Use of a Smart TV as a Platform for Social Engagement for Senior Citizens

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Abstract
The number of studies investigating computer use or other technologies used by senior citizens has progressively increased in the last twenty years. The interest stems from a diverse range of research disciplines including human computer interaction, education, and many others. However, this group of people is less likely to use technology compared to younger groups. Senior citizens generally have a positive attitude towards technology, and they are willing to use the product if they need it. Positive attitudes are also more likely to be expressed towards devices used every day at home, such as the television, microwave etc. Even if those devices are now typically digital, senior citizens are familiar and comfortable with them. A common reason for not wanting to learn different technologies was the feeling that it may be too difficult for them or not having access to a computer or tablet. These characteristics drive us to offer a solution by rethinking the use of some existing technologies and making them more affordable and accessible to older people. It is offered on a TV, something that senior citizens are familiar and comfortable with and which most of them have it at home.

As the first step, we identified different requirements and factors that affect senior citizens’ daily lives, the things that they do most during the day. Based on these requirements, we had to find services that will fulfill them. The system is constructed from four major services such as video conferencing, news, books and different recreation videos (e.g.: tips about exercise, hunting, cooking or gardening.) Each one of these sections is identified by a review of previous research using a literature survey. These services were chosen, among others, for their effects on senior citizens' quality of life. Thus, our goal was to provide them with an adequate set of required services. The working environment (Smart TV) is based on the different reasons stated below in the research. Some of them are a) a Smart TV is an integrated system which offers features of both a traditional TV and a personal computer, b) it provides a large screen, is easy to use and always ready, and most importantly, c) the TV, the most user-friendly electronic device, is a basic activity of senior citizens in their daily life. Design perspectives and functional requirements are presented. Finally, we describe some scenarios and assessment methods of the proposed system with the target group (senior citizens). Based on the findings, we can conclude that there was great acceptance from senior citizens for the support of daily living and the ability to control their daily activities provided by this service.

Keywords: Senior citizens (and/or elderly people), human computer interaction, Smart TV, social engagement, system design, interaction, video communication.
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1. INTRODUCTION

Social interaction is an essential and basic need for people at any age (Abraham Maslow's Hierarchy). This phenomenon is more evident in senior citizens because of their gradual mental and physical decline which makes them more inactive and dependent on others. Based on statistics and literature, the growth of senior population is increasing year by year. Moreover, the total number of senior citizens (65+) is almost 20% of the overall population (Statistics Sweden, 2012). The percentage can slightly differ based on the country, as the countries demography and starting age to be considered a senior citizens can vary from country to country. Nevertheless, there are predictions stating that this number will continue to grow in the years to come (Statistics, Sweden 2012).

The development of new technologies has created many ecosystems that have been rapidly developed and deployed in people’s lives. However, this fast development has also created a big usability gap (Wilson et al., 2004) between its users. This is due to incessant changes in technology and the capability of people to catch up with trends. Young users find these rapid developments fun and attractive, but it is not the same case with older people. Senior citizens find it hard to cope with constant changes. They need more time to become familiar with a certain product.

Even though senior citizens use ICT and social media to a lesser extent than younger citizens, it is important to remember that senior citizens are not a homogenous group, but rather a heterogeneous group with various wishes, demands and expectations (Gunnarsson, 2009). Due to their age and their physical restrictions, senior citizens are more affected by lonelines, and they have a greater need for social interaction and assistance. There are different services that have tried to make products focused only on senior citizens such as the Talk Television project (Svensson et al., 2008) or Super Dots (Foverskov, 2011). However, they have failed in their attempts to be introduced to and used by the senior citizens because of their computer-like interface and neglect of simple requirements that have proven to be successful with the elderly people (Vital, 2010). These requirements are factors such as: easy usage, simple, affordable, easily integrated in their living environment etc.

Senior citizens usually have limited experience with technology (Willis et al., 2010). Therefore, to develop a new product focused on senior citizens, a tradeoff between simplicity and functionality is necessary. This should be taken into account, because any difficulty in using these devices will be a barrier to their acceptance (Trinh et al., 2012). Inappropriate design, small buttons, or complicated interfaces makes the use of computers, smart phones, and other devices cumbersome for adoption and use by senior citizens (Willis et al., 2010). Thus, designing a product for this group of people must be based on above-mentioned requirements in order to encourage the elderly to use these technologies for indispensable assistance, access to information, and better social engagement. This is not only for the sake of being involved, but also to accomplish something like avoiding loneliness, creating a communication network, and maintaining existing connections.

To be able to offer a good solution that will serve senior citizens in the best way possible, it is important to pin-point all requirements, prioritize needs, and outline the gaps. Surveys are utilized as the primary way to identify these points as they are tackled in this research, and together they form this study and highlight the importance of it. The state of the art chapter is used as a principal purpose to survey the current state of knowledge about social engagement of senior citizens.

Based on many research studies and papers (Willis et al., 2010; de Ruyter, 2010; Alaoui et al., 2012) presented later in the document, the technological device that is most familiar and most often used by senior citizens is the TV. 98.3% of the senior citizens from 60 to over 80 years possess a TV, which makes its use economical because they do not have to invest that much (Gollner, 2007).

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1 http://en.wikipedia.org/wiki/Old_age#Demographic_changes
2 http://seniors.lovetoknow.com/What_Age_Is_a_Senior_Citizen
Thus, this thesis will describe the steps of the study, for developing a TV based solution that will create ways for communication and interaction and increase social engagement of senior citizens through the creation of what could be called an online living room.

By combining different existing technologies, devices, and requirements mentioned, the scope of this project will include design, development and implement a social media service for the social engagement of senior citizens that will be deployed using the Smart TV as a platform.

1.1 Motivation and Background

Every project has a specific motivation and background, and this study is no different. The tremendous pace of technological advancement has been and is being made, but seniors' concerns are often ignored. The lack of attention of important related issues in senior citizens' lives is the main motivation for undergoing this project in the hopes of finding a solution. This motivation is also supported by the fact that there is no need to invent a distinctive technology to build a platform that will focus only on senior citizens. In fact, the only thing that is missing is the attention from developers. The focus of this project will be on incorporating existing technologies and ideas into a single product that will help make senior citizens' lives easier and more interesting.

The idea for this project was born on a typical day spent with my family when my grandparents were trying to contact my uncle who lives abroad. There were so many platforms that we always use for communicating with them, but each one of them was too complicated for them because of their age and their lack of knowledge in ICT. Thus, I suddenly began thinking of what could solve this problem in the best and simplest way possible. After doing research on this kind of solution, I found many projects that tried to solve this problem in the ways mentioned above, but almost all of them have failed because they have not incorporated the essential needs of senior citizens. Even in cases where senior citizens were the primary focus, usually they associated them only with the need of simple interfaces with larger buttons (Phiriyapokanon, 2011). That is not sufficient. They should consider the age-related problems which make it hard to adapt to new technologies; thus, the solutions should be offered in much more familiar environments. Offering services with easy navigation and interaction will encourage this group of people to assent and use the service. To better understand the problem and gaps between user ability and technology, the “state of the art” section will present what others have done to solve these problems and how they have approached them. To achieve this, we have done a systematic literature review, which is explained in detail in Chapter 2.

1.2 Problem Definition

Increased portability and the wide adoption of social media services and mobile devices have resulted in the fact that they are no more perceived as distinct technological objects but more as integrated tools to support our everyday activities (Sheth, 2010). Different ICT devices have been around for a different periods of time, which is also reflected in the fact that telephone and TV sets are more pervasive in today’s senior citizens' lives as they have been exposed to them almost from their birth or early childhood; therefore, the TV can be more prone to adoption.

Even though socializing is one of the most important human activities at any age, senior citizens are the most vulnerable group when it comes to social isolation. This is explained by the fact that family and other relatives have limited time for care.

Using those assistive devices that are familiar to senior citizens to improve the condition of social isolation, we conducted the first part of the project. This part is for finding a way of utilizing the above-mentioned devices to help senior citizens enrich their social interactions and communication.

The problem of social isolation among this age group is a growing concern, because it is one of the most significant indicators of physical or mental changes, especially decline, in aging patients. A recent study (Holt-Lunstad, 2010) has even shown that the lack of social relationship leads to increased mortality in aging people.
There are separate effects that stem from social interaction, as having friends and external interests can make a difference in living longer and healthier lives. As the popular proverb says “the friend who brings the chicken soup makes a difference in feeling better faster than the soup itself”. Conversation, sharing information, being in touch with others is needed especially as we grow old.

Rather than addressing autonomy and dependency, our goal is to determine whether ICT could alleviate isolation and loneliness.

Our hypothesis is that virtual networks and online communication can offset lack of relationship, increase self-esteem and prevent isolation for older people. Having communication with their friends or families anytime from anywhere could enable senior citizens to talk about their problems and worries.

Below we have summarized all the challenges highlighted from this section:

- Limited time for care
- Finding appropriate device
- Low levels of social interaction and communication

As a conclusion we should consider the age-related problems which makes it hard to adapt to new technologies that drives to lowers social interaction.

### 1.3 Objectives

Based on the above-mentioned reasons, the objective of this thesis is to help senior citizens live more independently and enable their greater involvement in society. This will be achieved by surveying currently available solutions, their problems and challenges.

Its purpose is to become familiar with the current market and the available solutions’ capabilities. After that, we will identify modules that are missing and modules preferred and required by senior citizens, and combine them with the working environment that will be identified during this phase. All the findings will be used to build the prototype for social engagement of senior citizens. It will be utilized to demonstrate and test the use of the findings.

Thus, the objectives of this thesis are to:

- Analyze and write a literature survey on existing platforms focusing on senior citizens' social engagement
- Identify the modules, functionalities and other needs required by senior citizens
- Identify a working environment to better deliver this solution
- Create a prototype that will address all of the above findings and challenges

Each of these goals can be viewed as separate tasks, which at the end complete the entirety of the thesis objectives.

### 1.4 Definition and Limitations

Besides innovation and bringing a new solution, this research also studies age-related topics. Because our core focus and target group are senior citizens, we want to make it clear to what we refer when we mention this term. Throughout this study, sometimes we have used different synonyms, to avoid the repetition of the same phrase for senior citizens and to make it readable for all kinds of users. Different terms have been used to describe the target group: elderly people, old person and older people. Because there are a few changes in different countries in the age group, in this thesis we refer to an older group of people beyond the age of 55. With senior citizens, we refer to a group of people that are retired and living an active life. The target group of this thesis is users: women or men who are over the age of sixty, in reasonably good physical and mental condition, and are preferably able to use most of the functions that a common TV set offers by using the remote control.

The limitation of this thesis was the testing sample. This was due to the insufficient number of people (target group) available to participate and also to the lack of tools that we had available (only one Minix³ and one camera).

The testing was done with a group of people who do not have English as known language, and despite the fact that the prototype is all in English, sometimes we had difficulties understanding some parts, or more detailed explanation was needed.

1.5 Thesis Outline

Introduction: In this section we will describe the overall content of the thesis. To have a clearer view, we have divided it into ten parts. The current chapter explains the introduction of the topic and we will also explain the motivation and background that motivated this work as well as the challenges found, the definition of elderly people, and the limitation of this thesis.

Methodology: Here, we explain the research overview step by step, by explaining in detail the steps followed to achieve the results. The methodology used, approach used for collecting literature of existing researches, reasoning the choice etc., will be explained.

Theoretical foundation: In this chapter, you can find information about how we analyzed and collected the literature review information and the results derived from state of the art or how we built and assessed the solution. On what characteristics we have grouped the solutions found will also be detailed.

Research Question: All of the above mentioned leads us on explaining the research question, the question that should be answered at the end that will guide us throughout this thesis.

Design Perspective: The goal of this chapter is to provide design insights with regard to technology to be used, how the technology should be implemented and the overview of the system design.

Technology Overview, benefits and challenges: This section explains the reasons for choosing the working environment and comparisons between different technologies available for our solution.

Implementation: After everything is chosen and reasoned, we give the first explanation of the prototype, especially about how it is developed and what its components are.

Interface and Navigation: After giving some hints about prototype idea and components to be used, we should have a design that will suit senior citizens’ needs. In this section we have described usability assessment and the motivation for choosing it.

Assessing the results: To check and verify the success of everything mentioned above, we made a usability assessment with the target group. All the consequences and findings are summarized in this chapter. It is summarized with the feedback that we received and includes an explanation as to how this feedback affected the changes made to the project.

Conclusion: To summarize everything in this thesis, the discussion, limitations and experiments are explained as a sub-chapter. Also included in this chapter are the details on the information about the challenges that we faced during this journey. Finally, we have the conclusion where the project in its entirety is briefly summarized.
Figure 1. Thesis Outline
2. METHODOLOGY

Methodology implies more than simply the method of data collection, but also the importance of how we plan to address the research question. We use the methodology to explain each of the steps from where the problem comes and to how it will be solved.

It was of great importance to this research to plan the project and proceed based on this plan. Dealing with different papers and research without knowing their exact content was problematic. It was challenging that there was such an abundance of information available when attempting to identify the specific data and research that pertained to the subject of my research. There are many ways of planning a project and presenting the plan. According to Hart (2001), we understood that the key success for conducting a research project was planning, understanding the obtainable information, maintaining that information, and extracting information from useful sources.

The first part was to define the problem and explain the area of research. After this, we had to state the motivation and goals that should be achieved. The state of the art portion was used to create a base for the research problem and to understand the existing solutions. To achieve this, we have followed the Literature Survey protocol (Mian et al., 2007). All the steps followed during this phase are explained in details below. This choice was based on several factors like, for example, the ‘truth’ out there about the existing solutions that needed to be discovered on existing projects and papers. The fact that this research should begin with a theoretical model in order to become familiar with what information exists and what the target group wants. Here we analyzed and classified different papers and research with existing solutions for similar problems. We analyzed them critically, because they would provide the foundation for our research. Not only does this data inform and refine the research objectives, but it also provides the benchmark against which we can compare and contrast our results (Gray, 2004). Based on the work of Gray (2004), which led us during this research, it was also important in the comprehensive review because of its following functions:

- Provides up-to-date understanding of the subject
- Identifies the kinds of research methods that have been used
- Identifies how experts think and view this situation
- Assists in the formulation of the objectives, ideas, and directions
- And most importantly, provides a basis on which we can establish our findings and research.

This part helped us to understand the approaches, issues, and technologies utilized in other projects. These were the first steps where we focused our implementation and built a table of requirements that should be addressed by this solution. Having in mind the requirements and functionalities that we should fulfill, we had to decide our working environment. Having the literature survey completed and the basic requirements of the project settled made us begin thinking about design perspectives for the prototype and ultimately the end product. Using all the findings and HCI examples, we created and implemented the first prototype. All the above-mentioned characteristics were included. Testing and evaluating the prototype told us whether or not we fulfilled the goals and answered our research questions. The findings and results were utilized to improve the prototype and publish the final solution. In addition to everything explained thus far, we will give thorough explanation for some of the steps that have only been introduce in the lines above.
2.1 Literature survey/Protocol

In order to deal with the objectives of this thesis, the first step was to identify and examine the existing research. The best instrument to create the foundation of the work for this proposal from existing research was to conduct a literature survey on the topics of Smart TV, senior citizens, and social media. In this chapter, I report on and analyze the literature survey and support it with different characteristics described below.

