Development and UI/UX Testing of an iTV Companion Application for Seniors

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Abstract: This paper presents the results of testing a second-screen mobile application designed for senior users. This work is part of the +TV4E project, a larger study which focuses on promoting info-inclusion among the senior Portuguese population by directly sending them information regarding public and social services. The developed mobile application was integrated into this project as a complement for the already existing iTV application, which delivered informative videos to seniors, serving both as a second-screen app, by augmenting the TV experience and as a standalone application, by allowing users to access their videos outside their homes. Initially, a prototype application was developed with the objective of being presented to a group of seniors in order to identify the major interface flaws, subsequently, the prototype was improved taking into consideration the gathered feedback.

1 INTRODUCTION

Population aging is an inevitable natural occurrence that has led to a significant inversion of the aging pyramid in the developed societies in the last decades. Nearly every country is facing an increased longevity of adults, which in turn reflect in an increase of older people, both in the number and proportions (Rosenberg et al., 2013). This phenomenon became one of the greatest challenges for modern civilization and is affecting all sectors of society, namely labour and financial markets, goods and services, such as housing, transportation and social protection (United Nations, 2015). Forecasts indicate that a rapid increase in the number of people aged 60 or over in the medium-term will occur in the near future. Between 2015 and 2030 it is estimated that the total population aged 60 years and over will increase from 901 million to 1.4 billion, reaching nearly 2.1 billion in 2050 (United Nations, 2015). This increase in life expectancy can be considered as a great achievement for developed societies, however, it raises various challenges and concerns to citizens, governments, and communities. Changes in public health policies, retirement and pension policies, social security and education, are some of the consequences of demographic aging (Teixeira et al., 2013) (He et al., 2016). Although aging is characterized by several physical, psychological and social changes which can result in various problems, being old does not necessarily have to be synonymous of illness, disability, dependency, isolation, or loneliness. Living longer can become distressing and problematic for both the individuals themselves and for those around them when proper conditions for being independent, active, and healthy are not available. It is important to develop policies and strategies that allow older people to maintain or improve their quality of life so that aging start being seen from the perspective of "add life to years" instead of "add years to life". Considering the aging process, the concept of “quality of life” is highly determined by the individual's ability to maintain their autonomy and independence (Kalache and Gatti, 2002). Particularly in Portugal, 2,032,606 citizens were 65 years or over in 2012. Considering optimistic projections and the current trends of fertility, mortality and migration, in 2060 this number will increase to 3,343,987 (Instituto Nacional de

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Estatística, 2017). Information is vital for everyone, especially the senior population, which needs to stay well informed so that they can adapt their lifestyle within social and governmental norms, maintaining their autonomy and independence. Access to information is one of the areas which influence seniors' quality of life the most. It allows people to be more knowledgeable about their environments and thus allow them to make decisions in a more supported manner (Silva et al., 2017). In Portugal, despite the existence of plenty of information regarding social and public services, which is made available in several service outlets as well as online platforms, often seniors cannot easily access it because it requires a certain degree of proficiency in technical terms which can be hard to understand by most of the citizens. To further aggravate this situation for the senior population, accessing this information involves a pro-active behaviour by the user, often not seen in seniors (Silva et al., 2018). In this context, the +TV4E platform's goal is to bring information regarding social and public services to seniors, allowing them to easily gain access to services without the need to search for them. The core of this platform consists in notifying users of informative content about social or public services while they watch TV. Not to lose any television content, the platforms allows the seniors to automatically pause the TV broadcast to watch an informative video and then continue watching the linear broadcast. These informative videos are divided into seven areas of general interest named ASGIE (Silva et al., 2017), which include Healthcare and Welfare services, Social services, Financial services, Culture services, Security services, Transport services and Local authority services. In addition, the +TV4E platform features a video library which aggregates every informative video sent to the user and a video recommendation algorithm, used to determine which videos should be sent to each user. The project intends to offer seniors an easier way to access information about public and social services, contributing to a more independent way of living. This project was developed in collaboration with several groups of seniors who took part in iterative design sessions and usability tests, to evaluate a high-fidelity prototype of the product.

