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INVOLVING OLDER PEOPLE IN THE DESIGN OF AN INNOVATIVE TECHNOLOGICAL SYSTEM PROMOTING ACTIVE AGING: THE SAAPHO PROJECT

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***Abstract*:** Active Ageing refers to the optimization process in health, social engagement, and security opportunities as people age. The demand to introduce technology to improve older people's quality of life is progressively increasing. The objective of the SAAPHO project is to support Active Aging by assisting older people to participate in society, preserving their independence and dignity through the application of innovative Information and Communication Technologies (ICT)-based solutions. SAAPHO creates a usable system that covers health, safety and social needs of end-users taking into account their preferences in the design of the system behaviour and architecture. Questionnaires and focus groups were run during the product design early stages to guarantee this. After completing the first year prototype, controlled sessions using the SAAPHO platform were performed with older people to study its usability. This article presents the general results of older people's participation in the design of SAAPHO system after completing the first year prototype.

Keywords: Active Ageing, Older people, Health, Participation, Security, Technologies, Usability, User-centered design.

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Introduction

Challenges to improve quality of life for older people involve the maintenance of their autonomy and independence. According to the recommendations made by World Health Organization (WHO) in the Active Ageing policy framework, this term entails the optimization process in health, participation and security opportunities in order to improve people's quality of life as they get older, including disabled, fragile people who need attendance (Organization & others, 2002).

On the other hand, the demand to introduce technology to improve the quality of life of older people (dementia included) is progressively increasing (Daniel, Cason, & Ferrell, 2009; Cook & Schmitter-Edgecombe, 2009). However, older people face some difficulties when adopting new technologies. Technological receptivity is directly influenced by pre-dispositional, necessity and social support factors, as well as by one's level of concern for problems that could be alleviated through the adoption of technology (Barroso Osuna, Cabero Almenara, & Romero Tena, 2002; Zimmer & Chappell, 1999). Therefore, usability and accessibility are major issues to be seriously taken into account.

Involving older people through participatory research (Ehn, 1990), enhances product´s usability and accessibility (Norman & Draper, 1986; Davies & Nolan, 2003; Mayhew, 1998). Participants were asked about their experiences, requests and preferences while interacting with ICT (interface features included) and their preferences in using health, participation and security technologies. Requirements were extracted from the field studies, specifically and especially from the questionnaire and focus groups results at the early stages of the project, and from the usability testing of the first year prototype of the SAAPHO project (Secure Active Aging: Participation and Health for the Old). Usability testing included think aloud techniques and user satisfaction questionnaires (Sharp, Rogers, & Preece, 2002). Usability parameters were used to assess user experience aspects (Ross et al., 2005; Walker, 2007).

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The structure of the paper is as follows: 1) The SAAPHO project, in which details are presented about the goal and scope of the application; 2) Technology tools, treating the ICT tools used in SAAPHO project; 3) Methodology used during end-users' involvement; 4) General results from end-users' participation in the design of SAAPHO system after finishing the first year prototype. This section will be followed by 5) Conclusions and further work.

The SAAPHO Project

The SAAPHO Project aims to enhance the independence and dignity of older people thought novel frameworks that promote Active Ageing involving four countries (Spain, Slovenia, Germany and Sweden). Thus, according to the three main axes of Active Ageing, the services provided will focus on offering intelligent, intuitive and user-friendly tools using a fixed tactile screen and mobile devices:

- Healthcare services: medication management and promotion of healthy habits and practises.
- Participation services: customised access to communication tools to talk, share pictures and play with their relatives, friends, caregivers, etc.
- Security services: monitoring of user's home elements (gas, fire, CO, temperature, presence, etc.) and safety.

The design process of different services to be provided by SAAPHO is supported by user-centered design to guarantee the accomplishment of a usable system. It implies direct participation of target users in the design process from the beginning of the project.

Technology tools

With the objective of providing the services previous presented, different types of ICT tools are included in the SAAPHO architecture. This is done in a

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transparent way, so the user can avoid a tedious learning process that could make the older person feel uncomfortable and not wish to use SAAPHO. A middleware with different web services based on a Service Oriented Architecture (SOA) is used to make easy the incorporation of more services and the independence of each service. The connection between each service is done with the use of an Orchestrator to avoid the connection between each two services, and the communication protocol is SOAP. The user interacts with an interface connected to the middleware and it is in charge of the access to all SAAPHO services. This interface was designed following the requirements specified by the end users in various meetings and the standards related to user interfaces for older people (see Appendix 1). Also an iterative process was followed, so each generated mock-up was tested by experts in user interfaces for older people, and the changes proposed by them were considered to generate a new one, until a final version was obtained.