2.1.1 Objectives

The first stage is based on the use of literature. One of the objectives is to study and summarize existing research on senior citizens' social engagement, especially regarding to what extent existing claims have been successful and the benefits of their use. To meet this end, we performed a systematic literature review (SLR) on the field of engaging senior citizens through social media. This approach helped us to well-define and identify existing solutions and ideas, evaluate them, and in the end, formulate the problem domain. The main steps of the SLR process are planning, execution and result analysis (Fig. 2) (Mian et al., 2007). To fulfill those steps, we have utilized both automatic searches and manual searches. The fulfilled conditions regarding SLR, venues, domain, keywords, etc., are described below. With all the collected materials, we aimed to collect information for the claims made for senior citizens' engagement on social media and identified the research areas for future research in our study.

2.1.2 Importance of Systematic Literature Review

There are diverse reasons why a Systematic Literature Review is performed in this study. It describes and links this study with prior related research. The protocol defined for research helps to reduce bias in the review process and covers an exact place and time for a definite field by yielding evidence about what is already known on this topic and what this study may add. The added value of this study will be based on the gaps found in published research and will generate new, creative ideas that will give more value to this study and to the solution overall. This part of the study is inspired by Weyns et al. (2011) by way that some attributes from that protocol are taken and adapted to fit with our present study.

2.1.3 Literature survey process

A systematic literature review (Kitchenham et al., 2007) is a well-defined approach toward gaining knowledge on a particular area or phenomenon, studying it, and evaluating relevant studies. As mentioned above, the approach of the three-step process (planning, execution, and result analysis) was used.
Taking into consideration that for this literature review we will have a number of different papers, we should ensure that we have a coherent planning process. We have, therefore, developed a study review protocol. First, we define the research question, the scope of the focus of this study, and then the data items that are needed. The research questions stated in chapter 4 is what will lead throughout this study, and the scope is based on the main places and venues that we searched and included in this literature review.

### 2.1.4. Search Scope and Strategy

In this research, two dimensions are defined: time and space. In time, the dimension included papers that were published from January 2010 until January 2013. The year 2010 is used as the start time because of the trends and novelties that Smart TV as a technology offered around that time. This time dimension was chosen because of the technology-driven society in which we are living. Every day we are waiting for the next major technology breakthrough. Thanks to the fast growing technology field more accurate the information and analysis has been developed overtime. That there are more up-to-date papers and research available as a result should also be taken into account. Regarding space, papers from major conferences and journals, which are related to our topic are included. Each source has its own advantages, which affected our selection decisions. Principal research databases consulted in the SLR were the Association for Computing Machinery's, or ACM's, digital library of major publications, and the Institute of Electrical and Electronics Engineers, also known as IEEE, which delivers the world’s highest quality on the latest technical research. Also some other venues related and useful to some modules in this thesis, are used. More exactly which of the venues are used, below you will find table with listed venues.

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**Figure 2. SLR process (steps: Planning, Execution and Result Analysis) (Weyns et al., 2011)**
Search string:

((Title: social OR Title: engagement OR Title: elderly OR Title: citizens OR (Abstract: social OR Abstract: engagement OR Abstract: elderly OR Abstract: Citizens))

For choosing necessary papers, we have predefined keywords that are used from different communities to refer to social engagement of senior citizens using interactive media devices.

**Keywords:** social engagement of senior citizens, accessibility, interaction, user acceptance, assistive technology.

*Note:* Accessibility and interaction are broad terms but we need them to define some of the papers that are necessary for some parts of our thesis. Because there were no more definite words available for our purposes, we used those, and later manually we eliminated and selected only those papers needed.

First, we searched the studies by automated search, and in the second step, we manually selected those related to senior citizens' social engagement.

In Table 1 are listed the venues utilized for this research and reasons why they are related to the topic.

<table>
<thead>
<tr>
<th>ID</th>
<th>VENUE</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEST</td>
<td>International Conference on Digital Ecosystems and Technologies</td>
<td>Will help to understand how is connected with the overall ecosystem.</td>
</tr>
<tr>
<td>DIS</td>
<td>Design Interactive Systems</td>
<td>To understand and learn more about the future and interactive systems design.</td>
</tr>
<tr>
<td>UIC</td>
<td>Ubiquitous Intelligence and Computing</td>
<td>To learn more about TV interface and the Smart Media World</td>
</tr>
<tr>
<td>ICCE</td>
<td>International Conference on Consumer Electronics</td>
<td>More general information about key technologies, products and services (such as Smart Remote Control)</td>
</tr>
<tr>
<td>HSI</td>
<td>Conference on Human System Interaction</td>
<td>Learn for ICT devices and how to use it for making information accessible to everyone</td>
</tr>
<tr>
<td>ITME</td>
<td>International Symposium on Information Technology in Medicine and Education</td>
<td>Lifelong Learning Paradigms for Seniors</td>
</tr>
<tr>
<td>PCTH</td>
<td>International Conference on Pervasive Computing technologies for Healthcare</td>
<td>To determine the needs of senior citizens</td>
</tr>
</tbody>
</table>

**Table 1. Selected Venues and Reasons Why They Are Chosen**
Based on the above-mentioned criteria, we selected the studies that are relevant to our topic (interactive media devices and some other conditions are summarized as inclusion criteria) then filtered out the studies that are related to health or other focuses that these projects do not cover (summarized as Exclusion Criteria).

2.1.5 Inclusion Criteria

We have limited our literature search over two dimensions: time (publication period) and space (publication venues).

- Studies that were published from 1 January 2010 to 2013. The year 2010 is used as the start time because of the trends and novelties that Smart TV as a concept offered around that time.
- The paper must be related to engaging senior citizens with social media or their ability to use and access those media.
- We included only those studies that provided evidence and assessment methods to prove their claims. The assessment may be in the form of an example application, simulation and evaluation, or survey analysis (e.g.: comparison of different existing solutions' advantages and disadvantages). We include these type of papers because we need examples that are similar to what we need to research and as a conclusion have a product.
- Papers that focused on explaining their methods and research for increasing senior citizens' social relationships through TV-based services, devices that can make TV more seemly for supporting interaction amongst older adults were included.
- We only included papers which were submitted in English language.
- The study must have addressed at least one of the research questions (or were pertinent to the research questions).
- Defined keywords must have occurred at least once in the title, keywords, or abstract of the paper.

2.1.6 Exclusion Criteria

- We excluded those studies that are related to a new claim but did not provide enough evidence about their new theories.
- We excluded short papers and tutorials, because they will not provide valuable information.
- Papers that are not related to senior citizens were excluded (e.g.: they are related to engagement in social media but in general).
- Papers that deal with assistive devices for seniors related to health or education were not used in this process, since in this phase we wanted to focus more on social engagement of senior citizens.
- Duplicate papers from ACM and IEEE were excluded.

In the first stage, we searched all the papers by the given criteria, and in the second stage all the papers were checked manually by title, keywords, and abstract to eliminate those that belong on the exclusion list or did not meet any of above mentioned conditions.

At some point, there was a need to go deeper into the documents to get necessary information unique to each document. After reading the full texts of the selected studies, we have further excluded some of them according to exclusion criteria. Finally, the remaining studies were summarized and explained in the state of the art section (Fig. 3).
This literature survey served to define the requirements that this solution will fulfill. The target platform was chosen based on the findings from the literature review. Those requirements were utilized to compare some of the interactive media devices available and become familiar with the current market, platform capabilities and, of course, define the working environment.

![Diagram showing query results and number of eliminated papers.]

**Figure 3.** Query Results: Number of eliminated papers
2.2 Iterative design- Prototyping

The third stage in our methodology was iterative design which is a design methodology based on a cyclic process of prototyping, testing, analyzing, and refining a product or process (Nielsen, 1993). The prototype and its design are developed based on the findings and requirements of the literature survey. Based on the literature survey, we have determined the most important requirements and needs that should be fulfilled, so this solution is provided in a proper manner. These requirements are put on a table where different possible working environments are compared. The one that best suits the requirements based on the literature and our belief, that can better serve and deliver this solution, was chosen. This methodology was used, because iterative design is commonly utilized in the development of human computer interfaces. It allows for the identification of any usability or user interface satisfaction issues (University of Michigan, 2013) before it is put into widespread use. The other benefit is that we can ensure the solution best suits the target group. The users' feedback is used to elicit the system’s real requirements improve the process. The typical steps of this design methodology are as follows:

- Complete an initial interface design
- Present this prototype to a group of users
- Collect their feedback and note any problems
- Fix the problems based on the feedback

Also, its benefits are the exploration and evaluation of different design options as well as increased communication among users and developers because of the feedback on ideas and changes in addition to the simple identification of problems and issues before construction. Those were some of the advantages, among others, of choosing this particular methodology. The principles for providing a more useful system are: immediate and continual focus on users and an iterative design whereby the system is modified and tested. It is important to stay flexible in all stages of the prototyping, so, changes can be made as needed during each phase. After building some of the modules, we tried to test them as developers before delivering to users. The second phase was to improve the prototype. After we gleaned what we wanted for the testers/users, it was time to replace and/or change some of the functionalities based on the feedback. To obtain this feedback, we used USE Questionnaires with our participants.

2.3 USE Questionnaire

The motivation behind using this type of questionnaire was the study suggestion. Users evaluated the products primarily using three dimensions: usefulness, satisfaction and ease of use. These are the parameters found in USE questionnaire (Lund, 2001). The questionnaire served as an instrument to validate its usefulness and importance. Even if in most cases the usability of the product is neglected in favor of performance measures, we should prioritize design problems and make the product usable because of our focus on senior citizens. They feel more comfortable with solutions that are easy to use and understand and therefore enable them to attain their goals with minimum frustration. Different dimensions were evaluated, but usefulness, satisfaction and ease of use served most effectively to distinguish between interfaces. This was also the reason for choosing this method, because when taking into consideration our target group, we have to focus on those elements that will make this solution better and accepted. Thus we used USE Questions - Usefulness, Satisfaction and Ease of Use (Lund, 2001). With this methodology we aim to produce results (Westerman et al., 2006) pertaining to effectiveness regarding how accurately and completely users are able to perform their specified goals, efficiency: the amount of effort that is required to achieve the level of effectiveness in

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performance of the goal. Lastly satisfaction: a positive attitude toward the system and a lack of discomfort while performing the goals. Those were the reasons behind the choice of this methodology over others.

USE questionnaires consist of a total of 30 questions each, divided into 4 different groups. Based on the importance of the group, the questions were distributed. Each question had a rating scale from 1 to 7 (Fig. 6). Their positions went from negative on the left to the positive on the right. In addition, each item had “not applicable” as choice. Also raters were encouraged to include any written comments.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>NA</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly disagree</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<tr>
<td>strongly agree</td>
<td>○</td>
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<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

**Figure 4. Rating scale**

A measurement scale is valid only if it measures what it is designed to measure. In our case, that means it gives information about the usefulness, satisfaction and ease of use - things that we as a developer are interested in, so we can modify and change the product accordingly. We took into consideration that this methodology covers the whole area of research, which means that while developing we wanted to make a prototype that would be accessible, easy to use, satisfy users’ needs etc. Thus, USE questionnaires contained question related to our concerns and helped to clarify as we continued working on modules with users’ feedback in mind. Having different ages and both genders in our test population helped to create a more complete sample for arguing our result. Validity, as used by us, can be also called content validity (Gray, 2004), because we taught and explained to them all the functionalities and modules of the system, and afterward, we gave questionnaires to ensure that they understood everything correctly and that things were easy to remember.

After the first part, or the “Alpha” prototype, which was used to explore design alternatives, testing theories, and other unexpected problems that may occur, we built the final version of the prototype which is expected to resolve identified issues and perform closer our expectations for the final production.

In the figure below, are all the steps followed to address the problem of this thesis for improvements so that it would better fit and be accepted by the target group.
Figure 5. Research Overview - Step by Step
3. THEORETICAL FOUNDATION

After defining literature survey and the way we collected, analyzed and filtered the existing research, we started following these steps. As a result, in this Chapter I, report and analyze my findings from the literature survey in this field.

3.1 State of the Art

In recent years, social media has expanded very quickly, leading to a huge developments and changes in the information technology society. As a consequence, senior citizens in most of the cases find it hard to cope and use newer and more complicated technological devices (PC, Web, Smart/Digital TV etc.) without prior knowledge. In some cases, the complexity of new technologies of today lead to what is known as “the digital divide”, where senior citizens find it challenging to access technology and interact with it. Besides complexity, design is also a difficult challenge for senior citizens, because it must be simple to use, affordable, and easily integrated in the home environment. Different papers, journals and conferences have raised ideas on developing a nd building something for senior citizens with more adequate user interfacing approaches and greater ease of use. To understand this, we needed to seek more information regarding senior citizens’ habits, daily activities, needs, and impairments.

As mentioned in the introduction, the total number of senior citizens (65+) is almost 20% of the overall population, which implies that modern medicine has made viable for people to live longer. However, an aging population also faces physical and social challenges. The way technology is developed today should take into consideration Abraham Maslow’s hierarchy (Abraham Maslow's Hierarchy) of human needs. In that way, it can be used to improve lives of and offer better aging to seniors’ citizens. One of the needs from this hierarchy is ‘love or social needs’ which includes the need of belonging to a family and/or a circle of friends. The first stage of having a useful service for senior citizens is to know their behaviors, needs, and characteristics, and how they communicate and interact.

In order to develop a product for senior citizens, we should foremost tend to adaptability level. This means that the new solution should be able to cope with unusual requirements (Willis et al., 2010). Based on the literature survey, we have divided the papers based on their content and the solutions offered, e.g. the technological aspect, social/loneliness concerns, physical constrains, etc. The key lessons derived from the research are used to label the sub-chapters of the literature survey outcomes found below.

3.1.1 TV as most suitable for the senior citizens

This issue was covered from a project about doing a genuine case study of the assistive living ecosystem. Mainly, the focus was about TV and phones in daily life activities. They found that media, like phones or television, do not disturb senior citizens. This is because they already have some daily activities connected with these devices, like watching the news, watching movies, or talking with friends/family. We will utilize some of this data in our solution, because we are aware of the impairments or technological literacy constrains that most seniors have and how those impairments can create psychological barriers for new terms and tools, like the internet, computers, or other new devices. Taking this into consideration, its best to utilize existing and familiar devices, like a TV or phone. We also planned to focus on the impairments that this project has summarized on the table below (Fig. 7) to make a more accessible and adaptive solution. This helped us make certain that this solution would be appropriate for as the entirety of the target group, in spite of said population's heterogeneity or different interests, needs, and wishes.

