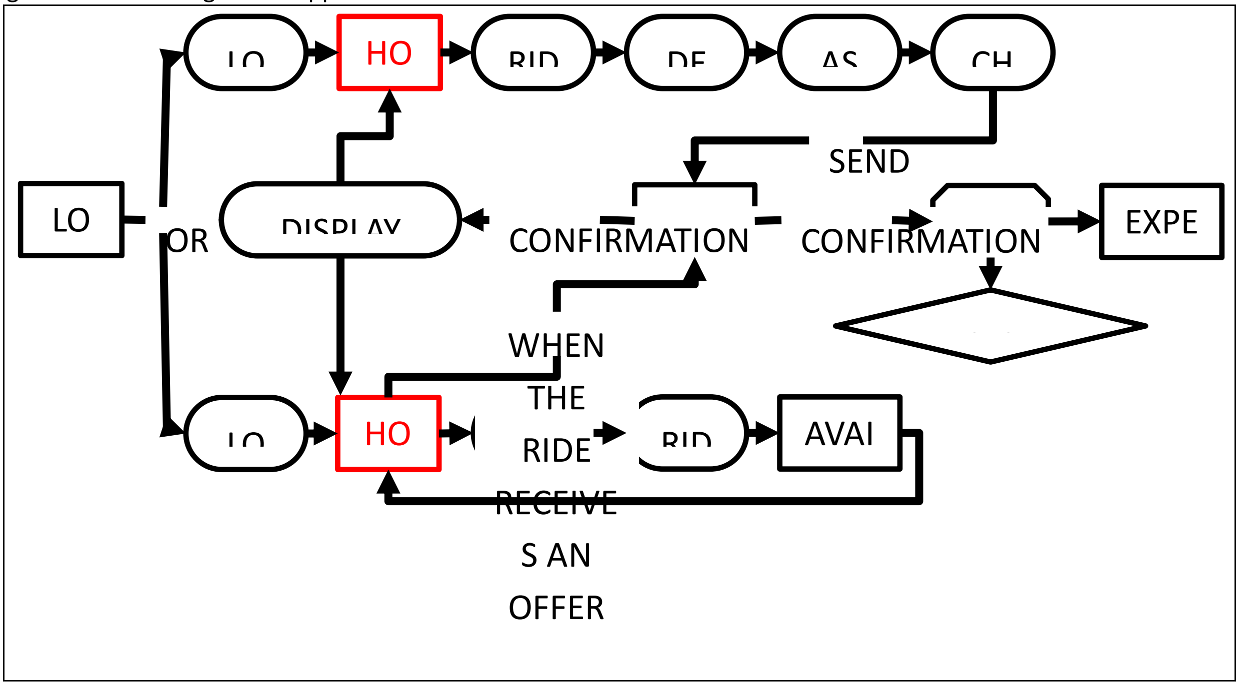
At this time the driver interface can display new passenger notifications until they fill all vehicle spaces.

By default, Home shows the driver the time and the total journey time. However, by clicking on buttons with passenger pictures (arranged in order of proximity of vehicle to hitchhiking point), the driver can know the specific times and routes to pick up for each passenger.

It is important to note that passengers can be boarded and disembarked at any of the hitchhiking points present in the total route of the offering vehicle, provided that the vehicle is no longer past that point. Therefore, the application programming must calculate the vehicle position in real time to ensure that no such mishaps occur.

When the ride is complete, ride data - such as time, commute, and travel time - is recorded in the app database and both users receive a notification where they can rate the ride experience by scoring it between 1 and 5 stars. Figure 4 presents the operational organization chart of this application, with visualization of the actions of the user registered in the system.

Figure 4: Ridesharing UFAM app action flowchart



Source: The authors

During the ride, both users have the option to cancel the ride, generating a notification on the other's interface and forcing the application program to recalculate the route data. If the driver deviates from the planned path, the app will alert you and count 10 seconds before recalculating the itinerary.

As already mentioned, the driver's menu has 8 options and the passenger menu has 7 options, Table 2 presents the functionality of each one.

