A Process to Design a Video Library for Senior Users of iTV

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Abstract. The adoption rate of technologies by older adults is dependent on several factors, such as the identified potential benefits in the users' perspective. In the scope of +TV4E project, which aims to deliver informative videos regarding public and social services to older people through an interactive television (iTV) platform, this study defines a process to design the video library allowing the access to the previous referred videos. Therefore, this article explores the process carried out to define the best design approach to present the video library. The research was conducted in three phases: (i) video library design; (ii) usability evaluation and (iii) definition of the final layout. Each phase included a specific sample of potential end users and different techniques of data collection were applied. The achieved results for this study revealed that working with older people is a difficult task and researchers need to be flexible, willing to adapt the data collection process to eventual needs that come up during a project's development.

Keywords: Elderly · iTV · Video library · Design · Usability · UX

1 Introduction

Nowadays almost all developed countries are facing an inversion of the ageing pyramid with an evident growth of the elderly population. Currently, the older population (people over 60 years old) reached 962 million in 2017, which represents 13% of the total population and it is expected to raise to 1.4 billion worldwide, by 2030 [1]. This phenomenon presents new challenges to societies at academic and governmental levels, in terms of finding the best ways to fulfil the needs and expectations of the elderly.

Being informed is a vital pillar to participate in today's society, which is increasingly becoming more and more dependent on information. Seniors are at a clear disadvantage when it comes to accessing information about nowadays topics since it is mostly scattered across various mediums such as the internet, which requires a certain level of digital literacy. However, the quick evolution and the high volume of technological innovations related to seniors' needs that have emerged in the last decades show that this is a dynamic area in terms of providing services that can answer their needs. It is important to build inclusive digital environments that promote easy access to digital tools so that the elderly

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can maintain and improve their quality of life [2]. Although, several times, developed technologies did not consider the needs and expectations of the target population which affect the perceived benefits and, consequently, the level of older people's adoption [3]. To avoid this problem and to transform technology into a real asset for the elderly, it is important that they become involved in the development of a product from its early stages, by sharing their perceptions and expectations.

As a response to the identified needs of Portuguese seniors, the +TV4E project aims to promote the info-inclusion of them, through an iTV platform, by interleaving the normal television broadcast with informative spots related to public and social services. This video spots are delivered accordingly user profile [4]. During the definition of functional and technical requirements of this platform, it was observed that a video library would be an added value allowing the visualization of video spots already saw, as well as to access to videos that were triggered but that were not visualized.

This paper aims to present and analyse the process of defining the best design and development approach regarding this video library.

Additionally to this introduction, the article is organized in the following parts: Sect. 2 presenting a theoretical framework on the questions to fulfil the informative seniors' needs and guidelines to follow when building TV interfaces for the elderly; Sect. 3 which illustrates the methodological steps followed to define video library; Sect. 4, where the obtained results are presented and discussed in detail; and finally, Sect. 5 where it is presented some of the conclusions drawn from this study as well as tracks to future work.

2 Theoretical Framework

Worldwide, societies are facing a serious increase in the number of older people. Although this is a very positive phenomenon, supported in several enhancements in many areas of society, a new set of problems and challenges arise. The report of the United Nations [1] reveals that in 2017, 13% of the global population is 60 years old or above, which corresponds to 962 million people. This segment of population is growing at a rate of about 3% per year. Projections indicate that, in 2030, the population over 60 years old will achieve 1.4 million, 2.1 billion in 2050 and could reach 3.1 million in 2100 [1]. This phenomenon is inevitable, concerning the fertility declines and the increase in life expectancy rises hampered by the expected decrease of global population (of 51 countries) between 2017 and 2050 [1].

Specifically, Portuguese resident population projections confirms this tendency and it is expected that, in 2080, the ageing pyramid approaches an inverted triangle shape [5]. Between 2015 and 2080, the number of people who are 65 years old and over will increase from 2.1 to 2.8 million [5].

The "active ageing" concept, is one of the first contributions with a global impact that recognized ageing population as an important phenomenon. This concept encourages older people to remain active by working longer and retiring later, through engaging in volunteer work after retirement, and by leading healthy and autonomous lives. "Active ageing", created by World Health Organization (WHO), is defined as the process of

optimizing opportunities in three pillars: health, participation and security [6]. This will promote the elderly's quality of life, highly influenced by the ability to maintain their autonomy and independence.