2 THEORETICAL FRAMEWORK

2.1 Active Aging

The term active aging was adopted in 2002 by the World Health Organization, they advocated that in order for older people to maintain a good quality of life, a lengthier lifespan must be accompanied by continuous opportunities in health, security, and participation.

These three concepts are defined as the pillars of what constitutes active aging and encourages individuals, throughout their life course, to realize their potential for physical, social, and mental wellbeing and to participate in society, while providing them the adequate protection, security, and care, when needed (Kalache and Gatti, 2002). The quality of life of the elderly depends on the risks and opportunities they experience over their life course, as well as the support provided by other generations (Kalache and Gatti, 2002). Active aging allows people to keep their sense of purpose and belonging after they become retired, disabled or incapacitated, encouraging them to play an active role in their respective families, communities, and social groups. This approach followed by the World Health Organization has based the recognition of senior's human rights and the principles of independence, participation, dignity, care, and self-realization defined by the United Nations (Fredvang and Biggs, 2012). This concept is pioneer when it comes to the recognition of the aging population as an important global phenomenon, it encourages people to work for longer and to retire later or to engage in volunteer work after retirement, thus maintaining healthy and independent lives. Making sure seniors continue to have access to means that allow them to age in a healthy and autonomous way, is one of the great challenges of public health (Rosenberg et al., 2013).

Technologies can provide the senior population with several benefits, helping them to maintain a higher quality of life for longer. Over time, several innovative technologies have emerged in the fields of medicine, robotics, assisted living mediated by sensors (Rosenberg et al., 2013). However, developing technologies for seniors can become a tricky process because, ultimately, their adoption relies on the senior's capacity to understand and adapt to them. It is important to never forget that this audience may have low levels of digital literacy and therefore can be less prepared to handle complex digital tasks, so these technologies need to be adapted to seniors instead of forcing seniors to adapt to them.

2.2 Mobile Interfaces for Seniors

When developing software for older people it is necessary to accommodate all the physiological changes that occur with aging, which cause them to

need a higher degree of support in executing tasks and activities (Eisma et al., 2004). It is often hard for seniors to get used to new technologies, however, one of the major causes for the low levels of technology acceptance comes from developers neglecting their accessibility issues on the application's design process (Holzinger et al., 2007). In 2006, Hawthorn highlights in his investigation "Designing Effective Interfaces for Older Users" (Hawthorn, 2006), that despite his users having ages between 65 and 85 years old, their numeric age was somewhat insignificant. The most important factor was the manifestation of the effects caused by aging, such as loss of vision and memory, as well as the decrease in learning speed. Most digital interfaces are not designed considering the sensory, physical and cognitive constraints of seniors (Pereira, 2013). Loss of hearing and visual acuity, for example, are factors that need to be considered when developing software for seniors. Reis and colleges (Reis et al., 2017) provide a good basis for this study by proposing guidelines to ensure high levels of usability among senior users. The loss of visual acuity causes seniors to have difficulty in focusing at short distances, distinguishing small details, discriminating chromatic differences and reading moving text. Additionally, it lowers their adaptability to lighting, what makes them more susceptible to brightness and requires for them to be in a more luminous space when performing tasks such as reading. To work around these visual impairments there are various solutions that ensure that the software is designed appropriately. Guidelines suggest that the onscreen text should be at least 40pts, the fonts should not have serifs, italic or other decorative elements, the text should be aligned to the left, the spacing between lines needs to guarantee fluidity and readability and there should be high contrast between the background and the text. Titles and labels especially should be large and easy to read. Regarding iconography, icons should be easily distinguishable, the use of abstract concepts or any current graphical conventions associated with the ICT should be avoided and most importantly, as a failsafe, be composed of a combination of text plus an image, where the text helps reinforce the meaning of the icon. The colours are also another important aspect to consider and should be chosen carefully to account for the limited colours spectrum seniors perceive and the fact that colours never look alike in different screens. Physical challenges of using technology, sceptical attitudes regarding the benefits of technology, complex security settings and even the complexity of basic online services related with social security, finances, or health services emerge as potentially dissuasion factors for the use of ICT by seniors. To some extent, this situation may contribute to the seniors' info exclusion (Verona et al., 2006).

