Perspective-Based Usability Inspection for Active Aging in Place Websites

Adriana Alexandru, Marilena Ianculescu, Maria Gheorghe-Moisii

National Institute for Research and Development in Informatics - ICI Bucharest

Bd. Maresal Averescu, nr.8-10, Bucharest, Romania
{manina, adriana, moise}@ici.ro

ABSTRACT

The effects of the ongoing and increasing aging population on the social and economic life have imposed a shift towards creating new ways to adapt the society. Elderly have become a group of people with enhanced demands and necessities. In order to release the financial burden on the health and social systems, an age-friendly approach of designing and implementing better adapted digital technology is a sustainable support for an active and independent life in the personal residence, namely aging in place. The user interface is a key element for making a web application suitable and accepted by elderly. Perspective-based technique for usability inspection is particularly beneficially for identifying these types of problems by ability of diverse typology of evaluators. This paper presents two case studies of websites for aging in place; the websites' usability is anylised with the above technique. The envisioned further improvement and development based on Big Data Analytics of the two websites should be done taking into consideration the recommendations based on the highlighted age-related general usability problems.

Author Keywords

User interface; elderly; Big Data; aging in place; usability

ACM Classification Keywords

H5.2; H-3.5; J3.

INTRODUCTION

The world's population is getting older due to the lower birth rates and longer and healthier lives. The aging population is the biggest consumer of the resources of longterm care, health, and social systems. Avoiding premature and unnecessary institutionalisation can relieve the financial burden and put forward a better and dignified life of an elderly and his/her family.

Aging in place has been defined as "the ability to live in one's own home and community safely, independently, and comfortably, regardless of age, income, or ability level" [4].

Aging in place implies the use of a large variety of smart devices such as embedded in-home and wearable sensors, assistive technology able to sustain the preservation of an active life on longterm and web applications aiming to support the management of chronic health conditions.

Due to the degenerative diseases, elderly undergo an increased number of challenges when they use a web application. Furthermore, even among the particular area of the elderly group, users have distinctive degrees of analytical competence, health and information and communications technology (ICT) literacy; therefore they can process and interpolate the same health information in a different manner. The user interface should be age-friendly to suit larger categories of users with degenerative problems or ICT skills.

Usability testing plays an essential role in implementing web applications that target the aging population. Identifying the issues that might restrain the acceptance and use of digital technologies by the elderly (even from early stages of software development) has demonstrated to be efficient and able to maximize the necessary adaptations to the older people's demands.

There late guidelines specifically applied to the design of web applications for elderly actively adjust and enlarge the user's accessibility and know-how [14].

Among the usability testing methods, the *perspective-based inspection* can provide a better approach for an elderly-centered evaluation of the web applications.

Big Data has rapidly imposed in healthcare due to the way it has revolutionized the exploitation of the massive stores of data and knowledge. That proved to be of a great importance, since in 2012 the Poneman Institute estimated that 30% of all the electronic data storage in the world was occupied by the healthcare industry [12]. Regarding the aging in place, Big Data has the potential to sustain it by an enlarged healthcare infrastructure that supports the healthcare specialists and providers to identify, handle, analyze, and exploit huge amounts of data in order to provide a better personalized degenerative diseases management.

This paper aims to use the results of usability inspections of two websites that address issues related to aging in place domain and which are presented in two *case studies*. Different types of inspectors have been chosen as the source of different perspectives, including the ones of the elderly. The results of this approach led to the statement of some recommendations for further development of the web applications and for a better design of new eHealth solutions targeting the aging in place.

AGING POPULATION AND DESIGNING APPROPRIATE USER INTERFACES

The personal residence is an environment where the elderly should feel safe, active, efficient and independent. Adapting and shaping the web applications into something familiar should be a well-defined goal in designing the interfaces. Their design should be based on affective, aged and home associated values and on appropriated standars like ISO/IEC Guide 71 that "has successfully addressed the importance of being aware of the needs of older persons and persons with disabilities" [9].