One key point that was tackled in this project was the lack of web accessibility which significantly impacts many groups of people: senior citizens, the illiterate or those with low levels of literacy, and people with older technologies or interaction capabilities (Willis et al., 2010). This is the reason why we planned to build a new interface with existing solutions. We wanted to build a platform with senior citizens in mind and bypass all the limitations and exclusions.
number of studies, information, and parameters introduced in this project helped us in defining some of the requirements and characteristics that we should cover in our study.

In Willis et al. (2010) conclusions, they have given the reason why the TV makes a suitable device for this study's purpose:

“Among the enormous variety of devices, TVs are the most suitable for the senior citizens. Senior citizens can use these devices without written instructions. They can use them easily. They want services that can be navigated with remote, and give them the feeling that they control it” (Willis et al., 2010).

<table>
<thead>
<tr>
<th>Impairments</th>
<th>Ambient Assistive Living User Interface requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Interface standard</td>
</tr>
<tr>
<td>Visual impairments</td>
<td>Use of Colors</td>
</tr>
<tr>
<td></td>
<td>Large text size</td>
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<tr>
<td></td>
<td>Background color of text</td>
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<tr>
<td></td>
<td>Background design</td>
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<tr>
<td></td>
<td>Audio description of the visual part</td>
</tr>
<tr>
<td>Hearing impairments</td>
<td>Volume control</td>
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<tr>
<td></td>
<td>Signing videos or animations</td>
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<tr>
<td></td>
<td>Subtitles/captioning of videos</td>
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<tr>
<td>Cognitive impairments</td>
<td>Headings and Subheadings</td>
</tr>
<tr>
<td></td>
<td>Scroll bars</td>
</tr>
<tr>
<td></td>
<td>Image/Icons/Graphs to illustrate textual content</td>
</tr>
<tr>
<td></td>
<td>Use of icons associated with buttons and pages</td>
</tr>
<tr>
<td>Dexterity impairments</td>
<td>Big size Buttons/Menu items</td>
</tr>
<tr>
<td></td>
<td>Allow users control the size and formatting of elements</td>
</tr>
<tr>
<td></td>
<td>Keyboard shortcuts</td>
</tr>
</tbody>
</table>

Table 2. Ambient Assistive Living User Interface Requirements (Dickinson et al., 2006; Willis et al., 2010; Europe's Information Society, 2008)
3.1.2 Loneliness, an Important Issue of Senior Citizens’ Daily Lives

Another important issue in the daily lives of elderly people and why this project may have the advantage is loneliness. This was tackled and noticed from the researchers that went to the majority of peoples in the senior housing. This observation was also noted in the Ticket to Talk Television Project (Svensson et al., 2008). It was a project about designing for the circumstantial nature of everyday social interactions of senior citizens. Its main goal was to obtain more direct information on how seniors manage their social lives, but the presence of loneliness was almost unavoidable for most of the seniors, especially those who had lost their partner since they are more likely to live on their own. And this issue was explicitly avoided talking about, since they do not want to be targeted from the community. Community groups or community dinners were some of the typical solutions communities developed to deal with the issue of loneliness.

The limitations of those gatherings in most of the cases were the senior citizens' health and weather conditions, which could make it hard to go out of their homes. Thus, new technology gives us the opportunity to avoid those limitations and gives a different way of engaging.

What we can notice and understand from this project is that technology at that time (2008) was mostly used for health care or for making it easier to lead independent lives, and there was no focus towards societal well-being. Designing a new remote for the existing TV gives us room to think about our way of interaction that we have to use; therefore, it should be more readily accepted by seniors and simplify the use of the solution.

3.1.3 Physical Constraints

Chou et al. (2010) indicate in their research that they have noticed that older populations, due to age related problems, tend to face physical weakness. Also, sometimes it is not only their willingness to learn and using new things but also the approach of environment, the development, and the design that can restrict seniors' technological aptitude. Thus, it is desirable to offer a solution without physical constraints that can be smoothly become part of the media with which they are already familiar. Seeing the growth of the population of seniors, we can conclude that they will become a great proportion of Internet users, but Web 1.0 or 2.0 are hard to navigate and both require user experience. Considering the focus of this solution as “senior friendly” service will give us a major advantage and put on the market some new norms on the web that should be suitable for elderly as well. In their research, Chou et al. (2010) have collected data from 60 Internet users, a group of 55-65 years. The top functions used by these people were the newsreader and browsing the web, which allows us to understand that elderly are more involved in intellectual activities followed by social activities online. As clearly important activities for senior citizens, this finding made us include and focus on those functions (news reader and browsing the web) while building our solution. During their research, Chou et al. investigated “Internet leisure constraints” and, mostly on the questionnaires, they have considered personal constraints, social constraints, and structural constrain.

From the results of this survey, we will distinguish some top elements indicated from this research that worry senior citizens, so, they can be used as suggestion for our study and knowing what to avoid to make our solution better and fill the existing gaps and problems (Chou et al., 2010):
- Do not like to go online alone with no interaction with other users
- Cannot find a friend to interact with on the web
- Have difficulty using keyboard
- Have difficulty understanding computer system
- Too many steps for web operation
- Worried about internet access costing too much

Even if senior citizens are not frequent social media users, they still have different needs that can be met via this medium. Social media can play a significant role in both public and private services. Due to physical infirmities, senior citizens need to give up from the activities that have been part of their lives, but the social media may be a viable substitute, able to provide for the needs the other activities previously fulfilled.

3.1.4 Active Seniors

In the Super Dots (Foverskov, 2011) project, they had separate workshops for defining the design and for how to build this project. The principle focus was to keep seniors involved in the community. Diverse opinions were shared among participants, and one of them was really worth trying.

One of the seniors in the workshop had been dealing with sailboat, but due to its health condition, he could not go to see the bulletin board in the club to participate with friends. Thus, he had an idea; while senior citizens sit at home alone they can participate via any screen at home, perhaps even the TV. During the days when they find it difficult to go in the club, they can choose to take part online. They also agree that only members should receive messages and should be able to control with and to whom they talk. We want to have a solution that will bestow such powers.

3.1.5 Seniors with less Knowledge on Computers and Internet are excluded and neglected from using these technologies

From the results of the research done for the TAGlab project (Baecker et al., 2012), we learned that now some of elders use Skype to stay in touch with their family. However, this way of communication excludes from its use those people with less knowledge about computers or the internet.

Knowing that current technology can be used as a bridge for physical and social distance, this project intends to fill these gaps and make this connection stronger for senior citizens. Cross-generational peers find it difficult to find a common topic or interested to discuss. Thus, from all the literature and existing solution we think that offering an online face-to-face communication can resolve this challenge by providing topics to talk about such as TV programs, pictures, and family history, or even collaboration for some project or club.
3.1.6 Simplifying the Use of TVs, e.g., With Remotes That Can Interact with Movements

The project known as “T-Seniority” (Moumtzi et al., 2009) describes its commitment to reducing existing digital gaps between senior citizens and the information society. TV’s easy form of interaction makes TV itself a favorite social inclusion and easily brings to people what is harder access via the internet or web. This means that there is a possibility of integrating some assistive devices into familiar TV technology, and in doing so, overcome the limitations of using the remote control as the only interactive tool. In addition, this provided us with the possibility to use more advanced remotes controls to make interactions simpler. Remote controls that can interact only with movements (e.g., Wii) and capable to facilitate text insertions with a keyboard. This simple interaction enriches input modalities and can increase friendliness and satisfaction from senior citizens.

Another project that suggests use of familiar technology (TVs) for their solution is Ambient Assisted Living (AAL) (de Ruyter, 2010). The reason they utilize the TV is based on the consideration that senior citizens are familiar with this medium, and this familiarity can positively influence the acceptance of the service. This is considered intuitive design, which means that there is no composite usage, instruction, and training necessary. With all the considerations given in this chapter, we want to the presently available technological possibilities that are offered to compensate for seniors' handicaps (physical state) and enable them to focus on their interests and fulfill their needs by respecting senior citizen’s privacy.

A qualitative study was done with aging people (age range 70-79) (Papa et al., 2011) for future services and their experiences. Based on this methodology that directly involves elderly people on a focus group, they have developed as a result some important points that should be improved upon by future developers. This paper further strengthens the claims that the TV is crucial and that it can serve for providing needed information and connections with friends, family and acquaintances. The need for information is common, so in seniors' daily activities, watching the news is significant. Some are even happier to be updated with the news from the BBC or CNN, because it gives broader information and different views. Thus, in our solution we will have a section with important news to keep them updated from different parts of the world and with different interests.
3.1.7 Interface Issues, Design Process, and Daily Activities

The FoSIBLE (Alaoui et al., 2012) project, still in the first stage of designing efficient and useful services dedicated to senior citizens, tackled some of the main points that include interface issues, design process, senior citizens, social interaction, and daily activities. They interviewed 10 participants who were aged between 65-90 years, including 8 females and 2 males. Most of them were widows or widowers, and after the death of their partners, their lives have changed. They feel lonely and have lost contact with many friends and family members because of extensive distance. They use telephones, but these lack a certain essence as a means of communication, because the users cannot see their family members while talking. The average day of a senior citizen consists of cleaning the house, reading, playing, and especially watching TV; however, the time changes according to participants. After they got the chance to express their needs, the first and most important was communication oriented. They wanted to be able to exchange real-life moments, see grandchildren evolve, share drawings and pictures, etc., through the TV. They also gave some ideas on what would help them feel better:

- Virtual guide tours on the TV about cities and museums where they can follow and give comments.
- Attending sport sessions or being part of a discussion in a round table
- Sharing texts, pictures, or drawings
- Having a photo album or something similar on the TV

Most of those ideas seem possible from the FoSIBLE project, but they have not yet been realized as the project is still in its first phase of development.

Building Bridges (Doyle et al., 2010) was a project that has the theme of building bridges for social connection. For this project, they used a supplementary device by reasoning that using additional stand-alone devices helps to hide the complexity that PCs offer. As noted in Lindley’s (2009) research, “the idea of updating a twitter feed may be as alien to many older people as the possibility of sending a telegram is a teenager.”

Physical, visual, and other impairments not only distance adults from technology, but they are also an important factor in designing a usable system and can affect whether or not the senior citizens might want to use such technology. The needs of the elderly are not fulfilled if they are not provided with an acceptable, adequate user interface.

Even though the user interface for the elderly can be very difficult, we have used some existing guidelines that are a useful starting point (Dickinson et al., 2005; Holt et al., 2002; Zajicek, 2001; Doyle et al., 2010).

From the existing guidelines and above mentioned literature, we identify some characteristics that needed to be taken into consideration in our initial design stage: use of font 14 point, color contrast in the background, no double clicks, no moving text, etc.

Problems faced during their (FoSIBLE) testing period were different and some of them were undertaken from our side as well:

- With this solution, the above-mentioned authors want to broadcast different shows where people can chat with text while watching TV, but it was difficult because they could not find a time that would suit all participants.
- Most of the participants refused to put this device in the living room, because this is a place where they watch TV, and they did not want to be interrupted.
- Another problem that made the use of the product more difficult was that participants would try to call offline contacts, and when this happened, they did not receive any indication that something was wrong.
Having control over calling features was also an issue. Some participants on certain times would not like to be contacted (for example, during their TV show, sleeping etc.). The device that we were using did not have to be unplugged to be turned off; they could just click a button to appear offline. Another participant noted: “If you provide in the future something that we could see each other, you’d get an indication of when to stop and when the other person could come in”. This issue was another additional characteristic that made us think about using Hangout as conference service, because we could use the settings to make it impossible for someone to call during your conversation with someone else.

Also, there were additional factors to be taken into consideration, and doing a literature survey enriched our knowledge on designing usable systems for senior citizens and helped us identify the gaps in existing solutions. Thus, while searching for papers and reading them, we put effort into finding some fundamental points on making our design as acceptable and usable as possible.

“T-Seniority” (Mountzi et al., 2009), mentioned above, also included some of the design aspects that should be taken into consideration in order to better present the information and content. This project has listed some characteristics that may be useful for our own project as well:

- Big icons and short sentences, easy to understand and to select (for vision impairments);
- Low number of icons (visible without scrolling)
- Clear highlighting of the selected item.

To summarize everything for the two years covered from this literature survey, there were some ICT innovations in favor of senior citizens. As mentioned above, many surveys and questionnaires have been done (Willis et al., 2010; Chou et al., 2010; Baecker et al., 2012) that highlight the requirements of senior citizens and help researchers with their future work and innovational ideas. Some of the solutions are managed by using IPTV (de Ruyter, 2010), a solution that is mostly based on giving senior citizens information about health or education. They promote education by giving information about geography or other interests. What we find negative about this project is its way of promoting education; it should use a more interactive method and avoid the traditional way of learning lessons. We planned to avoid this pitfall by finding a way that will enable learning and having fun at the same time.

One set of possibilities is the solutions offered by using “smart” objects, such as shopping bags, yoga mats or phones (Foverskov et al., 2011). But to introduce this technology and to convince senior citizens that this is also a technology for them is a considerable step and something that should be started on a smaller scale. There are other groups of solutions that are more useful and efficient, but they are not without disadvantages like the extensive involvement of writing, the interaction not generally being considered very acceptable by senior citizens, and sometimes being or seeming remote from users’ needs and interests (Alaoui et al., 2012). These are modules that look simple but have appreciable influence and are key factors for product acceptance, meaning they are qualities that must be kept in mind and avoided, mitigated, or rectified.

Different problems were identified from the literature reviews and research done in this field previously. Listed below are some factors and challenges we needed to bear in mind while developing this thesis:

- Design aspects of the new interaction paradigm that should be considered while focusing on social engagement of senior citizens.
- New technical approaches, for facilitating social engagements of senior citizens.