Table 2: Menu Features

Profile	Allows the user to view and update their own profile. The driver profile shows the number of rides given.
History	Shows data for hitchhiking performed, displaying the most recent at the top.
My Places	Allows the user to program three shortcuts in the "Destination" bar: one for the location of their home and another two within UFAM's five hitchhiking points.
Settings	Allows you to silence notifications and view the Terms of Use and Privacy and the technical information of the application ("ABOUT").
Help	Displays the most frequently asked questions about how the app works and their answers.
Contact Us	Space for the user to send criticism, compliments, questions and complaints about the application. The same is answered through the email registered in the profile.
Exit	Allows the user to log off the application.
Benefits (Exclusive to drivers)	Displays the Cards explaining and validating the benefits of using the blue lane and using special vacancies at UFAM.

Source: The Authors

4.6. SCREEN LAYOUT AND DESIGN

The screens were projected in the vertical orientation, with the aspect ratio of 360x640 pixels. The grid used was a grid of 20 pixels per square. And the screen margins were defined as follows: top and right and left sides of 20 pixels each, with the top margin reserved for the info bar in the Android version; the bottom has 50 pixels reserved for the navigation bar in the Android version and an additional 20 pixels margin to allow readability of information near the edges of the interface.

The background of the application was made using images that refer to hitchhiking with a blue filter over the branding and branding of the application.

The information was organized into white rectangles with rounded vertices (5px radius) based on Google's Material Design style. Care has been taken with the dimensions of these rectangles so that when triggering an element that will display the keyboard, it will not cover the information or the information fill area.

The font chosen for flowing text and low hierarchy information was Roboto, also from Google, as it was designed to be used primarily in mobile applications. It has good readability, which is a prime aspect of information ergonomics. The colors used in the letters range from blue (# 0A80F5), light gray (# 888888), dark gray (# 707070) and white (#FFFFFF), depending on the importance of the information and background applied, Figure 5 shows the configuration of the selected typography.

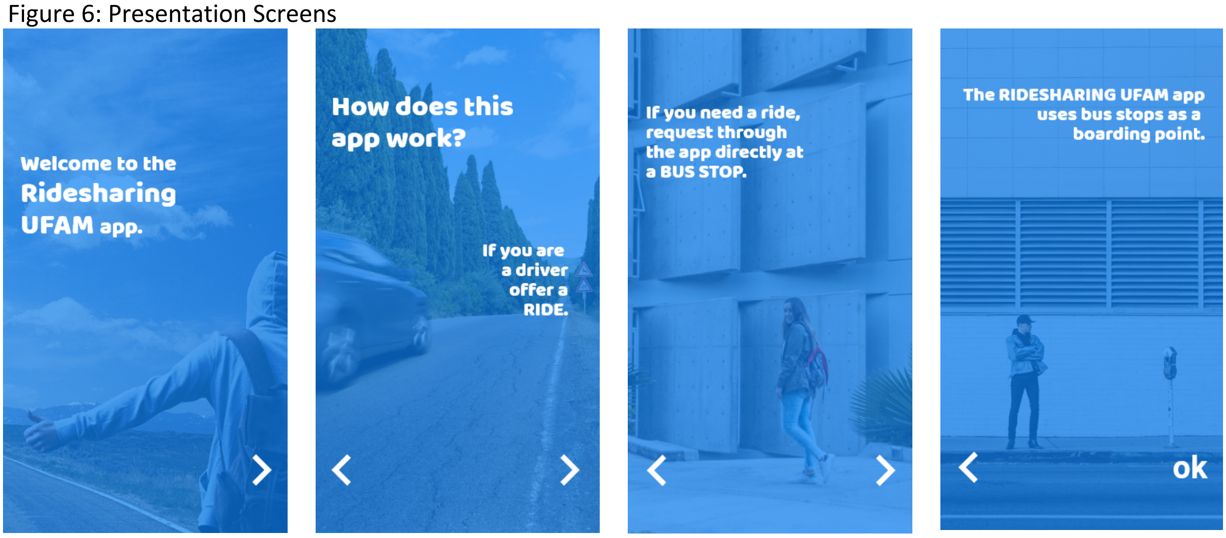
Figure 5: Typography and colors.

Source: The Authors

In the highlight texts and titles, we chose to use the same logo font (Baloo Bhai) to maintain the cohesion of the visual identity.

