Accessibility analysis for the visually impaired using *LazarilloApp*

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Abstract

Visual impairment causes limitations, including mobility. Studies show that there are about 1.3 billion people in the world with some type of visual impairment. Another important factor refers to the need to include these visually impaired people in schools and universities, for autonomy, learning and personal development. Public policies seek to implement measures that ensure the inclusion of people with disabilities, in order to ensure the use of environments in an equal manner. However, these measures are not implemented due to several factors, such as the lack of knowledge of professionals and the lack of financial and technological resources. This research project aimed to evaluate the use of LazarilloApp, a georeferencing application that helps the mobility of people with visual impairment. The tests were conducted at a university in Brazil. Although it has many features and potential, the application was partially effective and efficient, since in only one of the four routes drawn by it the user arrived at the destination. The accessibility problems identified reinforce the need to enable access through structural changes in physical spaces. The results indicate the need to foster the improvement of the functionalities of LazarilloApp and other mobile applications of free access, for the disabled.

Keywords: Accessibility, School Environment, Visual Impairment, Lazarillo app, Assistive Technology.

1. Introduction

The autonomy of movement is a fundamental right of the human being, and therefore requirement essential to enjoy citizenship. However, in the age of human rights, many people fail to enjoy it, because the lifestyle, historically consolidated, enshrined a type of social organization of architectural structures based on full physical capabilities, established as "normal", regardless the congenital or acquired physical impairment [1].

The convention about the rights of persons with disabilities adopted by the United Nations Organization indicates that the government must create measures that ensure accessibility for persons with disabilities with the utmost independence [2]. According to the 7 Principles of Universal Design, developed by the Center for Universal Design, the environments should allow people with diverse physical abilities to use them equally [3].

Among those with congenital or acquired bodily impairment, the most notable are the visually impaired, blind or low-vision persons, who account for about 18.6% of the world population (1.3 billion people), which represents the most commonly incident disability [4].

The visually impaired face difficulties related to their social inclusion due to their physical limitation, which starts with locomotion in different environments because of structural problems. These problems can be solved or minimized with the use of assistive technology (AT) appropriate to the needs of the disabled. The AT refers to the development of products, systems, services, and technologies that improve the living conditions of persons with disabilities, with the gain of autonomy and their social inclusion [5]. The information and communication technologies (ICTs) enhance the application of ATs, expand the forms of communication, interaction and integration of people with the environment which they live in. The technological   resources generated by the ATs modify the lifestyle, interactions and social behaviors by innovating habits and daily attitudes, and facilitating the independence, security and improving the quality of life [6] [7].

Several technological resources have sought to assist people on their journey, usually through apps and / or specific devices that map the user´s routes.

An app was designed to map the areas that are not covered by the Global Positioning System (GPS) devices, such as a mall area. The app was named iExplore and it adds to the map generated by the Google Maps, an additional layer of information of places of interest, with ease for the identification of the indoor shopping spaces by the visually impaired, however it was developed only for the iphone [8].

The Easy Return is another app aimed at guiding the visually impaired person to move around indoors. The difference is that it automatically maps the routes traveled by the user and creates a graphical representation that can be used later. It provides guidance on the direction and the amount of remaining steps to reach the destination through voice messages. It is available only for Apple devices [9].

Another app, made up of   radio communication devices distributed in the environment and a hardware that provides guidance about the environment to the user, through the voice, was developed to assist the displacement of visually impaired people in a university library [10].

As a solution for outdoor environments, the Crosswatch app was developed, it provides real-time feedback to the visually impaired about their location in relation to the crosswalk, with the use of computer vision [11]. Later the researchers added new resources to the app, such as the geographical coordinates of the crosswalks and the presence of traffic lights, from the location obtained out of the smartphone (SM) [12]. These works point out the difficulties encountered in identifying the different types of crosswalks, technology used in photographic cameras and the accuracy of GPS in SMs.

The Virtual Mobility Trainer is another type of app, consisting of two parts: the Route Creator, which allows the creation of routes by an authorized person; and the Virtual Mobility Training, which the disabled uses to navigate the created routes. While defining the routes in the Virtual Mobility Trainer the user can indicate places with obstacles or points of interest with the SM GPS. The app was developed only for the Android operating system [13].

In order to create a collaborative solution, the SoNavNet social network was structured, it uses the user's location to obtain pertinent information and share with other users. An evolution of SoNavNet was developed in order to allow the users to provide supplementary information regarding the accessibility of places in use, classifying them as accessible or inaccessible [14, 15].

