Towards Mobile Accessibility for Older People: A User Centered Evaluation

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Abstract. As people age, they experience a decline in a wide variety of their abilities such as vision, hearing, mobility and so on. Mobile technologies could be used to improve their quality of life in a wide set of situations such as security, autonomy or personal communication. One of the main threats in the use of mobile devices by our elders is the accessibility barriers that exist on the devices and mobile applications. Unfortunately, addressing these issues is even harder in new devices like smartphones or tablets where there is not a proper set of guidelines focusing on this domain. Based on our own set of accessibility guidelines, an accessibility evaluation of two mobile applications with elderly involvement has been carried out in this work. The outcomes support the suitability of the set of accessibility guidelines proposed as a method to evaluate; on the other hand the data collected from the study with users provide interesting findings about the perception of the older users when they interacting with mobile applications.

Keywords: Accessibility, Older people, Android, Mobile Interfaces, evaluation.

1 Introduction

According to the European Commission [3] in early 2012, 17,8 % of the European population had 65 years old or over, and the 4,9 % had 80 years old or over. That is, almost a quarter of the European Population could be considered as older population. This number will grow up exponentially in the years to come.

Maybe older people don't use the mobile devices in the same way that other younger users but, in fact, what older users expect from mobile communications is not very different from what generic users expect; mainly, personal communication and services to improve their safety and quality of life [4].

Nevertheless, this trend will change in a few years from now, when the middle-age population becomes the new elderly population. We've all grown up using personal computers, mobile devices, and in general, any device that makes our lives easier.

In fact, now our elders use mobile devices to keep the contact with their families or use simple applications that help them in their daily basis. More and more, mobile devices and new technologies are used to improve the quality of life of older people by using for example Medical Assistance applications, smart houses, and so on.

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Sadly, this improvement of the quality of life of our elders is not possible for everyone. In fact, there are a substantial number of people that is being excluded because they are affected with one, or more than one, disabilities.

Address accessibility issues are not a simple task but is even harder in the mobile context where the devices and technologies evolves faster than the accessibility problems are addressed.

In this paper, we proposed a checklist in order to improve the accessibility of mobile interfaces. This checklist mobile accessibility guidelines is an improved version of one developed previously. This checklist is being used to conduct expert evaluations. In order to demonstrate the suitability of this resource and conduct a more complete accessibility evaluation following a User Centered Design (UCD) approach [2], this paper includes the elderly users' participation in an evaluation of mobile Apps.

Section 2 shows the background and related work in this topic. Section 3 details the experimental design for the evaluation by older users of the Mobile applications. The analysis and the results of the study are discussed in Section 4. Finally, Section 5 exposes the conclusions and the future work of this research.

2 Background

As we said above, mobile devices and technologies are evolving so fast. This continuous evolution implies new challenges to be tackled. Accessibility issues have been, and will be, one of these challenges.

The Web Accessibility Initiative (WAI) from the World Wide Web Consortium (W3C) is working on adapt the Web Content Accessibility Guidelines (WCAG) and the User Agent Accessibility Guidelines in the mobile context [5].

Many authors have studied the accessibility and usability issues and propose many guidelines or a set of best practices that could be applied to the mobile context too [6], [7], [8].

Mobile operating system providers such as Google, Microsoft or Apple provide some guidance to develop accessible application for their operating systems [9], [10].

During years, mobile devices have not been designed with older people in mind and are often difficult for them to use and excluding them from the technologies. Several studies demonstrated that a mobile device or application, if carefully designed, can be used effectively by older people [11],[12].

Nowadays, we have better devices with better screens and powerful technologies that are most appropriated to be used by older people. Nevertheless, apps are not normally created with older users in mind.

Most of the studies developed to investigate mobile applications for older people share the same starting point: the important premise that "elderly people want to stay and live in their homes as independently and as long as possible" [13].

This is not a trivial issue, because older people are not a homogenous group of users, so design apps for older people is a hard task. In the literature, we can found several guidelines (mostly focused on web applications not in mobile apps) that try to address the design issues for older people [14] [15] [16].