When working on strategies designed to promote the access of information by seniors, it is important to understand them and be aware of their information consumption habits. With these concepts in mind, the +TV4E team sought to provide the users of the platform with an alternative way of consuming information with the addition of a mobile application. Currently, the platform was designed only with the TV as a medium of delivering informative content regarding social and public services to seniors, so the inclusion of a mobile application in the +TV4E ecosystem aimed to further expand the reach of the platform so that it can better serve the needs of seniors.

3 DESIGN AND DEVELOPMENT OF THE FIRST PROTOTYPE

The design and development process of the mobile application was divided into three steps, the definition of the functional and technical requirements, the design of the interface and finally the implementation. The first step, defining the functional requirements, was arguably the most important step in this process, since, it was necessary to find a balance between the iTV and the mobile applications in order for the mobile application to serve as a complement and not a replacement to the +TV4E iTV platform. To accomplish this objective, the mobile application was planned to take advantage of the functionalities available on smartphones that are not available in most TVs, namely having a keyboard, which allows for easier typing, touch controls, a microphone, a camera and most importantly being portable. Therefore the following functional requirements were defined:

a) Scan QR codes for a simplified user login
b) Allow the user to access his/her video library
c) Enable the user to watch informative videos on the smartphone
d) Allow the user to select a video and watch it on the TV
e) Allow the user to search videos on his/her video library
f) Provide the user with recommended videos for his profile
g) Allow the user to use voice commands to interact with the TV
h) Include a tutorial to help the users

Considering these requirements, the +TV4E mobile application was designed to work as both as a second-screen application, for when the user is watching TV at his home, and as a standalone application to watch informative videos when he's outside. So the application would allow the user to browse his personal video library anywhere, thus being fully a functional way to watch informative videos when he's away from the TV, but also allow the user to interact with the TV by using the application to search for and push videos to the TV.

Next, it was necessary to define the technical requirements that would allow for the implementation of the features listed above. The following technical requirements were defined for the mobile application:

a) Run on Android smartphones
b) Be able to communicate with the set-top box
c) Be able to access the internet
d) Be able to access the smartphone's camera and microphone
e) Feature touch controls

Since developing for both Android and iOS was more time consuming, Android was chosen as the target platform in order to save resources, since it is easy to deploy applications to any Android device, while for iOS either the application needs to be published in the app store or the device needs to be configured to allow the installation of unverified applications. Furthermore, Android devices are vastly more common than their iOS counterpart, so it would not negatively affect the gathering of participants to test the application. It was also important that the mobile application was able to directly communicate with the set-top box in order to function as a companion application for when the user is watching TV, as well as connect to the internet in order to stream the informative videos, access the smartphone's microphone to record the user's voice during voice commands and the smartphone's camera to scan the QR codes.

