Seniors' Info-Inclusion Through Interactive Television: Results of a Field Trial

Telmo Silva[1,2], Hilma Caravau[1,2], Jorge Ferraz de Abreu[1,2] and Liliana Reis[1,2]
[1]*Department of Communication and Arts, University of Aveiro, Campus Universitário de Santiago 3810-193, Aveiro, Portugal*
[2]*CIC.DIGITAL/Digimedia, University of Aveiro, Aveiro, Portugal*

Keywords: Seniors, Interactive Television, +TV4E, Field Test.

Abstract: Television platforms are becoming more relevant due to multiple factors, namely the interactive features that can be provided. Interactivity can effectively support citizens' problems and needs and open a range of opportunities in several society's sectors. One of these opportunities is related to seniors' level of information. In this framework, to improve Portuguese seniors' info-inclusion in subjects such as social and public services, the +TV4E project aims to develop an Interactive Television (iTV) platform to broadcast personalized content regarding these topics. This paper presents the process and the results of the +TV4E prototype evaluation considering usability and functionality. The platform was made available to a sample of seniors that used it for five weeks in their homes. After this period, the research team applied an evaluation scale and a questionnaire survey to collect data. Despite the high level of usability depicted in results, it was also possible to identify a set of features that should be improved in the final iTV platform.

1 INTRODUCTION AND MOTIVATION

Today's societies are increasingly embedded in the available technology solutions and products, with significant consequences for the consumer behaviours and life styles (Van Woensel *et al.*, 2015). With the spread of technologies in the last decades, comes the growing to assure that products and services are easy to use, especially to newbie users or to people with lower levels of digital literacy. Furthermore, all the technological solutions developed should be designed and developed according to the needs and expectations of their target audience, thus improving their efficiency and efficacy (Silva, Caravau and Campelo, 2017). This is even more important when the products aim to achieve a particular segment of the population with specific requirements, as in the case of older people. The significant increase in the number of older citizens' all around the globe, a trend that will persist according to projections (United Nations, 2017), creates a wide range of opportunities in the field of technological solutions for the elderly. The high volume of technological innovations related to seniors' needs that have appeared shows that this is a dynamic area. To counter difficulties experienced by seniors in maintaining their information levels, technologies may help by spreading information throughout means which elderly are already familiar with. Also, it is important to guarantee that the experience is efficient and pleasant for the individual, which will help to ensure the acceptance of the solution.

A supportive environment can help older people to continue doing their daily activities and start doing new things, thus enhancing their quality of life. The promotion of older adults' well-being, autonomy, independence and quality of life through technology has already encouraged the creation of dozens of innovative solutions for seniors. Technologies have a long tradition in helping seniors with physical impairments but they are also currently recognized as an important support for the promotion of social life (Harrington and Harrington, 2000). In 2012 with the "European Year of Active Ageing and Solidarity Between Generations 2012" a Portuguese action plan was created to develop several projects that support individuals aged over 50 in the national context. As an example, the SEDUCE project (Ferreira, Veloso and Mealha, 2013), aimed to assess the impact of the

Silva, T., Caravau, H., Ferraz de Abreu, J. and Reis, L.
Seniors' Info-Inclusion Through Interactive Television: Results of a Field Trial.
DOI: 10.5220/0006730201340141
In *Proceedings of the 4th International Conference on Information and Communication Technologies for Ageing Well and e-Health (ICT4AWE 2018)*, pages 134-141
ISBN: 978-989-758-299-8

use of ICT in older adults' emotional variables. This type of products should address a real need in a simple and trustable way. To achieve a high level of acceptance users' opinion should be considered during development. Obviously, if seniors were already familiar with the solution, the adaptation process would be easier.

In Portugal, television (TV) is one of the most used media platforms with high importance in seniors' way of living (Silva, Caravau and Campelo, 2017). The numbers reveal that, in average, people with 65 years or more watch TV for 5 hours and 8 minutes per day (Marktest Group, 2011). The high consumption of TV contents is recognized, both for people living in their homes, which constitutes the second most time consuming activity for seniors, and for institutionalized people, which it is the predominant activity (Martins, 2010).

