MOBILE APPLICATIONS AND ASSISTIVE TECHNOLOGY: FINDINGS FROM A LOCAL STUDY

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ABSTRACT

This paper reviews the study of mobile applications for disabled people, considering the fact that these sort of mobile devices present great potential for the social inclusion of these users as well as help them in their daily tasks. However, most of the existing applications have few support functionalities or a low range of interaction, as in the development of these applications the special needs and specific capacities for the disabled have not been considered (Visagi et al, 2019). The present study suggests strategies and solutions to be used for an overall accessibility.

KEYWORDS: Assistive technology, Mobile devices, Disabilities, Mobile applications.

1. INTRODUCTION

All individuals whether with a disability or not have a range of rights that must be respected. One society susceptible to variety, researches its isolating instruments and finds out new tracks for the inclusion of a disabled person. This has awakened and stimulated new researches, including the adaptation of the technological advances available today.

However, what embarrasses great part of the disabled people is the dependency from others to do some activities but the development of information and communication technologies enables several ways of relationship with knowledge, as well as with the most recent conceptions and possibilities; the relevance of this paper stresses the importance of assistive technologies as a tool to provide a greater independence, quality of life and social inclusion to the disabled, through the amplification of his/her communication, self control, human motricity and competence in the execution of physical tasks.

Today, with the growing flexibility of objectivity and subjectivity facing the most scientific and hard technologies, the engineer needs other capacities. The emerging of information technology in the work place caused that all technicians became a link among the most diverse sectors of the productive chain and the society. The actual engineer is no longer only a professional technicist as before, it is in fact a qualified human being for the flexibility demanded by the society and required for a more open market (Laudares & Ribeiro,2000).

The most recent international treaties have demonstrated the desire to build a society that not only recognizes the difference as an unquestionable human value but also promotes conditions for the full development of the potentialities of every one in its uniqueness (CIBEC/MEC,2010).

The global study from UNESCO reveals that technologies have a positive influence in several perspectives of the disabled people's lives (Mohammadi, Momayez, & Rahbar, 2014). According to Domingo (2012) and Emam (2017) information systems aim to offer disabled people the support they need to attain an admissible quality of life allowing them to participate in the economic and social environment.

Assistive technologies are related with the capability of causing extreme technological changes that transform humanity and its culture and have the potential and tendency to generate a quick cycle of development and create derived technologies applied virtually to all areas of knowledge in order to benefit the increase of human performance, its processes and products, quality of life and social justice.

Several are the possible solutions to be approached in order to meet the adaptation problems of people with disabilities, but in what refers to the development of the software or hardware devices, its success is measured through the level of user satisfaction. In this connection any developper must take into account what type of solution must be given and if it solves the problem presented by the disabled person, or at least, if it solves the gaps of greater relevance presented, as in some cases as referred by Wong et al.(2009) the use of some assistive technologies may not be appropriate to certain individuals with severe or profound disabilities. Both the level of difficulty and the support requirements and level of adaptation need to be considered in order for the disabled person may to use the technological artifacts in a significative way (Redford, 2019). Actually, quick alterations to technology became an efficient tool for development in the individual, community, national and global perspectives (Islam, Ashraf, Rahman, & Hasan, 2015).

This paper emphasizes the gap among theory, speech and practice in the area of computer ethics. The choice of this sector is due to the growing observations referring the potential of information and communication technologies to help people with disabilities to overcome their limitations. The growing need for the development of new technological solutions is obvious. The quick development of the information and communication technologies brought the hope that, in the near future, this area of research and development may provide viable solutions.

On the other side, topics like ethics and social responsibility have emerged specially as how the implementation of these technologies should be made near the groups of vulnerable users (Ienca et al, 2018).

However, although they are in a stage of quick growth in development, assistive technologies are still a devising topic. It is known that it is important to develop solutions that contemplate the inclusion of disabled people, but not many significative advancements have been made in the ellaboration of unified adaptations for people with different disabilities (this also refers to the fact that several people may have the same pathology but in diferent degrees).