3 Previous Work

The previous work [1] provided a set of guidelines to keep in mind in order to achieve accessibility in mobile interfaces for older people. This set is provided in a list of checkpoints or checklist. This checklist is the result of a review study of the literature, accessibility standards and best practices that are being performed in this knowledge area, by using of this check-list of accessibility aimed at elderly people, a survey of three mobile native Apps on Android platform was carried out by accessibility expert.

3.1 Checklist Mobile Accessibility Guidelines for Older People

A set of criteria collected from different sources and focused mainly on older people was provided. This set of criteria has been improved, some of them has been erased; because some of them are good criteria to address accessibility issues, but they are not good enough to solve or to improve the accessibility for older people and they were replaced by another ones.

The different sources were accessibility standards and guidelines established by the W3C [5], from the literature [6], [7], [8] and finally from the accessibility best practices recommended by Apple and Google in their application developers guides [9], [10].

The result has been a checklist mobile accessibility for older people. This checklist is provided through barriers common to mobile device. The table 1 shows this checklist; a code and brief description of each checkpoint (barrier common) is described.

Table 1. Checklist proposed to address accessibility issues for older people

Code	Description of accessibility barrier
W3CP001	Information conveyed using color (for example, "required material is shown in red") with no redundancy.
W3CP002	Non-text objects (images, sound, video) without text alternative
W3CU001	Long words, long and complex sentences, jargon
W3CU002	Content spawning new windows without warning user.
W3CU003	Blinking, moving, scrolling or auto-updating content
WDG-TD	Unsuitable Target Design (larger targets, clear confirmation of target capture, etc.)
WDG-UG	Use of unsuitable Graphics or not accessible (Graphics should be relevant, images with alt tag, etc.)
WDG-BWF	Unsuitable design features for browser windows (Avoid scroll bars, only one open window)
WDG-CLD	Not accessible content and unsuitable layout Design (Language should be simple and clear, highlight important information, etc.)
WDG-UCD	Unsuitable design according to cognitive barriers (Provide ample time to read information, support recognition rather than recall)

Table 1. (*continued*)

Code	Description of accessibility barrier
WDG-UCB	Unsuitable Use of Color and Background (Colors should be used conservatively, background not in pure white or change rapidly in brightness between screens, insufficient contrast, etc.)
Android001	No provide redundant information for information only auditory (Make sure that audio prompts are always accompanied by another visual prompt or notification, to assist users who are deaf or hard of hearing)
Android 002	Forms difficult to understand. Interface controls have properly labels and these labels are understandable and descriptive
GB001	Opaque Objects. The page contains components (eg. a Flash object) that is totally opaque to screen readers
GB002	Too many links. A large number of links requires that users perform a lengthy and exerting activity when listening to all of them.

3.2 Accessibility Audit/Expert Evaluation

We performed the evaluation of three different apps [1]: Big Launcher [17], Fontrillo [18] and Mobile Accessibility for Android (MAA) [19]. These Apps have as aim to modify the default interface for another more accessible one.

An expert on mobile accessibility was carried out an evaluation. He tested each checkpoint of Table 1 for each App. The results of study indicated Big Launcher is the most accessible for older people of the three applications.

In order to conduct a more complete accessibility evaluation following a User Centered Design (UCD) approach with the elderly users' participation, a user tests are presented in this paper.

4 Experimental Design

We performed a study with the participation of older users. This study is composed of three different stages. First of all, older users had to perform some easy and day by day tasks with two applications. Second, we performed an interview to each user guided by a set of question that will be shown later on this paper. Finally, a user survey was carried out and the results are presented.

4.1 Object of Study

We focus this study on perform an accessibility evaluation of two different applications from the Google Play Store with real older users and taking into account the Checklist Mobile accessibility guidelines for older people (see Table 1).

The evaluation was performed with 8 participants (two men and six women) with ages between 65 and 82.