Other elements used in screen compositions were scroll bars, banners, icons, buttons, load bar, geometric shapes, and transparency filters (to cause the blur effect). Figure 6 presents the four initial screens of user interaction with the application.

Figure 6: Presentation Screens



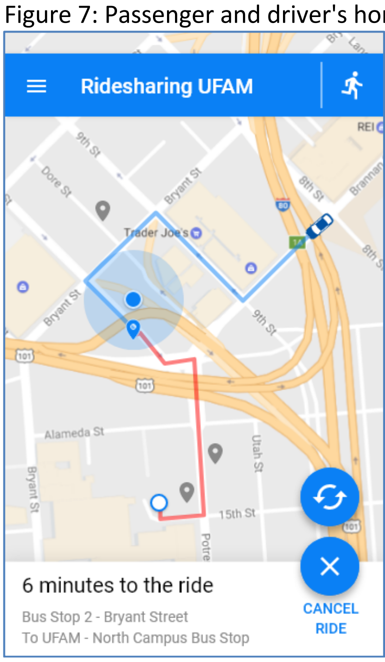
Source: The Authors

4.6.1. Dialogues and Notifications

The direct dialogue with the user occurs in three moments: during the first access, in the presentation and registration part of the same; on confirmations of irreversible actions such as profile editing and ride cancellation; and when it is necessary to instruct the user to proceed with an action within the interface.

The other dialogues are indirect, often composed of a single term or pictograms (icons). Such information is intuitive and quite necessary so that the application does not become polluted and difficult to understand. The main communication element of Ridesharing UFAM is a card positioned at the bottom of the screen that displays status, data and instructions regarding the ride process. Figure 7 shows the configuration of home screens for offerors and riders.

Figure 7: Passenger and driver's homes with information card



Source: The Authors

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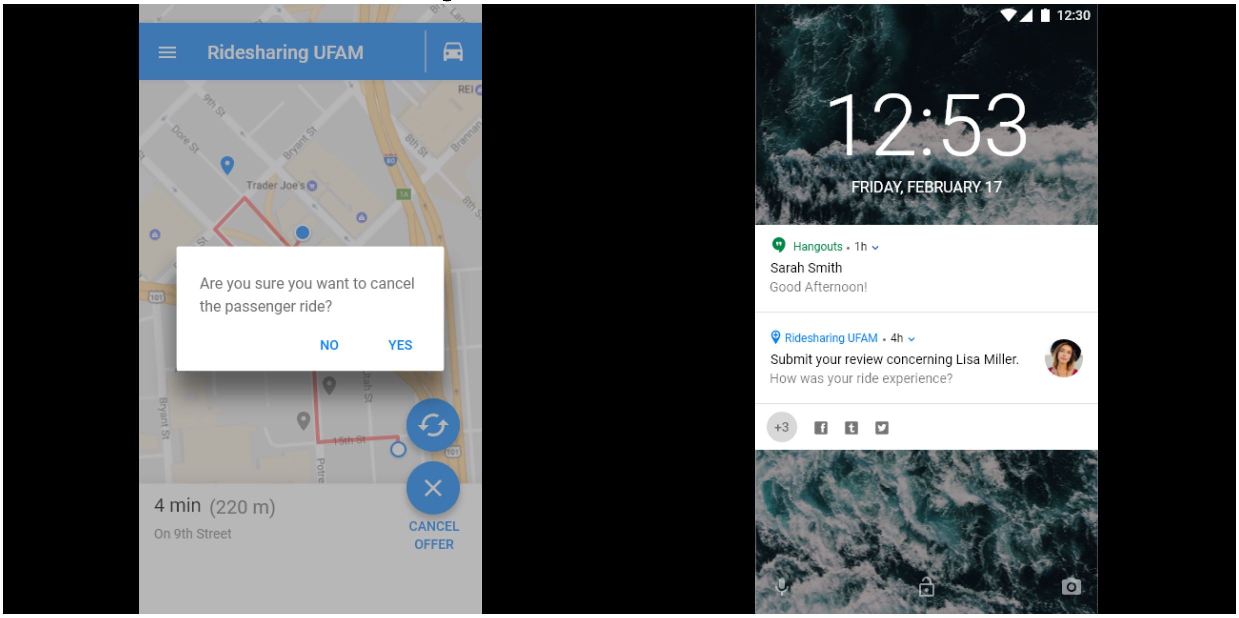
There are two types of notifications in the app. The first occurs while it is in use and warns users about the offer and request for a lift, cancellation and rerouting. These are presented in rectangular elements that protrude from the front of the Home. The second type appears on the smartphone notification tab and prompts the user to rate the ride experience. Clicking will take you to a screen to fulfill the request. Figure 8 exemplifies the notification screens cited.