Assistive technology helps individuals with disabilities to reach more autonomy and more independence, considering that the resources and services involved in this concept aim to facilitate the development of daily tasks for this kind of people. Further more, it is an important tool for the so called social inclusion.

An in-depth review of full text papers concerning the different types of disabilities, assistive technology and existing mobile applications was performed and resulted in the production of a research relating to this topic.

Having this in consideration, the following initial question arose:

"- In what way can assistive technologies contribute to improve the functional capacity of the disabled in the use of mobile devices?"

In this connection, a local study was implemented and which comprised an identification of the main assistive tools for mobile devices, to study their main limitations, and to test those technologies near a pilot group of people with disabilities through surveys in three different phases. The results of this initial study led us to an indepth analysis of a case. A mobile application was chosen and conceptually analysed. The methodology employed in this local study appeared as a valuable strategy for the presentation of a solution aiming to solve or minimize the main gaps referred in this project, as a prototype of an application for mobile devices identifying a solution that may comprise the limitations found.

2. ASSISTIVE TECHNOLOGY (AT)

Assistive Technology models have been defined with the aim to guide the study and development of this technology. Bearing in mind that to develop a technological artefact several are the points that have to be considered, in the specific case of AT, factors like culture, disability and activity to be accomplished need to be taken into account. There are several models, crossing knowledge from several different areas.

2.1. Horizontal European Activities in Rehabilitation Technology (HEART)

The main purpose of this model is to study solutions, devices, methodologies, etc. that balance or lessen limitations not only of the individual but also of the physical and social environment. It can be subdivided in three components: technical, human and social.

2.2 Human Activity Assistive Technology (HAAT)

The HAAT model proposed by Cook and Hussey (1995) is based on a *framework*, and used by engineers and psychologists to examine the functional behaviour and performance of individuals, through the execution of technological activities. It proposes four components: Context – referring to the social and physical environment where the individual and the AT are included; Human – presenting the individual as the main element of the model; Assistive Technology – referring to the externa device used to suppress any contextual constraint; Activities – comprising all the actions of the daily life.

2.3 Telematic Multidisciplinary Assistive Technology Education (TELEMATE) (Turner-Smith & Blake, 1999).

This model determines that specific training should consider the several areas of knowledge.

2.4 Matching person and technology (MPT) (Scherer, 1986)

A mixture of people and technology demanding attention to the several environments where technology will be used, to the needs and preferences of the user and to the functions and resources in technology.

The availability of specialists in AT that understand the value of a process directed to the consumer and adequate to provide proper services is fundamental so that an individual may get a quality evaluation of the needs and most appropriate technologies for personal use (Scherer, 2005[1], 2012).

3 ASSISTIVE MOBILE DEVICES AND SYSTEMS

3.1 Accessible Interfaces

Accessible interfaces are the border between the individual and the product, through which information is exchanged (Cook & Polgar, 2008). The intelligence of the interfaces makes systems to adapt to users, solve their questions, or show integrated and understandable information through the use of several ways of communication.

According to Saci (2005), there are seven principles that sustain Universal Design: To people with different capacities; Flexible use; Simple and intuitive; Easy to understand; Communicates easily the necessary information; Fault tolerant; Requiring few physical effort.

3.2. Assistive Mobile Devices

Assistive Mobile Devices are defined by IDEA (2004) as any item, equipment or system, acquired, modified or personalized, used to increase, maintain or improve the functional resources of people with disabilities.

França, Borges and Sampaio (2005), state that a computational project directed to handicapped does not differ from another project, however “involving other own issues that lack a differentiated human interaction, the use of special tools and the constant care with the user well being”. Handicapped people face important challenges in acquiring digital technology, due to cost and availability (Samant Raja, 2016). Several initiatives were developed to promote accessible web content.

To evaluate who has access to mobile technology tends to be a complex task. To evaluate technology availability, accessibility, capacity and accessibility will develop an understanding of who has access or not (Roberts e Hernandez, 2017).