5 https://www.google.com/+learnmore/hangouts/
### Table 3. Summary of Challenges and Methodology/Approaches Found in Literature Review

<table>
<thead>
<tr>
<th>Project</th>
<th>Challenge</th>
<th>Methodology/Approach</th>
<th>Solution/Technology used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe’s Information Society (2008)</td>
<td>Impairments or literacy most of seniors have</td>
<td>Summarizing users requirements to find patterns needs and wishes</td>
<td>TV/Phone</td>
</tr>
<tr>
<td>Svensson’s et al Project (2008)</td>
<td>Loneliness Designing for the circumstantial nature of everyday social interaction of senior citizens</td>
<td>Community groups and community dinners, but for most people was impossible due to weather or health condition</td>
<td>New remote for existing TV</td>
</tr>
<tr>
<td>Chou’s Research (2010)</td>
<td>Limitation of learning new things is the way of environment their development and design</td>
<td>“Senior Friendly’’ service and norms on the web for being suitable for senior citizens</td>
<td>Questionnaires that lead on finding top elements that worry senior citizens</td>
</tr>
<tr>
<td>Super Dots (2011)</td>
<td>Keep seniors part of the community</td>
<td>Participate online to see bulletin board in the club with friends through their solution</td>
<td>Any screen at home or TV</td>
</tr>
<tr>
<td>TAGlab (2012)</td>
<td>Seniors with less knowledge on computer and internet eliminated and disjoint from their usage</td>
<td>Online face to face communication</td>
<td>Interactive media device</td>
</tr>
<tr>
<td>T-Seniority (2009)</td>
<td>Reduce digital gaps between senior citizens and information society</td>
<td>Simplifying the usage of TV e.g.: with remotes that can interact with movements</td>
<td>Integrate some assistive devices into the familiar TV technology e.g.: (WII)</td>
</tr>
<tr>
<td>FoSIBLE (2012)</td>
<td>Interface issue design process and daily activities</td>
<td>Interview to find ideas on what senior citizens want</td>
<td>Ideas that help building a solution</td>
</tr>
</tbody>
</table>

The gaps and problems found and the desire to meet the demands of a growing elderly population made us think about improving the current situation by providing a new solution, one that will facilitate communication, help to avoid loneliness, facilitate new connections, and maintain those bonds which already exist.
<table>
<thead>
<tr>
<th>Requirements</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avoid Loneliness</td>
<td>Svensson’s et al project (Svensson et al., 2008)</td>
</tr>
<tr>
<td>Familiar way of interaction</td>
<td>T-Seniority (Moumtzi et al., 2009)</td>
</tr>
<tr>
<td>Voice Communication</td>
<td>FoSiBLE (Alaoui et al., 2012)</td>
</tr>
<tr>
<td>User friendly interface</td>
<td>FoSiBLE (Alaoui et al., 2012)</td>
</tr>
<tr>
<td>Font 14</td>
<td>(Doyle et al., 2010)</td>
</tr>
<tr>
<td>Color contrast to the background</td>
<td>(Doyle et al., 2010)</td>
</tr>
<tr>
<td>No Double clicks</td>
<td>(Doyle et al., 2010)</td>
</tr>
<tr>
<td>No moving text</td>
<td>(Doyle et al., 2010)</td>
</tr>
<tr>
<td>To see each other</td>
<td>(Doyle et al., 2010)</td>
</tr>
<tr>
<td>Big icons</td>
<td>T-Seniority (Moumtzi et al., 2009)</td>
</tr>
<tr>
<td>Updated with news</td>
<td>T-Seniority (Moumtzi et al., 2009)</td>
</tr>
<tr>
<td>New Remote for simplifying the</td>
<td>T-Seniority (Moumtzi et al., 2009)</td>
</tr>
<tr>
<td>interaction, e.g.: movements</td>
<td>Svensson’s project</td>
</tr>
<tr>
<td>Integrate some assistive devices</td>
<td>T-Seniority (Moumtzi et al., 2009)</td>
</tr>
<tr>
<td>into the familiar TV technology</td>
<td>TAGlab (Baecker et al., 2012)</td>
</tr>
<tr>
<td>Gardening, Cooking, Exercise and</td>
<td>Activ Senior</td>
</tr>
<tr>
<td>Hunting tips</td>
<td>Senior citizens network, Sweden</td>
</tr>
</tbody>
</table>

Table 4. Summary of Requirements Based on Table 1 and the Literature Review

The state of the art section gives us clear pictures about what senior citizens want and what is more or less acceptable and adaptable to them. In the study performed by Carrasco et al. (2007), they state that 98.3% of senior citizens from aged 60 years and over possess and regularly use a TV set. For this reason, we feel reasonable to choose the TV and consider it a suitable technological platform for our purposes in this thesis. Also, we have summarized both the requirements that this solution should fulfill and the conditions that a technology needs to meet. Based on the above-mentioned project and our findings, we have distinguished some services and technologies that are more suitable for usage and social engagement of senior citizens (See Table 4). We used all the above-mentioned data from existing solutions, the surveys done with elderly, and the results from this table, to design a TV-based solution that we feel encompasses the best possible ways for these requirements to be delivered with appropriate ease of use.

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http://www.aktivsenior.se/cm1v/default.asp Accessed on: 12.05.2013
4. RESEARCH QUESTION

Taking into account the challenges identified in the introduction section and motivation from the literature survey, we have formulated the research questions (RQ) that will lead us through this thesis. First of all, we had an idea about on what we would focus. From this idea, we extracted some basic concepts that helped during literature survey and research papers. The literature survey has given us a factual and scientific foundation that helps in defining the research problem that needs to be addressed. This will focus on offering a solution that will help aging people in their daily activities and also provide for their needs for greater social interaction.

To present this idea, there are two research questions that will define the problem.

**RQ1: How can interactive media devices be used as assistive devices to help senior citizens?**

**RQ2: Will the use of interactive media devices lead to better social engagement?**

For RQ1, we want to do research and get insight about existing media devices, and how they are used by other developers on offering solutions for assisting senior citizens.

As for the second question (RQ2), we aim to assess which interactive media devices can be used to address the problem with loneliness in the elderly and how different devices from the environment can be connected and integrated to improve seniors' social engagement and e-participation.
5. DESIGN PERSPECTIVE

The goal of this chapter is to provide design insights with regard to the technology we used and how the technology was implemented as well as an overview of the system design.

5.1 Age Related Issues and the Implications for Design

The capabilities and limitations of senior citizens must be better understood in order to guide designers and developers to create more usable technologies. We are all aware that as we grow old, we change (Caprani et al., 2012), further developing some skills while losing others and suffering a decline in our functionalities. Some of these changes have the capacity to greatly impact how we interact with technology (e.g., vision problems). There exist different characteristics that should be taken into consideration when discussing these sorts of challenges (see Fig. 7 for a summary).

![Characteristics of Ageing](image)

**Figure 6. Summary of Age-Related changes that have implications for Interactions with Technology (Caprani et al., 2012)**

Fig. 7 highlights common changes, and it logically follows that there is the need for attention in these specific areas. Therefore, the design of the new technology should have appropriately sized text or design features, high contrast colors, and adjustable audio output at low frequencies (Fisk et al., 2009; Hawthorn, 2000). Thus, we have used simple text, colors, and icons that should significantly reduce confusion and increase ease of use.

There are uncountable different incidences when senior citizens are forced to interact with technology. For example, different transport services require customers to check-in online. If users do not like the interface and design of the application, they will avoid this situation or ask a friend or family member to do it for them. (Coleman et al., 2010). If you offer a system that will be used by a specific target group, e.g., a senior citizen, then it is crucial for the system to be user friendly, intuitive, and accommodating for this group.
Besides the requirements mentioned on Table 4, there are additional functional and non-functional requirements described below.

### 5.2 System Requirements

Defining the requirements of the system from the beginning gives a more positive view of the focus point. Above we have defined different requirements that we have summarized from the literature review (state of the art) and existing solutions (Table 3).

Functional requirements describe the behavior of the system as it relates to the system’s functionalities. On the other hand, nonfunctional requirements fall into areas such as accessibility, extensibility, privacy, effectiveness, etc. From the non-functional side, we tried to make sure that the system would work quickly and will answer users’ orders. In order to fit these criteria, it should avoid delay and crashes, and it should be optimized to save memory space. Additionally, it should also be developed and designed in such a way that will fit different screen sizes, like those of a TV or a tablet/mobile.

Besides the functional requirements derived from those mentioned on Table 4, below some others identified during our continuous research and based on what we plan to offer are explained:

- Should provide privacy by allowing users to log in with a username and password.
- Should allow users to choose separate modules from the homepage
- Should permit users to choose the color of the background and the size of the fonts.
- Should have a zoom in and zoom out option on some of the parts where text is displayed
- Should permit the activation of the camera automatically when video is required.
- Should permit loading books or news from the given source.

All of those requirements should be fulfilled for a user interface with senior citizens as its target group. The design perspective has some of its own.

### 5.3 Accessible User Interface

Wrinkles are not the change thing correlated with age which is why the interface of this application is expressly adapted to senior citizens’ needs and requirements. It was designed for the familiar TV set, but the architecture that we have developed is also compatible with PCs and tablets. From the system design perspective, we have considered concept of extensibility where we leave space in the implementation to consider future growth.

This process of development allows for numerous other possibilities for this platform, such as how the same platform can be utilized in tablets without any modifications. This can be a major advantage of this project because the platform is not functionally limited to a specific device. Another benefit is the possibility to use the platform from desktop computers. The difference of usability from a PC or a TV is in the access method. In order to use the platform from a PC, users can access it directly from the web browser, and it will work just as normally it does on TV (Android) devices.

We have analyzed guidelines, professional articles, and scientific literature on the requirements of people’s needs related to aging. By this review, we mean existing papers on the issue of training of older adults to use ICT, the web, and different design aspects (Web Accessibility Initiative, 2008, 2010, 2012; Arch et al., 2009). The reason behind this is to have information on how older adults use the web, the possible limitations for them, and what their needed specifications are according to different readings mentioned in the literature survey as Ambient Assistive Living user accessibility.

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interface requirements (Dickinson et al., 2006; Willis et al., 2010; Europe’s Information Society, 2008).

Text size is one of the requirements that senior citizens need due to declining vision. Thus, this solution has by default font size 14, and we will be able to resize it. Small text sizes that are hard to read were avoided.

Text style is another issue raised. By default, Times New Roman font is used. Text justification, line spacing and line length are considered as well. If these criteria are not successful for everyone, we provided some buttons that change the font style, so that users can adjust it according to their needs. Most importantly, the use of different fonts on the same page are avoided to spare users’ confusion and eye strain.

Color and contrast is something which the ability to easily see and distinguish changes with age (Porcheron et al., 2013). Here we used different colored background, which will avoid the white background behind and black text that creates extreme contrast. Regarding the information, text will be displayed in different color. This will make distinct different information and pop-ups that are meant to draw the attention of the user to take action. The same is true for font size and style. A button will be offered that will give the user the possibility to change the background color based on what suits best to them.

Audio and video that presents equivalent information for live audio and video-only content will be provided.

Navigation and location is considered as well because of declining cognitive abilities. On the first page, we plan to put 4 big icons, each corresponding to a specific function (video, news, video communication and books). The icons will be separated between each other by margins, which also help users clicking on the right icon without mixing them. On each page, we provide a button to the main page.

Interaction- in addition, this solution will provide us with the possibility of using more advanced remotes controls to make interactions simpler, remotes that can interact only with movements (Wii) and being capable to facilitate text insertions with the keyboard available. This simple interaction enriches input modalities and can increase friendliness and satisfaction from senior citizens.

Distractions such as pop-ups and unnecessary sounds older people will be avoided. The remote bestows upon them the possibility to stop the sound. Even for places that we need a sound alarm, there is a limit of its duration.

Page organization and understandable language are also taken into account. The page for each service will be well organized, and different headings are used to describe the topic or the purpose. Technical jargon will be used as infrequently as possible as will be complex or unusual words.

When a service supports usable accessibility features, users are more likely to demand it.
5.4 Working Environment

Based on the literature survey and technological background, we have determined some services and technologies that are more suitable for use and social engagement of senior citizens. We have summarized the conditions that a technology needs to fulfill. Based on literature survey and other sources (included in footnote) we have compile the Table 5 below.

Looking at the advantages of TV usability compared to that of PCs and tablets while targeting senior citizens, it is readily apparent that TV is a great platform on which to base our solution and also wouldn't be an overly difficult challenge for the elderly to adopt. The table below (Table 5) further explains the benefits of using a TV over a PC or tablet by giving the devices grades in each category. We use a scaling system from 1(low) -4 (high grade). The higher the grade it means more support for the conditions mentioned.

<table>
<thead>
<tr>
<th>Conditions</th>
<th>PC</th>
<th>TV/Smart TV</th>
<th>Tablet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affordable</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Screen size</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Familiarity</td>
<td>3</td>
<td>4(^8)</td>
<td>2</td>
</tr>
<tr>
<td>Versatile -Heterogeneity target gr (Different needs interests etc.)</td>
<td>3</td>
<td>4(^9)</td>
<td>4</td>
</tr>
<tr>
<td>Up and running factor</td>
<td>2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Device used on daily activity</td>
<td>2</td>
<td>4(^10)</td>
<td>1</td>
</tr>
<tr>
<td>Relaxing/orthopedic use</td>
<td>2(^11)</td>
<td>3(^12)</td>
<td>3</td>
</tr>
<tr>
<td>Easy way of interaction</td>
<td>3</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Support for I/O devices</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Integrated easy in the home environment</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Complexity</td>
<td>2(^13)</td>
<td>4</td>
<td>3(^14)</td>
</tr>
<tr>
<td>Adaptive solution</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Suitable for senior citizens</td>
<td>2(^15)</td>
<td>4(^16)</td>
<td>3(^17)</td>
</tr>
<tr>
<td>Need for maintenance</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 5. Benefits of Using the TV over PCs and Tablet Devices

By reviewing currently available solutions, we found the TV as a working environment that would fill most of the above-mentioned conditions and requirements. Based on the positives of the TV and following the logic of the Bridge
project (Doyle et al., 2010) which reasons that using additional stand-alone devices helps to hide the complexity of PCs, we plan on using an additional device that will convert the normal TV into a Smart TV without ‘scaring’ our target group. We thought of using an additional device for some simple reasons: first, because most of people already have a TV, so users need to invest only on the device. Purchasing a new Smart TV is still not affordable for everyone.

Other technologies could be utilized for this project, but based on the literature mentioned, we consider TV to be the most appropriate. Other approaches could also be considered in further research, but they are not the focus of this master thesis.

After the research done on the existing market to decide about the most suitable device to meet our needs, we made a specification table to compare devices (Table 6): The devices that made it into comparing list had to be based on Android OS, capable of Web-camera, have HDMI output, and be equipped with remote control.