TV has the potential to reach a large population segment and considering this there are several projects developed with the aim of broadcasting specific information to the elderly citizens through TV, thus helping them to age at their homes.

There are some projects in the scope of iTV aiming to promote physical and psychological well-being for the seniors. Med-Reminder (Stojmenova *et al.*, 2013) is a health project designed to inform people when they should take their medication and make emergency calls to health professionals. The VitalMind project developed an iTV application that provides cognitive training for seniors aiming to slow the psychological and cognitive ageing. Finally, iNeighbourTV (Abreu, Almeida and Silva, 2013) allows its users to organize information about medical exams and alerts caregivers of potential emergencies, and it also includes a social component where it is possible to make calls and send text messages.

2 DESIGNING AND TESTING TECHNOLOGIES FOR ELDERLY PEOPLE

Most seniors want to live at home as long as possible, which sometimes is not possible due to health, physical and social limitations that naturally appear in advanced ages (Schneider and Irigaray, 2008). These limitations make seniors depend on their caregiver's network. Despite that, those limitations can sometimes be overcome with a little help from technological solutions. According to Rosenberg (2013) and colleagues one of the most important principles when designing innovations for seniors, is the co-creation process. This means that potential end-users are engaged since the initial stages of the product development. This participatory design process also helps to assure high levels of usability benefiting the user experience (UX), which in turn increases the probability of acceptance and success of the technical services and devices (Madan and Dubey, 2012).

The usability concept emerged in 1980's and has often been associated with the ability of a product to be easily used (Martins *et al.*, 2013). Throughout time many definitions have surged for the usability concept. Each model includes sub-attributes that should be accomplished to guarantee the usability of the software. In 1998 the International Organization for Standardization (ISO) created a model consisting of three basic sub attributes, namely effectiveness, efficiency, and satisfaction (ISO 9241-11). In 2001 ISO 9126 defines the following sub attributes of usability: understandability, learnability, operability, attractiveness and usability compliance (Madan and Dubey, 2012).

As referred in the literature review carried out by Martins and colleagues (2013), improving the usability presents several benefits, such as: increasing effectiveness and efficiency; increasing productivity; reducing the number of user errors; decreasing the training needs; improving the level of acceptance; supporting users with less technology literacy skills and supporting users with disabilities. Usability's evaluation consists of interactive cycles of design, prototyping, and validation (Dix *et al.*, 2005). Taking this and the co-creation aspect into account, developing a product or service with inputs from potential end users may represent an advantage to overcome the usability challenges. Usability should be assessed through an evaluation process, with one or more available methods, for example, inspection, empirical testing or questionnaire (Madan and Dubey, 2012; Martins *et al.*, 2013).

The methodology applied to data collection should consider the specificities of the target population, and the research team should be flexible to understand if the applied technique is the most adequate both to the population and to the data under evaluation. Despite there are no clear and established standard rules about how to test technologies targeted to elderly, there are some authors who have shared their experiences and provided recommendations for further testing (Demirbilek and Demirkan, 2004; Swallow *et al.*, 2016).

The USERfit tool is a methodology oriented to the development of usability and accessibility specifications, created for the Assistive Technology

field that supports the Design for All (Abascal *et al.*, 2002). USERfit is composed by seven protocols that allow the design team to collect, evaluate and develop information to construct a product specification.

Developing tests with the elderly allows to better understand the potential of a specific technology and can help to define what challenges must be overcome for success. Tests can be implemented under a set of controlled conditions in laboratory or in the natural environment. With the inputs collected through product tests in a "real life" background, it is possible to create a "problem list" with valuable information for developers and designers that helps them shape the solution according to the precise requirements of the ageing population (Rauterberg, 2017). Initiatives that test technologies in a real context with people along a specific period of time, during which the person uses the system autonomously with no supervision have several benefits in comparison to laboratory tests, like a better understanding of the users' reactions in their familiar environment (space, objects, dynamics, routines, etc). This type of experiences allows the researchers to collect a lot of detailed data and find social facts that may not be immediately obvious or that the participants may be unaware of (Rauterberg, 2017). However, field trials also have some drawbacks, like requiring a high degree of effort and engagement from the users, which sometimes can be difficult to encourage. The equipment also has to be installed at participants' home, causing some practical implications. It is also known that having adequate support when problems occur is crucial for the field trials' success (Rauterberg, 2017).