4. DISABILITIES

The World Health Organization, in 1976, defined three international, differentiated and independent classifications: Disability: “in health, disability means any loss or alteration of a structure or psychological, physiological or anatomic function”; Incapacity: “any restriction or lack of capacity (resulting from a disability) to do an activity within the normal limits for a human being”; Handicap: “is a social condition of prejudice suffered by a certain individual, resulting from a disability that limits or prevents the performance of an activity considered normal for that individual, given age, sex and sociocultural factors”.

International classification (according to WHO) are fundamental to the development, selection and evaluation of the Assistive Technologies (Glennen & DeCoste, 1996).

4.1. Assistive Applications

A study published by *WebIam* (2008) shows that the number of users with special needs has grown exponentially.

The need of better applications is the result of this research. The study asked the participants to select the most problematic items in list, in order of difficulty, and the result was: *CAPTCHA*: images used to check if the user is human; screens or parts of screens that change unexpectedly; *Links* or buttons that do not make sense; Lack of accessibility in keyboard; Complex or difficult shapes; Images with missing descriptions (alternative text); Missing headings; Many links or browsing items; Complex data tables; Not accessible or missing search functionality; Missing *links* "to go to main content" or "to go out browsing".

4.2. Accessibility tools for mobile devices

The access to the benefits of mobile devices is limited to disabled people as the majority of this technology is projected to younger people that tend to have greater facility in dealing with complex electronic devices. Disabled people find obstacles in dealing with these devices because in many cases they cannot operate controllers, cannot get information about the devices or simply do not understand the functioning. Lately, several mobile options have been suggested as how people with special needs may benefit from services based in ITC. However, many solutions concentrate only in usability and do not attain success, once those products show the idea of disability too much.

5. MATERIAL AND METHDOLOGY

This research comprises, in a first phase, the description of a pilot study, based on questionnaires done to disabled people met in a professional and familiar context, in a religious institution, concerning the assistive technologies used. The same study includes, also, an interview with the same participants and the application of the questionnaires. In order to make this more functional, the study has been divided in five parts that include, respectively: Description of the pilot study and the main study; Characterization of the tested applications; Population and sample; Selection of data collection; Presentation and justification of the data analysis procedures.

5.1. Description of the study

This study comprises two different phases, being one the pilot study and another the main study. The pilot study focused on the application of the case study of this research and also on existent assistive mobile applications working with different operating systems. The main study consisted on submitting questionnaires to the participants and also some interviews.

During the pilot study, the applications were tested during 30 days by part of the group of participants and also the researcher, in order to do an ecological description of the behaviours

(learning anatomy) (Damas & De Ketele, 1985), using an observation grid where the results obtained are kept as additional to the results of the main study as it allows to collect in a global way what happens in terms of learning and behaviour changes during the use of AT. Bearing in mind the disparity of the disabled characteristics in relation to the disability, type of device, different systems, there was also the need to use the comparative method (Glaser & Strauss, 1967), even superficially.

To add value to this research, it was decided to also do interviews, in order to obtain relevant data for the analysis of certain observed behaviours. The interviews provided the main utility of showing certain aspects of the subject under study that maybe the researcher would not have considered and, in a certain way, to complement the lines of work suggested during the research or by the observations done.

5.2. Characterization of the tested applications

The following mobile applications tested due to the fact that based on a previous research, it was considered that were the most used applications.

iOS Accessibility – This brand (Apple) is known to take the maximum advantage of its hardware and to be a pioneer in the use of assistive tools. The iOS native assistive application is composed by several tools developed in order to assist several types of disabled to perform the most diverse tasks.

Android Accessibility- The accessibility options can vary according to the device and version of Android. It has a set of native assistive resources/tools and configurations that can be found in any device that allow that anyone with some kind of disability can execute the same actions that a user without that limitation.

Telepatix- Developped by Tix Tecnologia Assistiva, is an application of augmentative and alternative communication (CAA) that allows the writing of phrases and reading in loud voice. It has an optimised keyboard for quick communication with the suggestion of words and phrases. All this can also be used with sweeping and external compatible actuators.

5.3. Participants

Pilot study: The respondent population to this study were people with some disabilities that had had not previous contact with any of the applications tested.