After establishing the functional and technical requirements the design process of the interface began, the goal was to keep the layout as simple as possible while accommodating all the features in a clear and visible way. Simplicity was the focus since familiarity with technology usually decreases with age and seniors tend to avoid technology when the product is too complicated for them. Individual abilities decline with old age, especially vision, since the eyes lose its ability to focus quickly or to react to rapidly-changing brightness it is important to accommodate these limitations in the design. Seniors often also cannot see thin lines or other fine details in interfaces and have difficulty distinguishing between similar icons, therefore, the interface was kept as clean and simple as possible consisting only of two main screens ("Library" and "Recommendations") the login screen, a menu, a tutorial and a total of only three icons. The "Library" screen aggregates all the videos sent to the user in the last 15 days in a vertical list ordered by the most recent, each video is presented as a card, similarly to the Youtube™ mobile application, containing the title, the duration, the date it was sent and a thumbnail representing the area of interest of the video. By clicking on the card, the user is shown an on-screen prompt which asks him if he wants to watch the video on the smartphone or the TV. Additionally, this screen contains a search bar which allows the user to find videos by their title which is represented by a magnifying glass icon. The "Recommendations" screen follows the same layout of the previous screen, however, it displays a maximum of six videos suggested by the +TV4E recommendation system and it does not feature a search bar since the video list is much smaller. To implement the login in a simplified manner a QR code was added to the set-top boxes which contained the serial number of the box, this way if a user needed to login in the mobile application he would only have to scan the QR code located on top of the box, thus removing the need to remember a username and password combination. The menu was positioned at the top of the screen, to avoid having the user accidentally clicking on it while scrolling, and featured two buttons which served both as shortcuts to navigate between the two main screens and to let the user know which screen he was navigating since the selected screen was highlighted. Finally, on the bottom right of the screen, two buttons were positioned, the "Help" button was represented by a question mark icon and opened the tutorial and the "Voice" button allowed the user to issue a voice commands to the ITV application. The result is seen in Figure 1 below, in which the basic navigation flow is depicted.

Figure 1: First prototype screens.

Afterward, it was necessary to choose a technological solution that would allow the creation of a high-fidelity prototype that would accurately represent the final product. Since the project programmers were used to developing Javascript web applications the chosen framework was Ionic, an open-source software development kit built on AngularJS, this framework allows the development of hybrid mobile applications using web technologies such as HTLM5 and CSS. The development followed the specifications stated previously, with the two main screens and a tutorial area, the voice commands were implemented using Google's Speech to Text service and the interaction with the set-top box was done by sending HTTP requests to the +TV4E web API which then communicated with the box via a socket connection (see Figure 2).

Figure 2: +TV4E mobile system architecture.

In the next section, the methodology used to evaluate the mobile application is described in detail, going over the objectives of the study, the sample, and the testing process.

4 METHODOLOGY

The current study's purpose is to study the inclusion of a mobile application and assess its added value in the already existing +TV4E platform, by determining if mobile devices are an appropriate medium for the project for the senior audience. In order to accomplish this task first, it was necessary to decide a set of methods and scales that can provide accurate results in assessing the usability and the user-experience of the mobile application, as well as being appropriate to be applied with the target demographic. The present section describes this process, going over the objective, the sample and detailing the entire process.

4.1 Objectives

The primary objective of this study was to evaluate the usability and user-experience of the +TV4E mobile application, which would serve as a component of the iTV application being developed under the +TV4E project. The development of this mobile application was self-proposed by the research team, rather than being an idea proposed during the participatory design sessions of the +TV4E project, however, despite this, the literature strongly suggests that the best way to develop software solutions for the senior population is to work closely with the target demographic. By engaging seniors in key development steps it is easier to create a solution that better suits the needs of this population, which often has difficulties handling newer technologies.

The +TV4E mobile application serves a similar purpose to the video library present in the iTV application, which allows users to watch videos on-demand, thus giving some control over which content the users want to see, as opposed to the way videos are automatically sent to users while watching the regular television broadcast in the iTV Application. In both the library and the mobile application, the users can re-watch videos they already saw or catch up on videos they missed or ignored while watching TV, however in the latter the users are given a higher degree of control since they can also watch suggested videos based on their usage of the platform. These suggested videos are provided by the recommendation system, which is also used when choosing which video should be sent to each user (Campelo et al., 2017). Additionally, the mobile application provides the users with a search feature to find videos more quickly, allowing them to watch videos either on their smartphones or in the TV and also to interact with the iTV application via voice commands. These voice commands only allow the user to perform a very limited amount of actions, namely selecting the next higher or lower channel, changing to a specific TV channel given its name or number, and accessing the video library. This feature was implemented due to the rising popularity of voice assistants in the market, such as Siri, Alexa and Google Assistant, which made the research team consider including them in the mobile application in order to assess how the senior population would react to them in a TV ecosystem.