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Minix Neo X5</th>
<th>Minix Neo G4</th>
<th>Raspberry Pi</th>
<th>JUSTOP TV Box</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Processor</strong></td>
<td>ARM Cortex A9 Dual Core Processor</td>
<td>ARM Cortex A9 Dual Core Processor</td>
<td>Broadcom BCM2835 700MHz ARM1176JFSE</td>
<td>Cortex-A9 Dual Core up to 1.6Ghz</td>
</tr>
<tr>
<td><strong>GPU</strong></td>
<td>Quad Core Mali 400 Graphics Processor with 1080P. Flash and other video hardware decoder built-in. (Open GL ES2.0/1.1, Open VG1.1, Flash 11.1)</td>
<td>Quad Core Mali 400 Graphics Processor with 1080P. Flash and other video hardware decoder built-in. (Open GL ES2.0/1.1, Open VG1.1, Flash 11.1)</td>
<td>GPU provides Open GL ES 2.0, hardware-accelerated OpenVG, and 1080p30 H.264 high-profile decode</td>
<td>Mali 400, 2D/ 3D/ OpenGL ES2.0(AMD Z430)/ OpenVG1.1(AMD Z160) 27M Tri/sec</td>
</tr>
<tr>
<td><strong>OS</strong></td>
<td>Android OS 4.0.4 (upgradeable)</td>
<td>Android OS 4.0.4 (upgradeable)</td>
<td>Linux - not supplied</td>
<td>Android OS</td>
</tr>
<tr>
<td><strong>Memory</strong></td>
<td>1GB</td>
<td>1GB</td>
<td>512MB RAM (Model B), 256MB RAM (Model A)</td>
<td>1GB</td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td>16GB SSD NAND Flash -Micro SD 3.0 for additional storage</td>
<td>8GB SSD NAND Flash -Micro SD 3.0 for additional storage</td>
<td>SD card socket</td>
<td>4GB NAND Flash</td>
</tr>
<tr>
<td><strong>Connectivity</strong></td>
<td>Ethernet 100Mbit WiFi 802.11 b/g/n</td>
<td>WiFi 802.11 b/g/n</td>
<td>10/100 BaseT Ethernet socket (Model B)</td>
<td>WiFi 802.11 b/g/n</td>
</tr>
<tr>
<td><strong>Video Output</strong></td>
<td>HDMI 1.4a</td>
<td>HDMI 1.4a</td>
<td>HDMI, RCA composite</td>
<td>HDMI</td>
</tr>
</tbody>
</table>

37
Choosing this kind of device was significant because of many reasons. First of all, it removes the precondition of buying a new TV that belongs to the category of ‘smart’ technology. Even with a very small budget, most old TVs can be turned into a Smart TV. Another positive of these kinds of devices is that they offer very good software support. Having the Android OS on this device offers many possibilities such as HTPC (home theater PC), web browsing, video conferencing, etc. Also another important feature is the possibility to customize the device. This is crucial, because our project is projected toward senior citizens and customization for their interests and limitations is paramount to our success. Using these possibilities, we can build a platform that is suitable for seniors by customizing it, so they wouldn't need to go through many steps just to use one simple process like Video Calling. Also, the air remote would help senior citizens with navigating through the software, which would make the platform easier to use.

Even though Table 6 shows that on some of the specifications that are important for this solution, Minix Neo X5 leads, Table 7 below presents the benchmarking process by comparing devices. The comparison reveals that there are more advantages to using our choice, Minix Neo X5.

<table>
<thead>
<tr>
<th></th>
<th>MPEG / MPG / FLV / ASF / TS / TP / 3GP</th>
<th>MPEG / MPG / FLV / ASF / TS / TP / 3GP</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Audio Output</strong></td>
<td>DMI 1.4a, Optical S/PDIF</td>
<td>HDMI 1.4a</td>
<td>3.5mm HDMI</td>
</tr>
<tr>
<td><strong>Peripheral Interface</strong></td>
<td>RJ45 100Mbit LAN Port</td>
<td>TF Card Reader (SD 3.0)</td>
<td>Connector for Raspberry Pi HD video camera JTAG connector SD card socket</td>
</tr>
<tr>
<td></td>
<td>3 x USB 2.0 port Audio in and out jacks</td>
<td>USB 2.0 port</td>
<td></td>
</tr>
<tr>
<td><strong>Web Cam</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes N/A</td>
</tr>
<tr>
<td><strong>Remote</strong></td>
<td>IR/ MINIX Air Mouse (wireless keyboard+mouse handheld controller)/Software Remote</td>
<td>IR/ MINIX Air Mouse (wireless keyboard+mouse handheld controller)/Software Remote</td>
<td>N/A IR</td>
</tr>
</tbody>
</table>

Table 6. Comparing device specifications for the Most Suitable Device selection

18 http://en.wikipedia.org/wiki/Home_theater_PC
These two devices are built from the same company and share same hardware components except that Neo X5 has 16 Gb Onboard memory, Ethernet LAN connection which is important for video reliability, 3 USB Ports which are important to connect Webcam, and air remote at the same time. One advantage of Neo X5 is the Bluetooth, Raspberry Pi can be used as multipurpose device, but all the components should be built manually. Starting from the software: R-Pi doesn't have a running OS and it requires manual configuration to run correctly also the hardware is sold separately starting from the board, power supply, case etc. Despite the ability to run Android OS, there is not any official support from the developer’s team. This is important because the development team of Neo X has big support for Android OS, Firmware and web cam support.

Justop offers same features as Neo Devices, but there is not as much software support in this device like in Neo X. Android is not very optimized and there is no official support for webcams from the development team. Also Justop doesn’t have Ethernet port and the Onboard memory is limited to 4 GB.

<table>
<thead>
<tr>
<th>Minix Neo X5 vs</th>
<th>Minix Neo G4</th>
<th>Raspberry Pi</th>
<th>Justop</th>
</tr>
</thead>
<tbody>
<tr>
<td>These two devices are built from the same company and share same hardware components except that Neo X5 has 16 Gb Onboard memory, Ethernet LAN connection which is important for video reliability, 3 USB Ports which are important to connect Webcam, and air remote at the same time. One advantage of Neo X5 is the Bluetooth, Raspberry Pi can be used as multipurpose device, but all the components should be built manually. Starting from the software: R-Pi doesn’t have a running OS and it requires manual configuration to run correctly also the hardware is sold separately starting from the board, power supply, case etc. Despite the ability to run Android OS, there is not any official support from the developer’s team. This is important because the development team of Neo X has big support for Android OS, Firmware and web cam support.</td>
<td></td>
<td></td>
<td>Justop offers same features as Neo Devices, but there is not as much software support in this device like in Neo X. Android is not very optimized and there is no official support for webcams from the development team. Also Justop doesn’t have Ethernet port and the Onboard memory is limited to 4 GB.</td>
</tr>
</tbody>
</table>

Table 7. Limitations on competitor devices compared to Minix Neo X5

As can be seen in the table above, these devices do not have many differences, and there is nothing wrong with using any of them as the primary device to implement similar projects, but Minix Neo X5 fits best in this particular project.

5.4.1 Environment and Operating System

Once we defined the requirements and the device, we had to decide about the environment and Operating System.

As mentioned previously, we have chosen to use Minix Neo X5, which by default has Android as its operating system. A great benefit is the open source and its ability to be run in different devices, in comparison to others, e.g., iOS where you need an iOS-branded device. Android is based on Linux, a free operating system, so most of the features are completely uninhibited which makes popular among manufacturers and developers as it does not cost much to launch an application.
5.5 TV

Smart TV is also known as Hybrid TV or Social / Interior Connected TV. It can be a television or a set-box that has Web 2.0 features incorporated into it. This technology is not limited only to Smart TVs or set-top boxes, but it can often deliver content from a computer or NAS. By interactive TV, we are referring to the user being able to influence the viewing experience. It is a new area for development and attractive for developers, but still, the number of people who own a Smart TV is low. Study shows that by 2014, over 120 million connected TVs will have been sold throughout the world. This growth can be taken as an advantage of this thesis, because of the novelties that it brings and benefits that users can gain. From the beginning of this notion, there started to appear different platforms in the market, from Sony to Samsung. Nevertheless, with the new technology called HTML5, barriers to making a solution in different platforms are being eliminated. Most of TV OEMs (Original Equipment Manufacturer) have started to integrate newer web presentations that use HTML5, which gives a competitive edge to this new technology and to our solution as a solution based on it (Wolf, 2013). For this thesis, we use an Android device, as mentioned in Chapter 1, to provide access to online services through the TV (Figure 8). Users simply connect the device with the internet, they will have access to the internet through their TV. These new experiences that Smart TV offers are affecting the television experience and how users interact.

![Smart Device Minix Neo X5](image)

**Figure 7. Smart Device Minix Neo X5**

There are many reasons why we have chosen to use the Android mini PC as the main device rather than a dedicated Smart TV. Most of the Smart TVs available on the market today have their specific OS and their dedicated apps. This would cause numerous complications for us because applications that work on one device may not work on another. Another reason is a chance to have access in the most used mobile operating system (Android) and its applications which Minix offers. To make things even better, Minix offers access to this environment even with old TVs that do not offer features like web browsing, etc.

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5.6 Prototype Development Components

5.6.1 Prototype

Based on the requirements gathered from the literature survey, we continue with the terms of implementing the system. In order for it to be possible to develop such a challenging project, besides a suitable working environment, there was a need to find also new and promising technologies. When talking about today’s web technologies, innovation is one of the most utilized words. One of the latest technologies that is associated to innovation in the field of web development is the Mashup approach”. Mashup is not a specially developed technology that is entirely unique, but it brings together many web technologies into a single platform and offers an abundance of possibilities for developers and users. Mostly, they are being used on social websites where, in most cases, websites that include Mashup gather data from different websites and put them into a single place.

Looking at the nature of the project, there was a need to merge many web technologies, APIs, and hardware devices into a single platform and Mashup made this possible in the best and seamless way possible.

5.6.2 Mashup

It is common these days to see the website of a restaurant in a given city that displays a map of the restaurant's location. Often, the two types of content are from different sites. This merging of a service and content from multiple sources into one is called Mashup. Using some freely available website content services creates additional benefits for the user. There are distinctive major web services that in recent years have opened their systems to the outside through the implementation of public application programming interfaces (APIs) (Auinger et al., 2008). When there is very useful functionality that fulfills the needs and requirements of the target group, we can use Mashup and focus on the design perspective and accessibility. In other words, Mashup gives us the chance to take part in the reuse software culture, and provides a productive ecosystem of data and services to our users.

Hence, traditional advertising using television, newspapers, and leaflets runs into a crisis caused by digital and analog information, which has impacted every single individual in our society. Having in mind the layers of the internet: physical (the wires), logical (the protocols), content and social, Mashup fits between the content and social layers by changing the way by which individuals relate to content (Gasser, 2007) which are also characteristics for which the Mashup service has gained attention.

The type of Mashup used in this project is a type of server-side. The platform is built on a proxy server which acts as a data collection from other APIs and websites and presents them as a single platform to users via web and mobile applications. All the necessary processes, including authentication and data wrapping, are processed on the server-side.

5.6.3 Prototype components:

On the basis of the current results, the state of the art section, and other different analyses (Tables 3, 4 and 5), we tried to find services that provided the needed easily learned and used performances and services. All the efforts made to identify and summarize the requirements will better fit and be resolved with components summarized in the figure below:
More detailed information about the prototype components is available in Chapter 7. But before we move on to the next chapter, we want to give a brief explanation in the sub-chapter below on what type of Mashup this solution belongs to.

This solution presents a mashup of 5 components in which 4 of them work in parallel to create and interface and the 5th is included for authentication and authorization mechanisms.

5.6.4 Client-side Mashup / Server side

As noted before, the type of Mashup used in this platform is server-side (Auinger et al., 2008). The reason for choosing this type of Mashup over client-side is because the project is consisted of several components which are taken from different websites and because the TV as the information flow that we are using does not have enough processing power for advanced processing. In order to make all these platforms work well together, there is a need for a proxy server which in the same case acts as a web server and brings all these platforms into a single website that can be available in the client’s web browser.

To better explain the Mashup used in this platform, below are examples of how the user will use the video conferencing module:

1. The user accesses the platform from his browser by pointing to the domain name/ IP address of the server
2. The server responds to the user by checking if he is already logged in (Authentication is done using Google authentication).
3. If the user is not signed in, the login page is presented. If he is logged in, the user is redirected to the platform homepage.

4. From the homepage menu, the user accesses the video conferencing module, which is presented with an icon.

5. The server then acts as a middleware between Google Hangout and the client’s web browser and makes a peer connection between these sockets.

6. After the connection is created between the consumer and Google Hangout, all communication is done outside the proxy server.

7. When the user finishes using video conferencing, the hangout app is closed and the user is returned to the home screen.
6. TECHNOLOGY OVERVIEW, BENEFITS AND CHALLENGES

After the idea of the product was completed and the hardware components that would make this idea work had been found, the next step was solving the software architecture. As explained in the above paragraphs, there was a need to create software that would be served by a web server to the clients. This would function very easily if the customer was accessing the platform from the web browser. This presents the first challenge of this project. The platform could not be accessed from a web browser because browsers that are available in the mobile platforms, in this case Android, do not have the same capabilities as computer browsers. In order to resolve this problem, we had to think of a solution that would include web browsing to be able to access the information from the web server and a mobile application in order to make it possible for android devices to access this information directly.

This challenge made us think of hybrid apps, which offer the possibility to work with HTML5, CSS and JavaScript to access native APIs and AppStore distribution. Below will be provided a more detailed comparison and the components of why we chose this way of solving this challenge.

There are several ways to develop an application for mobile platforms. These methods are called native apps, web apps, hybrid apps, and so on. The software that we are developing to make this solution work is based on hybrid apps.

To facilitate a better understanding of the differences and advantages of each of these method, they are briefly explained below.

6.1 Native Apps

Even if they are expensive to develop and maintain, native apps have many benefits. Once the native app is installed on the mobile device and launched by the user, it interacts with the mobile OS through propriety API calls that the OS exposes. It is through those API calls that the app gets access to all the dissimilar hardware components of the device. Using the API, the app can interact directly with the touch screen or the keyboard, connect to networks, process audio received from the microphone, play sounds through the speaker of headphones, receive image or video from the camera, or access something similar. Another important set of APIs that OS offers are GUI Toolkit. Each mobile OS comes with its own set of user interface components such as buttons, input fields, menus, sliders, and so on. Apps that make use of these components inherit the looking field of that mobile OS, and these native UI components usually provide a very smooth user experience. It is important to note that each mobile OS comes with its own unique palliative UI components, which means that if we want an app that will work across multiple OS’s, we must be familiar with the UI components of each OS, in order to make it accessible and user friendly.
6.2 Web Apps

We are all familiar with mobile browsing. There are even some companies that have made their web look like a native app (Dremel). But there are also companies like YouTube that not only make their apps look like native apps, but they also provide very similar functionalities and even prompt the user to install it on the device. This also makes it hard for the users to define if it is running on the browser. The user visits them by typing the URL into the browser or clicking a hyperlink. The logic for rendering these pages is executed on the server, for example using PHP, JSP or Python, which means that the user usually waits for pages to be retrieved from the network. In Fig.11 we have tried to show the web app interaction with mob app.

HTML5 and JS have become so powerful that it is now possible to develop very advanced applications using them, which also bring us to the next category of mobile web apps. HTML5 allows creating a genuine cross platform application with only one code base. HTML5 is the contemporary target of HTML standardization process. In many ways, HTML5 signals the transition of HTML from a page definition language into a powerful technology for creating browser-based apps. While native apps have full access to the device, there are various features that web apps cannot access at all such as the calendar or address book. This will likely change with the evolution of HTML5, but we are not there yet.