The surveys mentioned highlight the use of apps to allow people with visual disabilities to move around, while other works [16] [17] evaluated the infrastructure of cities to verify the accessibility and mobility.

The results show the needs and expectations that the visually impaired have about the public facilities in the city [16]. There are cities that encourage social initiatives to help citizens with disabilities to have greater autonomy and quality in their travel [17].

The Lazarillo App is a georeferencing app that produces intelligent and automatic spatial orientation by generating voice messages that guide the handicapped with information about their location and the services available nearby.

Given the importance of ATs in improving the quality of life of visually impaired people, this article aimed to test and evaluate the use of Lazarillo App in the context of a university campus.

2. Materials and methods

This is an experimental and technological research, carried out through the observation and collection of field data. With qualitative approach and objective to analyze the practical use of the mobile application LazarilloApp. The research was conducted on a university campus in the state of Mato Grosso do Sul, Brazil, in June 2019.

2.1 Materials used

Two SMs were used, an iPhone with the iOS operating system and another Xiaomi with the Android system, with LazarilloApp installed in both.

The annotations of interactions, conditions and problems observed in the field were recorded in manuscripts, photographs and screenshots of the SMs.

2.2 LazarilloApp

It is a free app from a project that started in 2014 in the city of Santiago (Chile) and its mission is to improve the quality of life and autonomy of visually impaired people.

The app works based on SM GPS data, it requires internet connection and it is available for iOS and Android operating systems, with support for Spanish, English, Indonesian and Portuguese languages.

It provides guidance through voice-message based on the user's real-time location, with information about the nearby services such as banks, restaurants, streets, intersections, bus stops.

2.3 Data collection

An interdisciplinary team of researchers was made up of professionals from the areas of health and computer science, in order to generate standard of conduct and observation of the reality and to maintain the coherence of the information generated by the app. There is little evidence of direct involvement of the interdisciplinary staff to conduct researches that develops improvements in the apps used as TA [18].

Initially the SMs were used simultaneously for the setting in the app and comparison of operation on Android and iOS system, later only the SM with Android system was used.

The data collection was performed through the researchers' interaction with the app and the university campus environment. One researcher took photographs of the university environment, another operated the app to get directions and screen captures, while a third wrote down the team's perceptions during the routes

they made.

2.4 The setting in the LazarilloApp

The first experiment was to create directions for the setting of the researchers in the app and to compare with maps presented by LazarilloApp and Google Maps.

The LazarilloApp not only has a database but also uses the main international databases to feed its maps, as shown in Figure 1A. The advantages offered by LazarilloApp compared to Google Maps are the higher audio interaction, both in its configuration and route usage, and the presence of a gallery with desired locations such as transportation, banks and ATMs, health, food, among others, as shown in Figure 1B.
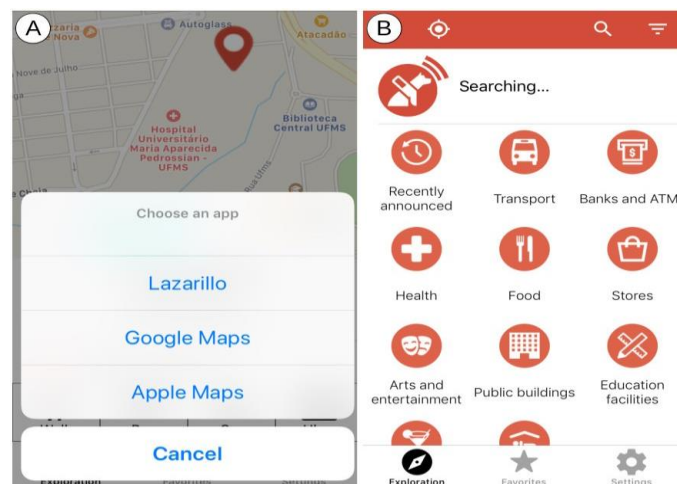

Figure 1. A) Screen for choosing the maps database to trace the routes. B) Screen with location categories available in LazarilloApp, 2019.

To evaluate the features of the app in the university campus, routes were defined to four places of interest to be walked: a bus stop (located at coordinates -20.499089 and -54.612672), core of bank branches (coordinates -20.500359 and -54.612687), a university restaurant (coordinates -20.503291 and -54.614394) and Faculty of Medicine (coordinates -20.497774 and -54.614366).

2.5 Data Analysis

The data were analyzed qualitatively through observations whose characteristics were noted in the field research, which, in turn, was organized into two distinct parts: app setting, use of the app with   the campus accessibility.