Social Aspects of Aging Population

The increasing aging of the population has revealed a specific and difficult relationship with digital technology, often leading to various fears such as the elderly-specific *technophobia* which represents the main obstacle to the efficient use of ICT. The aging process involves factors such as health, socio-economic, psychosocial that might have an important influence on the senior and his family.

Health factors: The natural aging process comes with continuous degenerative disorders like hearing, vision, perceptual, cognitive and sensory impairments, which often make difficult the use of digital technology. For instance, texts may become difficult to be read, pictures difficult to be interpreted, cognitive problems can cause difficulties of understanding, or mobility constraints can limit the accessibility to ICT.

Socio-economic factors: Socio-economics factors are very important in terms of the quality of elderly's life. The aging generations have slower adapted to the enhanced presence of digital technology, with increased vulnerabilities as consequence.

Technologies that encourage a successful aging in place have the potential to bring major benefits and reduce the social and health costs. It is therefore necessary to reconsider older people as a class of relevant users and provide them appropriate technology as a real support for physical independence, a dignified and integrated life in society.

Psychosocial factors: Throughout the process of aging, the man's personality is changing, reflecting the ability of the psyche to withstand the life's challenges. Some events may precipitate psychological aging: retirement, children's departure, the partner's death, and adaptation to the new life might have major psychological implications. Seniors that continue to live at home have minor depression compared to the institutionalized ones.

Particularities of Designing User Interfaces for Aging people

Designing web applications adapted to aging population implies taking into consideration some key principles. The most relevant ones are presented as follows:

Principle 1: Personalized perceptible information

An increased degree of acceptability of web applications cannot be achieved without an aging user-centered process. The interface must effectively communicate the information to the users, regardless his/her physical and cognitive skills. Representation of essential information must be provided under different modes (visual, verbal, tactile). Compatibility between the elderly with a diversity of impairments and digital technology people requires a special attention.

Principle 2: Multidisciplinary teams for development

The development process of an aging-friendly web application should be performed by effective multidisciplinary teams [9]. The analysis, design and implementing activity must imply ICT specialists, psychologists, sociologists, usability experts, and elderly users.

Principle 3: User-centered equability use

The focus on the user, the targets of the activity, the work domain, the context of use, the user's goals, tasks and needs should guide the development of a web application [7]. Designers should understand the context in which it will be used, including the particularities of the end users and the way in which they interact with the information. Thus, the usage aspects will be centered on the aging user from the early stages of development.

Principle 4: Reliability, accessibility and flexibility

The development of the aging-friendly web application should be both iterative and incremental [7]. It is necessary to consider the user's specific needs and allow him to choose among different methods of accessing the interface and the context of use, depending on his/her knowledge, perception and adaptability degree.

Principle 5: Elderly participation in the design process

Representative elderly users should actively, early and continuously participate throughout the entire development process and throughout the system lifecycle [7, 9, 13].

Principle 6: Simple, intuitive design

The design of the user interface must be done so it could be easily understood by end users and all other stakeholders [11]. The using of the interface must be easy to understand, regardless of the elderly user experience, knowledge, and cognitive skills. Ensuring compliance with user expectations and abilities must be achieved taking into consideration the particular elderly capabilities.

Principle 7: Anticipating user needs

Aging people being the target users, the design team should take into account all the aspects that may occur in the context of future use, including the continuous diminishing of vision, hearing, cognitive, and motor abilities.

A Perspective-based Technique for Usability Inspection

Usability inspection has proved to be a major support for improving the quality of the software applications, even during the development stage. In usability inspection methods, specialists examine usability-related aspects of a system interface by using their experience and knowledge

of usability standards [1]. The most used methods are the following:

- *Heuristic evaluation* - specialists in usability evaluate the interface as concerns the way it follows usability heuristics [8].
- *Cognitive walkthrough* - task-oriented method involving the analysis of an interface by an analyst who goes through its functionalities, simulating step-by-step user behaviour for agreed-upon tasks [8].
- *Feature inspection* - inspectors are given use cases and end results and they test each feature for its availability, understandability and other usability features [6].
- *Pluralistic walkthrough* - a version of cognitive walkthrough which involves not only experts, but also users and software developers, in going through the system and discussing about the dialogue elements [15].
- *Perspective-based inspection:* divides the large variety of usability issues along different perspectives and focuses each inspection session on one perspective [18].