4.2 Sample APP's

The Apps of the sample modify the mobile interfaces to convert them in more accessible interfaces for people with disabilities or elderly people.

From three different apps (Big Launcher, Fontrillo and Mobile Accessibility) evaluated in previous work, we have removed the Mobile Accessibility for Android for this study, because although it is a really good accessible app, it is focused mainly on blind people and does not fit exactly with the study target.

The BigLauncher application was tested on its 2.3.4 version (latest version available). Since our latest analysis in the previous work BigLauncher doesn't evolve so much.

The evaluation of the Fontrillo Application has been made in its 1.1.2 version (latest version available). Since our latest analysis, in contrast to Big Launcher, Fontrillo has had a considerable number of changes. This version includes some new functionalities that increases the app value like an alphabetical ordered keyboard, screen to configure favorite apps, etc.

Figure 1 shows screenshots of the BigLauncher App on the left and Fontrillo App on the right.

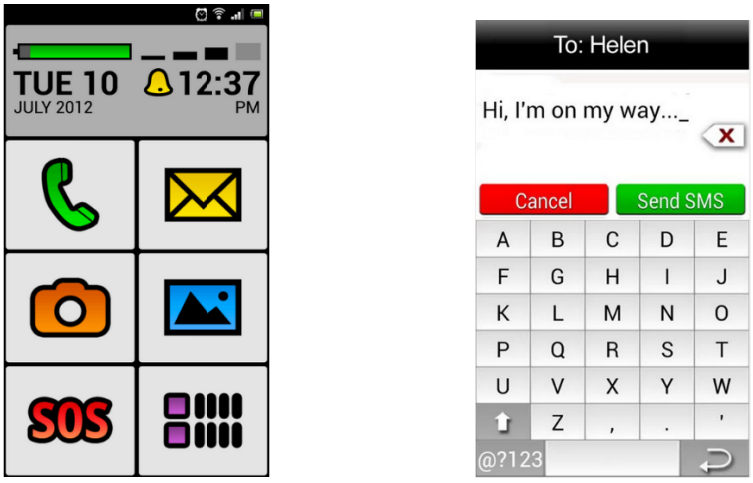

Fig. 1. Main screenshot of BigLauncher App (left) and text input main screenshot of Fontrillo App (right)

All these apps have good acceptance by users and they are highly scored in the Google Play Store. The score of Big Launcher App in the Google Play Store is 4,3 out of 5 stars and Fontrillo has 4,4 out of 5 stars.

4.3 Participants

In this study 8 users with ages between 65 and 82 years old have participated. The users had different cultural levels and different know-how in the use of Smartphones.

None of them have a severe disability but they have some visual, understanding or ability issues. The table 2 shows the characteristics of users.

Table 2. Users information

	U1	U2	U3	U4	U5	U6	U7	U8
Age	65	69	82	72	68	71	68	70
Device	LG optimus L5 II	Samsung Galaxy S	Galaxy S4	Huawei Ascend W2	Huawei Y300	Samsung Galaxy Ace	BQ Aquaris 5	Samsung Galaxy S
Disability	Glasses	N/A	Manual Dexterity, Glasses	Glasses	Glasses	Glasses	N/A	Glasses
Gender	Woman	Woman	Woman	Woman	Woman	Man	Man	Woman
Studies	Primary	Primary	Secondary	Primary	Primary	Primary	Primary	Primary
Smartphone used for	Calls, text	Calls, Texts	Calls	Calls, Text, Pictures	Calls, Text, Pictures	Calls	Calls, Text, Pictures	Calls
Problems using a Smartphone	Iconography, Small Fonts, Understand the apps	Understand the apps	Mobility. She uses a pointer device.	Iconography, Small Fonts	Iconography, Small Fonts	Iconography, Small Fonts	Understand the apps	Understand the apps and small fonts
Time using a smartphone	Over 2 years	Between 1-2 years	2 years	Less than 1 year	Between 2 and 3 years	Less than 1 yeas	Between 2- 3 years	Between 1-2 years

4.4 Procedure

We perform two different sessions with the participants. During the first one, perform a simple and brief explanation of our research. In the second session we teach them how to install the applications and demand them to perform some simple tasks with both applications. Finally, for each user we perform a structured interview with the use of a questionnaire based on the Checklist Mobile accessibility guidelines for older people (see Table 1).