Figure 8: Notifications.



Source: The Authors

Animations are also considered nonverbal forms of dialogue as they can be used to situate the user within the interface. It was soon chosen to use left-sliding screen animation as a sign of step progression and right-sliding animation as a sign of step regression, following the human tendency to perceive increasing progression from left to right.

Other animations were filling of the loading bar and sliding up of the screen when the app opens or sliding down when it is closed or placed in the background.

Dynamic components are also the user and driver locating pins, which move in real time indicating where they are located.

4.6.2. System Functions

Ridesharing UFAM uses three smartphone functions: camera, storage and geolocation system.

To process geolocation data it is necessary to use software that translates this data into graphical information, i.e. in maps. So it was decided to use the most widely used, complete and stable product on the market, Google Maps.

Since June 2018, the Google Maps App Development Kit has changed its pricing and availability policy. Previously, there were three plans, the most basic being free of charge for low-traffic and/or non-profit applications. Now the system is based on usage credits, where the developer buys prepaid credits which allows him to use a predetermined amount of data from Google Maps geolocation services.

For small developers, the multinational Google offers free monthly credits, and allows the developer to stipulate limitations on the use of data in order to get the most out of such credits.

To connect Ridesharing UFAM to the Google Maps platform, use the Android Studio software, install all necessary kits, codes, and files, and program according to the platform guidelines.

Regarding the proper functioning of all application functions, it will be necessary to release a beta version, also known as a trial version.

The beta version is usually released by the app aggregator stores (Google Play, Play Store, and others) to a restricted audience who sign up for these platforms to help improve new apps in exchange for bonuses at these stores.

During the term of this release, it will be necessary to compile and classify all complaints, suggestions, criticisms and bug reports in the system to then release the final version.

From the launch, the process of constantly receiving user feedback and updating the platform is critical so that over time the application will not become obsolete or lose users.

Feedback can be done either through the app's "Contact Us" function or through the product page in the online stores. The developed screens passed usability testing, then improved and finally compiled for use in the UFAM academic community.

4.6.3. Usability Testing Application

The first step occurs with the development of the test plan, also known as the test protocol. The protocol includes specification of the observation situation, technique used and materials to perform. The procedures and observations in script form guide application of the test.The observation situation consisted of the usage record of the mobile Ridesharing UFAM application interface prototype. The test site was the Usability Laboratory (LABUSI) of the Department of Graphic Design and Expression (DEG), in the facilities of the Faculty of Technology - FT / UFAM.

The test took place on June 10, 11, 13 and 14, 2019, with seven typical users. Three users were male and four females. All men owned a motor vehicle and only one did not offer rides to members of the UFAM community. Among the women, all were public transport users and had already hitched a ride to or from UFAM. The objective of the research was to attest to the degree of user satisfaction when using the application and its intuitiveness when performing the application functions.

The technique used was the Guided Prototype Use Analysis with the addition of open questions after the test.

The materials used were camera, smartphone with Android operating system, smartphone charger, extension cord; Adobe XD virtual environment for interface prototype emulation; and test protocol for annotations. The general test procedure was as follows:

- Receive the user and identify their type (Driver / Ride, Student / Teacher / Collaborator);
- Prepare the smartphone with the prototype initialized and ready to use;
- Introduce the app and explain the test to users;
- Orally guide the user in using the application;
- Question the choices and make suggestions;
- Photographically record the entire test (throughout the test).