The perspective-based inspection aims:

- "To devise a usability inspection technique by inspecting from one particular perspective at a time.
- To understand the feasibility, effectiveness, and scope of perspective-based usability inspection" [5]

CASE STUDIES

The objective of the present case studies was to evaluate the usability of two websites addressing aging in place by taking into consideration the degenerative problems of an elderly user. Another target was to identify the perspectives of improving the websites with the help of Big Data.

Aging in Place Website

Aging in Place is an American website that provides resources and support for an appropriate daily living and home-remodelling in order to ensure a safe and independent life for a getting older person. (see Figure 1) [http://aginginplace.com/]

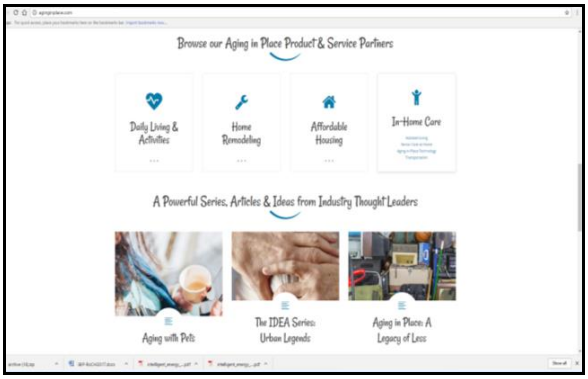

Figure 1: *Aging in Place* website

Ana Aslan International Foundation Website

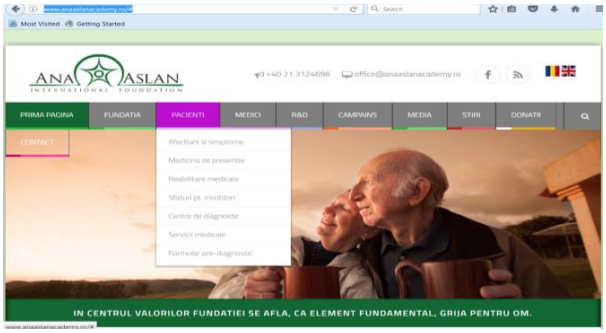

Figure 2: *Ana Aslan International Foundation* website

Ana Aslan International Foundation is a Romanian organization aiming "to integrate scientific progress into the original concept of 3P Medicine - Preventive, Predictive and Personalized medicine -, thus offering patients, medical and scientific bodies, instruments with which to make out of the Medicine of Aging". The foundation website presents products and services designed to promote longevity, prevent pathological cerebral aging and to facilitate a viable aging in place. (see Figure 2) [http://www.anaaslanacademy.ro/#]

Procedure

Perspective-based usability inspection of the websites took place independently, the inspectors being asked to perform specific tasks and qualitative analyses by adopting different perspectives.

1. Aging related perspectives have been defined, taking into consideration the common objective of the two websites, namely providing support for a successful aging in place.

2. The inspectors have received updated information about elderly user experience issues and usability inspection.

3. Specific evaluation tasks and criteria have been defined.

4. The results of the independent inspections have been discussed and prioritized.

Usability inspection completion

At the beginning of the usability inspection process, the specific tasks and two papers with examples of perspective-based usability inspection (as references) have been provided to the selected inspectors (see Table 1).

No.	Task
1	Getting information about aging-in-place
2	Getting information about technology for aging-in-place
3	Obtaining information from specialists

Table 1: The evaluation tasks

In this study, 5 inspectors examined independently the two websites and reported the usability problems found in each one for each task:

1. *Expert in application inspector* – testing issues of efficiency or aspects of the website to support the user.

2. *Inspector with disabilities* – three elderly persons with specific disabilities and noting where the product is not accessible.

3. *Psychologist inspector* – looking for violations of psychological principles related to memory, learning, attention, fatigue, etc.