However similar in terms of functionality, the mobile application greatly differs from the video library when it comes to its interface and user experience especially since it is developed on for a different platform with a vastly different interaction paradigm, therefore the need to perform new tests to validate it with seniors. The key elements in need of validation were the navigation, the interface, the voice commands and the general receptiveness for

this technology to be integrated into the +TV4E platform.

4.2 Sample

The sample for this study was divided into two groups, a first group to perform a preliminary usability analysis, which aimed at finding key usability issues in the application (Nielsen and Molich, 1990), and a second group to participate in a Focus Group.

The first sample group was composed of five individuals of the Senior University of Curia, four females (80%) and one male (20%), with an average age of 71.4 years, four of these individuals completed a higher education degree while the fifth only completed middle school. The only requirements to participate in this sample were being at least 60 years old, which is a limit stipulated by the +TV4E project, having a basic knowledge on how to use a smartphone since the application was being designed for users who already use a smartphone on a daily basis, and being familiar with the +TV4E project. This sample was inquired regarding their smartphone usage, none of them required help while using their smartphones, four users (80%) used an Android device while one (20%) used an iOS device and the average time spent user their phone per day was 1.1 hours. Lastly, the participants were asked about which actions they perform using their smartphones, the results are shown in the following table (Table 1):

Table 1: Smartphone usage for the first sample group.

Smartphone usage	n	%
(1) Making phone calls	5	100
(2) Sending text messages	5	100
(3) Reading news	3	60
(4) Using social networks	2	40
(5) Play games	1	20

As expected all users use their smartphones to make phones calls and send text messages, which are the most basic features of all smartphones, however the more advanced features, which require a higher level of proficiency, were less prevalent in this sample.

This group also participated in the focus group.

4.3 Tests

After the design and development process was concluded, the next step was the evaluation of the mobile application's first prototype in a controlled environment with a sample of five users to find the major flaws in its design. To accomplish this, the application was presented to the first sample group composed of students of the Senior University of Curia. The first testing phase was divided into two parts, initially, the application was presented to each participant which then tested it individually during a cognitive walkthrough and then all the participants were gathered to discuss their experiences in a focus group. After this phase, various improvements will be made in the mobile application considering the data gathered. The team plans to carrier a second phase of tests in the homes of a second sample group to evaluate the solution in a real context of use using the entire +TV4E platform, being followed by interviews and a focus group in the end. The entire process that the team aims to develop is represented in Figure 3. The 1st test phase was already carried out and will be described in greater detail in the following sections.

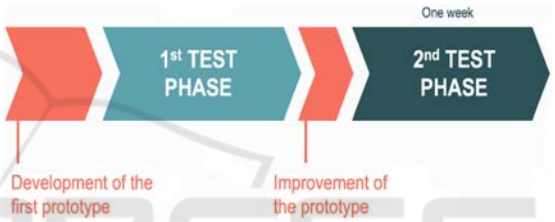

Figure 3: Mobile application test phases.

4.3.1 Controlled Environment Tests

This phase began by contextualizing the participants regarding the test they were about to take part in, reminding them about the +TV4E project, since all of them took part in previous data gatherings, explaining that their participation was voluntary and that the data collected would remain anonymous and would not be disclosed. Afterward, the participants signed the informed consent to take part in the study and their demographic data was collected, the participants were asked their age, gender and level of education, followed by a survey regarding their smartphone usage habits, on which they were asked what device they use, their daily average use and which tasks they perform regularly with the smartphone.