One of the living areas that influence older people' quality of life is the access to information. This allows people to stay aware about their surrounding environment and consequently make decisions in a more supported manner [7]. In Portugal, despite information about social and public services being available in several service counters and online platforms, this information is sometimes shrouded in technical terms hard to decipher by most citizens. To make this process even more complex, especially to older people, accessing this type of information involves a pro-active behaviour by the user [8]. According to Silva and colleagues [7], informational needs of the Portuguese elderly encompass: health care and welfare services; social services; financial services: cultural, informal education and entertainment; security services; local authority services and transport services.

Technological products can help seniors to improve their quality of life. In this manner, interactive TV applications have a great potential to support seniors' needs mainly due to the fact that they spend lots of time watching television. In this context, an academic project is under development aiming to develop an iTV platform, specially designed for the elderly and based on simple interactions, that delivers information about social and public services through brief video spots without active search required from the user. The video library is an important platform enhancement that strengths the overall solution for the elderly. This feature allows the users to navigate through a list of all generated videos in the last five days. To the development of this feature the research team was guided by the motto: the development of new innovative products should be conducted, since the beginning of the process, with inputs from potential end users that represent the target population [9].

In the beginning of the +TV4E project an extensive study regarding guidelines to follow when building TV interfaces for the elderly has been conducted. This study was focused on a literature review regarding the specific characteristics of the seniors that come from the ageing process, such as loss of hearing and visual acuity [10]. These characteristics need to be taken into account while developing software for seniors to guarantee high acceptance ratio. However, since there is no sound in the video library, only visual-related recommendations were considered, specifically regarding text, icons and colours. The following guidelines were extracted from the study of Reis and colleagues [10] in order to help the design of the library.

Most notably, loss of vision in seniors causes them to have difficulties in focusing at short distances, distinguishing small details, discriminating chromatic differences and reading moving text. It also reduces their adaptability to lighting, makes them more susceptible to brightness and requires them to have more luminosity when reading, for example. To counter these limitations there are several design recommendations to make visual content more suitable for the elderly. In general, the literature suggests that text in screens should be at least 40 pts, serif fonts should be used, opposed to italic or decorative fonts, 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. When it comes to icons, they should be the combination of an image

and text, never one without the other, be easily distinguishable and avoid the use of abstract concepts or graphical conventions associated with recent digital technologies. Lastly, the colours need to be chosen carefully to consider the limited colour spectrum of televisions and the seniors' needs. Concerning this, the development of the video library available on +TV4E platform will take all these orientations into account as well as inputs gathered from potential end users. So, in the coming section, the methodology used to select the preferred layout for the +TV4E platform is described in detail, going over the objectives of the study, the sample and the whole process.

3 Methodology

The present study was held with the main objective of determining and creating a fully functional video library layout that would fulfil the needs of the Portuguese seniors allowing them to access to videos delivered through the +TV4E project iTV application. The main purpose of this video library is to allow the users to visualize the informative videos provided by the platform in a manner similar to an on-demand video service. In the video library, the users are able to re-watch videos they had already seen and watch videos they rejected/missed, therefore complementing their user experience and giving them some degree of control over the system.

Initially, the methodology defined included a design phase [11] followed by a layout presentation to a group of seniors, and the inclusion of the interface layout in the final prototype to be tested at home by potential end users. However, over time, the research team realized that the achieved results should be corroborated with more tests in a laboratory context, to improve the interface layout. The redefinition of the followed methodological steps underwent some changes over time, which transformed this path into an evolutionary process.

The data collection occurred in three key moments (see Fig. 1), with potential end users and different techniques: (i) one focus group with 4 seniors for the video library design; (ii) one cognitive walkthrough and a survey with 11 seniors to evaluate usability, and (iii) one focus group with 4 seniors to define the final layout for the video library.

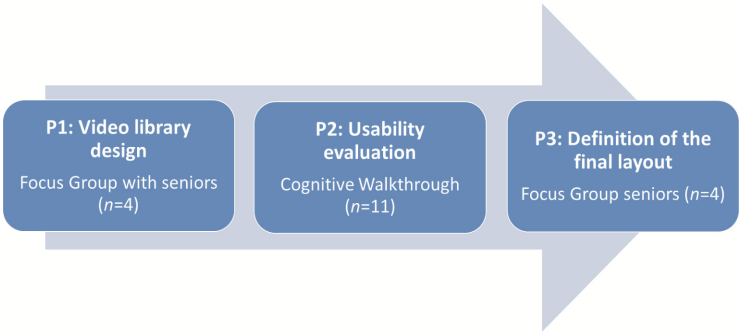

Fig. 1. Phases of the process to define the video library interface

Thereafter, the stages to achieve the final layout of the video library interface and the corresponding process will be described in detail, as well as the sample and process of each phase.