The tools employed to give health, social and safety services, are the following:

- Healthcare services: some sensors to take measurements of glucose, blood pressure, pulse, and activity, and to monitor the medication are used to control the health information of the user. These sensors are connected to the middleware with an intelligent backend that decides if an alert or notification has to be sent to the user and his/her caregivers and medical services if there is an abnormal measurement.

- Participation services: to provide the user with access to communication tools, SAAPHO is going to use Facebook (to share pictures and establish friendships), Skype (to allow textual and video communication), and Gmail (as service to send emails). Nevertheless, the type of social tool used in each case is totally transparent to the user. They are integrated to look like the other information in the project, maintaining a coherence of the global interface making its use easier. In this case there is also an intelligent backend to send

new mails notifications, etc. and to carry out social mining to detect user patterns, frequent contacts, etc.

- Security services: sensors take measurements of smoke, CO, gas and temperature, they also monitor falls and motion in the indoor environment, and location and falls in any outdoor environment. The backend through which the measurement is sent to the user is also intelligent, and decides whether sending an alert or notification to the user and to the caregivers or emergency service if necessary.

In all cases the information will be presented to the user taking into account the user profile using a web service called User Interface Recommender. This service has an Ontology that contains the user profile and all aspects influencing the way in which to present the information. A motor interference tool is used to generate adaptations (increasing font size if the user has visual problems, change the interface contrast, etc.). Another kind of information stored in the Ontology is the information obtained from the social mining. These user interface adaptations are important when an application is oriented to older persons, because they have to handle the application without any knowledge of what is under the interface (Wojciechowski & Xiong, 2008).

The union of Ontology, Web Service and SOAP have been used in SAAPHO because it is presented as one of the most suitable combinations to satisfy the requirements of the context-aware systems domain in general, and particularly useful in the AAL domain (Baldauf, Dustdar, & Rosenberg, 2007).

Finally, SAAPHO gives the user the option to access more specific information incorporating another web service: a services broker. It is a service in charge of providing the URL of a specific web page. It will consider the user preferences to deliver one URL or another. This information will be provided with all available adaptations but maintain its format and the name of the provider.

In the case of ICT tools employed in the first year prototype, they were limited to be simple (development in the first prototype was centered in the

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communication between web services) and to focus users attention in the interface's usability and accessibility. Health and safety services were simulated using a web page in which measurements and alerts were generated by an expert, and social services were limited to sending and receiving mails.

Methodology

SAAPHO applies a user-centered design methodology using a participatory design. Questionnaires and focus groups in relation to general requirements of SAAPHO, health, participation and security technologies were run during the product design early stages in Spain and Slovenia.

Regarding the questionnaire, participants were asked about general requirements from SAAPHO system (preferences in relation to ICT and user interface adaptations). For example: 'Do you think a touch screen would be easy to use?'; They indicated their needs and preferences in monitoring their health (medication, activity and location monitoring). For example: 'How would you like to monitor your medication compliance – e.g. buzzer light…-'?; They indicated their preferences in participation using technologies (devices and programs used to keep in touch with friends and relatives and use of the Web to find information of interest). For example: 'Which devices (computer, Smartphone, tablet PC) and which programs (Skype, Twitter, Facebook…) do you use to keep in touch with friends and relatives?; Participants indicated also their preferences in security using technologies. For example: 'What would you like to have at home to feel more secure - video cameras detecting intruders, sensors identifying gas escapes…-'?). Issues such as privacy were also addressed.

201 older adults (Spain, n=101; Slovenia, n=100) completed the questionnaire. Participants were recruited from older people's associations. Participants had an ID number to ensure the anonymization. Participants received an information sheet explaining the aim of the questionnaire and signed an informed consent.

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Based on the questionnaire results, 1 focus group in Spain and 1 focus group in Slovenia were run with 8-12 older people to deepen the knowledge about their needs. The same participants met four times in two hours sessions to discuss aspects related to the different technical issues and to assure consistent results. The main objective was to extract information from older people related to the interaction modes and also about devices' preferences in relation to the general requirements of the system and health, participation and security technologies. A moderator carried out the sessions and an observer took field notes. Moderators followed the same script in both countries. Some images of devices (tablet PC…), programs (Picasa…) and sensors (physical activity, presence and proximity sensors, temperature alarms…) were presented as support. Participants had no previous experience in ICT projects and were familiar with the project since they had previously participated in the questionnaire. The sessions were audio recorded for post analysis. Participants completed demographics and general questions at the beginning of the focus groups and received an information sheet explaining the aim of the focus groups.

After finishing the first year project's prototype, ten participants were invited to perform a 'controlled' session of the SAAPHO platform in Spain (n=5) and Slovenia (n=5). We used a convenient sample of subjects, who already knew the project since they had participated on the questionnaire and focus groups. Having experience using computer was an inclusion criterion for the test. As they had experience using computer, participants did not represent the population of older people without experience.