Next, each participant was given a brief explanation of the application's features, emphasizing the fact that it mostly consisted of a complement to the iTV application they tested previously, and then took part in a cognitive walkthrough. This test was composed of 14 tasks which aimed at evaluating key aspects of the interface and layout of the application. The tasks were the following:

1. Open the +TV4E mobile application
2. Read the application's user guide
3. Login using the provided QR code
4. Access the help menu and review the application's user guide
5. Count the number of videos in the list "My Videos"
6. Point out when the 3rd video of the list was added
7. Use the search function to search for the video "USF Almada"
8. Watch on the smartphone the video you searched
9. Close the video you are watching
10. Switch to the list "Recommended Videos"
11. Point out the duration of the 2nd video in the list
12. Chose a video from the list and watch it on the television
13. Click on the microphone button and use a voice command to change the TV channel
14. Use a voice command to access the video library

During the execution of these tasks, a researcher filled a performance evaluation chart where it was registered whether the task was successfully completed or not, the number of mistakes, the execution time and potential observations. The participants were encouraged to perform the tasks independently, thus the researcher gave as little instructions as possible and instead just motivated them to keep trying. However, if the participant decided to give up it the solution would be explained to him while he explained why he could not finish the task since some tasks required the completion of previous ones. After concluding the tasks, the participants were asked to fill out a Self-Assessment Manikin test.

After each participant tested the application individually, the entire sample was gathered for a focus group where they were encouraged to discuss which aspects of the mobile application they considered to need improvements, which features should be included to this initial prototype and if they found the application useful or not. The focus group was structured to discuss these three aspects and included the following open-ended questions:

1. Did you consider that the +TV4E mobile application could be an added value for you to stay informed?
2. Do you consider that being able to access the +TV4E platform outside your home is useful?
3. Do you think that the mobile application should include more information, such as weather forecasts?
4. Do you consider useful having the "Recommended Videos" list?
5. Did you have any problems navigating in the application?
6. Did you have trouble reading the text in the application or understanding the iconography?
7. Did you find the voice commands useful?

All the participants were given an opportunity to express their opinions as well as discuss among themselves their user experience, this step was considered crucial for this early testing since it provided a very direct feedback of the main problems found in the application at the moment.

All the data gathered was compiled and used to fix the most recurring problems in the application, as well as to improve the current layout in order to better suit the target audience needs, all these changes are detailed in the following subsection.

4.3.2 Bug Fixing and Improvements

The first phase of testing proved to be very successful in determining the key problems in the current prototype, in total nine issues were found in the application which needed to be addressed before the next testing phase. The majority of these issues were obtained through direct user feedback while some of them were inferred by the research team, they were divided into three categories, issues reported directly by the users, issues identified by the researcher during the user testing and software issues. The complete results are detailed in the "Results and Discussion" section, however, the changes made to address these issues will be listed below for the sake understanding the differences between the two prototypes.

Starting with the user reported problems, the most frequent issue, which occurred in all user tests, was the fact the users were assuming that the duration of the video was instead the time at which it was added. To fix this, the duration was moved to fit inside the ASGIE icon, the sent date was aligned to the right while the name of the ASGIE was included and aligned to the left to avoid a large blank space. The majority of users complained that it was difficult for them to exit a video while watching, so a button was added to the top right corner of the screen with the label "exit" which would only appear while a video was being played. Also, regarding the video player, it was decided to remove the player controls and only keep the play/pause function by tapping the screen since the users frequently clicked on the timeline by accident. The contrast of the colours was slightly altered to allow for better legibility since some users complained it was too bright to read. Regarding the

buttons, since most users found it difficult to understand the chosen iconography for “Help” and “Microphone” buttons, labels were added to them to avoid confusion. Additionally, the overall size of all buttons was increased since most users expressed difficulty in pressing them. Beyond the issues reported directly reported by the user, it was identified that a search bar should also be present in the “Recommended Videos” list both for consistency and for times when there are several recommended videos. Furthermore, the tutorial was also considered not to be very useful since it lacked clear instructions on how to use the application’s features, therefore it was updated to include close-ups of each function and text clearly explaining each one of them. The improved prototype can be seen in Figure 4 that depicts the more significant changes.