In Table 2 are presented 10 usability factors considered in the QUIM (Quality in Use Integrated Map) consolidated model for usability measurement [19], as well as an 11th factor – *acceptability* - that introduces new criteria specifically for the elderly population: safety, discretion, dependability, non-obtrusiveness, appropriateness, understandability, and trustworthiness [8]. Taking into consideration these criteria, for each usability problem detected in the websites, each inspector recorded information concerning: context, cause, suggestions for improvement, and severity (*severe* – failure to accomplish the task goal, *moderate* – with important impact on task execution but passable and *minor* – with not important impact on task goal).

Usability inspection results

The collaborative inspection of usability conducted to a total of 40 usability problems for both websites. Each of the problems detected by the inspectors has been analyzed in order to agree on the severity. The usability evaluation results are presented in Table 3.

Relationship between Factors and Criteria (sub-categories)											
	Factors										
Criteria	Efficiency	Effectiveness	Satisfaction	Productivity	Learnability	Safety	Trustfulness	Accessibility	Universality	Usefulness	Acceptability
Likeability			+								+
Controllability							+	+	+	+	+
Simplicity					+			+	+		+
Privacy							+		+	+	+
Security						+	+				+
Familiarity					+		+				+
…											
Safety											+
Discretion											+
Dependability											+
Non-obtrusiveness											+
Appropriateness											+
Understandability											+
Trustworthiness											+

Table 2: The set of perspective usability inspection criteria

Task	Aging in place website				Ana Aslan Foundation website			
	Total	Severe	Moderate	Minor	Total	Severe	Moderate	Minor
1	14	5	8	1	11	4	5	2
2	4	1	3	-	4	1	3	-
3	3	2	1	-	4	3	1	-
Total	21	8	12	1	19	8	9	2

Table 3: Usability problems per task and severity

Two of the severe problems are related to the lack of specific visual and audio accessibility characteristics for elderly people (e.g. fix dimension of characters in the texts) in both websites and the third is related to Errors management issues in *Ana Aslan Foundation* website (pages under construction).

Most of the moderate problems are related to:

- Difficulties in accepting the information related to aging in place for *Ana Aslan Foundation* website (unstructured and insufficient information).
- Insufficient available information in *Ana Aslan Foundation* website that affects the website usefulness.
- Absence of searching facilities for finding information in *Aging in place* website, even if, in general, elderly users preferred to navigate the website by browsing rather than searching.
- Limitation of obtaining information from specialists for *Ana Aslan Foundation* website, a discussion forum not being included.
- Provision of indications not personalized for the elderly / caregiver and lack of downloadable forms for recording information in both websites.
- Poor clarity of menus, insufficiently structured web pages, lack of consistency of presentatiion for different pages, all these leading to the reduction of the efficiency of use in both websites.
- The absence of a "Help" button in both websites.

The perspective-based inspection of usability proved to be useful for training the inspectors that are not experts in the application domain, the detection rate of usability problems being higher for them.

ISSUES FOR FURTHER DEVELOPMENT OF AGING IN PLACE WEB APPLICATIONS

Opportunities brought by Big Data

The last advances in ageing-in-place are focused on incorporating software programs and monitoring device into senior homes, which will help them to increase well-being, provide additional safety nets, and identify any behavioral abnormalities that might indicate a problem [3]. As part of aging in place, a more efficient long-term care is based on the progresses in ICT aimed at developing home monitoring devices and software that allows seniors to live more independently and provides the opportunity of online medical diagnostics, and interventions. Such examples are wearable devices for continuously monitoring senior physical activities and tracking vital signs allowing patients to receive real time help in case of any abnormalities detected in their information, low-cost laptop computers with sensors to read vital signs, and sending data and images to physicians at other locations, integrated platforms for providing inclusive health services to older people, use

of mobile phones and Internet as elements for rehabilitation, education, mentoring, goal-setting, personal feedback, and counseling [2].

All these new devices that can connect elderly people to friends, family, and caregivers without requiring constant, in-person supervision generate a huge amount of information, structured or unstructured. That is why, Big Data is used to facilitate aging in place and one should promote systematic data gathering and analysis in order to provide support to seniors across the continuum of care. Aging in place is a comprehensive domain including public health, medical treatment, nursing care, and welfare work (Figure 3).