Main study: The respondent population with some degree of disability, were users of some of the tested applications. Suggestions from discussion forums on disabilities and technology were also taken into consideration for this study.

5.4. Data collection

Data collected from the interviews occurred during the months of May and June 2019. Interviews were transmitted to capture the exact speech.

The questionnaires were sent by email, with previous explanation of the objectives of the research and the filling procedures. This occurred during the months April to July 2019.

The selection of these data collection instruments is based on the fact that it guarantees the collection of information on the main points of the research: to specify the purpose of the research and to motivate the participant in a way that he/she could share important issues for this research (Merriam, 1988).

5.5. Data analysis

Questionnaire A : It was difficult to find participants that would not use any assistive technology. So it was decided that users using Android would be submitted to iOS and vice-versa, and both groups tested the application Telepatix. It was intended to collect data that could allow to meet the following purposes: Sex, disability, difficulty in adaptation, understanding integration with the various applications, identify the most used tools for each type of disability and to know the opinion of the participants related to the technologies tested.

Questionnaire B: Done to regular users of assistive technologies adapted for mobile devices, allowed to compare data obtained from questionnaire A. Following Figari (cited by Ribeiro, 2005), it is not only a way of validating data but it also allows the researcher to complete data and even to “decipher”, or better, to understand it in terms of its context. It was intended to get the following results: Identify the tools most used for each type of disability, to study the main limitations of the existing technologies, to know other supporting tools not referred in this research, to understand the opinion of the disabled towards assistive technologies.

The content of the interviews was fully reproduced in writing. For a better understanding it was made a categorization not only to understand the general use of the AT but also the specific need of each disability.

5.6. Analysis and discussion of the results of Questionnaire A

It is important to stress that the purpose of this Questionnaire was only attained after three interactions with the participants; the Questionnaire was so divided in three parts: before use, during use, and after use.

Considering the aims for this research in relation to the attitude of people with disabilities in relation to assistive technologies and the importance of technology in what concerns inclusion in the more diverse contexts, it is viable to form certain opinion that will establish the main course of this discussion: Before use: The motives that took the handicapped never to have experimented an AT in the mobile adapted devices (or that specific OS); How frequent do they use mobile devices; For what purposes more use the mobile adapted devices; During use. Level of adaptation difficulty; Which are the greatest difficulties encountered; Which are the major advantages encountered; After use: Which is the level of satisfaction in relation to the tested technology; Which are the tools more used; How do you classify the interaction among applications; How did the technology tested facilitated interaction between tester and mobile device;

Replies varied a lot; factors like the type of disability, level of technological knowledge in relation to the use of devices and even age were determinant for that variation in replies.

The ten participants were subdivided in three categories (four to Android, 4 to iOS, 2 to Telepatix), three with physical disability, three with earing disability and four with visual disability.

What was found was that those with physical disability that are not totally amputees of superior members, do not show great difficulties in handling the devices; in what concerns interaction among applications and t the level of satisfaction, preference was almost unanimous to choose the native applications of the operating system, as they are more complete and adaptable to the several disabilities; others are more developed towards a certain public and do not interconnect with other applications.

The main limitation found in the native applications is that for both operating systems the functionalities only function efficiently with internal applications, presenting some problems when operating with third party applications.

In the case of *Voice Access*(Google) the more recent native application for Android, was considered the least satisfactory as it only accepts commands in English.

5.7. Analyse and discussion of the results of Questionnaire B

The opinions of the 25 participants to this Questionnaire were fundamental to answer to some of the questions base to this work mainly “Which is the AT more used for mobile devices?” “Which are actually the main limitations of the AT in mobile devices?” and “What can be implemented to improve the actual state of the AT?”.

It could be concluded that the majority of the users use the assistive application of the OS Android, probably due to the fact that an iOS device is financially more expensive, given the fact that many participants assumed to prefer the Apple operating system in what refers to adaptation and functionalities.

6. MODELO CONCEPTUAL

Based on what was found though the Questionnaires and interviews, a conceptual model was developed for the development of an assistive mobile application directed to the disabled people studied in this research. The name given to that application is “*HelpApp*”, as it is an assistive application.