Figure 4: Improved mobile screens.

Finally, a couple of technical problems were discovered during testing, the search bar did not update when the user pressed the backspace and the “Microphone” button was not properly requesting permission to access the smartphone’s microphone, needed for the voice commands. Both these issues were fixed which lead to the second prototype of the mobile application ready for testing in a new round of tests.

5 RESULTS AND DISCUSSION

A total of 5 individuals took part in this study which spawned across a testing phase and a Focus group. The evaluation was composed by a cognitive walkthrough, a SAM and a focus group. The results of these moments with seniors are analysed in the next section.

5.1 Cognitive Walkthrough Performance

Almost all the tasks requested by the participants were successfully concluded, as shown in Table 3. The tasks with the highest and lowest success rates are further analysed. Also, some additional information observed in the performance evaluation grid is provided to help understand the obtained results.

Table 2: Results of the Cognitive Walkthrough (n=5).

Task	Success (%)	Run Time (s)	Errors
T1.	80	16.4	1.25
T2.	80	41	1.8
T3.	100	9.2	0
T4.	60	44	2.4
T5.	100	15.4	0.2
T6.	100	5.8	1
T7.	80	76	1.6
T8.	100	6.6	0
T9.	80	20.6	1
T10	100	7.2	0
T11	100	3	0.2
T12	100	8.8	0.2
T13	100	34.4	1.4
T14	100	18.4	0.2

Looking at the results of the cognitive walkthrough, out of the 14 tasks only 5 were not successfully completed by all the users. Tasks 5, 6, 8, 10, 11, 12 were carried all without any issues by all the users. Task 1 proved to be problematic for some users for two reasons, two users complained the icon was not easy to identify while a third had problems since she was an iOS user and therefore was not used to Android smartphones. Task 2 had a high rate of success, but four users had some trouble understanding they needed to swipe right to forward the tutorial. Task 3 had a surprising 100% success rate contrary to the team’s expectations, which were due to the fact that seniors do not seem to be familiar with QR code technology, however, since the process was compared to taking a photo with the smartphone there were no problems in this task. Task 4 displayed the lowest success rate since three of the five users could not identify the question mark icon as being the help button, this was later fixed as described in the section “Bug Fixing and Improvements”. Task 7 proved to be somewhat difficult for three users, the users had no trouble finding the search area, and however, they had difficulty typing the title of the requested video. This can be due to the smartphone used for testing being different to the devices the users are used to type with. Task 9 had a high success rate, however, the average execution time was higher than expected since exiting

the video should be a simple task, users reported that using the smartphone's back button was not an intuitive way to exit the video since not all smartphones have a back button and sometimes the button is swapped with the overview button. Finally, Tasks 13 and 14 had a 100% success rate despite all the users claiming that they never used voice commands previously, they reported this feature was easy to use after understanding how to issue a voice command which was reflected in a significantly lower execution time average between Task 13 (t=34.4) and Task 14 (t=18.4).

5.2 SAM

The SAM scale was applied at the end of the cognitive walkthrough. SAM uses a pictorial scale that ranges from 1 to 9 and where a high score (closer to 9 than to 1) indicates better usability in terms of how the user feels interacting with a certain system, in this case, the mobile application. This evaluation tool focuses on three items, namely pleasure, arousal, and dominance. Figure 5 integrates the mean average score obtained for each item.