3.1 Video Library Design

Since this work aims to define the best approach for a video library for seniors, before starting off with the first phase of the design process, a state of the art review was conducted to identify trends regarding iTV applications for seniors [11]. Using this state of the art review as a theoretical support, three layout proposals were developed to be validated by the seniors allowing them to choose the most suitable solution. Even though there were three different approaches, all layouts had a similar structure regarding static elements, specifically the header containing the main information and the instruction to return to the TV broadcast. Besides sharing the header, in terms of navigation, all layouts were based on a list of videos generated in the last seven days and sorted chronologically from newest to oldest.

The first layout (Layout 1 - Fig. 2) shows two horizontal navigation lists, where the first one displays the unseen videos while the second list aggregates the seen videos. It is also the simplest proposal since each video card contains only a thumbnail, a title and video duration.

Fig. 2. Developed layouts presented to seniors in phase 1.

The second layout (Layout 2 - Fig. 2) was based on the Netflix interface, with horizontal navigation, similarly to layout 1, however containing a lot more information. In this layout proposal, the two video lists, for seen and unseen videos as shown in the first layout, are condensed to the bottom half of the screen, in order to include a main section previewing the content of the videos. This section provides more details about the selected video, specifically title, description, duration, thumbnail and how long ago the video was created.

Lastly, layout 3 (Fig. 2) is a variation of layout 1 where the navigation is done vertically instead of horizontally. In this proposal, each list only shows two cards on the screen, which leaves room to include more information, including date and a larger font-sized title.

The main goal of this phase was to understand which of these navigation typologies, vertical or horizontal, was best suited for the project's target demographic and what kind of information was most relevant to be displayed.

To conclude which of the three video library layouts was preferred by seniors, an experiment with a restricted number of participants was conducted. Each layout represents a way of presenting information and navigating through it.

The sample for this study's phase consisted of four participants, 50% males and 50% females, all of them over 65 years old and students at Senior University of Curia - Portugal. They were selected via convenience sampling due to the difficulty of selecting a random sample. The participants were already familiar with the project, since they had already been involved in previous data collections, where other visual elements of the iTV platform were defined [12]. Each participant had the opportunity of navigating through each one of the proposed layouts so that the choice of the preferred one would be based on actual user experience and not solely on expectation. This experiment was divided in two parts, an individual Cognitive Walkthrough followed by a focus group with the four participants. The Cognitive Walkthrough, described by Wharton et al. [13], is considered a very effective usability inspection method to apply during the design and development process of a technological solution. With this analytical technique, a sequence of actions should be performed by the user to complete the designated task, included in a list of tasks requested by the responsible researcher.

The Cognitive Walkthrough would start with the investigator contextualizing the user about the experiment and, subsequently, it was explained to the participants that they would be able to interact with three distinct layout proposals for the video library.

Prior to this more effective phase, the researcher talked with all the participants about trivialities to create a more relaxed environment. After testing the three interfaces, each participant would be asked to wait in a room while the other participants finished their tests. Afterwards, all the participants were gathered in the testing room to start the focus group and then encouraged to share their opinions regarding their experience. In the end, they were required to choose their preferred layout, which needed to be a group decision.

3.2 Usability Evaluation

After the participants selected the video library interface that most appealed to them in the first phase, the chosen design was implemented to the high-fidelity prototype of the platform, which led to a posterior second phase of tests, focused on the overall system's usability.

Thus, the second phase consisted in testing usability of a high-fidelity prototype of the platform through an observational study with potential end users. These tests were conducted by two members of the +TV4E research team and took place in an adult day care center in Aveiro, Portugal.

The participants included in this study were selected by convenience among seniors integrated in an adult day care center in Aveiro city. For the sample selection, the considered inclusion criteria were: being over 60 years old; watching television regularly; knowing how to read and providing an informed consent. Exclusion criteria were all the other conditions or circumstances which could compromise the subject's ability

to take part in the study. The number of elderly participants included in the sample was 11, namely seven women (63.6%) and four men (36.4%). The participants had an average age of 84.8 years (SD = 7.35), with a maximum of 99 and a minimum of 69 years. The participants were invited to perform a list of previously defined tasks through a Cognitive Walkthrough method that was verbally explained by the responsible researcher. Simultaneously, a second researcher registered the participant's actions in a performance evaluation grid as well as observations/critical incidents occurred during each task in a specific area.