6.1. Aim

The aim of this application is to adapt a common device to guarantee accessibility and to contribute positively in the process of social inclusion through improvement of the autonomy of disabled people in relation to technologies.

HelpApp must possess a large number of accessible tools in order to answer to the limitations presented by the different disabilities, the capacity of integration with the several operating systems, a friendly interface so that interaction is pleasant independently of the level of technological knowledge and access to the functionalities of the device.

It must guarantee the existence of basic requirements of a system like security, integrity, availability, among others.

6.2. General Description of the Application

The design of this application comprises an integration with all (or great part) of the applications found in devices like *Smartphones* or *Tablets*; in order that can be possible the best option is a native application as it has access to all functionalities. The application is addresses to disabled people that use mobile devices in carrying out their daily activities.

6.3. Modules of the Application

Module Blind: this module is directed to people with visual disabilities, allowing the user to use voice commands, interact with a personal assistant and reading from screen (with the use of a camera). It is necessary to access the Internet to interact with the personal assistant.

Module Mute: this module is destined to people with mute disability, it has a white screen where text must be written and the pretended text reproduced.

Module Deaf: this module is destined to deaf people, transcribing in the form of text what was given orally.

Module Move: this module is destined to people with physical disabilities; in this module, only the accessible routes are presented, as well as parking places for this group of people.

Module Total: it comprises all functionalities.

6.4. Specific Requirements

Functional Requirements: The application must be rather friendly and intuitive, possible to be installed in an economic mobile and include all the modules: To fill questionnaires for the choice of the module; to supply visual and/or audible feedback according to the module chosen; Localization management: it should identify the localization of the user; The application should recognize voice commands; to textually transcribe commands given orally; to issue orally the elements presented in the interface; alerts in real time.

Non Functional Requirements: The application must be resilient to failures that may prevent its normal functioning, in order to be always available; the reply time must be very low; easy to maintain, in order to include improvements and updates; it should guarantee security and integrity; in terms of usability all the actions must be transparent, in a way that the user understands all its effects; it should be capable of interacting with other heterogeneous applications for the change of information and the use of its functionalities.

7. SYSTEM PROTOTYPE

The development of the prototype and its main functionalities were conceived to operate in any of the main development platforms of mobile applications; Android or iPhone. The choice was made in order to be different from the existent applications.

7.1. Proposed structure

PhoneGap is an open-source development structure that allows the development through web technologies so that they can be later distributed as native applications.

There are several benefits that put forward the choice of a structure like PhoneGap towards other languages and native SDK's: the probability of deep knowledge of web technologies (HTML, CSS e JavaScript) is greater, contrary to technologies and native languages of the several existent systems: the possibility to use Javascript tools already existent makes very attractive this development approach.

7.2. Screen prototype

HelpApp will only have screens, as the purpose is the interaction with all the existent applications of the device.

When accessing the application, the loading screen is opened: we have opted for an intuitive background that attracts the attention of the user and demonstrates the interaction of the application with the others. The menu screen is as simple as possible, allowing the user to select the module that pretends to use and so activate its functionalities. Most of the application functionalities do not need an interface, but those that need present themselves in the most accessible way.

8. CONCLUSION

As a result of this research, it can be concluded that there are distinct resources of assistive technologies that help in the inclusion of people with disabilities (visual, earing, physical and mental). Meanwhile, through observations, questionnaires and interviews, it could be concluded that these type of technologies have a reduced level of growth.

With the world growth of the use of mobile devices, there is the need to adapt them to any type of user. The greater difficulty encountered during this study is related with the gap in documentation on assistive technology. Many are the computer resources but few is the knowledge on the process of creation, although there are several social sciences, educational and health forums talking about this subject.

Throughout this project, it was really noticeable the additional necessary effort to conceptualize an assistive application compared with a standard application. This additional effort focused essentially the need to really know the sample population, to fully understand its limitations and the medical condition of the disabilities in order to guarantee that an assistive application correctly functions.

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