Therefore, aspects related to efficiency were considered by defining the shortest and / or fastest route, and the most appropriate and signaled for the visually impaired people. And regarding effectiveness, resulting from the identification and arrival at the destination, proposed through the route traced by the app.

An analysis of the accessibility condition existing in the university campus was also performed.

3. Results and discussion

During the evaluation of the app were found interesting points to be highlighted regarding the effectiveness presented.

Initially for the definition of routes there was a problem regarding the starting point for navigation, the physical space was not tracked: the location was identified by the app, but no route could be defined from it.

The version of the app for the Android operating system showed only an error message on the screen, as shown in Figure 2A, while on the iOS system, in addition to the message on the screen, a beep repeatedly indicated a search for a route. At other times the error screen was shown, as shown in Figure 2B, however the app continued to function and pass along sound instructions.
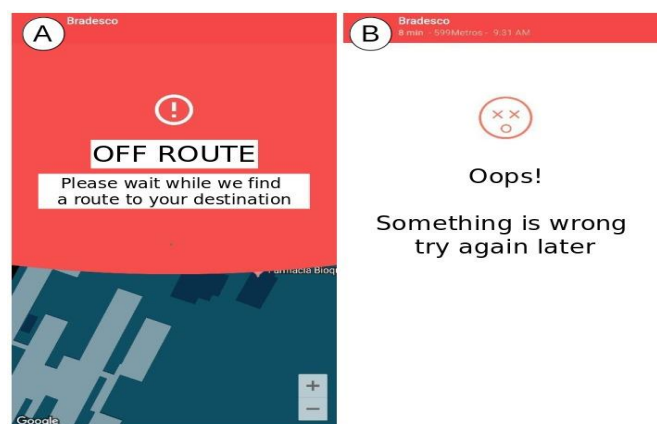

Figure 2. A) Screen with problem to detect the route start point in Android version. B) Screen with error message displayed while using the LazarilloApp app, 2019.

One of the highlights of LazarilloApp is the voice message notification, which indicates locations near the user. This fact was evidenced when the route was close to the university library and the app sent the message with the information. But this is an uncomfortable factor when there are several prominent locations along the route, such as near the campus bank branch area, as there were constant beeps and this disturbed the interpretation of the other messages. Despite the inconvenience, there is the option to disable or customize the messages you want to hear.

Another notification option refers to the user's location, which was sometimes based on cardinal points, such as north, south, east, west, and other times in relative directions, such as front, back, right, left. There is the option to choose the type of beep format for user´s location, as shown in Figure 3A, but even with the relative directions option enabled, notices based on cardinal points were heard.

Still regarding the sound notifications, in the Android version, the messages were sometimes issued in local language (Portuguese) and other times in English, including some messages in both languages, which represents a problem.

Regarding the language, it is not possible to change it in the Android version, using Google's text-to-audio engine, as shown in Figure 3B. In iOS version it is possible to configure for several languages, as shown in Figure 3C.

Another feature observed in LazarilloApp was that after a period of time without interacting with the screen, it darkens, but the app's sound information continues to transmit without change.
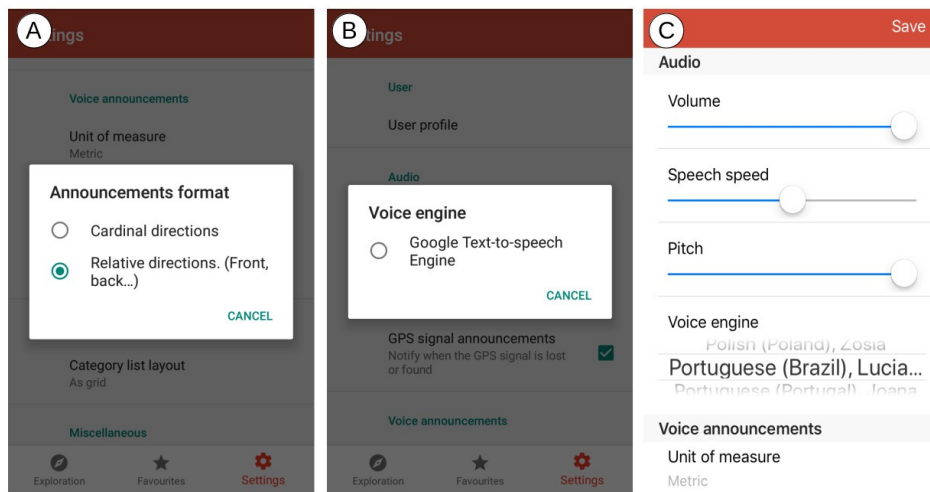

Figure 3. A) Configuration of the sound notices format in the Android version of LazarilloApp. B) Language and voice engine configuration in the Android version of LazarilloApp. C) Configuration of language and voice engine in iOS version of LazarilloApp, 2019.