One specific element of the browser is the Rendering Engine, which is the heart of the browser. It’s the part that translates the HTML, CSS and JavaScript into a real live user interface. Today, most of the smart phone vendors are using the same rendering engine in their devices. This rendering engine is called WebKit, and it is an open source project that is mostly used by Apple and Google that have most of HTML5 features implemented already. So, while vendors makes their own changes to the WebKit, the browser has a nice level of compatibility between them.
6.2.1 Hangout Limitations

After we compared native apps with web apps, we faced another problem. When we started to work on this solution, Hangout was served together with Google+, so we did not have a chance to customize it and make it useful only as a Hangout. After some months Google released the ‘new’ Hangout, which means they introduced it as a stand-alone service. It gave us some hope that we might still be able to use it, but Google left in place some restrictions in cases when users use ARM architecture (ex: mobile). As a result, we cannot use this service on a browser as users, because we would be redirected to the Play Store to download the application. Nevertheless, we researched and we found that there exists another solution, which can be considered more elastic because of the advantages it offers. It combines web and native apps’ features - hybrid apps.

6.3 Hybrid Apps

To circumvent the limitations mentioned above, we decided on a solution that would split all the components into native and web components. After all the research was done, the hybrid app was the natural choice. We studied all the pros and cons to see if it would fit with our requirements. Below, we will describe some of the characteristics that hybrid apps have:
A hybrid app is native app with embedded HTML.

It has some benefits of native apps: full access to APIs, app store presence, etc.

Selected portions of the app are written using web technologies.

The web portions of the app can either be downloaded from the web or from packages within the app.

All those advantages are because hybrid apps operate in a different manner. They have two separate components:

- There is a native portion of the app. This part can call all the APIs provided by the OS, meaning that we can have a full access to everything that the devices offer, including things like the camera, microphone, and even high level services like the calendar or address book.

- The second component is the web portion of the app. This part is written in HTML, CSS and JS, which are executed in the same rendering engine that is the heart of the browser. By default, this web code can only access service that it renders and the engine exposes. Theoretically, we can see that it may have the same limitations that web apps do; however, a native portion of the app has control over the rendering app, and as such, it can create the so called bridge. This allows the web portion of the app to access all the OS APIs. After achieving this bridge, Phonegap can be used as an open source library. It comes with both with native and JavaScript end points and provides a JS interface to select device capabilities which are consistent cross operating systems. This is a suitable solution; even bank of America, Facebook, and Morgan Stanley are using this solution.

Figure 11. Hybrid app-interaction with Mobile Device
At this point, the question became how to develop a hybrid app. We should make it clear that, first of all, it is a native app, so we have to create that first. Native apps should be coded in a way that launches the HTML on the rendering engine where appropriate.

To summarize we will compare all three developments:

<table>
<thead>
<tr>
<th></th>
<th>Device Access</th>
<th>Speed</th>
<th>Development Cost</th>
<th>App Store</th>
<th>Approval Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native</td>
<td>Full</td>
<td>Very fast</td>
<td>Expensive</td>
<td>Available</td>
<td>Mandatory</td>
</tr>
<tr>
<td>Hybrid</td>
<td>Full</td>
<td>Native speed as necessary</td>
<td>Reasonable</td>
<td>Available</td>
<td>Low Overhead</td>
</tr>
<tr>
<td>Web</td>
<td>Partial</td>
<td>Fast</td>
<td>Reasonable</td>
<td>Not</td>
<td>None</td>
</tr>
</tbody>
</table>

- **Positive or Fully available**
- **Negative, not preferred**
- **Available but with restrictions or low**

*Figure 12. Native vs. Hybrid vs. Web*

Comparing the requirements and services we want to offer with all the advantages and disadvantages inherent to each of the three types of apps, we can say that hybrid is the one that can serve us best in delivering our solution in the proper manner and with all the functionalities mentioned until now.

The solution that would give the best result regarding usability and reliability was writing an Android application that would contain web browsing. The ability to include web browsing inside the app is very important because the software that runs on a server and offers all these features is presented as website. The software should be in a position to access information in the web server and present them inside the android app.
As a tool set for development, we used Eclipse. Eclipse is a computer program composed of a set of programming tools for developing a cross-platform open source. Besides the fact that is free, it has great CVS integration, which is good when planning to code in different languages (a single IDE for different languages), and last but not least, different plug-ins can be added.

7. IMPLEMENTATION

The following part will explain briefly the implementation process without too many technical details, but in a way that is understandable for the reader. The first feature implemented in the project is the ability of users to log in with Google Authentication.

This feature gives the platform more security and makes it easier for users to use their Google accounts to use the platform.

7.1 Google Authentication

To ensure that user data is not abused, we have used Google Account for certain activities. Access control consists of two components: authentication and authorization. This login involves a sequence of interactions between our solution, Google’s login authentication service, and the end user.

![Sequence diagram of Google Authentication](https://developers.google.com/storage/docs/authentication)

If the user is already logged into their Google account, the login step may be skipped and the login button will disappear.

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This sequence diagram is numbered as Figure 13, which indicates that the detailed explanation and diagram are provided earlier in the document, possibly in a previous chapter or section, and is referenced here for a visual representation of the Google Authentication process.

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21[https://developers.google.com/storage/docs/authentication](https://developers.google.com/storage/docs/authentication)
7.2 Video Conference

Previously, all the restrictions that Hangout as service has for ARM architecture were noted. Because of them, we had to find a solution that none of the existing products had. We can access hangout from two ways:

- The first way is via the web, with the Hangout button. The API offers access to Hangout services without any limitations, but only on the web for PCs. The same cannot be said for tablets or mobile devices.
- The second way is using a hybrid application, which offers the possibility of using Hangout as a native application. Hangout as a ready-made application offered by Google cannot be accessed as other native applications that we could build.

We opted for the second approach. While developing the hybrid app, Intent was used as an abstract description of an operation to be performed. Web Intents is a framework for client-side service discovery and inter-application communication. Applications request to start an action and the system will find the appropriate service for the user to use (in this case Hangout). This method helps developers to not anticipate every new service. Also, Web Intents circumvents the problem we experienced with Hangout previously and its restrictions regarding use as a web app by initiating one app from another.

Intents allows Android components to request functionalities from other components of the Android system (e.g., one activity can send Intent to the Android system which starts another activity). In this case, we had to make our application listen for Intents, which required a bit of work because Intents for Hangout is still not used, or at least we do not have any online information about such usage.

We had to modify our AndroidManifest.xml file and use some JavaScript to make it notice when the app should be launched. We had to write some of the functionalities that will help to make Hangout function as a native app. To get Hangout from Android OS, four parameters are used: action, url, type, and extras.

```javascript
window.plugins.webintent.startActivity({
  action: window.plugins.webintent.ACTION_VIEW,
  url: 'com.google.android.talk'
}, function () {}, function () {
  alert('Failed to open URL via Android Intent');
});
```

The idea behind this solution (the code shown) is that Web Intents is something like: “I want to view this URL” or “I want to start the Hangout application.” The system checks what apps are able to fulfill this request and, if there are several possibilities, allows us to choose one of them.

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22 [https://developers.google.com/+hangouts/button](https://developers.google.com/+hangouts/button) Accessed on: 08.08.2013

In our case we chose Hangout and the user have access to the camera and microphone of the device. It also should be noted that the user could not tell if he is using a web or native app.

Due to the modularity that this solution has, we consider that it should not be complicated to extend/adapt with other video-systems. This work is not limited to these scenarios. The proposed solution has potential for future scenarios, although these are not assessed in this thesis and are considered for future research studies.

### 7.3 Google Books API

Having the possibility to login to the application through Google gives us the possibility to choose from a wide range of services that Google offers. One such service is the Google Books API, which has a mission to digitize the world’s book content and make it accessible on the web. The positive effect is that people can read every book wherever and whenever they want. We exploited this and used this API for the book service of our application. To use this service, we have also used Backbone.js.\(^{24}\) It enforces the communication to the server and makes it possible to make the code modular, so we can use different independent modules to execute only one aspect of the desired component. It connects the entire existing API over a RESTful JSON interface. Also, when the model changes, the views simply update themselves. We do not need to write a glue code that looks at the DOM to find elements with a specific id.

```html
<div id="viewerCanvas" style="width: 600px; height: 500px"></div>
```

To clarify what a DOM is and why it is used by the Google Book API, consider the following: allowing a book to be displayed on a web page is done by creating a name div element and obtaining a reference to this element in the browser’s document object model (DOM).\(^{26}\)

The code is shown to describe the importance in viewerCanvas. It is the name of the div ID that we will need in order to launch the viewer.

For this solution, when the user searches for a title or author, we offer full access to all the books, assuming that they have Google account, or because of the popularity for books here in Sweden, they may want to pay for books in which they are interested. We can filter the returned search results. An example would be for the search to return only free books or only books for purchase according to the selected preferences of the user. Filters could also be used to return only those titles or authors that provide eBooks, to return only those with partial book previews for non-eBooks, or to find or eliminate search results using various other specifications.

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\(^{25}\) [http://support.sas.com/documentation/cdl/en/wbsvcdg/62759/HTML/default/viewer.htm#n0uxdl0ugxduw6n1gduq1rcbo7l5.htm](http://support.sas.com/documentation/cdl/en/wbsvcdg/62759/HTML/default/viewer.htm#n0uxdl0ugxduw6n1gduq1rcbo7l5.htm) Accessed on: 18.06.2013

\(^{26}\) [https://developers.google.com/books/docs/viewer/developers_guide](https://developers.google.com/books/docs/viewer/developers_guide) Accessed on: 20.06.2013
7.4 RSS News

For this part, we have used RSS (Rich Site Summary). It is a format for delivering regularly changing web content. This enables us to take different information and be updated with news from Swedish newspapers. It retrieves the latest content from the site. The main advantage of RSS is that it lets us tune out mainstream media and tune into alternative and personal media. Also, having all the news in one place when we want it and only the type we want is another benefit. The list of notifications used is called the RSS Feed. RSS aggregators are the ones that automatically access the RSS feeds of websites and organize the results. A list of items is provided in order from newest to oldest. Each item usually consists of the title description along with a line of commentary or explanation. The RSS information is placed into a single file on a website similar to a normal web page; however, the information is coded in the XML computer language which is used by a program in the RSS aggregator. The diagram below shows how web browsers use information from different sources on the internet, and how the RSS Feed and XML files are both being monitored simultaneously by an RSS Feed Aggregator.

![Diagram of RSS](image)

Table 8. How the Parts of RSS Are Connected

7.5 Recreation Videos

The fourth functionality of this solution was based on Aktiv Senior, which is an independent network of active seniors. Based on their research, we found out that the priorities of senior citizens regarding social engagement are:

- House or Gardening
- Hunting
- Exercise
- Cooking


29 [http://www.aktivsenior.se/cm1v/default.asp](http://www.aktivsenior.se/cm1v/default.asp) Accessed on: 18.06.2013
When we searched for a way to combine all of four of these topics, YouTube offered the best solution. This is achieved by using the public YouTube API, which offers a full range of possibilities. By using this API, it is possible to create customized platforms based on YouTube.

When the user presses the picture, for example, gardening, a new page is opened in the background and sends the additional parameter to this page (Figure 22). Here, senior citizens can search for different videos simply by selecting some pictures that refer to the above-mentioned priorities. For example, when they click a figure related to gardening, it will retrieve a list of videos that match specified search criteria. Only videos that match these criteria are submitted to the user.

For this solution, the IFrame player API is used. It allows for both embedding a YouTube video player website and controlling the player using JavaScript. Instead of writing an empty <div> element on our page, which later would be replaced with an <iframe> by the player API’s JavaScript, we created the <iframe> tag ourselves.

```html
<iframe id='player"+i +"' type='text/html' width='420' height='315'
src=http://www.youtube.com/embed/" + result.data.items[i].id + 
frameborder='0'></iframe>
```

This code dynamically generates the table, and also specifies values for width and height, which are designated as attributes of the <iframe> tag. Further, we did not have to specify the videoID and other parameters, because they are specified by the source URL. Instead of using the words gardening, hunting, exercise, or cooking, we used parameter. As an extra security measure, we included the origin parameter to the URL, specifying the URL schema (http:// or https://).

To avoid a great deal of scrolling by default, only the first 9 videos that correspond to the selected group are shown (e.g., gardening).

```javascript
for (var i=0;i<result.data.items.length;i=i+1){
    if(i<9)
```

This method is the same as visiting the site normally, but in our case, it saves senior citizens frustration by bringing to them everything in one place and avoids the redirect-there-redirect-back element, thus the user experience is much better.
8. INTERFACE AND NAVIGATION

8.1 Solution architecture

This section covers the architecture and the modules that are developed to completely make the platform. Firstly, as mentioned before, the architecture is Client-Server. The application runs on a web server based on HTML, CSS and JavaScript. This choice of languages was made because of the diversity of products/modules offered. All these modules are developed and run on separate classes and parts because their sources of information come from different places. Also, the technical details for the implementation of each module are presented in the implementation part. Here we show how they are interconnected and presented as a single platform.

![Figure 14. System Overview](image)

8.2 Prototype Design

Once we had accounted for all of the above-mentioned requirements regarding the design and functionalities, we had our first User interface for the system.

![Figure 15. Home Screen of the Prototype](image)

As video conferencing is the main feature of this project, it was made easily comprehensible for users as an icon with people communicating between each other.
After the user enters this section, the module for video conferencing is activated. This module is built as a bridge with the Google Hangout application. Depending on the device, the user accesses this service and the module runs the specific app. In this case, the target devices are based on Android, and Google’s Hangout application is used as the app to make video calls. The module is built such that when the user uses the TV device and wants to make a video call, when he/she clicks on the icon, the module then redirects the user to the Hangout application (Fig. 17). This is the way the call is processed (Fig.18). Here we have used some methods mentioned in the implementation section. This module was also a reason while deciding to make the application hybrid. When the call is finished, the user is then redirected back to the main application.

Figure 16. Interface of the Hangout App (friend list)

Figure 17. Calling a Friend with Hangout (No Picture for Privacy Issues)
The same idea applies to the news section of the platform. This module runs as a separate app, and when the user accesses it from the main form, they are linked to the News module. This module is built as an HTML application which uses the RSS technology to gather news from a specific website. A Swedish newspaper is used as the RSS news provider (Fig. 19).

This module is designed in a way that is not visually complicated for users and has only the information and sections needed. The news is presented as small cubes that show the title and some text or video from the article. If the user wants to read a specific article, when he/she clicks on the cube or the title, the full text of the article is then opened in a single window. Also, the possibility of going back to the homepage or main window is offered.

Figure 18. News Interface Module (News from Expressen.se)

The next module developed in this platform was Books (Fig. 20). This module is based on Google Books and gives users the ability to access the library of millions of books from Google servers. The layout is designed as a bookshelf and has the ability to search for books by the name, author or keyword. After finding the book, the user can read only the abstract (Fig. 21). The selected book can be read on a full page directly from Google servers to the user’s screen.
The last module developed in this platform is the videos section (Fig. 22). As mentioned before, this module uses the YouTube API by offering users the ability to have a diverse selection of videos. Unlike the Books section where users
can search and read a peculiar book, this module is designed in a different way. Videos are selected from different categories that elderly people might find interesting. This idea of presenting videos in selected categories helps elderly users enjoy different types of videos without complicating use. This menu is chosen based on elderly needs from the state of the art section and also from the real time data. ActivSeniorinSvedal AB\(^\text{30}\) brings to the project the experience of leading a senior citizens network.