During the testing sessions, participants had to conduct four tasks studying usability, defined from an end-user perspective and guided by a professional: 1) Writing a message using the touch screen-keyboard of the slate device and sending it; 2) Receiving a notification of fire at home; 3) Checking a health alert; 4) Checking the message when a notification of a new message is received. Participants had to enter into the different pages via icons (health, participation and security) to perform the tasks. Participants were not instructed on how to use the SAAPHO platform.

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Sessions lasted 1 hour. Each centre was equipped with a tablet personal computer device. Professionals checked whether the participant was able to use the platform from the usability test parameters: effectiveness, efficiency and satisfaction (Hornbæk, 2006). Effectiveness parameters of the participant usability test were the following: task complexion (accomplished of task yes/no), accuracy (number of mistakes), completeness (% subtasks completed) and grading of perceived quality of product. Efficiency parameters were as follows: time (total time per task), mental effort (perceived ease of use) and usage patterns (number of unnecessary steps taken). Results were obtained by questionnaires after finishing tasks and examiner's observation. A video camera recorded the interactions for posterior analysis. Satisfaction with the system (content, navigation, text size, colours, lay-out and icons) was acquired by a participant questionnaire at the end of the session.

Firstly, participants performed the tasks using the standard adaptation of the SAAPHO platform: bigger size, louder sound and normal colours. During the sessions, participants performed the tasks using aloud techniques (users were asked to articulate all the steps of their actions) and professionals noted their observations while participants performed the tasks. After finishing each task, user satisfaction questionnaires were filled in by participants. Secondly, participants were asked about the ease of use of the other two specific adaptations: size and colour. Size adaptation consisted on decreasing size. Participants entered into the different icons (communication, security and health) using the smaller size. Colour adaptation consisted on the white contrast and the black contrast. Participants entered into the different icons using a white and a black contrast. All participants were informed about the usability testing and signed the informed consent.

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Results

Characteristics of the involved subjects are shown in table 1.

Table 1. Characteristics of the involved participants

	Questionnaires		Focus Groups		Testing sessions	
	Spain N=101	Slovenia N=100	Spain N=10	Slovenia N=8	Spain N=5	Slovenia N=5
Gender						
Male	26%	36%	30%	45%	40%	40%
Female	74%	64%	70%	55%	60%	60%
Age*	68 (61-87)	67 (51-82)	68 (63-75)	68 (58-73)	69 (64-85)	63 (58-75)
Previous use of ICT devices						
None	40%	30%	0%	8%	0%	0%
Computer	58%	70%	100%	92%	100%	100%
Smartphone	2%	0%	0%	0%	0%	0%
Tablet PC	0%	0%	10%	0%	0%	0%

*Median (range)

Questionnaire

General results from the questionnaire showed that older people considered ICT as an opportunity to facilitate their daily life, they felt quite confident with the use of ICT and they preferred easy to use devices and adapted interfaces. Participants reported that data collected by the ICT system should be provided in a secure and simple way, being worried about their privacy and the use of their personal information.

In relation to health services, users believed that an ICT system would be useful for dealing with health issues and they liked to involve health care professionals when taking decisions regarding the use of ICT applied to health. Participants would like to monitor some aspects related to health such as medication compliance or physical activity. Participants also liked the idea of promoting healthy habits through ICT.

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Regarding participation services, older people considered that using communication tools would facilitate their contact with relatives and friends. Mobile phones were commonly used. Most of them used the computer to keep in touch with friends and relatives and to find information about topics of interest.

On the subject of security services, participants would use sensors identifying gas leaks at home or registering their location, especially in case of outdoor falls. Participants would like to be warned in a multimodal way (noise, vibration, light or text), adapted to their needs and preferences to alert indoor and outdoor emergency situations.

Focus Groups

General results of the focus groups showed that the SAAPHO system seemed very interesting and it could be very helpful for older people, especially those living alone. Concerns arose about its price and privacy.

In relation to Health Technologies, participants liked the idea of promoting healthy habits through ICT and monitoring their health (medication compliance, physical activity, blood pressure). Medication bottle alarm though light and sound and step counter were highly appreciated. Participants were interested in blood sugar sensors, but only for diabetics.

Regarding Participation Technologies, participants preferred to use the Computer and E-mail; Facebook, Messenger and Skype. They preferred the Picasa program to share pictures with intended target (friends or relatives). Participants were also interested in using a unique password for all communication tools.

Concerning Security Technologies, participants preferred to use as less devices as possible to alert emergency situations indoor and outdoor. They would be warned in a multimodal way (sound, vibration, light, text) adapted to their needs and preferences. Gas escapes sensors and smoke sensors had a very good acceptance. Security cameras at home were not well accepted due to invading personal privacy. Participants were concerned about the economic cost of the sensors and the services.