The use of Big Data in a collaborative system also brings challenges in terms of information sharing, standardized data gathering, and security of personal information [16].

User Interfaces (UI) help presenting complex Big Data in a visually appealing manner to users. Thus, it has become an integral part of Big Data. "This ubiquitous use of UI among all sections of users has added to its worth as an important player in the big data revolution" [10].

Ana Aslan Foundation website creates a bridge to the inclusion of Big Data due to the embedded medical forms suitable for further development and broader access to health systems based on Big Data Analytics.

General Recommendations

Although the two presented websites are focused on elderly's health related problems, distinctive functionalities, provided resources and approach make the difference in terms of implementing a practical support for the empowerment of the seniors that chose to age in place.

Thus, *Aging in place* website mainly presents informative resources, while *Ana Aslan Foundation* website also brings forward a pre-diagnostic evaluation form which, together with the several under-deployment functions, represent a step towards developing an interactive ehealth solution.

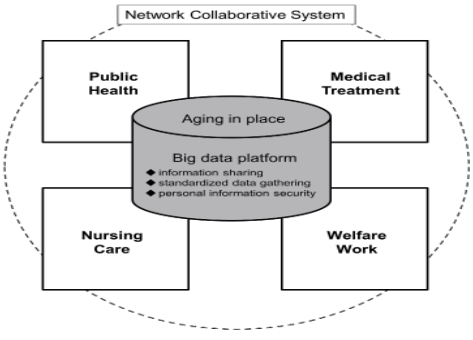

Figure 3: Use of Big Data in a network collaborative system for ageing in place [16]

In the same time, there are some common usability challenges that have to be taken into consideration to better meet the specific necessities and demands of an older user.

Also considering the guidelines specified by Nielsen Norman Group in 2013, in the second edition of "Senior Citizens (Ages 65 and Older) on the Web" [14], some recommendations can be drawn for making the two websites more accessible and engaging for elderly:

- Navigation controls should be avoided for the elderly. Especially seniors with cognitive and motor dysfunctionalities might have difficulties to elaborate mental models of the structure of the websites.
- Homepages, a permanent and visible home button on the screen in both layout and content areas should be very accessible and distinctive.
- The use of the keyboard has to be diminished and, if possible, replaced by a virtual keyboard adapted to the type of content.
- The text and style should be adapted to the visual impairment.
- The terminology used in the user interface should be appropriate and familiar to the one of the elderly.
- The search function should have a design and usage that facilitate a quick and simple finding of information.
- The content should help the seniors to process information and to enhance the understanding of it.

Because aging in place implies the use of digital technology (like Internet of Things) that generate massive amount of health data, Big Data Analytics can properly address the challenge to aggregate and integrate it. This is the reason for the necessity of further development of web applications like the two discussed in this paper with integrated models based on Big Data. Moreover, the health data regarding a senior which are collected from residential homes should be in real-time correlated with the personal ones from the National Integrated Health Information System for a quick and appropriate action in case of an emergency.

For a faster adaptation to the increased ageing of the population, a roadmap with critical information for the development and implementation of best practices, solutions and future directions of eHealth domain in Romania, enlarged with guidelines stipulating design principles for providing appropriate digital services for elderly represents a practical support for an active aging in place.

CONCLUSION

The global aging at a growing rate, the enhanced everyday presence of ICT and the increased seniors' technology acceptance and expertise have imposed to reconsider seniors as a class of relevant users that are looking for digital technology able to provide a real support for a dignified and active life in a personal environment. That is

why there is a need to use age-related aspects in designing interfaces based on familiar patterns specific to seniors' degree of understanding and acceptance.

Usability testing should allow the ICT specialists to better meet the requirements of the elderly.

Big Data support aging in place by allowing access to huge amounts of health data and analytical results and by creating a framework for implementing pro-active health and social models.

The results of the presented case studies and the general recommendations can be used both for designing new aging-related websites and for a future development of the two ongoing websites.

Addressing the age-related challenges can bring extended possibilities to better engage elderly with web applications that can support them to improve the management of their health condition and the quality of an independent and active life, namely for a successful aging in place.

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