We define a list of day-to-day tasks and a high-skilled task that the users should try to carry out with both applications. We didn't give them any support while they were carrying out these tasks.

The simple tasks included the following:

- Make a call
- Looking for a contact
- To add a contact

- Text a contact
- Review the calls list
- Take a picture
- Look for the picture you just take
- Search for whatsapp application and use it.

The high-skilled task consist on configure the emergency call number.

Each user has his/her own device and the accessibility tools, provided by the Android Operating System (TalkBack and the Explore by Touch) features were disabled (because they haven't got any severe visual disability).

4.5 Questionnaires

Once our users had performed the task commented on Section 4.4, we had an structured interview with each one. We conduct these interviews through a questionnaire (see Table 3) that has been designed based on the checklist (see Table 1). So besides that we carried out the evaluation of users, we have been able to validate the suitability of the proposed checklist comparing data resulting from the analysis of experts with users.

The questionnaire is composed by three different types of questions which allowed us to collect different data (qualitative and quantitative):

- Personal Questions: These questions allow us to collect data for statistical purposes (age, experience, etc.)
- Question based on each criteria of the checklist: These questions will be the core of our research and are based on the criteria established. Users must grade their answers between 1 to 5; where 1 mean totally disagree and 5 totally agree.
- Qualitative Questions: These questions are useful to obtain users opinion because answers are opened answers and users can explain their answers.

The complete collection of questions is shown on table 3.

Table 3. Questionnaire used in evaluation with elder users

Personal questions
Age
Mobile Device
Disability/Disabilities
Gender
Educational Level
Do you use your smartphone mainly for …? (calls, internet, messages, …)
Do you have any problem when you use your smartphone? (small fonts, understanding, …)
How long have you been using a smartphone?

Table 3. (*continued*)

Questions based on the criteria (graded between 1 and 5)
The Application language is understandable (W3CU001)
Popups makes me hard the use of the application (W3CU002)
Blink and scrolling makes hard to interact with the application (W3CU003)
Iconographies and links are larger enough to interact with them (WDG-TD)
Iconography is understandable (WDG-UG)
Popups or alert messages makes hard to use the application (WGG-BWF)
Application provides ample time to read the information important information appears highlighted (WDG-CLD)
Background colors and icons colors are appropriate (WDG-UCD)
Interface buttons and controls have appropriate text captions (Android 001)
Audio prompts are always accompanied by another visual prompt (Android002)
There are so many links or buttons that make me hard to understand and to use the application (GB002)
Qualitative questions
Which application do you prefer?
What is the main strength of the application you choose?
What is the main weakness of the application you choose?
What is the main strength of the application **you didn't** choose?
What is the main weakness of the application **you didn't** choose?

4.6 Evaluation Method

Statistical and qualitative data have been produced by user answers. These data have been used to provide the analysis and the discussion of the results. By the way, for each criterion, except for those related to the use of screen readers and high visual disabilities, we had a different question that could be graded from 1 to 5, the final result for each criterion/question will be the average between them.

In next section we provide the scores for each criterion and the analysis of the results.

5 Analysis and Results

Regarding to the user answers to questions based on the checklist. Table 4 shows the average and standard deviation between each answer. Both applications got similar scores. The standard deviations are small with a few exceptions; this data indicates that most of the users have close answers.

Most of the criteria have obtained high scores, with the exceptions of the answers concerning to the checkpoints W3CU002 and WDG-BWF. It is due to open new windows (Popups) without notice to users, multiple windows open or scrolls that hinder the use of interfaces in the two app. The answers concerning to the checkpoint GB002 get low scores, it is because users have the perception that the interfaces have too many links with the consequent effort involved access to many links for older people.