Introducing the application to the user explained the purpose of the application, how it would work under optimal conditions and the limitations of the prototype. It was made clear that the application was the object of study of the test and not who is testing it, that is, the user would never be wrong, because any

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adversities found in the interface would be the responsibility of the developer who should design it so that there were no problems in its use.

The user was asked to describe aloud all that he was doing or thinking while using the application to clarify any usability issues. The test consisted of two steps: the user registration, common to the driver and the passenger of the ride; and the ride itself, which had two versions depending on the type of user;

The script for the user registration step was as follows:

- Access the application;
- Confirmation of system authorizations and terms of use;
- Read app welcome screens (did the user swipe or click?);
- Describe all screen elements;
- Change user type (ask if it was easy to identify symbols and change interface type);
- Register account in the application;
- Purposely choosing the wrong option;
- Go back and choose the correct option;
- Touch, confirm and proceed (twice);
- Add image by any method and advance;
- Choose user type to login. If the user is a Passenger, end the step. If you are a driver, proceed;
- Fill in by touch, confirm and proceed;
- Add image and finish;

The procedure for the passenger ride was as follows:

- Access the application;
- To purposely choose the wrong user mode;
- Test the hide password and login feature;
- Change mode;
- Select the ride point (bus stop);
- Choose the UFAM mini campus destination;
- Click on the button "Update";
- Ask for a ride and choose the driver;
- Click on the "Update" button to proceed (twice);
- Give the driver five stars;

The driver ride step performance was as follows:

- Access the application;
- To purposely choose the wrong user mode;
- Test the hide password and login feature;
- Change mode;
- Choose the Mini campus of UFAM destination;
- Expand and collapse the informational card;
- Offer hitchhiking and select the number of seats;
- Click on the "Update" button to proceed;
- Confirm ride.
- Select passenger;
- Click on the "Update" button to proceed (twice);
- Give the passenger five stars;

Finally, users were asked about their views on text font size, icon size, clarity in written and unwritten messages, button touch area, and intuitive usage procedures. Based on the analysis of the answers, elements that provided errors or discomfort to users were improved.

4.7. Interface Settings

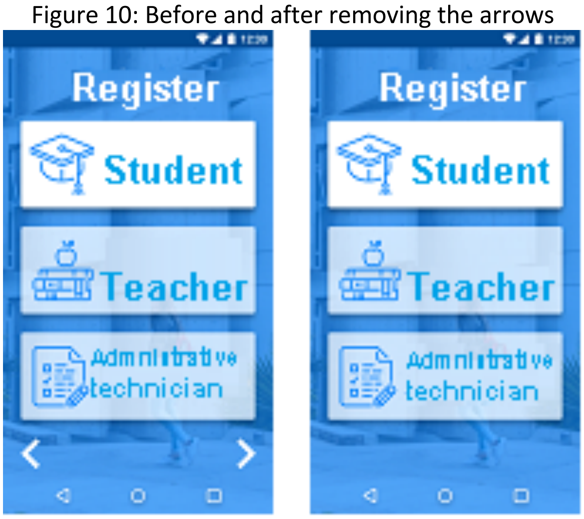
The usability test evaluation results found the need to add the "Swipe to the side" message on the welcome screens to clarify the action to be performed on this set of screens, as shown in figure 9.

Figures 9: 1 Before and after the welcome screen

Source: The Authors

A problem pointed out by some users was the unnecessary use of the arrow icon (proceeding) on some screens which caused confusion as to its use. Therefore, the screens were reviewed and some arrows were removed, as shown in Figure 10.

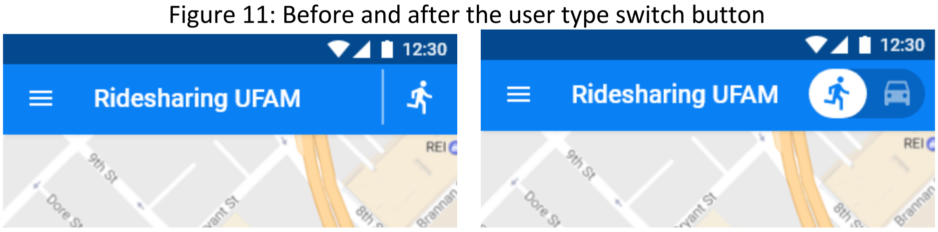
Figure 10: Before and after removing the arrows



Source: The Authors

Another problem cited recurrently was confusion when switching the user-driver interface to the passenger-user and vice versa. One user suggested adding text below the icon to highlight the option, and two other users suggested that the icons be replaced with a switch that would indicate the status of the exchange while making it clear that this is a button type, see Figure 11. This second suggestion was accepted.