3.1 Analysis of the traced routes

As already reported, we could not start the route from the desired location. The researchers went to another point, where the app pointed as the beginning of the route, for then the first destination be traveled, with destiny to a bus stop. The selection of the destination to be traveled was made in the app gallery, with the option "transport": the bus stop was automatically selected by choosing the "bus stop" option. On the way to the destination, two other bus stops were identified, however there was no notification of the app. It was observed that one of these bus stops was closer than the one indicated on the route.

The route required the crossing of a street, but at the end of the crosswalk there was no sound notification about the direction to continue, the only notification was about the distance to reach the destination. Purposely the team converged in the opposite direction to the destination, the app only continued the notification of the distance increase to the destination, that is, the opposite way.

Another route was from the bus stop to the bank branch region, on which the route suggested by the app was used, as shown in Figure 4. However, it was not possible to reach the destination, once that only part of the path has tactile floor. The researchers started a different route and the app automatically updated the path.
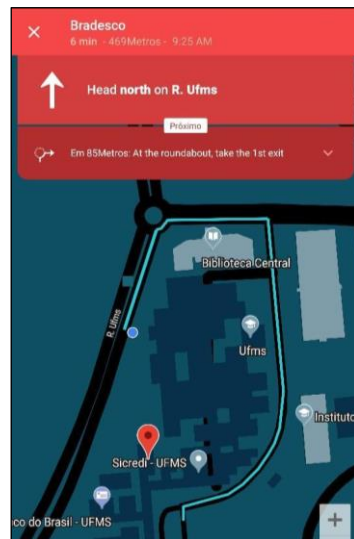
Figure 4. Screen with the route mapped to the bank branch region in the LazarilloApp app, 2019.

One more route was set up from the bank branches toward the university restaurant. Unfortunately, there were problems regarding the location validated by the app, lack of tactile floor, and problems with pavement on the streets. An alternative route was performed by the researchers, not identified by the app. The area of the university restaurant was the one which presented the highest accessibility problems for the visually impaired, such as paving in poor conditions for use and the absence of tactile floor.

The return to the initial destination was also problematic due to the need to cross the street and incomplete information, due to inaccuracy in SM GPS location.

It is worth to mention the importance of combining the use of the app with the accessibility of environments. An example was the difficulty in converging and go down the sidewalk to cross the street due to the absence of tactile floor, as shown in Figure 5.

Figura. 9. Intersecção da calçada com a rua sem a devida marcação de piso tátil, 2019.

3.2 Acessibility within the university

When considering the problems encountered, unfortunately in some places there is a lack of tactile flooring and this makes it impossible to use the app correctly. Along the way he observed that there are many uneven

paving areas, extremely steep ramps and areas of total tactile floor wear due to lack of maintenance. In some regions due to lack of attention there were obstacles such as garbage bags and cars under the tactile floor line to be followed by the visually impaired.

One part of the campus had irregular pavement and no tactile floor, which made it impossible for the disabled to have autonomous access to classrooms, auditoriums and health clinics.

These problems must be analyzed and worked on by the university management in favor of adequate physical mobility and maximum independence of its teachers and students with disabilities. Since these aspects are discussed and listed by WHO and other social actors in favor of improving the quality of life and access of people with disabilities [2, 3, 17].

4. Conclusion

One advantage of LazarilloApp is that it is freely accessible and available for Android and iOS operating systems.

Another important feature is the sound interface of good quality that allows the communication of the app with the user. However, this sound information suffers interference in the way it is presented, making its understanding difficult.

Considering the proposal to evaluate the functionality of the app in the university campus, concluded that can be applied in the several situations encountered provided that the structural and mobility conditions are adapted and preserved to the needs of the disabled.

From the technological point of view the inclusion of visually impaired people in several spaces and also in the university depends on public policies to improve infrastructure conditions and the existence of apps with adequate resources for the environment.

The importance of apps for SM was verified, and in the case of LazarilloApp its functionalities should be improved to avoid confusion during the use.

As a proposal for future researches, new apps can be developed and evaluated, as well as a complete mapping of the university campus.

Finally, it is concluded that the inclusion depends not only on the existence of laws, but also on an effort to develop technologies and financial resource that enable their use.

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