![Figure 21. Video Interface Module](image)

### 8.3 Interaction

One of the focuses was to have an application that will help elderly people to be more socially engaged and simplify their work. Because this is considered as an important issue, we tried to work carefully on the design aspects and its interaction. No matter user’s experience, with this solution they should be in a position to access any information that is available through the platform with relative ease. Different types of information are treated with different treatments. The book section is shown as a bookshelf, which has the “look,” if not the feel of a library. In this way, seniors should learn the system quickly, and greater and better interaction with the portal will begin to occur. In other words, we are trying to humanize the experience by presenting their needs in a simpler format and mitigating the user’s frustration.

\(^{30}\)[http://www.aktivsenior.se/cm1v/default.asp](http://www.aktivsenior.se/cm1v/default.asp) Accessed on: 18.05.2013
To this end, we have given special attention to each step of using the portal. Besides visual design, which we consider to be beautiful, the interaction design builds a fluid workflow from page to page and from state to state. We managed each step, made four of the modules with similar steps, and ensured that each step is logically followed by another, e.g. after the login page, people can access the first main page of the portal. This logical flow adds credibility to the brand and increases users’ trust in the design.31

8.3.1 Supporting Multiple Screens

Another important issue is the screen size. This portal renders properly on each screen configuration by scaling the layout to fit the screen size/density. With this, we give the users the ability to choose the working environment: TV, PC, tablet or mobile. For the purpose of this thesis, we tried this portal on a PC (15.6-inch), Mobile (5.0 inch), Asus tablet (10 inch), and a Smart TV (32 inch), and it worked fine (Figs. 23&24&25) with no need for adjustments. Having in mind that older users may also have problems with pressing buttons on devices, such as with a television remote, we offer the possibility to use the same solution on a touch screen based device (e.g.: tablet). Touch screen technologies can be used to avoid this particular age-related limitation. As seen in the pictures below, the menu buttons are large enough for a finger to press accurately. Also the advantage of large icons is that they are (a) easier to see and (b) easier to select.

Figure 22. Desktop Screen Size

Figure 23. Mobile Screen Size (Left) and Tablet Screen Size (Right)

Figure 24. Smart TV Screen Size
8.3.2 Color Contrast by Senior citizens

As people age, their ability to discriminate between colors is negatively affected, especially in the less saturated colors of green, blue, or violet. Different users have different needs. Some want softer colors and others do not prefer them. Thus, we have offered a case different background colors for different modules on the portal. E.g., the news section by default has grey color, but based on user’s needs they can change the color to four different ones (Fig. 26), some grey with different shadow and other totally black. Also, as seen on Fig. 26, they can change the size of the letter to a bigger or smaller. With these functionalities, they can have the view that they want and feel more comfortable while using it.

8.3.3 Remote Control

The need for an alternative to the traditional TV remote control comes from the frequent problems older adults have in choosing which button to use for activating a certain feature. The solution considered here is using gestural interaction via a remote pointing control. For this, a Minix Neo Air Fly mouse with the keyboard is used. Users can control a mouse pointer by waving the remote.

![Figure 25. Minix Neo Air Fly Mouse With keyboard](http://ijy.cgpublisher.com/product/pub.187/prod.90 Accessed on: 18.07.2013)

This is a remote that was compatible with the device that we are using, and is designed in a way that simplifies the approach of interaction. It can be used with movement and do not have many of the unnecessary confusing buttons. It removes the need for having 2 remote controls, for interacting and for writing; because it has a build in keyboard for the part where text input is needed. With this remote elderly can watch TV themselves without requiring assistance. There is no need of remembering different buttons for different purposes and functionalities. Only waving the remote and pointing to the desired module gives to seniors what they want.

It helps seniors with memory issues or some other kinds of cognitive disabilities, to continue to be independent and interact with the TV. This remote has also a light that provides feedback that a button is pressed, so, that the user knows when a button has been pressed, either intentionally or unintentionally.

It allows for inaccurate pointing of the control, means that it sends a signal across a wide angle both horizontally and vertically, so, they can handle it as they feel more comfortable.

Nevertheless, there are some supplementary interaction characteristics. For example, users can do different things on the device without the need of Logging off. Another important issue is the possibility of sharing different pictures or videos with other peoples while communicating with hangout.

As a conclusion, we can see that not only the design but also how we interact with the device is important and can make portal’s acceptance easier.
9. ASSESSING THE RESULTS

Previously, we discussed the usability assessment and the reasons for this choice in the methodology part. In this section, we describe in details how we achieved up until here, our findings, and how we used the feedback.

Before utilizing the USE questionnaires, we did four scenarios that will be performed by them. Each of the users performed one or two of the scenarios in order to understand the application and see how it works. A basic explanation was given on how everything works, how can you access it, and what is provided. The environment for the usability assessment consisted of the TV, Minix Neo X5, remote control, and the camera. Each of the users had to perform two of the scenarios which, depending on the user took approximately 5-7 minutes to complete including the time for clarification if something was not clear. After the scenario, they had to fill out the USE questionnaire, which took between 40 and 45 minutes, including the answers and discussions as necessary during this time. Overall, this process took around 40-50 minutes per user.

Note: Taking into consideration that the testing is done in Macedonia, Kosovo, and Serbia, where the target group cannot read or speak English, more explanation was given until they understood each section. Also, since all the functionalities were in English, for the sake of testing, we made some changes on few of them, translating from English to Albanian, so they would be understandable and produce more useful results. We used the same procedure for each participant, by video-conference to read news, thus showing the interface and how it can function with the given remote.

Scenario 1
This scenario describes the possible use of a Smart TV as familiar device to be used to communicate with other family members. John gets the remote control, selects the picture, which describes communication, and searches for his son's name. He then clicks the name, and his video with sound is shown on the TV. He enjoys the talk.

Figure 26. One of the participants during scenarios and/or assessment

Scenario 2
The second scenario was about people that are more curious about gardening, hunting tips, and cooking tips, or separate exercises for those that have reduced their activities during the day. Thus, they have a part of this application, which gives different videos for each of the above sections.
They can access these videos by clicking on the picture that describes those sections, which make them easier to find and point with the remote. The participants should choose one of the available videos and watch it.

Figure 27. One of the participants during the scenarios and/or assessment

Scenario 3
John and his wife are worried, because they did not get a chance to go and get the newspaper. They are worried about the situation in their country and abroad. So, his wife takes the remote, turns on the TV and opens the news section where they can find up to date information with properly sized letters and easy-to-read colors. After they see that nothing terrible has happened, his wife starts to prepare dinner, and he continues to read the book he started two days before.

Scenario 4
John opens the books section and chooses the book that he has already started to read. He zooms in some parts of the book and zooms out when that is no longer necessary. In order to illustrate how the system reacts in this given scenario, we will illustrate with the diagram Scenario 4 (Figure 30). The system has similar interaction for other modules of the system.
Unlike the explanation above, here we will use more technical terminology to explain the steps.

Fig. 28. Sequence Diagram for the Book Section

Fig. 30, gives step-by-step instructions on how to select a book based on what criteria the search needs to be done and how it is connected with Google DB. Each of the books can be searched by author, title, or a specific keyword that describes the book. After communication with the DB, the user will get a list of books that fulfill the selected criteria. From the results, they can choose one book, read the abstract, and if interested, continue reading the book. The search for a new book is a loop, because all the steps are the same for each different search.

We observed while participants completed this task. If participants completed the scenario without assistance and produced the correct output, we directed them to the questionnaire. Otherwise, explanation was given and the problem was noted from us. Arnie Lund (2001) proposed the usefulness, satisfaction and ease of use (USE) questionnaire. As mentioned in the methodology part, it consists of 30 questions divided into four categories. Also, the questionnaires were translated into Albanian.

9.1 Method of Approaching Questionnaires

Subjects: The participants, 4 males and 6 females, were people ranging in age from 55 to 73 (in different places aging starts either from 55 or 60, as stated in the introduction part). They differed widely in their level of computer or other technology (excluding TV) experience. 30% had used a computer for communicating with family members, and 40% had experience with computers but only with the help of someone else. The rest had never used a PC or other device to communicate (excluding the telephone). All of them (100%) had used a TV in their everyday life to watch the news.
or movies, and some were even regular visitors of the Discovery Channel, which is mostly known for its documentaries. Only 2 of the participants had not completed primary studies (only 4 years), while the others had completed their primary studies, and 4 had accomplished university studies.

**Materials:** Participants were given printed questionnaires along with written and spoken instructions describing how to complete the questionnaire. When a question was not clear, additional explanation was given.

**Procedure:** The questionnaire distribution took place during our visits to the participants' homes. As we entered, we mounted the device that we would be using to their TVs and asked if they wanted to try to use it. All of them accepted, because I had informed them prior for the visit regarding my project and how they can “play” around. Meanwhile, we discussed that we would be trying to take notes based on their face expressions, body language, etc.

**Instruments:** The participants' TVs were used along with our remote control, which can be used much like a simple mouse for a computer, so participants could point to what they wanted by moving the remote. There was always one person from the project with them while they used these instruments. We connected our device, Minix Neo X5, on their TVs to enable the solution to run.

### 9.2 Analysis of the Result

#### 9.2.1 Usefulness

Usefulness was the first section of the questionnaire, consisting of 8 questions. Users tend to use or not use a tool according to whether they believe it meets their needs and will help them perform the task better. In this part, we aim to understand if using this portal enhanced users' performance.

The experience a user may receive from this portal depends on the usability, design, and content information. A large percentage of the survey participants (80%) agree (grade > 5) that this solution will help them to be more effective. This was due to the simplicity of the system and the adequate information offered.

Only a small percentage (20%) was not totally sure (voted with grade 3 and 4) if they were more efficient when using this application.

Regarding the next question, that of whether they are made more productive through using it, and the results were the same (80% agreed) that they were, probably due to participants connecting the two concepts. Different comments were given about the content of the portal. We were delighted to hear these comments, because we put a tremendous effort into finding out and selecting appropriate material in terms of seniors' needs and requirements.

However, 20% of users still wanted for us to include a section with information about different cities and their history instead of the video section. Those 2 users were asked about their opinions, and they did not like the video section because they are not interested in either hunting or gardening, so they said:

“*I find it more interesting knowing about different cities and countries. Knowing about hunting and gardening never was my passion.*”

This portal has to meet the requirements of a wide range of users in terms of usability. This is not a single, one-dimension property of the portal, but it is a contribution of different components and factors. It should be easy to learn to use, facilitate the ability to quickly accomplish a task, be easy for users to remember the steps, and lastly, should provide high levels of user satisfaction. Most of the participants (9 out of 10) stated that according to the above-mentioned parameters this portal fulfills their needs. One of the users was neutral; he said “I have most of my family members around me, so I contact with my family abroad when my son calls them.” We understood that the issue was
not that this portal was not useful generally, but that it was not useful for him personally because of the reasons that he stated.

When asked if this portal gives them more control over the activities of their lives, not all participants agree. But, some of them agreed that they will have more control and they can be sure they will fulfill their activities during the day. This was because they can read the news even if it is raining outside or they can talk with their families even if they are alone. Because everything was offered in one place, no external help was needed, providing greater control and independence. They can control what to read, what to watch, and with whom to talk. This portal was designed in a clean and simple way, so it can provide easy access to its various areas and functions. Multi-level or complicated menus were avoided by offering quick access to useful information on the home page. Most of the participants agreed with us about this, voting with 5-6 out of 7 on the question about whether they can accomplish things more easily. Not only that, but they also save time by using our device, according to the analysis. 70% voted with 6 and 30% with 5.

“Getting things done easier- saves time” said one of the participants.

Regarding needs and expectations, our participants supported the portal by agreeing that they were satisfied with the service and that it fulfilled most of their needs, like talking with family or friends, reading books and the news, being updated on their passions like cooking, gardening etc.

Table 9. Summary Graph of the Questionnaire for the First Phase –Usefulness
9.2.2 Ease of Use

Additionally, part of the questionnaire is about Ease of Use. This section consisted of 11 questions. The first question to be answered was “for whom should it be easy to use”? With our target group, the elderly, it was a bit challenging. Simplicity, clarity and some other parameters were used as measures of ease of use. Usability alone is not enough. It should be easy or pleasant to use as well.

Regarding navigation within the portal, it appears that most of the participants (80%) were satisfied with its contemporary status. This significantly high percentage is indicative of the ease of navigation with the portal. Since most of the participants were inexperienced with the portal usability or the internet in general, we tried to keep it as simple as possible.

Even though the majority of the content is intended to be used by this target group, a statistically insignificant percentage (10%=1 participant) thought he/she would not use all of them. The main reason for his/her lack of interest in all the functionalities was his/her family distribution. All of his/her close family, such as children, brothers, or sisters, lived in the same city as him/her. Based on participants' education level, we are satisfied with the result. This satisfaction is because even people that had only 4-8 years of primary education managed to successfully complete most of the scenarios given.

While performing the scenarios, a sizable majority of participants (9 out of 10) said that they could recover from mistakes quickly and easily, and they could succeed most of the time while performing a task. 5 of the participants said that they could use it without written instructions or explanation, because of the pictures that represent each of the modules.

Since video and voice are involved, feeling is extant on this portal. It gives the user the feeling that they are part of a community by encouraging them to contribute to activities without feeling lost or isolated. All of them were confident while using it, and on the question of whether both occasional and regular users will use it, a significant percentage (90%) were positive that they would and agreed that it was easy to use and fulfilled their needs.
9.2.3 Ease of Learning

The third phase of the questionnaire was ease of learning. It consisted of 4 questions. Ease of Use and Ease of Learning are two different things. Some things can be much easier to learn or much easier to use (i.e., more productive). They are not entirely the same, but ease of use can certainly facilitate ease of learning.

No small amount of effort was put into the simplicity of design and use through providing a user-friendly environment that would help users find the information they need. As a result, portal users did not face any difficulties in learning how to operate the system, because the portal requires the only slightest input from the users. Most of the portal users were left with a good impression about their interactivity with the portal. Learning steps and remembering them apparently was not seen as difficult.
9.2.4 Satisfaction

The remaining information from the participants was about satisfaction. Satisfaction's meaning can be found or said to be many different measures and definitions, but our purpose was to understand if our product meets or surpasses users' expectations. It is an important and powerful point to complete the portal. This part consisted of 7 questions.