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First year prototype of the SAAPHO platform

Regarding effectiveness, results showed that all subjects in both countries accomplished all the tasks and performed all the subtasks. Only one participant in Slovenia found difficulties during the process of completing the task 3 ('Checking a health alert'), entering to wrong icons as 'Communication' or 'Security' instead of 'Health'. Most participants perceived that the tasks were successfully achieved.

Regarding efficiency, the duration to perform the tasks was perceived as adequate by participants in both countries. The interface used was efficient since participants did not make unnecessary steps performing the tasks and they found it easy to perform them.

Table 2 shows the usability parameter satisfaction in both countries. Most of the participants reported that content and design were good and navigation was easy. Icons (Health, Participation and Security) were very high scored by all participants. All participants would recommend the SAAPHO system to another person, since they considered it was easy, useful and friendly for older people familiar with technology or interested in using it.

Table 2. Usability test parameters in both countries: satisfaction

Satisfaction	Spain (Mean, range)	Slovenia (Mean, range)
Content (1=Very inadequate; 5=Excellent)		
Text length	4.2 (3-4)	3.1 (3-5)
Understandability	4.6 (4-5)	3.9 (3-5)
Quality of image	4.8 (4-5)	4.8 (4-5)
Navigation (1=Very inadequate; 5=Excellent)		
Quality of navigation	4.6 (4-5)	4.1 (4-5)
Design (1=Very inadequate; 5=Excellent)		
Text size	4.2 (2-5)	3.8 (3-5)
Colours	4.8 (4-5)	4.2 (3-5)
Sound of alarms and notifications	4.4 (4-5)	3.5 (3-4)

Satisfaction	Spain (Mean, range)	Slovenia (Mean, range)
Layout	4.2 (3-5)	4 (3-5)
Icons	5 (5)	5 (5)
Ease of use (1=Strongly disagree; 5= Strongly agree)		
Ease of use	4.5 (4-5)	4 (3-5)
Engagement (1=Very stressed; 5= Very comfortable)		
Comfortability to use	4.2 (4-5)	4 (3-5)
Enjoyment	4.6 (3-5)	4.8 (4-5)
Grade of the quality of the SAAPHO system reported by participants (1= low quality; 10= excellent quality)	9.4 (9-10)	7.8 (5-10)

Conclusions and further work

During evaluation performed on the SAAPHO platform, it was perceived as an interesting and useful opportunity for participation by older people. It was easy to use according to usability test parameters of effectiveness, efficiency and satisfaction.

Older people involvement at the beginning of the project and during the first year was very helpful for the involved technologists to make decisions about the SAAPHO design in order to meet real needs and preferences. These decisions had a direct impact on the design of the User Interface Recommender Web Service, because the adaptations of the user interface provided by it have to be appropriate for older persons, and not for any type of user. Feedback provided by users was essential to ensure user satisfaction. For example, change in text size is crucial for older people as well as horizontal scrolling avoidance, or reduction in the number of steps per task.

Decisions about services used in relation to health (sensors to control medication compliance and physical activity), participation (social networks

and tools -Facebook, Skype, Gmail and Picasa-), and security (gas escapes sensors and smoke sensors) were confirmed after consultation with prospective users.

Older people involvement at the beginning of the project is not enough. It is necessary that older people participate in the project at the end of every iteration in order to detect errors, and to introduce new requirements to be considered in the next prototype. Thus, testing sessions of the SAAPHO system will be conducted to continue creating a usable system that covers the health, safety and social needs of the older people in the next two years of the project.

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Appendix 1. ISO norms applied

ISO 9241-303: 2011. Ergonomics of human-system interaction – Part 303: Requirements for electronic visual displays. International Organization for Standardization (ISO).

ISO/IEC TR 29138-1:2009. Information technology – Accessibility considerations for people with disabilities – Part 1: User needs summary. International Organization for Standardization (ISO).

ISO/IEC TR 29138-2:2009. Information technology – Accessibility considerations for people with disabilities – Part 2: Standards inventory. International Organization for Standardization (ISO).

ISO 9241-303:2008. Ergonomics of human-system interaction - Part 303: Requirements for electronic visual displays. International Organization for Standardization (ISO).

ISO/TR 22411:2008. Ergonomics data and guidelines for the application of ISO/IEC Guide 71 to products and services to address the needs of older persons and persons with disabilities. International Organization for Standardization (ISO).

ISO/IEC 24755:2007. Information technology — Screen icons and symbols for personal mobile communication devices. International Organization for Standardization (ISO).

ISO/IEC TR 19766:2007. Information technology — Guidelines for the design of icons and symbols accessible to all users, including the elderly and persons with disabilities. International Organization for Standardization (ISO).