Each participant was invited to complete 14 tasks, previously defined in a task script and verbally explained by the responsible researcher, to offer the research team an overall view of the system's usability. While participants were performing the tasks, an observer registered quantitative data in a performance evaluation grid. For each task, the following data was observed: the success or failure in carrying out the task, the execution time (in seconds), the total number of errors and observations/critical incidents.

Although this test was focused on the usability of the system as a whole, in the context of this paper, only the tasks regarding the video library will be focused. Within the list of 14 tasks defined for system overall testing, tasks number 11, 12 and 13 were specifically related to video library interactions. The users were asked the following orientation regarding these three tasks: T11 (Access the video library) – press the key number "0"; T12 (Check how many videos are in the library sorted as viewed) – if applicable, explore the video library (through the d'pad buttons) and verbalize how many videos are in this feature classified as "viewed" video; T13 (Watch a video available in the library) – choose one video available and press the "ok" button to start the visualization.

Afterwards, the responsible researcher applied a Post-Study System Usability Questionnaire (PSSUQ) to test the usability of the high-fidelity prototype. The PSSUQ is a tool developed by the International Business Machines (IBM) to understand the user satisfaction regarding a system usability [14]. Rosa and colleagues [15] validated the PSSUQ to the European Portuguese version, with positive results of psychometric evaluation.

After the PSSUQ, a final questionnaire was applied to the participants in order to collect qualitative data concerning usefulness, aspects that should be improved and satisfaction levels. This questionnaire was previously defined, including open-ended questions for which the participant's answers were written down by the researcher.

3.3 Definition of the Final Layout

After collecting data during the second phase, it was clear that some key aspects in the video library feature should be improved to enhance the potential of this feature.

In line with this, it was developed a new layout for the video library, based in the state of the art review and in the results of phase 1, which showed that the best approach is a horizontal navigation list without video categorization. Beside this, strong colours were also adjusted. Previously, the text was pure black (hexadecimal colour value: #000000) and the background was almost white (hexadecimal colour value: ##FEFBF7), so they were replaced for softer tones (see Fig. 3) in order to soften the interface. It was

added a subtle space between video cards to reduce visual weight and a soft blue stroke highlighting the selected video. These were adjustments focused on providing a simpler, softer and cleaner design to the library.

Fig. 3. Developed layout presented to seniors in phase 3. (Color figure online)

Similarly to phase 1, a focus group was conducted with four participants (one male and three females) with an average of 72 years old (SD = 5.4) and aimed to validate the best approach to the video library between the layout chosen back in phase 1 and the new layout (Fig. 3). All individuals included in the sample were students at Senior University of Curia – Portugal. This moment was guided by two members of the +TV4E research team, namely the responsible researcher and an observer. After the explanation of this moment's dynamics, the participants were invited to freely explore the two video library layouts. Simultaneously, the observer registered observations/critical incidents that occurred during the interaction.

The participants were asked some short questions regarding their experience, which helped gather individual opinions from each participant before having them discussing their opinions during the focus group. The questions were made in the following order (during the focus group): (1) In which of the templates was more difficult to find a video?; (2) If you want to watch a video, which of the templates would you like to use? (3) Do you consider that categorizing the videos is important/useful?; (4) which of the templates was more useful and comfortable to use?.

In the end, the responsible researcher required the participants to choose their preferred layout, which needed to be a group decision.

4 Results and Discussion

The main results achieved in the several phases are presented below.

4.1 Video Library Design (Phase 1)

The phase 1 wielded both individual results for each participant and a group decision for the best overall interface layout. The individual results are synthetized in Table 1

and include all the suggestions that users made during the several components of the design phase (see Figs. 1, 2 and 3).

Table 1. Individual opinions' for each layout (phase 1)

	Layout 1	Layout 2	Layout 3
Subject 1	The video cards are easy to distinguish since the title occupies less space	The selected video is not big enough. The lighter colours are not distinguishable	The background colour cannot be distinguished from the cards
Subject 2	The play symbol should be blinking to make it clear that it plays the video	Headers should be bigger. The font should be changed or have a different colour	Vertical navigation is better than horizontal. Having two cards per column is appropriate since they are bigger
Subject 3	Liked it because it was simple and easy to navigate. Should have less cards shown on screen	Has too much information. Should have less cards shown on screen	Easy to understand which card is selected. Two cards per column makes it easy to read
Subject 4	Duration of the video is important to keep. Intuitive navigation	Too much information makes the layout confusing. Number of thumbnails is appropriate	Prefers horizontal navigation

Regarding each of the participant's individual preference, all participants with the exception of participant 2 chose layout 1 as their favourite.