Table 4. Averages and the standard deviations of the user answers

Criteria	BigLauncher		Fontrillo	
	Average	St. dev.	Average	St. dev.
W3CU001	4,38	0,74	4,00	0,76
W3CU002	1,38	0,52	1,13	0,35
W3CU003	3,38	0,74	3,88	0,64
WDG-TD	4,25	0,71	4,50	0,53
WDG-UG	4,25	0,71	3,13	1,25
WDG-BWF	1,50	0,53	1,75	0,71
WDG-CLD	4,00	0,76	2,63	0,52
WDG-UCD	4,50	0,53	4,13	0,83
WDG-UCB	4,50	0,53	4,63	0,52
Android001	4,25	0,71	4,00	0,76
Android 002	4,63	0,52	4,38	0,52
GB002	2,50	0,53	2,38	0,74

The most valuated criteria were those that improve the interaction with the application like WDG-TD or WDG-UG for example; and those that improve the cognitive design like WDG-UCB or Android 002.

The results of the open questions indicate that the users remarked that BigLauncher app is so easy to use; they all committed the simple task and many of them even the high-level skilled task. Regarding Fontrillo app, most of them remarked that this application is more complete than BigLauncher but that it is a little harder to use and to understand. They all completed the easy tasks (but using a little bit of time that with BigLauncher). High-skilled task was only accomplished by two of them. Fontrillo has a minimum advantage over BigLauncher, but users prefer BigLauncher because, according to them, it was easier to use. In the other hand, users said that Fontrillo has more functionalities which they like as the alphabetical keyboard for text.

Users agree that both applications are accessible and useful for they needs but, as we said before, according to the qualitative answers most of them prefer BigLauncher because its interface is easier to use. This is because the BigLauncher interface is very visual, includes big icons with metaphors that users understand well. In this way, Fontrillo is not as visual. Also Fontrillo has transitions from left to right to move from one interface to another which users do not understand. Users understand better and are more comfortable with BigLauncher that includes only a main interface, and they do not need to navigate. Only two users (U5 y U7) chose Fontrillo and they were those that had been using smartphones since long time ago.

As a curiosity, the user (U5) said his favorite application was BigLauncher, however she changed his mind, and finally she decided that the best application was Fontrillo because it included a flashlight, and this functionality it is essential for her.

With regard to app versions evaluated in previous work, the new version of Fontrillo under study improves considerably the weaknesses that it had. New version accomplish with most of the criteria established. BigLauncher doesn't add new functionalities that could be useful for older people. Finally, in order to analyze the

suitability of the checklist developed by the authors, the results of user reviews coincide with the evaluation carried out in previous work by the expert, this similarity of results indicates that the Checklist itself could be a valid tool to evaluate the accessibility of mobile applications for the elderly

6 Conclusions and Future Work

In this paper we continued with the research started in 2013 that tried to collect a set of accessibility criteria or best practices that could be applied to mobile interfaces for older users. We reviewed the set of criteria and improved it by adding new criteria and deleting those ones that don't fit well with our target audience.

In addition, and to test the suitability of our checklist, we performed an evaluation of two android applications, Big Launcher and Fontrillo, with eight users with ages between 65 and 82 years old. We designed a set of easy tasks that they had to perform and a set of questions that they had to answer after they have been using both applications.

According to the results, both applications get similar results, and users concluded that both applications would fit well for they needs; most of them, preferred Big Launcher because, according to their answers, is easy to use.

As main weaknesses, in this evaluation none of the users had any kind of severe disability, so criteria focused on address concrete accessibility issues such vision, hearing, and so on couldn't be correctly evaluated (they don't use any kind of accessibility tool such as Talkback).

We want to perform more studies over our checklist, next steps could be to make it extensible to iOS or Windows Phone applications and to extend this checklist to new features such as those that are task-oriented like call or info search or those that are context-dependent like videophone or desktop application.

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