In spite of the pros and cons, the test phase is very important, and should never be neglected, not only to measure the usability aspects of the system's user interface, but also to identify other specific problems (Madan and Dubey, 2012).

Taking in consideration the course of TV technologies for seniors and the importance of testing these types of solutions, the +TV4E project and the field tests carried out in its scope are presented in the next section.

3 +TV4E PLATFORM

It is common for Portuguese citizens of all ages to face difficulties when it comes to accessing and understanding information concerning social and public services (Silva, Caravau and Campelo, 2017). This is especially problematic when referring to the elderly, a situation that causes high levels of informational dependency on their formal and informal caregivers (Silva *et al.*, 2016).

Taking into consideration the seniors' informational needs related to social and public services, the +TV4E platform is currently under development and consists in an iTV platform, running in android set-top box (STB), with the purpose of promoting the info-inclusion and improve the quality of life of Portuguese seniors through the transmission of video spots, presented on TV, with informative content about these services. The information presented in the videos is aggregated into seven macro-areas of interest, previously studied, titled *Assistance Services of General Interest for Elderly* (ASGIE) (Silva, Caravau and Campelo, 2017). These seven areas are: (1) health care and welfare services; (2) social services; (3) financial services; (4) culture, informal education and entertainment; (5) security services; (6) local authority services and (7) transport services.

For each ASGIE, there are informative online sources defined, in which the system checks regularly if there is new informational content that could feed the platform. In its majority, the sources feeding the platform's informative contents belong to highly credible and reliable sources, specifically governmental web sources. To achieve this, an algorithm selects content from different web sources and builds audio-visual pieces on its own.

After the video spots' creation, which includes an audio track narrating the news content, the system injects it into the linear television presentation flow. At this moment, the regular TV broadcast is locally paused and later resumed after the presentation of the informative video.

When the informative content is sent to a STB it triggers a notification on the screen allowing two options, visualize or ignore the video (Figure 1).

The notification remains present on screen during three minutes and a half, however after the initial 30 seconds it is minimized to reduce the intrusive appearance.

Figure 1: New informative content notification.

It should also be observed that when the STB is turned on, a splash screen is shown with contextual elements: a greeting based on the time of the day; information regarding the weather (temperature and an icon that visually represents the weather); the time and date; the current season.

All the video spots available in the +TV4E platform have the same structure, typically composed by an introduction animation, the informative content itself and a closing animation.

Additionally, there is a video library that gives the user access to the videos generated in the last five days, categorized as seen and unseen.

All the elements and functionalities available in the high-fidelity prototype were defined through a participatory design process with seniors. The design and development of a technical solution should consider that it is important that the product improves user's life in an easy and intuitive manner. In this context the aim of this study is to evaluate the usability, usefulness and aspects to improve in the +TV4E platform.

In addition to this introduction, this article is organized in the following parts: section 3 which illustrates the methodological steps followed for data collection; section 4, where the obtained results are presented in detail and discussed and, finally, section 5 presents the main conclusions and future steps for the +TV4E project.

4 METHODOLOGY

To collect information for the improvement of the +TV4E platform field tests were carried out in the real context with a reduced sample of seniors. The results from these tests will help to identify the aspects that should be adjusted in the platform. This test occurred after a set of previously developed steps, summarised in Figure .

In the first phase, the research team aimed to analyse and define several key aspects: the areas in which Portuguese elderly feel lack of information; the most appropriate web sources to feed the information areas, and the functionalities of the platform (Silva, Caravau and Campelo, 2017). The compilation of this information allowed the creation of a first prototype. In the second phase, the developed prototype was evaluated by a group of seniors, through a focus group methodology, focusing on the audio-visual elements and functionalities (Silva, Caravau and Campelo, 2017). This phase allowed the identification of major problems in the seniors' point of view, which after were corrected by the developers. At the end of this process, the research team created the high-fidelity prototype which had almost all the predefined functionalities implemented, with the audio-visual elements adjusted according to the elderly's suggestions. To complete the platform's evolution and evaluation process, towards the fully functional iTV platform, a field test with a sample of seniors was performed in their natural environment. To further improve the platform, this field test aimed to give people the possibility to use the platform freely and without time constraints, since it is only possible to detect specific problems that may arise during a continuous use.