Since most participants had already chosen layout 1, the focus group results were very similar to the individual results. In the end, the majority of the participants preferred layout 1, since it featured horizontal navigation and fewer interface elements. The participants justified this by saying they were already familiar with the horizontal navigation, therefore making it easier to use. The focus group participants also decided that the appropriate number of video cards per list should be three, in order to allow them to be bigger and thus easier to read.

4.2 Usability Evaluation (Phase 2)

Almost all requested tasks were successfully performed and concluded by the participants in phase 2. However, analysing the performance evaluation grid it was notorious that tasks requiring interaction with the video library registered the lowest success rates. When participants were asked to interact with the video library interface, none of them could understand the concept of video library and how it worked.

The data recorded by the observer shows that, in T11 (Access the video library): several participants were very insecure and did not know/remember which key should have been pressed; many participants pressed other key numbers and the "OK" button and searched for a key labelled "video library". In task number 12 (Check how many videos are in the library sorted as viewed), several usability problems were detected, such as: people did not understand how the video library worked, especially the video

categorization as "seen" and "unseen"; participants did not quite understand the layout arrangement of the components on the screen. Finally, in T13 (Watch a video available in the library) the participants did not understand which card was selected and how to navigate between videos/elements. These difficulties were reflected in the error rates.

One of the addressed features in the questionnaire survey was focused on the video library usefulness ("Do you think the video library is useful?"). In this question, nine participants (81.8%) considered this feature to be useful. Crossing this data with the information collected on the performance evaluation grid and in the PSSUQ, the research team realized that this feature can be very helpful for elderly, but the interface should be rethought and improved to become easier to use.

4.3 Definition of the Final Layout (Phase 3)

Regarding the results achieved in phase 2, another layout possibility was designed for the video library interface which was evaluated side by side with the previously chosen layout (Layout 1 vs Layout 4).

From the four participants included in the final phase, two of them had previously tested the +TV4E project, while the remaining two were exposed to the project for the first time. During the free exploration moment, when layout 1 was presented to the participants, all of them were able to switch between the video lists ("seen" and "unseen"), as well as to realize how many healthcare videos were in the library and to select a requested video. Despite this, when layout 4 was shown, the participants stated that this new propose was easier to navigate and considered it more attractive and easier to read due to the larger thumbnail size.

It was also easily perceived by the sample that the videos, classified as "seen" and "unseen" in layout 1, were mixed in a single line which was not considered a limitation in the interface use. Some participants recognized the benefit of separating the videos in two lists but globally preferred the simplicity of having all videos in one list sorted by date.

In the end, the elected interface by unanimity was layout 4. This choice was justified by the larger scale of the elements which improved readability and its simplicity, since it only requires horizontal navigation.

5 Conclusions and Future Work

Developing technologies that cater to needs of seniors is paramount to promote their quality of life. Quality of life can be measured in terms of independence from their informal networks, such as, the informative dependence from their caregivers and dependence while doing day-to-day activities, such as shopping, eating and dressing.

The aim of this study was to define the best interface for a video library feature to integrate in the final +TV4E prototype. This process proved to be complex concerning the difficulty of recruiting participants to integrate the process in order to define the video library, as well as the perception what entails in practice to choose one of the layouts. It is known that the number of participants in the sample is limited, however,

it was considered sufficient to obtain guidelines to define the improvement points of the platform.

At the end of this evolutionary study was considered successful since the participants clearly understood the purpose of the tests carried out and it was possible to get a decision between all of them.

Following the final choice of layout 4, this feature was integrated into +TV4E project iTV application and it is being evaluated at the moment as part of another ongoing +TV4E study. This study is being carried out in a domestic environment with real context users and has the goal of testing the first iteration of the application as a whole.

One of the main contributions of this work is related with the data collection methods when working with older people. It is difficult to predict the participants' reactions, answers or behaviours when trying to define a data collection tool, however, the ability to adapt the process in the simplest way is essential to obtain good quality data. Despite this, seniors' participation in the design and development process of the video library leads to a better efficiency of the final product, which amplifies the possibility in having a technological solution able to answer end-users' needs and expectations.

In conclusion, this study appraised the need to involve seniors in the development process of platforms and showed that, occasionally, it is not easy to achieve final decisions in a single interaction moment.

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