Whether or not participants are satisfied with the product varied based on different factors, such as easiness of use, easiness to learn, and others. The results showed that the majority of the users were satisfied on different levels and some of them were not 100% sure because of some minor changes that would make them more satisfied. Those changes were mostly about the color, and a few of them were about the guidance, which could be improved, for example, by having video beforehand to show the steps of how to use it. Users with the need to communicate with their families abroad feel the need to have it, and the feeling while using it was described as wonderful, because they could talk and see each other without any help from someone else. One of participants even said that he has to get a bigger screen once this solution becomes available. In the end, we were glad to hear they fully agree that it should be recommended to friends and family.
Table 12. Summary Graph of the Questionnaire for the Fourth Phase – Satisfaction
9.3 Findings

The first thing that we noticed was that the results were different for users with close family members abroad and those that live with someone. Before starting with the scenario and questionnaire, we had a brief conversation about whether the participant had family and other friends that communicate, and if yes, how often during a week.

![Communication during the week](image)

**Table 13. How Many Times Participants Communicate With Their Family or Friends during the Week**

From the table above, we can see that users communicate an average of 1.75 times, which means once or twice per week. And with our application we expect growth to 2.75 or 3.75. This assumption is based on three of the participants that had the application at their houses for 1 week (Table 14). These three participants were number 2, 3 and 8 from table 13. They started to talk more often with their close ones, e.g., participants that had contact 2 times per week without the solution increased the level of communication to 4-5 times during the week.

![Graph of the Communication of Three Participants with (Red) and Without the Solution (Green)](image)

**Table 14. Graph of the Communication of Three Participants with (Red) and Without the Solution (Green)**

The aim of the questionnaires and other experiments done (e.g., giving the tools for one week or discussions with participants) was to help us to analyze and see the portal from the user's point of view.
The questionnaires used covered a wide range of aspects, from the appearance to ease of use and learning and many other characteristics that were important for the offered solution.

More than 80-90% of participants found this solution useful, easy to use, and easy to navigate. Satisfaction and ease of learning received more positive grades. A major part of this success was the simplicity offered in the steps that the user should take to execute a task. For example, to read a book, users have to open the app and click on the book section. In addition, we made some trivial changes to the interface of the application. The first remark was about the background color of the application. The original prototype had a gray colored background as seen in Fig. 31, which not very light, so participants had a hard time reading some parts of the content. Some of the participants emphasized that they sometimes want to read with lights off, and the color we had used makes it hard to read and fatigued the eyes under those circumstances. We therefore changed the color from gray to WhiteSmoke which was lighter and made for easier reading of text from far.

![Figure 29. The First Version of the Background Color](image)

<table>
<thead>
<tr>
<th>WhiteSmoke</th>
<th>#F5F5F5</th>
</tr>
</thead>
</table>

![Figure 30. The Second Version of the Background Color](image)

An additional important remark was about the size of the text. We researched and discovered that the size of the letter should be higher than or equal to 14 pt. (Willis et al., 2010), so we made the text in some sections 14 pt. And in other sections 16 or 18 pt. Participants told us that they were confused, because they thought that 18 pt. font letters were an indication of something serious or needing special notice, like a warning. Since this was not our intention, we changed everything back to 14 pt. Senior citizens favored the things that were static or the same size, because they became distracted when a change occurred. They said when they opened the page, the thing that immediately captured their attention was the paragraph with the largest letter size. Changing everything to 14 made reading easier and helped avoid distraction.

Besides the negative remarks, we also were given some that were positive, e.g., about the news and books parts where users can change the color or the size of the letters as well as the background color (Fig. 33). Additionally, seniors suggested that some parts of the text (type: italic) should be zoomed in.

![Figure 31. Background Color Default (Right) and changed (Left)](image)

The final change was made to the Youtube module. During the discussion, we noticed that participants were confused by one of the figures that we used in the cooking section (Fig. 34) and thought that this part was about different fruits,
and one participant thought it was about ingredients rather than cooking. This was because the picture that we used had no people in it, only food items. Thus, it was mistaken as a reference to or symbol for something else. Changing the image to one of people who are cooking made everything more understandable.

Figure 32. Picture Chosen to Represent the Cooking Section, Before (Left) and After (Right)

The vast majority of the responses showed that users were highly satisfied with their experience with various aspects of this solution. However, all this feedback was used as a guide for the ultimate implementation that will lead in high-quality service and educational resources, as well support the research question stated in the beginning.
10. CONCLUSION

10.1 Discussion

The original plan for the participants for this project were senior citizens from Sweden. Because of the time frame and conditions under which this thesis was developed, we changed our location and chose participants from Macedonia, Kosovo and Serbia. During the discussions, we noticed that the majority of seniors in this area have never or barely used computer during their lifetime either at home or at work, especially in comparison to other European countries, like Sweden, where computers are seen as a primary resource for different jobs and positions. Perhaps this limitation affected our results about the acceptance of the portal. Clearly, we needed time while senior citizens from this area became familiarized with the solution.

Another issue was with the sample that we used. Only 10 participants were willing to test the application, and only 3 of them had the chance to have it in their houses for 1 week. This was due to the tools that we had available, only one Minix and one camera, and also due to the number of senior citizens existing in my circle.

As mentioned in the beginning, this study was tested in Macedonia, Kosovo and Serbia. We think that the result may change in other European Countries due to their possibility to work with computers or other technologies in early age, when in Balkans PC was not available. Therefore, we encourage studying the impact that such solution would have in countries with a more extensive history in use of technology.

Although we had technical issues, they were solved during this time. The original idea of building a smart system and something that would fulfill senior citizens' needs as something easy to use and well known for them, so we researched the services, working environment, and many different things that we needed to offer that are already mentioned in the previous chapters.

One of the services that we saw as essential was Hangout, provided by Google+. This was chosen as the only service that can be used by up to 10-15 users at the same time from devices like mobiles, TV boxes, etc.

When we started the implementation, Hangout was provided only as part of Google+ (beginning of the year 2013), so, we could not use it as a single application. We concluded that Hangout could not start from a browser (in mobile) as it was for desktop.

Thus, we made some changes with the device. We changed it from the Android to the Linux operating system. Because until then, there was no solution online for this problem, we had to create one from scratch. We began by making MINIX work with Linux without the GNOME interface or internet. The next step was to install Xubuntu and the GNOME interface, which also helped us easily configure the internet connection. We decided to make it with Linux because Google had released the official plugins only for Linux OS. Nonetheless, after everything was completed, we checked if Hangout worked, but the result was the same as with Android, so we made detailed analyses and arrived at an unanticipated result. The Google restrictions were for users that use ARM architecture (e.g., in mobile devices). Therefore, this service could not be used on the browser, because it would be redirected to the Play Store to download the application. So, we continued to work on our application as a web application until we found a suitable solution.

Luckily, after some months Google released the ‘new’ Hangout (May-June 2013), which means they introduced it as a stand-alone service. It gave us some hope that we might have been able use this service, but the restriction with the usage of Hangout on a browser on ARM architecture remained.

33 https://www.google.com/tools/dlpage/hangoutplugin
Nevertheless, we did more research and we found that another solution exists which can be considered more elastic because of the advantages it offers. It combines web and native apps’ features. In other words, the solution was to use a hybrid app. So, we used three of the modules (Books, YouTube and News) as web apps and Hangout as a hybrid app. We open Hangout as a native app, calling from a device on which Hangout was previously downloaded.

With new technologies and solutions like WebRTC, it will be easier to use Hangout or similar apps, because it will eliminate the plug-in part. Therefore, after figuring out this solution, additional study needed to be done to simplify the development.

10.2 Research Ethics and Societal Impact

While developing and testing this solution, we had to deal with a wide range of ethical issues, since this research inevitably deals with and affects people. Before starting the survey, we talked to them and explained about the nature and the purpose of the survey, why I am doing this topic and how much of their time would be required in answering it.

All of the participation was purely voluntary; none of the participants were forced to take part. As a matter of confidentiality, care was taken to ensure that data sets or the results of the study would not allow individuals to be identified.

None of the sampling frames will be passed to third parties, including other researchers, without the consent of survey participants.

All pictures taken and used for documentation have participants' faces blurred, so no participant can be identified by readers.

Participants had the freedom to openly declare their goals and intentions, as well as to answer as they pleased and to comment. They had the right to stop answering or participating any time if they did not feel comfortable.

We provided for them an environment where they could feel safe and comfortable.

10.3 Conclusion

Improving the social engagement of senior citizens has increasingly been the concern of different research groups and companies in recent years. New trends in Smart TV technology have opened new possibilities to provide better ways of interaction and engagement. The system in this thesis is developed with senior citizens in mind and for senior citizens. We provided them with services that fulfill their needs in their everyday life. Based on the assessments, the senior acceptance rate was high due to the user-friendly interface, appropriate content, the easy way of interacting, and the easy to use environment.

The reflection upon the potential development of television technology as a medium for social interaction in senior housing communities raise issues (Svensson et al., 2008) that we believe may this long standing concern with the social and technical in human-computer interaction and system design. In summary, we believe our contributions are twofold.

First, we made a literature survey based on rules and standards to find the existing solutions on the market and their limitations and disadvantages. We studied those solutions to find the gaps. The state of the art section can be used as part of a research foundation for studies in the same academic field or area as well.
Second, based on our findings, we built a solution designed for TVs to make them ‘smart’ that can also be used on different devices with different screen sizes and carried out an assessment which details the users’ experiences and their feelings regarding the system etc.

This assessment presents strong evidence that there are possible ways to combine different media devices and use them as assistive devices to help senior citizens. We have made a summary of our literature review: “Among the enormous variety of devices, TVs are the most suitable for the senior citizens. Senior citizens can use these devices without any written instructions. They can use them easily as they are effortless to learn. They want services that can be navigated with remote and that give them the feeling that they control the technology.”

Even though we found answers for our first research question, we wanted to make sure we could use this data and build a prototype. Afterward, we subjected this prototype to a usability assessment to check if it provided the expected or other benefits. The evaluation results suggest that various aspects of the portal prototype meet the needs of a senior citizen in terms of interaction design and social engagement. Furthermore, participants were eager to see more from this solution as they found it useful and that it improved their social engagement.

Now regarding the summary of the thesis: this system consists of four major services: video communication, book reading, news information, and different recreation videos (e.g., tips about exercise, hunting, cooking or gardening. As mentioned in the methodology part, using the stated rules gave us different knowledge on existing technologies, their approaches, and the requirements covered through by solutions. This helped us in building our own table of requirements and research questions which our system was focused during all the phases of the research. The usability assessment was important to verify the usefulness and ease of use of the system.

On a general level, the conceptual design, development, and evaluation of the portal prototype have shown that the majority of senior citizens enjoy using it. Furthermore, the evaluation results suggest that various aspects of the portal prototype meet the needs of a senior citizen in terms of interaction design and social engagement. While looking at the platform design and its modules which are built to fulfill specific needs of senior citizens and the behavior of this category of people, when they come in contact with this platform, it is clearly understood that these types of services can indeed be very assistive for their daily activities. Giving them access to these types of devices/platforms can be very advantageous, because they can lead to better social engagement and e-participation. While seniors might find it interesting and attractive to use these services, their engagement in social meetings, games, talks etc. can also grow in such a way that it may help us find new ways to use this platform and develop new modules.

Based on the results described within this paper, we can also conclude that in the future, study and development should be done in order to make the portal customizable. Senior citizens then could be the ones that decide about the services, content and where to use it according to personal needs rather than just those of a broader grouping. We had cases that participants wanted something else instead of videos about hunting or gardening.

It is important to keep in mind that future generations of senior citizens will be familiar with different technologies, due to generational differences. Thus, the considerations regarding the design and functionalities used within this paper are certainly valid for a vast majority of today’s senior citizens.

Nevertheless, the importance of this research was also that the solution is provided with a technology, which is easy set-up, reduces access barriers, and is a relief for family members. Finally, all the advantages of having an assistive device for better social engagement and e-participation may encourage family members to enrich the lives of their parents, grandparents by introducing suitable service for their daily live activities.

Since the system is based on HTML5 and native app, maybe in the future we can consider to develop this solution with minor changes for mobile devices. They are more ubiquitous and have a large deployment in nowadays market, which will also give us the possibility to extend to different scenarios.
As a conclusion, we can say using a Smart TV to enable social engagement for senior citizens is promising when they, their behavior, and their needs are well analyzed. In future different services, possibility of customization and interaction should be considered.
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# 12 Appendix

Results of USE Questionnaires for all participants

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<thead>
<tr>
<th>USEFULNESS</th>
<th>Participant 1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>It helps me be more effective</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>6</td>
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<td>4</td>
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<tr>
<td>It helps me be more productive</td>
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<td>4</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>6</td>
<td>6</td>
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<td>5</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>5</td>
<td></td>
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<tr>
<td>It gives me more control over the activities in my life</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>4</td>
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<td>5</td>
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<td>6</td>
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<tr>
<td>It makes the things I want to accomplish easier to get done</td>
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<td>6</td>
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<tr>
<td>It saves me time when I use it</td>
<td>5</td>
<td>6</td>
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<td>6</td>
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<td>It meets my needs</td>
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<td>7</td>
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<td>It does everything I would expect it to do</td>
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<tr>
<td>EASE OF USE</td>
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<tr>
<td>It is easy to use</td>
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<tr>
<td>It is user friendly</td>
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<tr>
<td>It requires the fewest steps possible to accomplish what I want to do with it</td>
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<td>6</td>
<td>5</td>
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</tr>
<tr>
<td>It is flexible</td>
<td>NA</td>
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<td>4</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>NA</td>
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<tr>
<td>Using it is effortless</td>
<td>7</td>
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<td>6</td>
<td>7</td>
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<td>5</td>
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<tr>
<td>I can use it without written instructions</td>
<td>6</td>
<td>7</td>
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<td>Both occasional and regular users would like it</td>
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<td>I can recover from mistakes quickly and easily</td>
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<tr>
<td>I can use it successfully every time</td>
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<td>Ease of Learning</td>
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<td>3</td>
<td>4</td>
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<tr>
<td>I learned to use it quickly</td>
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<tr>
<td>I easily remember how to use it</td>
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<td>It is easy to learn to use it</td>
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<tr>
<td>I quickly became skillful with it</td>
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<tbody>
<tr>
<td>I am satisfied with it</td>
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<tr>
<td>I would recommend it to a friend</td>
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<td>It is fun to use</td>
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<tr>
<td>It works the way I want it to work</td>
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<td>It is wonderful</td>
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<td>I feel I need to have it</td>
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<td>It is pleasant to use</td>
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Sequence Diagram for searching books
Native vs Hybrid vs Web

- Approval Process
  - Native: Variable
  - Hybrid: Low Overhead
  - Web: None
- App Store
  - Native: Available
  - Hybrid: Available
  - Web: Not
- Development cost
  - Native: Expensive
  - Hybrid: Reasonable
  - Web: Fast
- Speed
  - Native: Very Fast
  - Hybrid: Not necessary
  - Web: Fast
- Device Access
  - Native: Full
  - Hybrid: Full
  - Web: Partial

Native | Hybrid | Web