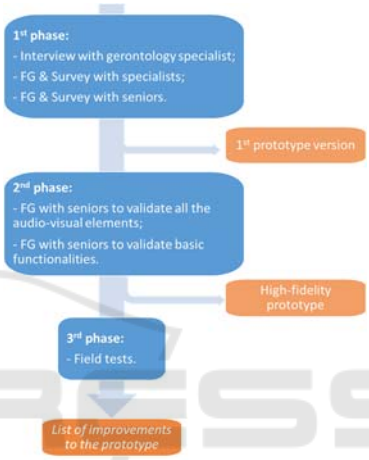

Figure 2: Timeline of developed phases.

The field trial carried out in this work consisted of three stages: (1) a first moment, where research team elements went to the participants' home to explain the project's goal and install the platform; (2) follow-up phone questionnaire survey; (3) final data gathering and collection of the installed material.

Participants who joined the study received, in this initial face-to-face moment, an information guide of the iTV application. Study objectives and aspects related to data collection were orally explained. All participants were given the opportunity to request further information on the study and were informed about the possibility to withdraw at any time without any personal injury and without further justification. After this, each person was asked to sign and date an informed consent, furthermore a sociodemographic data questionnaire was applied. The installed STBs offer seven channels, as is practiced in Portuguese Digital Terrestrial Television (DTT). During the time of this field trial, the high-fidelity prototype tested in the participants' home, only generated videos in five of the seven ASGIE: health care and welfare services; financial services; culture, informal education and

entertainment; security services; and local authority services. Social and transport services did not have available web sources to produce news.

In this initial moment, participants had the opportunity to explore the platform alongside one researcher that, after a first utilization without any help, answered all questions about the system asked by the participant. In the second phase, a follow-up phone questionnaire was conducted aiming to preserve a frequent contact with the participants as well as to record incidents or events that may occur. Sometimes this is an often-neglected aspect and not referred in final projects prototypes' evaluation. Moreover, this phone call intended to promote the trust relationship between researcher and participant maintaining the individual's engagement with the project. A questionnaire survey (Quivy and Campenhoudt, 1995) and the Post-Study System Usability Questionnaire (PSSUQ) were applied on stage three, five weeks after the field tests begun. The PSSUQ, a tool to evaluate the usability of the high-fidelity prototype, allows the gathering of results concerning usability and perception of utility and thus it was selected.

The PSSUQ is an instrument that assess the user satisfaction with system usability (Lewis, 2002). It consists of 19 items rated on a 7-point scale ([1] – strongly agree; [7] - strongly disagree) in which the lowest scores indicate better usability. The PSSUQ consists of an overall satisfaction scale and three subscales: system usefulness - SysUse (items 1–8); information quality - InfoQual (items 9–15); and interface quality - IntQual (items 16–18) (Lewis, 2002). The final score in these three subscales is achieved through the mean of the corresponding items for each one. The final score of overall satisfaction scale is the mean of item 1 to 19 (Lewis, 2002). The PSSUQ was validated to the European Portuguese version, with positive results of psychometric evaluation (Rosa *et al.*, 2015). Among the several methods used to evaluate usability, PSSUQ was selected due to the success achieved by other authors to evaluate iTV systems for seniors (Ribeiro *et al.*, 2015).

After PSSUQ, a questionnaire was applied. This questionnaire was essential to collect qualitative data concerning the usefulness, aspects that users found that should be improved and their satisfaction levels. This questionnaire was constructed by the research team, with open-ended questions, which were written down by the researcher based on the participant's answers.