Figure 11: Before and after the user type switch button



Source: The Authors

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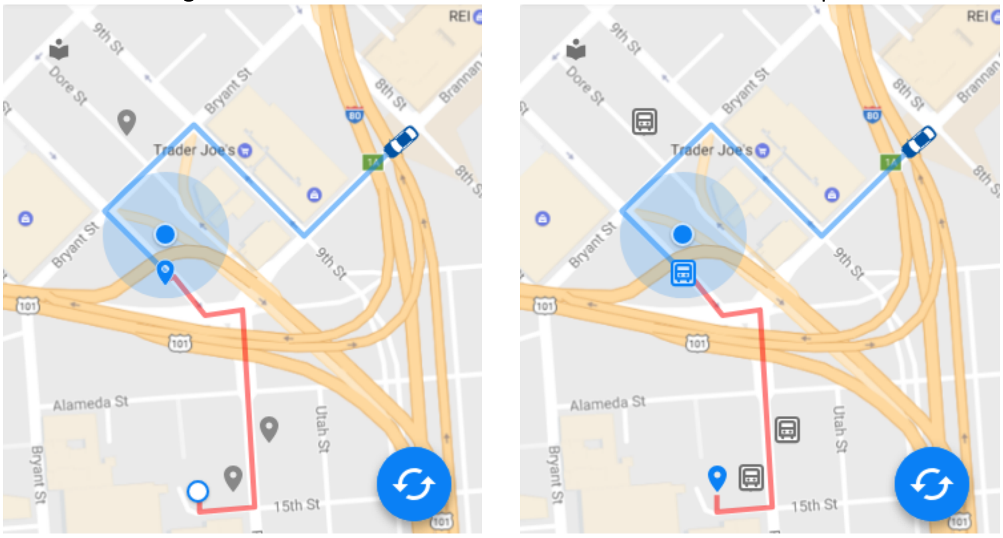
The last pertinent problem cited was the confusion generated by the representativeness of the passenger, hitchhiking and final destination icons. The icon known as the "locating pin" was used to demarcate the hitchhiking points, while a simple blue circle represented the passenger and a simple white circle marked the destination. After the replacements, the location pin icon became the final destination. Hitchhiking points now have their own icon and the passenger user remained the same, according with Figure 12.

Figure 12: Before and after the demarcation icons on the map



Source: The Author

5. Conclusion

The Ridesharing UFAM application creation project required the gathering of multidisciplinary subjects such as visual programming, informational ergonomics, usability, knowledge of information technology and creativity in order to develop a friendly, simple and functional interface to enable the safe practice of "solidarity riding", also known as ridesharing.

The feedback from users in the usability test validated the development of the idea and ensured that the visual programming carried out establishes an efficient and satisfactory communication with the end user, enabling the success of the UFAM members' operation of solidarity ride.

Concerning the benefits to the carpool driver mentioned in the research, with the exception of the use of the blue lane, it was concluded that they are viable and that this research serves as a basis study for future reservation requests for parking spaces at UFAM and increasing the number of books allowed for loans as application bonuses.

Regarding the familiarization of the target audience with the application, the disclosure materials guarantee an initial contact that generates interest in the solution developed.

This study also serves as a basis for the future implementation of Ridesharing UFAM, due to the Computer Engineering scholar responsible for programming the parameters described here.

Having the action flowcharts and guidelines of the interface elements in the form of "prototyped" screens in Adobe XD, the programmer develops from source code, paying attention to meet the criteria established by the designer for the smooth operation of the interface.

The ultimate goal is to launch RIDESHARING UFAM, and perhaps integrate it into a platform that brings together urban mobility enhancement applications (such as the CARPOOLING UFAM app), allowing the community member to have a set of tools to help them move around comfortably and sustainably.

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