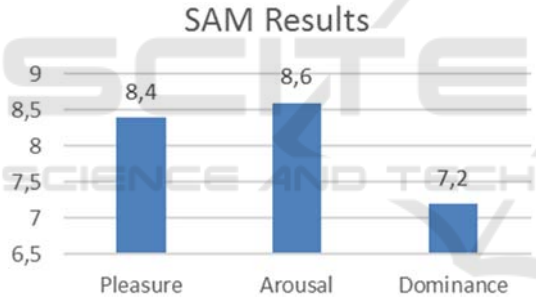

Figure 5: First phase Self-Assessment Manikin results.

Analysing the results, it is clear that, the users rated the application highly on all three items, arousal and pleasure were especially high, which can be attributed to the fact that the users where testing technologies that are still relatively new to them, especially the voice commands, which all five users later reported to find very interesting. However, the lowest score in dominance was the main take away from this SAM, which cannot be dismissed and reflected the usability problems already presented.

5.3 Focus Group

For the final step of this phase, all five participants were gathered for the structured focus group organized based on seven questions. The results of this focus group were important to better understand the biggest issues the user had while performing the cognitive walkthrough, as well as gather suggestions to fix these issues.

Regarding the added value of using the mobile application to stay more informed, the participants stated that adding a mobile component to the +TV4E platform was a good idea, while another participant stated that it could be hard for him to use it in his daily life since he's not used to mobile applications.

In regard to the usefulness of being able to access the +TV4E platform outside their homes, the participants said that they found it useful having the platform available anywhere since they could watch the informative videos as a way to pass the time while also staying informed.

When asked if the mobile application should include more information beyond the information provided by the videos, they replied that it should also contain information regarding public transports, namely train schedules, information about the weather, local shows, and other events.

Next, the participants were asked if they found the "Recommended Videos" tab useful, which is a new functionality to the +TV4E platform, they replied that having more control over the videos they can watch is a positive aspect and that the videos should be recommended based on their search history. These replies allude to the fact that some senior users enjoy looking for the content they want to watch instead of automatically receiving videos suggested by the system.

The next question inquired the participants about any navigational problems they had while testing the mobile application, to which they replied that closing the videos with the backspace was not intuitive and needed to be changed. They also suggested adding a small button on the screen to close the video.

Subsequently, the participants were questioned about their opinions regarding the font and icons are chosen for the mobile application, the font Tiresias was considered to be easy to read, however, the users requested that blue colours used in the menu should have more contrast and that the icons needed something to make their purpose more evident.

The final question inquired about the voice commands, participants stated that they found them very useful and even more practical than using the TV remote, all the participants expressed some degree of enthusiasm regarding the voice commands which motivated the team to further test their potential applications in the +TV4E platform.

6 CONCLUSIONS AND FUTURE WORK

Developing software that caters senior population needs is a process that requires their direct collaboration. In this work, by following a participatory design philosophy it was possible to vastly improve the initial proposal of the mobile application to meet the target audience needs. Although it is not possible to address the concerns of every senior by keeping the general interface and interaction paradigm simple it is possible to reach a broad audience of older adults. The results from field trials revealed that many of the issues present in the first prototype were fixed since the data gathered in the second phase of tests pointed towards higher levels of usability in the prototype. However, it was possible to identify several aspects that could still be improved or added in future versions of the mobile application. Notifications were a feature suggested by some users that were not yet explored. Notifications were considered as a way to remind the users to watch videos they missed in television or to alert them that new recommendations are available in the "Recommended" tab. Additionally, the users stated that it would be a suitable way to remind and motivate people to use the mobile application and not just the iTV application, so this feature will be considered for future tests which would be used to assess the frequency of these notifications and what information should be notified. The voice commands were a small feature included to test new ways for seniors to interact with the iTV application, therefore this functionality was very limited since it only allowed to change the TV channels and access the video library. Going forward, the team wants to explore this feature in new ways in order to fully integrate it with the +TV4E platform, for example by allowing the user to ask for specific videos or search TV channels by content, thus giving the users new ways to interact with the TV.

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