The sample of this study was selected by convenience (Carmo and Ferreira, 2008). For the selection of the sample, inclusion criteria considered were age over 60 years; watches TV regularly; lives in Aveiro area and neighbouring cities and provides informed consent. Participants needed to have a TV with High-Definition Multimedia Interface input to connect the STB provided, as well as an internet connection.

The sample was composed of four homes contexts, in which each house was composed of two individuals (n=8), with four females (50%) and four males (50%) with an averaging age of 71. The two elements of each dwelling where a couple, thus the marital status of all were "married". Around 25% of the sample completed the higher education and the remaining the medium literacy levels. On average, each individual watches 3 hours and 45 minutes of TV per day and all have pay TV services. Concerning the use of the operator's STB four participants said they do not use any of the box's available features, and the remaining referred: view the upcoming schedule (n=3); rewatch past TV broadcasts (n=2) and schedule recordings (n=1). The most frequently watched programs categories were: news (n=8), entertainment (n=6), documentary programs (n=3), sports (n=3) and soap opera/TV series (n=3). All participants said they did not need help from others while watching TV.

5 RESULTS AND DISCUSSION

During the questionnaire survey, the research team identified one house, with two participants that over time showed disinterest in using the platform. Concerning this disengagement situation, it was determined that these participants should not be considered in the results since it was not possible to collect the desired data. Also, one participant (a member of a couple) did not answer both the PSSUQ and the questionnaire survey because since he had access to a pay TV service with more interesting (in the participants opinion) channels, he declared that he did not use the platform. In this section, it will be presented and discussed the results of the data collected through the follow-up questionnaire survey applied and the PSSUQ (n=5), after five weeks of participants' use.

5.1 Questionnaire Survey

The final questionnaire applied was composed by 16 questions. All the participants (n=5) said that the platform could be useful, both for themselves and for others, to stay updated and engaged with their surrounding context. These opinions corroborate with

what some authors have been saying about the seniors' need to be aware of what is happening in the surrounding environment, allowing them to age well and to be socially included (Everingham *et al.*, 2009; Silva, Caravau and Campelo, 2017). All the elements of the sample also agreed that the splash screen (Figure 1) is an important feature. Besides allowing time orientation, in a simple and visual way, this feature also provides updated daily information of seniors' interest. The decline in cognitive functions can indicate the emerging of cognitive impairments, but the normal cognitive ageing may also entail some cognitive slow down (Spar and La Rue, 2005). Concerning this, the splash screen seems to be an important informative screen.

Regarding the ASGIE categories in which the platform offers information, one participant referred that the available ASGIE are enough while, the other four participants mentioned that they would like to see contents on other subjects, namely about sports (n=2) and decoration activities (n=1). These inputs allowed a better understanding of the relevance that leisure activities represent in seniors' daily living but allowed also to infer that seniors understood the existence of content specific areas. Although, this type of information is outside the scope of social and public services, which are the key information areas of the project.

Regarding the notification that appears when a new video is available (Figure 1 and Figure 2), the following features were analysed with the sample: perceptibility of the icon size; text readability (font type and size); perceptibility of which button should be pressed to start watching the video, considering the visual hint. Most of the sample considered that all the elements are perceptible and easy to understand. Only one person mentioned that the notification's icon should be bigger. The voice-over (female gender), font type and size (*Tiresias Screenfont* at 55 pts) of the text presented during the informative videos (Reis *et al.*, 2017) were perceived with no difficulty by the five participants. The background images and the low volume background music present in the video spots were not considered problematic elements for the content understanding. These results are expected since those elements were firstly designed based on literature guidelines and then discussed and validated with a group of seniors in a participatory design process (Reis *et al.*, 2017;). Despite these positive answers, the voice-over was considered monotonous by one of the participants. The five participants classified the time interval between videos as "acceptable". The entire sample also considered the video library (Figure 1) a useful extra feature, with two participants (40%) using this tool to watch "unseen videos", while the other three (60%) to visualize "seen" and "unseen" video spots. These results reveal that the easy and fast access to available content is highly appreciated by +TV4E platform's potential end users. Only one participant, denoted problems in using the remote control, saying that sometimes it did not reply instantly to the click (e.g. "*Sometimes I tried to change the channel and it would not work*"). After some tests carried out by the developers, it was noticed that this problem was related to the internet connection available in the participant's house.

When the participants were asked "Have you ever felt disoriented and/or confused with the operation system, losing the control over what happened on the TV?" they replied with two "no" and three "yes". Two of the participants who answered positively said that sometimes the video stops without any reason and they do not know how to react ("*The video and the image stop several times and I do not know what to do*"). The other person referred that in the beginning of the field test, had some difficulties in realizing how the STB remote control works, but by end of the field test, it became an easy and intuitive task. All the participants expressed that if the platform is available without financial costs they will use it. Furthermore, all the participants had the opportunity to add observations that are not included in the questionnaire. Only one person referred that the minimization process of the notification, which informs about the availability of new content, is very fast (defined as 30 seconds after the notification appears).

5.2 PSSUQ

Results from the PSSUQ showed that the participants were satisfied with the usability of the +TV4E platform (see Table 1).

Table 1: Results of PSSUQ subscores (n=5).

	Mean	**SD**
Overall satisfaction	2,24	0,49
System usefulness (SysUse)	2,04	0,59
Information quality (InfoQual)	2,48	0,37
Interface quality (IntQual)	2,20	0,80

Analysing the results by subscale, the lowest average was for "System usefulness" and the highest for "Information quality". When analysing each question of PSSUQ, the lowest score was question number 15 "The organization of information on the system screens was clear" (mean=1,6; SD=0,55) and with the highest observed is question number 10 "Whenever I made a mistake using the system, I could recover easily and quickly" (mean=3,6; SD=1,52). It was clear that the highest average obtained in question

number 10 reflects that improvements in the system should be addressed. For example, the system may generate and send automatic messages when the video stops playing due to internet connection problems, something that was not happening at the time. This will help the user to clearly understand the error that is occurring. If the results are analysed disaggregated by participants, the person with the lowest scores on all the subscales classified: "Overall satisfaction" (mean=1,64); "System usefulness" (mean=1,45); "Information quality" (mean=1,95); "Interface quality" (mean=1,33). The participant with the highest results in almost all subscales achieved: "Overall satisfaction" (mean=2,83); "System usefulness" (mean=2,79); "Information quality" (mean=2,64); "Interface quality" (mean=3,33).

6 CONCLUSIONS AND FUTURE WORK

The main goal of the field tests was to collect inputs from a group of seniors in their real use context, concerning the functionalities available in the +TV4E high-fidelity prototype.

This study allowed the research team to assess the usability and the functions that should be improved in the platform, through the administration of PSSUQ and a questionnaire survey. Despite the reduced size of the sample, a recognized limitation of the study, it was possible to collect several valuable data concerning system usage. It is mandatory for the research process that more field tests are carried out with improved versions of the +TV4E. Although, the achieved results reveal interesting inputs for the upgrading of +TV4E high-fidelity prototype.

Regardless of the high usability's levels obtained in PSSUQ, some components should be improved. Error messages should appear whenever the system crashes. Also, the best way to provide messages that help the user to recover easily and quickly from unexpected situations should be analysed. Most of the issues that arose during the field tests were related to internet connection problems. To assess this issue, a more reliable internet connection and with more bandwidth should be used. The complaint of the voice-over being monotonous tone will encourage the developers to further improve the Text-To-Speech solution. The developed software must have mechanisms that increase the reliability of the platform functionalities, thus minimizing potential errors (e.g. misclassifying videos in the video library).

After improving the high-fidelity prototype, according to the gathered inputs, the team plans to do new field tests with potential end users. The team also plans to analyse some aspects that only one or two participants considered important, such as to improve the duration of the notification message and functionalities available in the remote control.

ACKNOWLEDGEMENTS

The research leading to this work has received funding from Project 3599 – Promover a Produção Científica e Desenvolvimento Tecnológico e a Constituição de Redes Temáticas (3599-PPCDT) and European Commission Funding FEDER (through FCT: Fundação para a Ciência e Tecnologia I.P. under grant agreement no. PTDC/IVC-COM/3206/2014).

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